Building on the Symptom Network: An Examination of Symptom Networks, Expanded Networks, and Racial Network Comparisons to Understand the Relationship between COVID-19-Related Stressors and Postpartum Psychopathology

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Submitted in partial fulfillment
of the requirement
for the degree of Doctor of Philosophy
under the Executive Committee
of the Graduate School of Arts and Science

COLUMBIA UNIVERSITY

2023

Abstract

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Background: Throughout the COVID-19 pandemic, women carried, birthed, and cared for infants in a drastically changed world. For perinatal women, the sudden increase in stressors compounded an already vulnerable time where they are at an elevated risk of developing symptoms of psychopathology. Moreover, the pandemic exacerbated pre-existing racial health disparities and disproportionately impacted Black, Indigenous, and People of Color (BIPOC)—particularly perinatal BIPOC women, due to the intersection of their race and perinatal status. This study investigated the relationships between COVID-19-related stressors and postpartum psychopathology using network analysis. Network analysis is used as an alternative technique for investigating the activation and maintenance of psychopathology and is increasingly used to examine the influence of external variables (e.g., stressors) on network dynamics. The relationship between psychological symptoms and stressors is typically examined in a unilinear manner—that is, stress causes psychopathology or vice versa. By using network analysis, we were able to investigate the bidirectional relationship between COVID-19-related stressors and postpartum psychopathology to reveal new insights into the individual stressor-symptom interactions that may underlie the emergence of psychological disorders for the perinatal population during the pandemic.

Methods: Participants (N=630) were recruited via social media and listservs and completed an online Qualtrics survey. Data quality measures were used to identify repeated, incomplete, and potentially fraudulent responses, which were removed prior to data analysis. Goldbricker, inter-item correlations, and variance inflation factor analyses were used to address topological overlap and identify statistically unique items to be included in the networks. A comorbidity symptom network was estimated to investigate the relationship between postpartum depression and anxiety symptoms in all participants. Bridge symptoms between the two conditions were identified using bridge analysis and clique percolation analysis. Next, an expanded model was estimated to investigate the relationship between postpartum symptoms and COVID-19-related stressors. Node-wise predictability and moderation analyses were used to investigate the effects of adding external variables (i.e., positive experiences, maternal functioning domains, and predictors of psychopathology) to the expanded model. Finally, moderated networks were estimated to investigate differences in the structure of the comorbidity network and the expanded network for mothers from different racial and ethnic groups.

Results: Fear-based symptoms were central in both the comorbidity and expanded networks and bridged postpartum anxiety and depression symptoms in the comorbidity network. The Depressed Mood and two Home Stress domains were central in the expanded network. Additional bridge symptoms in the comorbidity network included feeling overwhelmed, concentration difficulties, and feeling disliked by others and in the expanded network included the Postpartum Stress, Emotional Stress, and Difficulty Adjusting domains. Moderation analyses revealed that the more mothers felt competent and the less challenging they perceived their infant's temperament, the weaker the node connections were in their expanded networks. Furthermore, mothers with a history of prenatal depression, prenatal anxiety, or baby blues had denser expanded networks (i.e., stronger and more unique edges) compared to mothers with no history of these conditions. Contrary to expectations, moderation analyses revealed that: 1) social support and engaging in positive experiences during the pandemic strengthened connections between stressors and symptoms; 2) middle-income mothers had denser networks compared to low- and high-income mothers. Finally, racial network comparisons revealed that Black mothers' comorbidity and expanded networks were denser compared to all other racial groups.

Conclusions: Our findings highlight the influence of major contextual changes, such as the COVID-19 pandemic, on network dynamics—that is, previously established peripheral network nodes (e.g., fear) may shift to the center during large-scale events. Therefore, researchers cannot assume that previously identified central nodes will remain as the main drivers of psychopathology irrespective of changes in context, as this may lead to a misdirection of prevention and intervention efforts. Further, our findings underscore that people with multiple intersecting vulnerabilities may be disproportionately impacted by these major events.

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Acknowledgments

Bismillah. In the name of Allah, the most gracious, the most merciful. I must begin by thanking God for His countless blessings in my personal and professional life. All my achievements and accolades would not be possible without His blessings, guidance, and protection, and this dissertation is no exception.

To my advisor, Dr. Helen Verdeli, there is no advisor as fiercely dedicated to her students as you. You push us to grow as researchers, clinicians, and, above all, humans. From day one, you have been committed to helping me prepare for a career in academia by shaping and pruning my ideas into viable research investigations. It has been a true privilege witnessing your creative genius firsthand, and I hope that in the ten years that I have known you, some of that genius has rubbed off on me. Dr. Verdeli, to me, you are not only an academic advisor, but also a lifelong mentor, collaborator, and friend. I am blessed to have found an advisor I can wholeheartedly entrust with my personal and professional struggles. Throughout this doctoral degree, whenever the light at the end of the tunnel dimmed, you reignited it. Thank you so much.

My deepest gratitude to my knowledgeable and supportive committee. Dr. Prerna Arora and Dr. Bryan Keller, thank you for your guidance throughout all stages of my dissertation project; you helped me refine it, strengthen it, and elevate it to the level it is today. Dr. Bryan Cheng, you have been a critical mentor throughout my academic career, especially in building my statistical acumen. Thank you for your insightful and pragmatic guidance on this project and beyond. Dr. Claire Greene, thank you for your enthusiasm, support, and contribution to this project.

To the GMH-lab members, working alongside you has been an honor. To my past cohort and lab mate, and current collaborator, Dr. Ceren Sonmez. I lucked out to be paired with such a curious, driven, and innovative person like you all those years ago. Likewise, I was equally lucky to be part of a dynamic, inspiring, and deeply human doctoral cohort. Shoutout to Dr. Devlin Jackson and Dr. Micheline Anderson for commiserating with me on our academic and maternal struggles.

To the hardworking P-4 research team, Caroline Lovett, Inna Goncearenco, Emily Dunkel, and Isabella Cuellar, spearheaded by Rachel Zhu and Sharon Ettinger, thank you for your passionate dedication to this project. Rachel and Sharon, you were there when this project was just an idea in my head; thank you for helping me bring it to life. Caroline, your commitment to seeing this project through to the finish line helped me cross it; and for that, I am so grateful.

A special thanks to the team leading the Psychological Networks Amsterdam Summer School 2020 (PNASS 2020), who made the training happen during a pandemic. Your dedication to sharing your knowledge and expertise with your peers across the globe is inspirational. Moreover, this project's statistical rigor would not be possible without the consultation and guidance of Dr. Irina Vanzhulla. Dr. Vanzhulla, thank you for refining and enhancing my data analysis approach, suggesting cutting-edge techniques to tackle my research inquiries, and answering all of my questions, big and small.

It would be remiss of me not to mention my mentors at Massachusetts General Hospital (MGH), Dr. Christina Borba, Dr. David Henderson, and Dr. John Herman, who saw my and my twin sister’s potential and fostered it. The Department of Global Psychiatry at MGH ignited my passion for Global Mental Health and set me on this career trajectory. I would not be where I am today without their unwavering belief in me and steadfast support. Dr. Borba, you gave credence to and nurtured my undergraduate curiosities, transforming them into research directions that

became the building blocks of my academic career. Thank you for dedicating so much of your time to advising on my professional and personal endeavors over the past 12 years.

To my twin sister, best friend, and life-long collaborator, Alaa Alhomaizi, thank you for never failing to show up for me personally and professionally. You have been my partner from the beginning. Since elementary school, we would catch each other up on what we learned that day in our respective classes, and whenever I discussed a topic with you, I gained deeper insights into the subject. This is true to this day. You are the first person I want to discuss my ideas with and the most person whose opinion I value. There is no other person whose skills complement and complete mine as well as you. I look forward to our future collaborations, where we can continue to bring our ideas to life, feed our curiosities, and work on what moves our hearts and stimulates our minds.

To my wonderful and supportive husband, Dr. Abdullah Alateeqi, thank you for standing beside me on this arduous journey, supporting me to follow my dreams, and being open to joining me wherever my dreams took me. You have been my number-one supporter from day one. Pursuing two concurrent PhDs while growing our family proved to be an incredibly challenging and rewarding journey, and I could not have picked a better partner to be by my side. Thank you for your commitment to our family, partnership, and future.

To my first-born son, Ibrahim, it is because of the incredible, challenging, and life-altering experience that I had when I first became your mother that I decided to pivot into perinatal and maternal research. Becoming your mother opened my eyes to the joys of motherhood as well as its inherent trials and helped me gain immense respect and appreciation for all mothers. And so, to honor them, I want to elevate their voices and unique experiences through my work. To my second-born son, Yaqoub, thank you for waiting to join us Earthside

after I defended my dissertation. Being pregnant with you while writing this dissertation made this experience so much more personal and special. To my children, of all the titles I have held in the past and will hold in the future, *Mama* will forever be the one I'm most proud of.

To my father and mother, Mohammed and Adeel, thank you for never wavering in your support and dedication to my reaching the heights of my potential. Dad, you supported my sister and I despite multiple naysayers around you. Instead of capping our ambitions, you cultivated them and helped them grow. Mom, I felt your prayers protecting me and easing every challenge I encountered throughout my academic journey. To my family and friends in Kuwait, thank you for supporting me from afar and making me feel like I never left home.

To my country, Kuwait, and its educational institutions, thank you for investing in building our country's academic and clinical capacity. My deepest gratitude to Kuwait University for funding and supporting my doctoral degree and to the Kuwait Foundation for the Advancement of Sciences (KFAS) for funding this dissertation project.

As I neared the end of this dissertation, I craved the community I once had and found it in The Academic Writers Space (TAWS). Thank you to Dr. Alison Miller and her team for connecting a community of driven students across the globe and inspiring them to push through the challenges of completing an academic degree. A special thank you to Dr. Melissa Schwartz for her guidance, wisdom, and gentle firmness—which were exactly what I needed during the final leg of my dissertation.

Finally, my sincere gratitude to all the P-4 participants who took the time to share their experiences with us through this project.

Dedication

This dissertation and, truthfully, all of my career milestones are, first and foremost, dedicated to my twin sister, Alaa Alhomaizi, without whom I would not be where I am today. Alaa, you were brave enough to push us to take the first step toward our destiny. And although I joke that you did this to get out of a statistics quiz, I know that you did it because you saw our potential before anyone else did, and you knew it was time to finally take the leap of faith…

Chapter 1: Background

The COVID-19 Pandemic

In December 2019, the Chinese government informed the World Health Organization (WHO) that an increasing number of people were presenting with pneumonia of an unknown cause in Wuhan, in Hubei Province, China. Shortly after the new year, countries worldwide began hearing reports of this novel disease. More information emerged in January 2020, including that this pathogen was a *coronavirus* and that human-to-human transmission was possible. By January 23rd, 2020, in a move unprecedented at that time, the Chinese government placed the entire city of Wuhan, with a population of 57 million, under a strict lockdown in an attempt to contain the novel virus. Shortly after, on January 30th, 2020, with 7,834 cases confirmed in 99 countries and 170 people dead, the WHO declared the disease, now dubbed "Coronavirus Disease-2019," or "COVID-19," a Public Health Emergency of International Concern (PHEIC). Less than two months later, on March 11, 2020, the number of people infected with COVID-19 had risen steeply to 118,000 in 114 countries, with 4,291 dead, prompting the WHO to declare COVID-19 a global pandemic (WHO, 2020)

Governments and organizations, such as the WHO, were unprepared for the COVID-19 virus. COVID-19 was significantly more transmissible than SARS and, within two months of its inception, had infected one million people around the world. Furthermore, beyond its transmissibility and unprecedented global reach, the world faced significant challenges in effectively addressing the evolving strains of COVID-19, which resulted in multiple "waves" of the pandemic defined by a spike in infection rates. Over the course of three years, the COVID-19 pandemic continued to impact people's personal and professional lives, to varying degrees.

The Five Waves of COVID-19 in the United States

The First Three Waves: Alpha, Beta, and Gamma. Throughout the COVID-19 pandemic, the United States experienced five waves: Alpha (January 2020), Beta (May 2020), Gamma (November 2020), Delta (Summer 2021), and Omicron (November 2021). Unique levels of transmissibility and lethality characterized each of the five waves. While the Alpha wave was a highly transmissible variant of the COVID-19 virus, the Beta variant was less transmissible but more lethal. Akin to the Beta variant, the Gamma variant was slightly less transmissible than the Alpha variant. However, the Gamma variant was not as lethal as the Beta variant.

Vaccination Development and Release. In December 2020, the first COVID-19 vaccine became available in the United States. The Centers for Disease Control and Prevention (CDC) created a vaccination distribution priority schedule, initially giving essential healthcare workers greater vaccine access to ensure their safety due to their limited ability to socially distance themselves from others (CDC, 2023a). Following essential healthcare workers came essential non-healthcare workers (e.g., sanitation), employees in critical industries (e.g., transportation and energy production), high-risk populations (e.g., those over 65 and those with chronic respiratory or immune system problems), and lastly, the general public. The COVID-19 mRNA vaccines were effective and safe. CDC data (2023a) showed that mRNA vaccines reduced the risk of infection by approximately 94%. Additionally, while breakthrough infections for vaccinated individuals could still occur, they were less likely to result in severe illness or hospitalization. Nonetheless, many people remained apprehensive about the new mRNA vaccines, particularly pregnant and breastfeeding women, who feared the potential side effects of the vaccines on their fetuses and infants (Bianchi et al., 2022; Galanis et al., 2022).

Delta Variant. The Delta variant of COVID-19 had fewer cases than the Gamma variant but was more lethal (Rashedi et al., 2022). The higher viral loads in those infected with the Delta variant led to more severe infections and an increase in hospitalizations. Further, there were increased fears of reduced vaccine efficacy (i.e., fear that vaccinated individuals were still capable of spreading the virus). Nonetheless, the CDC still recommended people receive the vaccine. With newly approved vaccines (i.e., Moderna, Johnson and Johnson) and the passage of time, the vaccine was more readily available and approximately 50% of general Americans had received their first vaccine by July 2021. Regarding the perinatal population, the U.S. Food and Drug Administration (FDA) approved vaccination use in pregnant and breastfeeding people around this time (CDC, 2023a). Moreover, no fertility issues were found in men or women as a result of receiving the vaccine. During the Delta wave, booster shots were also introduced and recommended for people of all ages.

Omicron Variant. The Omicron variant of COVID-19 was first identified in South Africa and was deemed a "variant of concern" by the WHO (CDC, n.d.-a) in late November of 2021. The Omicron variant was characterized by a significant increase in transmissibility (1.6 times more transmissible than the Delta variant), and many people feared that this mutation's higher transmissibility would also mean higher lethality (i.e., cause more severe cases) as well as potential vaccine ineffectiveness (CDC, n.d.-a). Therefore, Omicron's exceptionally high transmission rate, giving rise to unprecedented infection rates, along with its tendency to cause a milder form of COVID-19, resulting in a substantial number of individuals recovering, prompted scientists to posit that the pandemic had entered its "endemic" stage (Powell, 2022). Eventually, the Omicron variant surpassed all previous surges in terms of the number of cases in the U.S. (Astor et al., 2022; Leatherby et al., 2021).

Containment Measures

The shifting containment measures enforced during the COVID-19 pandemic significantly impacted people's daily lives and created new stressors. Recent epidemics (e.g., Severe Acute Respiratory Syndrome, Middle Eastern Respiratory Syndrome, Ebola), including those that were declared PHIECs, were either contained within a limited number of countries or, in the case of the 2009 H1N1 Pandemic, were not disruptive to the scale of the COVID-19 pandemic. COVID-19 was both a fast-spreading and serious disease. Initially, the world took an elimination approach, trying to confine the spread of the disease to certain countries or regions. However, the swift and extensive spread of COVID-19 in the first few months of 2020 forced the world to shift gears and focus on taking measures to contain and slow the disease's spread.

Beginning as early as March 2020 in the United States, strategies to control the spread of COVID-19 were implemented at either the individual or the community/institutional level and continuously evolved. Prevention strategies at the individual level included face coverings, frequent and thorough hand washing, and, beginning in December of 2020, vaccination (e.g., Pfizer/BioNTech vaccine). Community and institutional-level prevention strategies included testing, contact tracing, temperature checking before entering an enclosed space, consistent disinfecting and ventilation of communal areas, lockdowns, and social distancing practices. Social distancing broadly refers to a diverse set of strategies that are implemented to reduce contact between people to contain the spread of disease, and include isolation of infected individuals, quarantine of non-infected ones, closures of schools and non-essential businesses, cancelation of public events and mass gatherings, working from home, citywide lockdowns, travel restrictions, and instructions to maintain a safe physical distance from others in public (Taylor, 2019). Lockdowns are a type of social distancing and by April 2020, just three months after the pandemic began, more than half of the world's population, or 3.9 billion people, were under some form of forced or recommended lockdown (i.e., home confinement; Sandford, 2020).

Regulatory policies for each of these measures, particularly mask-wearing, continuously changed throughout the pandemic as vaccines became more readily available and as variants of the disease emerged. During the Delta wave of COVID-19, the CDC recommended that everyone in areas with substantial or high transmission wear a mask indoors due to the variant's surge in transmissibility (CDC, n.d.-a). The Delta wave was marked by a general lack of unification in regulatory measures for school and business closures, social distancing and mask-wearing rules, and other containment measures. Containment measures during the Omicron variant were also mixed across state and international borders. Research studies from prior epidemics have shown the adverse mental health effects of infection control measures (Bai et al., 2004; Hawryluck et al., 2004; Liu et al., 2012; Lu et al., 2009; Mak et al., 2009; Reynolds et al., 2008; Shultz et al., 2015). Regarding containment measures, the coronavirus pandemic surpasses every other epidemic since the 1918 Flu Pandemic in its scale, and as such, the mental health effects were devastating. To date, several studies from various countries have shown that the pandemic was associated with increases in stress, anxiety, depression, post-traumatic stress disorder (PTSD), sleep disturbance, and suicidal behavior (Kennedy et al., 2022; Reinke et al., 2023; Yunitri et al., 2022).

COVID-19's Impact on Specific Populations

The impact of the COVID-19 pandemic was not uniformly felt by all people. Specific populations who interacted with healthcare more (e.g., perinatal, geriatric, and immuno-compromised individuals) were more likely to be affected by the increased infection risk, ever-changing healthcare guidelines, and containment measures. Furthermore, existing inequalities (e.g., gender, racial, socioeconomic, etc.) were exacerbated during the pandemic. In this section, and in this study, we will be focusing on two populations: the perinatal population in general and the Black, Indigenous, and People of Color (BIPOC) maternal population in particular.

The Perinatal Population: Navigating a Challenging Transition Amidst a Global Pandemic

Transitioning to motherhood is often viewed as a joyous journey filled with happy and meaningful experiences. However, this transition can be an extremely emotional experience accompanied by major life adjustments and abrupt physical and emotional changes, which can cause significant distress (Furtado et al., 2018; Yim et al., 2015). These adjustments increase vulnerability to experiencing psychological symptoms, such as depression and anxiety symptoms, during any trimester of gestation as well as the postpartum period (i.e., up to one year post birth). Experiencing mental disorders during the perinatal period can lead to increased maternal morbidity and mortality, including suicide (Cantwell et al., 2011; Fuhr et al., 2014).

COVID-19's Impact on Perinatal Mental Health. The perinatal population's emotional health and well-being were severely impacted by the COVID-19 pandemic. Mothers experienced additional stress in almost all aspects of their lives, including childcare, work, economic, health, and social. COVID-19 also caused heightened feelings of fear and panic; mothers were particularly fearful for their health and the safety of their families (Hoffart et al., 2021; Taylor et al., 2021; Zhang et al., 2021). Further, the lack of clear and accurate information related to COVID-19 generally, and related to pregnant and postpartum individuals specifically, exacerbated perinatal women's distress. Guidelines and knowledge about the virus were constantly evolving with new information on how pregnant women and their developing fetuses were threatened by the virus (Kotlar et al., 2021; Preis et al., 2020a; Wang et al., 2020; Zhang et al., 2020).

Before the pandemic, postpartum anxiety and depression rates were 15% and 17%, respectively (Dennis, 2004; McCue Horwitz et al., 2007; Shorey et al., 2018). During the COVID-19 pandemic, postpartum anxiety and depression rates sharply increased to 41.9-55% and 26%, respectively (Furtado et al., 2018). The research on prenatal psychopathology rates before and after the pandemic, however, is not clear. Some meta-analyses found a statistically significant increase in prenatal psychopathology rates during the pandemic (prenatal depression: 25.6%, prenatal anxiety: 30.5%; Tomfohr-Madsen et al., 2021), while others reported that they were not significantly higher than pre-pandemic rates (prenatal depression: 22.6%, prenatal anxiety: 22.3%; Cevik et al., 2022). This study specifically focused on investigating postpartum depression and anxiety during the pandemic.

Predictors of Postpartum Psychopathology. There are certain factors that can increase the likelihood of developing a mental disorder during the postpartum period. Regarding depression, several studies have found that women who experienced antenatal depression, antenatal anxiety, low self-esteem, "baby blues," or who had a prior depressive episode are significantly more likely to develop postpartum depression (PPD; Beck, 2001; Biaggi et al., 2016; Matthey et al., 2003). Additionally, systematic reviews and meta-analyses have consistently found that low social support (e.g., from partner, family, friends), childcare stress (e.g., child's feeding, sleeping, and health), life stressors, poor marital functioning, infant temperament, being unmarried, lower socioeconomic status, and having an unplanned or unwanted pregnancy may also lead to postpartum psychopathology (Beck, 1996, 2001; McGrath et al., 2008; O'hara & Swain, 1996; Robertson et al., 2004). Conversely, research has found that perceived and received social support, especially partner social support, decreases the chance of developing PPD (Yim et al., 2015).

Researchers have also examined predictors of postnatal anxiety. For example, a study by Britton (2011) found that mothers of infants with challenging temperaments were more likely to experience symptoms of postpartum anxiety. On the other hand, more anxious mothers may perceive their children differently, thus reporting higher rates of problems with feeding, sleeping, and poor health (Coplan et al., 2005). Additionally, low social support from friends, families, and partners is associated with postnatal anxiety (Feinberg et al., 2022a). Similarly, not being married or having problems within the marriage have been found to contribute to postpartum anxiety symptoms (Bedaso et al., 2022; Odinka et al., 2018; Roux et al., 2002). Employment and low socioeconomic status, particularly low income, were associated with higher rates of stress and postpartum anxiety (Beck, 2001; Field, 2017; Mollard et al., 2021). Unwanted pregnancies, unplanned pregnancies, and maternity blues were also related to postnatal anxiety (Clout & Brown, 2015; Dennis et al., 2017; Engle et al., 1990; Grant et al., 2008; Radoš et al., 2018; Reck et al., 2009; Roomruangwong et al., 2016). In terms of mental health predictors, research has shown that prenatal depression and anxiety are associated with postpartum anxiety (Britton, 2008; Engle et al., 1990; Grant et al., 2008; Reck et al., 2009).

During a large contextual change or crisis, such as the COVID-19 pandemic, research is required to investigate whether the predictors of perinatal psychopathology indeed remain predictive of perinatal mental health outcomes. Studies found that, during the pandemic, some predictors of perinatal psychopathology continued to provide protection against or increase the risk of psychopathology, while other predictors were found to have no significant association with mental health outcomes (U. Iyengar et al., 2021). For example, prior to the COVID-19 pandemic, primigravida (i.e., being pregnant for the first time) and employment status were not found to be significant predictors of postpartum depression or anxiety (Abiodun, 2006; Agoub et al., 2005; Gao et al., 2022; Nagpal et al., 2008). However, studies that took place after the COVID-19 outbreak found that these two factors were significant predictors of postpartum psychopathology (U. Iyengar et al., 2021; Luscombe, 2020; Wu et al., 2020; Zhang et al., 2020). Additionally, research has found that perinatal women with a history of psychiatric illness, a well-established pre-pandemic risk factor for perinatal psychopathology (Beck, 2001; Field, 2017), experienced elevated symptoms of depression and anxiety during the pandemic (Berthelot et al., 2020; Cameron et al., 2020). Interestingly, research also found that some predictors had an inverse impact on perinatal psychopathology compared to before the pandemic (U. Iyengar, 2021). For example, many pre-pandemic studies found that the fewer years of education that a perinatal woman has, the higher her risk of developing perinatal depression and/or anxiety (Fisher et al., 2012; Kannenberg et al., 2016; Nisar et al., 2020), which is consistent with most COVID-19 studies (Berthelot et al., 2020; Cameron et al., 2020). However, some COVID-19 studies actually found the opposite—with more years of maternal education associated with worse mental health outcomes (Farrell et al., 2020; Mappa et al., 2020).

Stress. A key predictor that may increase perinatal distress and lead to postpartum depression and anxiety is stress. Lazarus and Folkman (1984) defined psychological stress as "a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being" (p. 19). In perinatal research, most studies have investigated stressful life events, which are well-established predictors of postpartum depression and anxiety (Abiodun, 2006). Stressful life events (SLE; e.g., death of a loved one, divorce, major illness, etc.) that occur in the year before childbirth, including during the pregnancy, are significantly associated with anxious and depressive symptoms during the postpartum period (Husain et al., 2011; Ritter et al., 2000; Rubertsson et al., 2005). The COVID-19 pandemic was undoubtedly a stressful life event for many mothers. For pregnant, laboring, and postpartum women, the pandemic-related stressors (reviewed in detail below) compounded the stressors inherent to the perinatal period, resulting in increased vulnerability to psychiatric illness.

The BIPOC Maternal Population: Coping with the Intersection of Multiple Vulnerabilities

Racial Disparities Prior to and During COVID-19. Black, Indigenous, and People of Color (BIPOC) have long faced discriminatory and unequal treatment at the individual and systemic levels that predate the pandemic. This inequitable environment has led to increased disparities in education, employment, and access to healthcare, as well as worsened physical and mental well-being within these communities (Williams et al., 2003). Subsequently, these pre-existing stressors were compounded by the COVID-19 pandemic, as it disproportionately affected BIPOC communities in the U.S. Particularly, Black/African American and Hispanic communities had higher infection and death rates compared to White counterparts (Mackey et al., 2021). In addition, research showed that indigenous communities were more likely to contract COVID-19, leading to increased numbers of hospitalizations, time in an intensive care unit (ICU), intubations, and deaths. Thankfully, due to targeted vaccination campaigns in July of 2021, American Indians and Alaskan Natives attained the highest COVID-19 vaccination rate of any racial or ethnic group in the U.S.

Several reasons may account for the magnified impact of the pandemic on BIPOC communities. For example, individuals in these communities tend to reside in denser and more impoverished neighborhoods, are more likely to be working “essential” and “frontline” jobs, face multiple barriers to accessing quality healthcare (e.g., lack of health insurance, transportation, etc.), and experience implicit bias and systemic racism in the healthcare system (CDC, 2020b;

FitzGerald & Hurst, 2017; The Henry J. Kaiser Family Foundation, 2013). Moreover, BIPOCs were also disproportionately affected by the measures put forth by the government to control the spread of the virus (e.g., social distancing, lockdown) and were more likely to experience unintended adverse consequences of the pandemic, such as job loss, food insecurity, and homelessness (CDC, 2020a).

COVID-19's Impact on BIPOC Mothers' Physical and Mental Health. BIPOC mothers faced the compounded vulnerability that comes with the intersection of their two identities, being mothers and people of color, increasing their risk for worse physical and mental health outcomes. To make matters worse, during the pandemic, longstanding racial disparities in maternal morbidity and mortality became more severe, especially among Black mothers (U.S. Commission on Civil Rights, 2021). For example, the number of Black women in the United States who died during childbirth increased during the first two years of the pandemic, enlarging the gap between Black and White maternal death rates (United States Government Accountability Office, 2022). Global studies have similarly found racial disparities, with one study in Brazil showing that Black mothers were *two times* more likely than White mothers to die from COVID-19 (Santos et al., 2021). In addition to Black mothers, several studies found that Latinx mothers also suffered elevated maternal morbidity and mortality during the pandemic. For instance, a study in Philadelphia found that the percentage of pregnant Black and Latina women exposed to COVID-19 in the summer of 2020 was approximately *five times* higher than pregnant White women (Flannery et al., 2020). Relatedly, Howell and colleagues (2020) found worse health outcomes for Black and Latina mothers within the same hospital, even after controlling for maternal age, obesity, hypertension, diabetes, and insurance type.

Pre-pandemic research suggested that people of color experienced significantly lower rates of common mental disorders (e.g., depression and anxiety), despite being more likely to be diagnosed with serious mental illnesses (e.g., schizophrenia), compared to their White counterparts (Bailey et al., 2019; Schwartz & Blankenship, 2014). Although people of color suffered from a greater burden of disability, as characterized by chronic and severe mental illnesses that affected their day-to-day lives, they were less likely to receive care and more likely to access poor-quality care (Rockville, 1999). Interestingly, this long-standing epidemiological pattern shifted during the pandemic: people of color, including Black, Latinx, and Asian Americans, experienced higher rates of psychopathology than White persons (Thomeer et al., 2023). Nevertheless, White people continued to access mental health treatment at higher rates compared to other racial groups (Thomeer et al., 2023). A similar trend was found in perinatal women, with several studies reporting that mothers of color experienced higher rates of perinatal stress, anxiety, and depression during the pandemic, especially Black and Latinx mothers (Gur et al., 2020; Janevic et al., 2021; Njoroge et al., 2022). These heightened rates may be due to a variety of concerns that were elevated for mothers of color, especially Black mothers, including increased economic burdens, unemployment concerns, fears of dying from COVID-19, discriminatory healthcare, and longstanding systemic racism (Gur et al., 2020; Janevic et al., 2021; Njoroge et al., 2022).

COVID-19-Related Stressors

The COVID-19 pandemic introduced many new stressors to individuals globally, the maternal population generally and the perinatal population specifically. During the pandemic, mothers were negatively impacted throughout every step of their pregnancy and postpartum journey. Pregnant women dealt with fears related to their own health and that of their unborn child, limited access to prenatal care, and uncertainty regarding the impact of COVID-19 on pregnancy outcomes (Kotlar et al., 2021). Laboring women had to manage a strained healthcare system as well as continually changing policies that impacted their physical and mental health during childbirth (Alhomaizi et al., 2021). Postpartum women were managing stress around their newborns contracting COVID-19, potential economic instability, disrupted routines, and social isolation (Kotlar et al., 2021). Moreover, the additional responsibilities that came about during the pandemic (e.g., homeschooling older children, disinfecting the home, etc.) typically fell onto mothers rather than fathers (Petts et al., 2021; Zamarro & Prados, 2021). Research has found that increased stress during the pandemic correlated with an increased risk of developing or experiencing symptoms of perinatal mood and anxiety disorders (PMADs) and postpartum depression, anxiety, and post-traumatic stress disorder (Gao et al., 2022; Kotlar et al., 2021; Racine et al., 2022). The pandemic thus underscored the perinatal population's need for increased support, mental health resources, and tailored care to mitigate the impact of COVID-19-specific stressors.

COVID-19-related stressors that impacted the perinatal population can be categorized as socioeconomic stressors, social stressors, and health-related stressors.

Socioeconomic Stressors

Education. Public schools in the U.S. were mandated to close in 2020, highly recommended to close in 2021, and recommended to close in 2022. During the Delta and Omicron waves of the pandemic, school lockdowns depended on state regulations, a school's status as public or private, and the number of local COVID-19 cases (Hale et al., 2021). School and daycare closures were sporadic and sometimes unpredictable, meaning postpartum mothers would have to juggle the responsibilities of caring for their newborns and facilitating their older children's education, sometimes with only a day's notice (Davis et al., 2022). Garbe and colleagues (2020) found that women struggled with this balance, as well as with motivating their children to learn at home. Other research studies reported that parents who were responsible for educating their children (typically mothers) felt overwhelmed, emotionally and physically exhausted, and as if they were losing control (Burns et al., 2023; Garbe et al., 2020; Nyanamba et al., 2021).

Work. By the summer of 2021, an estimated 5.1 million women had left the workforce since the start of the COVID-19 pandemic (CDC, n.d.-a), most likely due to the COVID-19 related layoffs and the increase in childcare demands (Kotlar et al., 2021; Zamarro & Prados, 2021). Of the women who continued to work, mothers faced a disproportionate burden compared to their male partners, as many had to adapt to remote work while simultaneously managing a larger share of household and childcare responsibilities (Petts et al., 2021; Zamarro & Prados, 2021). As a result, working mothers experienced a significant decline in their well-being compared to working fathers (Vicari et al., 2022). On the other hand, mothers who had undisrupted childcare or had more time for parenting due to less pressure from work or unemployment found increased parenting time to be a source of joy during challenging times (Anderson et al., 2022, Calarco et al., 2020).

Employment and type of work may also have been contributing factors to the significantly higher rates of COVID-19 cases in BIPOC communities. BIPOC individuals are more likely to be working "essential" and "frontline" jobs during the pandemic (e.g., hospital administration, nurses; CDC, 2021), putting them at higher risk of viral exposure and likely increasing the rates of stress and worry in these communities. Furthermore, frontline workers were less protected by regulations as the pandemic continued and staffing shortages worsened. In fact, the CDC released new quarantine guidelines in late December of 2021 during the Omicron wave. They stated that isolation and quarantine periods for healthcare workers, and later anyone infected with COVID-19, were shortened to seven days after the initial infection, provided they did not exhibit any symptoms and were able to produce a negative test result (CDC, n.d.-a). Moreover, fully vaccinated healthcare workers did not need to quarantine after high-risk exposures unless they tested positive for COVID-19. Within a week, the CDC once again shortened the isolation period to five days, followed by wearing a mask for the next five days (CDC, n.d.-b)

Economic. The economic impact of the pandemic led to widespread uncertainty. People were experiencing job loss, reduced income, and financial instability. Moreover, the pandemic's effect on low-income families was amplified as they were more likely to experience loss of pay or employment, food and housing insecurity, and unstable phone and internet connections, which made remote work and learning more challenging (Goldschmidt, 2020; Karpman et al., 2020; Katz et al., 2017; Wolfson & Leung, 2020). As a result, low-income families, and mothers specifically, experienced higher rates of mental health symptoms during the pandemic. Relatedly, a meta-analysis by Gao and collogues (2022) found that low income, and not unemployment, significantly increased a mother's risk for postpartum depression. This is in line with pre-pandemic research that established low income as a predictor of increased postpartum mental health problems (Belle, 1990; Chaudron et al., 2005).

Social Stressors.

Social Isolation. Due to quarantining and social distancing regulations, people were separated from their friends and families, forced to cancel celebrations and gatherings, unable to travel or participate in religious ceremonies or activities, and struggled to engage in normal social activities. Parents were more hesitant to spend time with their adult friends or dine out at restaurants in fear of contracting COVID-19 and bringing it home to their children. For perinatal women, social isolation, and related feelings of loneliness, have been shown to increase their risk in pre-pandemic research (Junttila et al., 2015), which is consistent with studies conducted during the COVID-19 pandemic (Durankuş & Aksu, 2022; Farewell et al., 2020; Harrison et al., 2022).

Increased Tension in the Home. The pandemic significantly impacted both nuclear and extended familial relationships, as individuals had to navigate their comfort levels regarding COVID-19 risk (Brugiavini et al., 2022; Feinberg et al., 2022b; Lee et al., 2022). This necessitated difficult conversations between parents and their adult children to determine the best approach for safely interacting with one another. Unfortunately, varying opinions on the virus' severity, often influenced by political beliefs and media consumption, resulted in strained relationships and even severed ties (Gilligan et al., 2020; Hernandez & Colaner, 2021). These increased conflicts likely led to higher levels of depression, as evidenced by research prior to the pandemic, which showed that adult children's differing beliefs with family members from different generations contributed to higher levels of depressive symptoms (Peng et al., 2021; Suitor et al., 2017, 2018). Further, many perinatal women rely on grandmothers to aid with childcare, which is protective against maternal depression and childcare stress (Chung, et al., 2020; Leahy-Warren, et al., 2011; Samman et al., 2016). Therefore, during the pandemic, strained familial relationships may have been particularly detrimental for perinatal women.

Within nuclear families and couples, minor arguments and major conflicts became more prevalent as family members spent more time together in confined spaces (Alzueta et al., 2021; Lee et al., 2022; Schokkenbroek et al., 2021). There was a significant rise in reports of disagreements and verbal fights, particularly among parents grappling with the challenges of balancing work and family responsibilities within the context of limited support during a global pandemic (Chung et al., 2023; Kotlar et al., 2021; McMillan et al., 2021). In a study that examined phone calls received by the U.S. and Canadian national child abuse hotline during the pandemic, the authors found that conflicts most commonly arose from disagreements on how to manage cases of COVID-19 within the household, the division of labor in the household, parental disapproval of a child's academic performance, and family members with mental health struggles that resulted in substance use and violence (Sinko et al., 2022). Living in close quarters and with intense fear for the family's safety may have negatively impacted the way conflicts were handled, leading to more explosive and hurtful conversations and, in some cases, physical violence. Relatedly, a global meta-analytic study found alarming increases in rates of domestic violence especially in the initial phase of the pandemic (Kourti et al., 2023). Specifically, studies from North America revealed a 12–20% increase in domestic violence that occurred during a time when the abuser would have been at work and a 16–23% increase in first-time abuse. These findings underscore that homes, ideally providing a secure and nurturing environment for mothers and their children, gradually turned into hostile places during the pandemic (Alhomaizi et al., 2021; Thibaut & van Wijngaarden-Cremers, 2020). Prolonged exposure to abuse during the pandemic may lead to long-term psychiatric and physical health problems, especially among vulnerable populations like the perinatal population (Alzueta et al., 2021; Bhandari et al., 2022; McMillan et al., 2021).

Reduced Social Support. Women's pregnancies and postpartum experiences were significantly affected by the social and movement restrictions imposed during the COVID-19 pandemic. One key protective factor that mothers lost was social support, which included emotional (e.g., encouragement, understanding, and reassurance), informational (e.g., guidance and advice), and instrumental support (e.g., childcare support; Milgrom et al., 2019). Although emotional and informational support may have been available to mothers remotely, instrumental support was harder to access during the pandemic due to movement restriction policies that affected at-home childcare (Osborne et al., 2021). As a result of COVID-19 restrictions, mothers no longer had access to several formal sources of instrumental support, including birthing classes, breastfeeding classes, and parenting support groups, as well as informal sources, such as family and friends helping with infants and childcare.

The loss of this critical protective factor may have had detrimental short-term and long-term effects on the mother and her child. Research has identified several benefits of social support and childcare support during the perinatal period, including a decrease in prenatal and postnatal depression (Beck, 2001; Biaggi et al., 2016), an increase in maternal self-efficacy (Leahy-Warren et al., 2011), and a decrease in behavioral problems and the overall risk of mental disorders in children of mothers with depression (Loureiro & Silva, 2014). Moreover, several studies during the pandemic documented a rise in depression and anxiety in perinatal women who reported receiving low levels of social support (Harrison et al., 2022; Lebel et al., 2020; Zhou et al., 2021). Perhaps the most relevant benefit of social support is its ability to buffer against stressors, making it even more vital during the COVID-19 pandemic (Cohen & Wills, 1985). Research has found that the more stressful a situation is, the more helpful social support will be (Milgrom et al., 2019).

Increased Childcare Burden. During the pandemic, formal and informal sources of social support for childcare were disrupted by social distancing measures (Alhomaizi et al., 2021). Parents faced increased childcare demands during the pandemic due to school, daycare, and camp closures. Children were confined to their homes and unable to socialize with their friends in their normal settings (e.g., school, playgrounds, homes). Although adolescents were able to spend time with their friends virtually, most younger children required a greater amount of parental engagement. This is especially true for children younger than five years old; before the COVID-19 pandemic, more than half of them were primarily cared for during the workday by individuals other than their parents, such as extended family members, nannies and babysitters, daycare centers, and schools (RegionTrack, Inc., 2019). This drastic drop in childcare support created a stressful environment for parents, forcing them to deal with the challenge of splitting up their time between work and family demands. However, this simultaneous increase in childcare burden and decrease in social support was more heavily felt by mothers, in what has been characterized as a "gendered pandemic" due to its disproportionate impact on women (C. Lin et al., 2022; Petts et al., 2021; Zamarro & Prados, 2021).

Nonetheless, this amplified burden may not have been uniformly experienced by all mothers. Depending on a mother's racial or ethnic background and socioeconomic status, her experience of parenting expectations, gender norms, and cultural pressures may differ (Damaske, 2011). For example, research reveals that mothers of color and low-income mothers are more likely to reside within a network of extended family members that they rely on for childcare support more than formal sources of childcare support, which may have continued to be available to them during the pandemic (Annette, 2011; Dow, 2019; Gerstel, 2011; Sarkisian & Gerstel, 2004). Conversely, White middle-income mothers are less likely to rely on extended family members to help with childcare, and if they do, it is often viewed as temporary (Hays, 1996; Uttal, 1999). Relatedly, a study found that compared to their White counterparts, Black middle-income mothers are less likely to internalize hegemonic motherhood beliefs, which purport that childcare is mainly a mother's responsibility and that working outside the home conflicts with motherhood (Dow, 2016).

Health-Related Stressors

Physical Health Concerns. During the COVID-19 pandemic, perinatal women were fearful of COVID-19's impact on their physical health and the well-being of their infants (Taylor, 2022). During the Omicron variant, pregnant and breastfeeding individuals, or those who were trying to become pregnant, were urged to receive the vaccine as COVID-19 had resulted in the hospitalization and death of more than 22,000 and 161 perinatal people, respectively (CDC, n.d.-a). In fact, pregnant individuals infected with COVID-19 were twice as likely to be admitted to an intensive care unit, 70% more likely to die, and more likely to experience adverse pregnancy outcomes (e.g., preterm birth, stillbirth, NICU stay) than their non-infected counterparts (CDC, n.d.-a).

During the more lethal Delta variant, the CDC noted that the impact of COVID-19 was severe in pregnant people. Reports during the summer of 2021 stated that contracting COVID-19 during pregnancy could increase the chances of severe pregnancy complications, preterm birth, and stillbirth. Relatedly, in a study conducted by DeSisto and colleagues (2021), it was discovered that pregnant women who tested positive for COVID-19 faced an increased risk of stillbirth compared to those who did not test positive. The study revealed that 1.26% of deliveries from COVID-19-positive women resulted in stillbirth, while the rate for COVID-19-negative women mirrored the pre-pandemic rates at 0.64% of deliveries.

Changes in the Healthcare Setting. The perinatal population interacts routinely with the healthcare system before, during, and after childbirth. Throughout the coronavirus pandemic, hospitals and other healthcare facilities had to continuously update infection control measures as new information about the nature of the virus, its transmission pathways, and its adverse physical and mental effects emerged. Moreover, these institutions had to toe the line between easing and firming up restrictions as herd immunity and vaccine uptake increased versus when new variants emerged, and cases surged. Therefore, over the course of three years, the pandemic continuously changed and impacted the nature by which perinatal women interacted with the healthcare system.

Following the initial COVID-19 outbreak, hospital systems shifted their focus and priorities to help address the increasing number of infected patients. Hospital staff and resources, in particular disposable N-95 face masks, were suddenly in short supply, and the COVID-19 units had priority in receiving the resources that did exist. As such, obstetric units suffered from the national nurse shortage and limited hospital space (Center for Reproductive Rights, 2020; Schmitt et al., 2021) During this phase of the pandemic, pregnant, laboring, and postpartum women dealt with numerous restrictions, such as a reduction in prenatal visits, not allowing support persons at pre or postnatal appointments, limiting the number of support persons present (e.g., spouse, parent, doula) during childbirth, restricting family members from visiting the neonatal intensive care units, among other things (Furlow, 2020; Gov. UK, 2020; Lee, 2020). These restrictions mostly reversed as the pandemic progressed, vaccination rates increased, and cases dropped.

However, some form of restriction was often reinstated during the various waves of the pandemic, with the measures being implemented diverging widely across different healthcare institutions, especially across state lines. Though many hospitals followed the guidelines put in place by the American College of Obstetricians and Gynecologists (ACOG), such as wearing face coverings during perinatal appointments, it was not mandated or regulated on a national or state basis (Hollier, 2022). The ACOG was aware that hospitals were responsible for creating their own guidelines and consequently warned pregnant people that their nonessential in-person visits may be limited or completely replaced by telehealth visits (i.e., online visits via video or phone call) depending on their obstetrician and whether they contracted COVID-19 during pregnancy (Kotlar et al., 2021). The ACOG also recommended that pregnant people present their birth plans to the hospital before labor, as changes may have to be made due to COVID-19 regulations (such as variable allowance for length of hospital stay, limitations to the number of birth companions allowed, and whether doulas are permitted in addition to a family member).

During surges, such as the Delta and the Omicron waves, the healthcare system was strained and institutions had to make choices about which services to prioritize (Kotlar et al., 2021). Nevertheless, restrictions to prenatal and labor and delivery services during later surges were not as severe as in the initial wave. In fact, the CDC specifically recommended that mothers keep all healthcare appointments during and after pregnancy, not delay getting urgent and emergency care due to fear of contracting COVID-19, and give birth under the care of trained healthcare professionals (Beck, 2001; Biaggi et al., 2016). However, some postpartum services were deemed "non-essential," such as preventative reproductive care, lactation support, and postpartum mental health support. Thus these services were scaled back or taken away entirely during surges, potentially depriving new mothers of crucial postpartum care (Rice & Williams, 2022; Weigel et al., 2020).

Racial/Ethnic Birth Outcomes. Well before the start of the COVID-19 pandemic, BIPOC mothers, especially Black and American Indian/Alaska Native mothers, experienced worse outcomes following pregnancy and childbirth than their White counterparts, including higher rates of maternal mortality (March of Dimes, 2021a; Petersen et al., 2019). The trend of poor birth and child outcomes amongst BIPOC mothers continued into the COVID-19 pandemic, as evidenced by Black women's higher rates of preterm births, low birth weight babies, and NICU stays in 2020 (March of Dimes, 2021a; United States Government Accountability Office, 2022). Moreover, Black and Latinx birthing people also had higher rates of emergency c-sections and traumatic birth experiences during the pandemic, which correlated with elevated childbirth-related PTSD symptoms and lower rates of engaging in maternal-infant bonding behaviors, like breastfeeding and skin-to-skin contact (A. S. Iyengar et al., 2021). Therefore, akin to the exacerbation of racial disparities during the COVID-19 pandemic in other domains (e.g., employment, education, and physical and mental health outcomes), birth outcomes similarly worsened.

Positive Changes

Although the COVID-19 pandemic created a lot of stress, there has been scholarly research and media documentation of its positive impact. Subgroups of people, including some perinatal people, experienced positive changes in their life in addition to the newfound stressors during the pandemic. Mothers were engaging in enjoyable hobbies, exercising more, and prioritizing self-care (Anderson et al., 2022). Numerous studies found that spending time outdoors and exercising was correlated with fewer adverse mental health symptoms (Dib et al., 2020; Hazlehurst et al., 2022; Hessami et al., 2022; Loebach et al., 2022; Young et al., 2022). Several new mothers were able to spend more time with their newborns, more easily breastfeed due to staying home, and more easily connect with family and friends using virtual platforms (Anderson et al., 2022). With lockdowns and restrictions in place, families found themselves spending more time together at home. This presented an opportunity for women to bond with their newborns and spend time with their partners.

Investigating the Relationship Between Stress Exposure and Psychopathology

The stressors of COVID-19 surpassed all previous pandemics and epidemics in their scale, chronicity, and widespread impact on almost every aspect of people's lives. The prolonged and intense stress of the pandemic must be investigated to reveal its differential impact on specific populations, such as perinatal women and BIPOCs, which is what we did in this study. However, measuring stress exposure has long been a topic of debate in the literature, with several competing researchers purporting that their theories capture the impact of stress best.

Stress exposure is typically examined to assess its impact on the development of psychological disorders, such as depression and anxiety. Several theories have been proposed to investigate the relationship between stress and psychopathology. The stress exposure model states that the incidence of stressful life events (SLEs) increases a person’s susceptibility to developing mental health symptoms. The dose-response theory expands on the stress exposure model by hypothesizing that a person’s risk for experiencing depression, PTSD, or other anxiety symptoms increases as the number of stressful events increases (Kendler et al., 1999; Manyema et al., 2018; Mollica et al., 1998). In both the stress exposure and dose-response theories, the person is perceived to be a passive recipient of the events, and, therefore, has little control over the impact of these events on the development of a psychological disorder.

However, in actuality, acute and chronic stressors impact an “active, not a passive, organism” (Rutter, 1986, p. 1085). According to the transactional model of stress, a person’s appraisal of life events, which is the degree to which they perceive an event as jeopardizing their well-being or surpassing their resources to cope, is also implicated in developing mental health symptoms such as depression and anxiety (Lazarus & Folkman, 1984; Loewenstein et al., 2019; Zimmer-Gembeck, 2016). Another theory, the stress generation hypothesis, flipped the direction of the relationship between stress and mental health symptoms by theorizing that people prone to psychopathology (e.g., depression) may behave in ways that contribute, at least in part, to stressful events in their lives (Hammen, 1991). This is consistent with several studies that have found that people with depressive and anxiety symptoms are more likely to experience a higher number of stressful events or perceive them as more intense (Adrian & Hammen, 1993; Conway et al., 2012a, 2012b; Hammen & Brennan, 2002; Harkness & Luther, 2001). As such, contrary to stress exposure theories, both the transactional model of stress and the stress generation theory highlight that an individual's characteristics, beliefs, and pathology shape their interaction with their environment and contribute to the generation of stress.

Given these opposing theories, does stress cause psychopathology, or vice versa? The reality may be that these variables affect each other in a bidirectional way. Several researchers have conceptualized a mutually causal relationship between stress and depression (e.g., Rutter, 1986) and stress and anxiety (Conway et al., 2012b; Meyer & Curry, 2017), but methodological limitations have constrained researchers' abilities to investigate this relationship empirically. Traditional modeling techniques, which conceptualize constructs as latent variables, assume a unilinear direction between indicators and constructs and fail to consider the cyclic causal relationships between indicators (Schmittmann et al., 2013). A candidate method to capture these relationships may be network analysis, which conceptualizes mental disorders as emergent phenomena that are caused and maintained by their symptoms (described below). Traditionally, network analysis has been used to investigate mutually interacting, reinforcing, and causal relationships between psychological symptoms in complex networks representing psychological disorders (Borsboom & Cramer, 2013). In recent studies, external factors have been included in symptom networks, such as stressful life events, to investigate the bidirectional causal relationship between these variables and psychological symptoms. Using the network approach, we would not need to assign variables (e.g., stressors and symptoms) as predictors or outcomes, and therefore we are free to examine their relationship outside of these constraints.

Beyond Severity Scores: Not All Symptoms and Stressors are Equal

Depression and anxiety are typically investigated by summing their symptoms to capture a measure of their "severity." By collapsing all the symptoms into a total score, researchers treat mental illnesses as monolith disorders whose symptoms are interchangeable and equally suitable indicators for the illness (Fried & Nesse, 2015b). However, in recent years, a considerable body of research has shown that almost all psychological disorders are heterogeneous conditions. Even following the same diagnostic classification system, people may display different psychological symptoms and still qualify for the same diagnosis. For example, according to the Diagnostic and Statistical Manual of Mental Disorders (5th edition; DSM-5), a person must endorse five out of the nine symptoms of depression to qualify for a diagnosis of Major Depressive Disorder (MDD; American Psychiatric Association [APA], 2013). In a large study that included 3,703 individuals diagnosed with MDD, researchers found more than 1,000 unique symptom profiles, some of which did not share a single symptom (Fried & Nesse, 2015a). Of those unique profiles identified, the study found 501 symptom profiles (48.6%) endorsed by only one person in the study, and the most common profile was endorsed by only 1.8% of participants. Even within the same person, researchers have found that symptom profiles are only moderately stable across different episodes of major depression (Oquendo et al., 2004). Similar heterogeneity in symptom expression, illness trajectory, and predictors of disorder subtypes have been documented by researchers for conditions such as common mood and anxiety disorders, PTSD, and perinatal depression (Galatzer-Levy & Bryant, 2013; Nandi et al., 2009; Santos et al., 2017b). Symptom sum scores and severity ratings can be deceiving because a high sum score may be the product of a few severe symptoms or moderate levels of many symptoms. Therefore, two identical sum scores of illness severity may not accurately represent two individuals' experiences of the illness.

The same argument can be made about investigating stressors, such as significant life events, traumatic events, or daily stressors. Several studies have found that depending on the type of stressor or its severity, a person may experience different symptoms (Cramer et al., 2012; Fried et al., 2015). For example, one study found that when participants were faced with interpersonal loss (e.g., death of a loved one, romantic breakup), they were more likely to experience sadness, anhedonia, and appetite loss, whereas when they were faced with chronic stress, they frequently experienced fatigue and hypersomnia (Keller et al., 2007). Similarly, De Schryver and colleagues (2015) argued that traditional statistical techniques—that is, those that are based on the latent model of psychopathology—are limited in their ability to investigate the differential impact of stressful events on symptoms of psychopathology, such as PTSD, in post-conflict situations. The authors claimed that valuable information about how individual stressors (e.g., economic problems) can trigger specific PTSD symptoms or clusters of symptoms might be missed if sum scores are used. Therefore, they advocated for the "unpacking" of composite constructs to allow for the exploration of specific symptom-stressor relationships.

Limitations of the Common Cause Model. Psychological research studies have long relied on the common cause model (i.e., reflective latent model) of psychopathology, which assumes that a disorder's symptoms correlate because of an underlying latent variable. Thus, the variability in observable indicators (e.g., depressive symptoms) is theorized to be caused by the variability in an unobserved latent variable (e.g., depression). However, the research on symptom heterogeneity has challenged this notion. The common cause model is limited in explaining the relationship between psychological symptoms and predictors, such as significant life events (SLEs). If symptoms are influenced by an underlying variable (i.e., a psychological disorder), then external factors, such as SLEs, would only affect these symptoms indirectly and through the underlying variable. Therefore, the assumption would be that an event's impact on all symptoms of depression would be uniform. However, as was stated earlier, specific SLEs have been found to impact certain symptoms more than others. The network approach, on the other hand, theorizes that SLEs affect symptoms without the common cause serving as an intermediate variable. Therefore, an event (e.g., a breakup) affects a particular symptom (e.g., insomnia) directly, and that symptom activates other symptoms that are strongly associated with it sequentially (e.g., insomnia → concentration problems → guilt → sad mood). A different event may trigger another symptom, which may activate the system of symptoms (disorder) in a completely different pattern.

In 2012, Cramer and her team tested whether the latent factor model or the network model was better at explaining the differential impact of SLEs on depressive symptoms and found that the network model fit the data significantly better. When examining the network models in their study, the authors found that depending on the type of SLE, correlations between depressive symptoms differed substantially (Cramer et al., 2012). For example, the correlations of the symptom network following a romantic breakup were stronger than other events, suggesting that people in that category may be at a higher risk of developing a depressive episode. This differential analysis provides a pathway that may guide the identification of individuals at a higher risk of developing certain psychological disorders, such as depression.

An Alternative Approach to Investigating Psychopathology: Network Analysis

Cramer and colleagues (2010a) introduced the network model as an alternative framework to the latent factor model of psychopathology. The network theory conceptualizes mental disorders as emergent phenomena caused and maintained by their symptoms. Unlike the latent factor model, which theorizes that symptoms are related because of an underlying latent construct, the network model hypothesizes that the symptoms co-occur because they activate, impact, and maintain each other. In 2013, Borsboom and Cramer published the first of many papers detailing methodologies suitable for estimating network models. Although there has been a surge in the use of network analysis to investigate psychological phenomena in the last decade, the majority of network methods remain in the exploratory realm. Moreover, new network methods are continuously and rapidly developing. As such, these massive methodological leaps will likely lead to several advances in the techniques in the future, including confirmatory network modeling, power testing, and model comparison of latent factor models and network models (Fried et al., 2017).

Network Models

A network model is a statistical structure extracted from a data set and represents statistical relations between variables. A network model is made up of a set of *nodes* connected by a set of *edges* (Hevey, 2018). Nodes are the network model variables and can represent any entity, most commonly, psychological symptoms. Edges are the links between network nodes and can represent associations, partial correlations, and conditional independence. Edges can be weighted or unweighted. Weighted edges can have a positive value, a negative value, or a value of zero, which represents no connection. Edges can also be directed or undirected.

The statistical network structures are typically depicted in graphs, which portray circles representing nodes with lines connecting them representing edges. The networks are usually colored. The nodes may or may not be colored in. If nodes are colored in, similar nodes (e.g., psychological symptoms, demographic variables, instrument subscale variables) are the same color in the model. As for edges, positive edge weights are either green or blue, whereas negative edges are red. The darker the edges' color, the stronger the connection between the two nodes (e.g., high partial correlation; Hevey, 2018). The edges' thickness may also be used to visualize the strength of the association, with thicker edges representing stronger connections between nodes (Hevey, 2018). Therefore, the darker and thicker the edge, the stronger the link between the two nodes.

Network models can either be directed or undirected, and this depends on the types of edges in these networks (Hevey, 2018). The directed network's edges have an arrowhead on one end, implying a one-way effect from one node to another (i.e., Node X – Node Y). The undirected network's edges are lines without arrowheads, which imply a bidirectional relation between nodes (i.e., Node X – Node Y). Directed models are typically used for confirmatory tests, such as Structural Equation Modeling (SEM), and use Directed Acyclic Graphs (DAGs) to describe the relationships between variables (Greenland et al., 1999). DAGs have acyclic edges: if you start at a node, you cannot end up back at that node again by following the directed edges.

Applications of Network Models

Expanded Network Models. Although traditional network models are symptom network models, several external factors can be included in a network model. External factors are any outside variables that can influence and activate psychological symptoms, including biological factors, demographic variables, and risk and protective factors. In their paper outlining the challenges to the network approach, Fried and Cramer (2017) highlighted that symptoms had been given importance over other potential variables that can be included in the network because of the traditional conceptualization of the relationship between mental disorders and symptoms. The authors argued that by focusing primarily on symptoms, other equally important variables that may play a crucial role in the etiology of mental disorders may be overlooked. For example, life events are key external variables that can be included in a network analysis of a psychopathological system, such as a traumatic experience activating PTSD symptoms or adverse life events triggering depression symptoms (Fried & Cramer, 2017).

In their commentary, Jones and colleagues (2017) suggested expanding the network model to include potentially causal variables implicated in the etiology or maintenance of mental disorders instead of relying entirely on psychological symptoms. In the past few years, there have been several studies that included external factors such as biomarkers (Santos et al., 2017a), inflammatory markers (Fried et al., 2019), potentially traumatic events and daily stressors (Corbett et al., 2020; Jayawickreme et al., 2017), functional impairment (Fried & Nesse, 2014), behavioral problems (Boschloo et al., 2016), treatment response (Snippe et al., 2017), as well as demographic variables and covariates.

Network Studies During the COVID-19 Pandemic. In the three years since the emergence of the COVID-19 pandemic, numerous researchers employed network analysis techniques to investigate the impact of COVID-19 on mental health symptoms. These symptom networks included psychological distress, depression, anxiety, acute stress, PTSD, and substance abuse. Furthermore, they examined the symptom networks of a variety of populations, including nursing students, healthcare workers, psychiatric outpatients, parents, adolescents, as well as adults from the U.S., Canada, China, Norway, Belgium, and Qatar, among other countries (e.g., Bogaerts et al., 2021; Cai et al., 2022; Karim et al., 2021; Kim et al., 2022; Skjerdingstad et al., 2021; Taylor et al., 2021).

Several network studies incorporated external variables into symptom networks to capture the impact of COVID-19 on psychopathology. For example, in a study involving quarantined individuals in Qatar and colleagues (2021) included COVID-19 infection status as a node in the symptom network and identified it as the most influential node in triggering depression and anxiety. Conversely, in another study, becoming infected with COVID-19 or people close to the individual being infected were added as nodes to the network, but were found to be less influential compared to symptoms of anxiety and depression (Zavlis et al., 2022). Therefore, it is unclear whether becoming infected was highly implicated in activating symptoms. In non-network studies, multiple researchers claimed that it is not exposure to COVID-19, becoming infected, or one's health status that leads to symptoms (e.g., depression and anxiety). Rather, it is the fear of COVID-19, which may be elevated due to factors such as health anxiety or media consumption, that triggers mental health symptoms (Gluska et al., 2022; Golding et al., 2021). This is in line with multiple network studies that identified that the top central nodes were symptoms of panic, fear (e.g., of becoming infected, the dangerousness, or dying of COVID-19), and fear-based somatic symptoms (e.g., Karim et al., 2021; Kim et al., 2022; Qi et al., 2021; Taylor et al., 2020, 2021; Tsur et al., 2021). Finally, it is notable that fear-based symptoms were found to be influential in both PTSD and non-PTSD networks because, to our knowledge, before the pandemic, these symptoms were not common central symptoms outside of PTSD network studies. In the above-mentioned studies, fear nodes activated networks of depression, anxiety, stress, and substance abuse, highlighting the significance and role of context in shifting symptoms from the periphery to the center during large-scale events.

Another frequently reported central symptom in these studies was sadness or depressed mood, which has long been a top central symptom in networks of depression and a top bridge symptom in anxiety-depression comorbidity networks. These findings are consistent with pre-pandemic research, which has consistently identified sadness and depressed mood symptoms to be central in activating depression and its comorbid conditions (e.g., Beard et al., 2016; Fried et al., 2017; Phua et al., 2020; Santos et al., 2017a). Finally, two studies in China identified irritability as a central symptom in depression-anxiety networks (Bai et al., 2021; Cai et al., 2022). This is unsurprising given that irritability, an established predictor of depression and anxiety (Vidal-Ribas et al., 2016), increased during the pandemic, especially during lockdowns and shelter-in-place orders that were both prolonged and strict in China (Bai et al., 2021; Lancet, 2022). Therefore, it is understandable that irritability would be highly influential in activating these symptoms during the pandemic.

Network Studies Investigating Perinatal Mental Health. To our knowledge, as of yet there have been only four network analysis studies conducted in the perinatal population, three prior to the pandemic and one during the pandemic. In 2017, Santos and colleagues were the first to use network analysis to estimate the network structure of perinatal depressive (PND) symptoms in a sample of pregnant women between their 22nd and 24th weeks of gestation (Santos et al., 2017a). The authors found that nodes related to negative affect, including sad mood, low levels of happiness, sadness, and feeling blue, were the most central within their network. In their second study, Santos and colleagues (2018) investigated the longitudinal network structure of depression symptoms and self-efficacy in low-income mothers of children aged six weeks to 36 months. In this study, the authors included depression symptoms, a composite self-efficacy variable, and a treatment variable that controlled for intervention effects over the different time points in the network. Their analysis revealed that “feeling disliked” and “concentration difficulty” were the two most central symptoms.

There is one study, to our knowledge, that looked at a comorbidity network in the perinatal population (Phua et al., 2020). In a study conducted before the COVID-19 outbreak, Phua et al. (2020) investigated depression and anxiety symptoms in women who were between 26 weeks pregnant and three months postpartum. Their findings revealed that most central symptoms for pregnant women were related to feelings of failure, worthlessness, and sadness, whereas the most central symptoms for postpartum women were feeling overwhelmed, feeling punished, concentration difficulties, sadness, and an inability to manage responsibilities. Furthermore, the majority of symptoms that bridged prenatal and postpartum depression and anxiety were anxiety symptoms, which the authors argued corroborates research that anxiety disorders tend to precede and potentially trigger comorbid depressive disorders (e.g., Falah-Hassani et al., 2017).

Finally, with regard to perinatal network studies during the pandemic, we have identified one study, by Zhang and colleagues (2021), that investigated depression in mothers and fathers during pregnancy in China. These data were collected during the COVID-19 pandemic and revealed findings similar to other network studies conducted during that period—that is, the authors found that feelings of sadness, fear, and panic were central to both paternal and maternal networks. Finally, although the following study is not a perinatal study, it investigated the experiences of mothers during the pandemic, and therefore, we will discuss its findings here. In a network investigating symptoms of depression and parental stress during the pandemic, the study revealed that feelings of worthlessness, overwhelm by parenting role, and sad mood were central (Skjerdingstad et al., 2021). The research literature regarding symptom networks of both mothers in general and perinatal women specifically has been steadily growing in the past few years. Importantly, recent studies have begun exploring the impact of the COVID-19 pandemic on these networks. In line with this, our goal in conducting this study is to contribute to this ongoing discussion to corroborate comparable findings as well as shed light on novel results.

Study Aims

Aim 1. To examine the configuration and characteristics of a comorbidity network of postpartum depression and anxiety symptoms.

Aim 1.1. To eliminate symptom redundancy across both disorders and retain only statistically unique symptoms in the comorbidity network.

Aim 1.2. To estimate the comorbidity network and descriptively examine network characteristics.

Aim 1.3. To examine comorbidity and symptom "spread" in two ways: 1) bridge analysis and 2) community analysis.

Aim 2. To examine the relationship between COVID-19 stressors and psychological symptoms in an expanded network model and explore how the relationship changes as the model increases in complexity.

Aim 2.1. To create subscales for each disorder and to estimate three baseline symptom networks: depression, anxiety, and a joint network.

Aim 2.2. To estimate an expanded network, which includes subscales of depression and anxiety, and sum scores of COVID-19 stressors, and descriptively examine network characteristics (e.g., centrality indices, bridge nodes, and node predictability).

Aim 2.3. To add maternal functioning domains, positive experiences domains, and psychosocial predictors in a step-wise manner to the expanded network model and examine how the relationship between COVID-19 stressors and psychological symptoms changes as the model increases in complexity.

Aim 3. To explore differences in network configurations across racial/ethnic groups.

Aim 3.1. To investigate racial/ethnic differences in COVID-19-related stressors and postpartum psychopathology.

Research questions:

1) Do racial/ethnic groups significantly differ in the overall number of COVID-19-related stressors that they were exposed to?
2) Do racial/ethnic groups differ in the type of significant COVID-19-related stressors that they were exposed to?
3) Is there a significant difference in the rates of postpartum depression across racial/ethnic groups?
4) Is there a significant difference in the rates of postpartum anxiety across racial/ethnic groups?
5) Is there a significant difference in the rates of suicidal ideation across racial/ethnic groups?

Aim 3.2. To examine the differences in the structure and characteristics of the comorbidity network across racial/ethnic groups.

Aim 3.3. To examine the differences in the structure and characteristics of the expanded network across racial/ethnic groups.

Chapter 2: Method

Participants and Procedures

Six hundred and thirty participants were recruited via an advertising flyer posted on social media platforms (Facebook, Reddit, Instagram), academic and professional listservs, and listservs and Discord forums targeting pregnant and postpartum people. Each platform differs in how its members form subgroups, and our recruitment approach reflects these differences. On Facebook, we posted on both open and closed groups that targeted mothers living in the U.S., mothers from minoritized racial, ethnic, or religious groups, and/or other grouping characteristics (e.g., mothers in Ph.D. programs or academia). On Reddit, we posted on "subreddits," or pages that cater to parents with shared interests or characteristics (e.g., stay-at-home parents). On Instagram, we created a page for the study that included a post with a description of the study, a picture of our flyer, and a link to our survey. We also reached out to Instagram influencers and motherhood accounts to share our Instagram account with their followers. For listservs and Discord forums, we sent a recruitment email with study details, our flyer, and a link to our survey. Across all these platforms, the principal investigator (PI: Dalal Alhomaizi) or a study coordinator would first reach out to group moderators/administrators and obtain permission to recruit from their followers before posting and/or sharing the study flyer.

The study flyer included a hyperlink and QR code that linked participants to our online Qualtrics survey. See Appendix A for the study flyer. The online survey consisted of all of the measures listed below. Prior to beginning the survey, each participant was required to answer eligibility questions to determine whether they could participate in the study. The eligibility criteria for the study were that an individual 1) can read and understand English, 2) is 18 years old or older, 3) has given birth to a live child who is currently older than two weeks-old but younger than 12 months old, 4) is not currently pregnant, and 5) is currently living in the U.S. The survey automatically ended if a participant did not meet one or more of the eligibility criteria.

If a participant passed the eligibility screener, the study consent form was presented next for their review before they could proceed to the survey. The consent form included a section detailing our data review process, which we indicated was put in place to protect against fraudulent responses that are common in online surveys. We explained to participants that we have embedded data quality checks within our survey to assess eligibility, consistency, and attention. In addition, we explained that a participant would not immediately know if they qualified for compensation when they completed the survey, and that the data review process would take four to six weeks (or six to eight weeks for Samples 2 and 3), given the anticipated number of responses, and that participants who do not pass the review will not be informed or contacted via email. Participants who consented to be part of the study then proceeded to the survey, which took 45-60 minutes to complete. Of note, to reduce the likelihood of missing data, all questions on the survey were forced choice. All eligible participants who completed the survey within a week of beginning it, met eligibility criteria, and passed our data review process were compensated with a $15 Amazon gift card that was sent via email. We also provided participants with the email addresses of the study team, the PI, the academic advisor on the dissertation project, and the Institutional Review Board (IRB) should they want to inquire about their payment or dispute not being paid.

The IRB at Teachers College, Columbia University approved this study (IRB Protocol: 21-389). The study underwent a full review because the data quality measures included confidential and sensitive participant information. We collected data between January 29 to February 10, 2022, and April 7 to 26, 2022.

Measures

We only included select survey sections and scales from our online study survey, the Pregnancy, Postpartum, and Parenting During a Pandemic (P-4) study, that pertained to the aims of this dissertation. They are listed below. The full P-4 survey is attached in Appendix B.

Demographics Section

In our survey, the demographic section consisted of questions about general sociodemographic information (e.g., age, race/ethnicity, relationship status, etc.) as well as questions specific to perinatal women (e.g., baby's age, pregnancy complications, parity, etc.). In addition, the demographic section included questions related to the COVID-19 vaccine (and booster) status.

Postpartum Depression Predictors Inventory (PDPI)-Revised

Our survey included select items from the PDPI-R (Beck, 2002) that asked about psychosocial predictors related to self-esteem, prenatal depression, prenatal anxiety, unplanned/unwanted pregnancy, history of previous depression, social support, marital/relationship satisfaction, childcare stress, infant temperament, and baby blues. The only items that were not included in our survey were ones that overlapped with domains captured in the demographic section (e.g., marital status) and the Epidemic-Pandemic Impacts Inventory (EPII) scale (e.g., life stressors). For most of the PDPI-R's domains, the response set is "Yes" and "No." However, we changed some questions' response sets to a 5-point rating scale of agreement or frequency.

Epidemic-Pandemic Impacts Inventory (EPII)

The EPII scale was developed in 2020 in response to the COVID-19 pandemic and aimed to assess the impact of epidemics and pandemics on multiple domains of life (Grasso et al., 2020). The scale contains 92 items that capture potentially adverse experiences during epidemics/pandemics across several subscales, including work and employment (11 items), education and training (2 items), home life (13 items), social activities (10 items), economic (5 items), emotional health and well-being (8 items), physical health problems (8 items), physical distancing and quarantine (8 items), and infection history (8 items). The EPII scale also contains 19 items related to positive experiences during the pandemic. The EPII's response set consists of four choices: "Yes (Me)," "Yes, (Person in Home)," "No," and "N/A." However, for the four items on the EPII that aimed to capture the experience of the entire household (e.g., the entire household was quarantined for a week or longer), the response set consists of three responses: "Yes," "No," and "N/A."

To capture the impact of the pandemic on pregnancy, laboring, and postpartum experiences, select items from three EPII supplemental scales were included in our survey: the **Epidemic – Pandemic Impacts Inventory Prenatal Module** (EPII-P; Briggs-Gowan et al., 2020b), the **Epidemic – Pandemic Impacts Inventory Labor and Delivery Supplement** (EPII-LD; Briggs-Gowan et al., 2020c), and the **Epidemic – Pandemic Impacts Inventory Infancy Supplement** (EPII-I; Briggs-Gowan et al., 2020a). These three scales are supplemental modules that are designed to be administered in conjunction with the main EPII scale. The response set for the EPII perinatal supplemental scales consists of three choices: "Yes," "No," and "N/A."

We did not calculate Cronbach's alpha for the EPII scale because it is an event-list scale, which follows a formative measurement model. Unlike latent factor models, a formative or composite indicator model conceptualizes indicators (e.g., stressful life events) as the causes of a composite construct (e.g., stress exposure), not reflections of an underlying construct. Therefore, it is inappropriate to use traditional psychometric methods based on classical test theory (DeVellis, 2006) because they assume that indicators of a construct are positively correlated (Bagozzi, 1994; Cronbach, 1951; Hulland, 1999) whereas formative indicators may have positive, negative, or zero correlations (Bollen, 1984; Diamantopoulos & Winklhofer, 2001).

Center for Epidemiologic Studies Depression Scale (CES-D)

The CES-D is a 20-item self-report scale that measures common symptoms of depression, such as sadness, fatigue, and lack of concentration (Radloff, 1977). The CES-D's rating scale ranges from 0 ("rarely or none of the time") to 3 ("most or almost all the time"). The CES-D total score is obtained by summing the scores of all items (items 4, 8, 12, and 16 are reverse-scored). The CES-D's scores range from 0-60, with a cut-off score of 16 and higher scores indicating greater severity of depression. The CES-D has been validated with pregnant and postpartum women (Mosack & Shore, 2006). Of note, given that the CES-D does not have an item that measures suicidality, we opted to add one question adapted from item 9 on the Patient Health Questionnaire-9 (PHQ-9; Kroenke et al., 2001) to inquire about suicidal or self-harm thoughts. In this study, the Cronbach's alpha for both the 20 items of the CES-D scale and the 21 items with the addition of the PHQ-9 item was .93. No item would improve the alpha if deleted.

The Perinatal Anxiety Screening Scale (PASS)

The PASS is a 31-item self-report scale that measures anxiety symptoms during the peripartum period (Somerville et al., 2015). The PASS includes items across four domains of anxiety: 1) excessive and specific fears, 2) perfectionism, control, and trauma, 3) social anxiety, and 4) acute anxiety and adjustment. The PASS's rating scale ranges from 0 ("not at all") to 3 ("almost always"). The total score for the PASS is obtained by summing the scores of all the items. The PASS's scores range from 0 to 93 with the following severity ratings: asymptomatic (range of scores: 0-20), mild-moderate symptoms (range of scores: 21-41), and severe symptoms (range of scores: 42-93). The suggested cut-off score for the PASS is 26. In this study, Cronbach's alpha for the 31 items of the PASS was .95, and no item would improve the alpha if deleted.

Barkin Index of Maternal Functioning (BIMF)

The BIMF is a 20-item self-report scale that measures postpartum maternal functioning across multiple domains, including adjustment, mother-child interaction, infant care, and self-care (Barkin et al., 2010). The 20-item scale includes two anxiety items (items 16 and 18). The remaining 18 items of the BIMF can be divided into two subscales, 1) the maternal competency scale (sum of items 1, 3, 4, 5, 10, 12, 14, 15, 17, 19, and 20) and 2) the maternal self-care scale (sum of items 2, 6, 7, 8, 9, 11, and 13). The BIMF's rating scale ranges from 0 (strongly disagree) to 6 (strongly agree). The BIMF total score can be obtained by summing the scores for all its items, except for items 16 and 18, which should be reverse-coded prior to being summed. The BIMF scores range from 0-120, with higher numbers indicating better functioning. Studies have found that women with an average score of 80 may present with symptoms of depression (Barkin et al., 2014, 2016). In this study, Cronbach's alpha for the 20 items of the BIMF was .84, and no item would improve the alpha if deleted.

Data Quality

Measures

With the rise and widespread use of online surveys during the COVID-19 pandemic, an increasing number of researchers reported large amounts of fraudulent survey responses (Bybee et al., 2022; Singh & Sagar, 2021). Accordingly, researchers recommended that data protection measures be implemented in both the research design and data collection phases of a study to increase the integrity and trustworthiness of the data collected (Griffin et al., 2021; Storozuk et al., 2020; Teitcher et al., 2015). Moreover, we had anticipated that the study may be particularly vulnerable to multiple, fake responses motivated to receive payment because the study compensates all *eligible* participants.

For the study, the initial set of data quality measures was developed and selected based on recommendations suggested by researchers as well as Qualtrics (n.d.; Teitcher et al., 2015). Then, following the data review for each sample, we evaluated the data quality measures' effectiveness in identifying potentially fraudulent responses and identified the successes and pitfalls of said measures. This in turn, informed the fine-tuning of current measures and the addition of new ones for the subsequent sample. All added or updated data quality measures were submitted to and approved by the IRB. Ultimately, we used 20 data protection measures categorized as eligibility, attention, or fraudulence checks across three samples.

Eligibility Checks. The full eligibility criteria were not included on the flyer. This aimed to ensure that potential participants who met our eligibility criteria and passed the initial eligibility screener did so without prior knowledge. A fraudulent participant may alter their eligibility information after failing the screener initially; however, they would be flagged for submitting eligibility responses more than once. Relatedly, another eligibility criterion was that a participant may only take the survey once, which was explicitly stated at the beginning of the survey and in the consent form. Accordingly, unique IP addresses and emails were checked to ensure that a participant had only completed the survey once.

Attention Checks. A total of five questions were dispersed throughout our survey to assess attention. All attention checks included the phrase “It is important that you are paying attention” and explicitly specified the answer the person must select in the response set. For example, at the end of the EPII section, question 20 reads: “It's important that you are paying attention in this survey. Please select "Yes (Person in Home)" to show that you are paying attention.” Furthermore, when a participant failed an attention check, a warning message popped up on their screen to remind them that they could fail up to two attention checks and still qualify for full payment. Also, the message included the option to end the survey. Relatedly, we created a prorated compensation model for participants who failed the attention checks, which was as follows. If a participant failed two attention checks, they were still eligible for full payment. If a participant failed three attention checks, they qualified for $10, and if they failed four, they qualified for $5. Only a participant who failed all five attention checks was not eligible for compensation. Also, irrespective of compensation (which was for a participant’s time), our plan was to not use data from participants who fail three or more attention checks in the data analysis.

Fraudulence Checks. We embedded fraudulence checks throughout our survey that aimed to ensure that our data is trustworthy, to reduce the likelihood of bots, deceptive, and fake responses, to ensure that participants meet our inclusion criteria, and to identify individuals who are attempting to complete the survey several times with the intent of collecting several payments (e.g., professional survey takers). We included a wide range of fraudulence checks; see Table 1 for their names, definitions, and how they were applied in the study.

Review Process

To evaluate whether responses were eligible for compensation, we followed a three-phase review process: an initial review, a research assistant (RA) review, and a scale-based review. For the initial review, this author and a co-investigator or study coordinator reviewed all submitted responses. At this phase, the metrics that resulted in immediate disqualification were incomplete responses, responses that failed eligibility, responses that failed clear fraudulence checks (e.g., low CAPTCHA scores), or duplicate responses (e.g., duplicate IPs, duplicate open-ended questions). Responses that passed the initial review (Phase 1) were then passed on to a team of four RAs (none of whom participated in the first review), and each RA conducted an independent review of the responses using our data quality algorithm. In Phase 2 (RA review), responses that failed two to three eligibility, attention, or fraudulence checks were failed by the RAs. Then, to determine the rate of consensus with an RA's decision, each response was reviewed in a group meeting that included all RAs (including the RA who initially reviewed the response), two study coordinators, and two coinvestigators. In the meeting, each RA presented the reasons behind failing or passing a response to the group, and the group then determined a final pass or fail for each response. For a response to pass, at least half of the group must agree. For a response to fail, all group members must agree. We created these benchmarks for passing or failing a response to increase the chances of a response being compensated.

Finally, after we compensated all eligible participants, we designed a scale that integrated all data protection measures that were used in all samples. This scale was used to evaluate participants' responses for data-cleaning purposes (Phase 3: scale-based review). Based on our experience during the data review process and our familiarity with the data quality measures—that is, which ones were better at detecting fraud or low-quality responses—we assigned different weights or scores for each measure within the scale, with higher scores suggesting a higher probability of fraudulence or low quality. For example, failing one to two attention checks was assigned a score of one, while having an identical IP to another participant was assigned a score of three, which was the highest score possible on the scale. We selected a cut-off of three to reflect being flagged on a data quality measure with a score of three warranted immediate disqualification. However, for lower-scoring measures, a response needed to be flagged on multiple of these measures to be removed. The data quality scale is attached in Appendix C.

Table 1

Fraudulence Checks Description and Application in the P4 Study

Measure	Definition and Application
IP Address	IP addresses are unique numerical labels assigned to electronic devices when connected to a computer network. IP addresses are composed of octets that reflect the host network and the host device. As such, duplicate IP addresses within our data set indicate that the same device, connected to the same host network, has completed the survey multiple times. Furthermore, truncated IP addresses (only the last 1-3 digits differed) were also flagged because although these responses did not come from the same device, they did come from the same host network.
Unique Email Address	Popular email servers such as Gmail, Yahoo, and Hotmail do not allow for more than one account to be created using the same email address. As such, email addresses are unique identifiers for participants and any duplicate email addresses suggest that the same individual is repeatedly taking the survey.
reCAPTCHA Score	A reCAPTCHA score is derived from image or audio challenge-response tools that are easily completed by humans but difficult to complete for robots. Based on how and the number of attempts it takes a respondent to complete these challenges, a score is derived between zero (0) and one (1). Scores closer to

	zero indicate that the respondent is more likely to be a robot and scores closer to one indicate that the respondent is more likely to be human. A reCAPTCHA challenge was included at the beginning and the end of the survey and then averaged together to produce a final reCAPTCHA score. CAPTCHA scores < 0.5 are considered to be fraudulent.
Invisible reCAPTCHA Score	An invisible reCAPTCHA challenge was embedded within the survey and flags responses that the software believes were completed by a bot. Similar to the visible reCAPTCHA score, this index is given a score between zero (0) and one (1), and scores < 0.5 are considered to be fraudulent.
Ballot Stuffing	Ballot stuffing is a term used by Qualtrics to describe multiple survey responses that are submitted by the same account or multiple fake accounts. The survey platform compares each IP address of one response to a list of known bot IP addresses. If the IP address is marked as problematic, Qualtrics will flag the response or remove it from the data set, depending on the settings. For this study, these responses were flagged and not immediately removed from the data set.
Honeypot	Honeypot is a bot detection tool that presents fake questions only visible to robots and tracks suspicious behavior, such as survey port scanning, that is frequently used by robots to bypass security measures. Any interaction with these questions suggests that a robot completed the survey. The survey was terminated if a honeypot was answered and the response was flagged. We embedded two honeypot questions in our survey. For example, one question reads: “Before your most recent pregnancy, do you define yourself as a human?”
Exogena Puermorbus	A fake condition, which is a Latin term that translates to “alien baby,” was presented as an answer choice to a multiple choice question asking about birthing and pregnancy complications. Respondents that chose this fake complication were flagged.
Duration < 10 Minutes	During our pilot testing of the survey, we estimated that it would take 30 to 45 minutes to complete. We estimated that the fastest the survey can be completed, without reading the consent form, while retaining the content of the questions, was 15 minutes. Therefore, respondents who completed the survey in less than 10 minutes (600 seconds) were removed from the data.

Unique Referral Link	We created a unique survey link for each platform and a question was presented in the eligibility screener that asked participants to indicate where they heard about our study. Individuals were flagged if they indicated that they heard of the survey from a platform that differs from the platform assigned to their unique survey link.
Start and End Time	The start and end times of the survey for each response were evaluated for several flags. Responses that were started between 1am and 5am local time, that had the exact same start and end time as another 2+ responses, or were started within one minute of a response that failed eligibility were flagged for suspicious activity.
Consistency Checks	Consistency checks asked for the same information twice, each time in a different manner. For example, "What is your birth YEAR? (yyyy)" and "What is your age?" We assessed inconsistency in the participants' age, their child's age, and the state they resided in. The responses to each pair of questions were compared to each other. In addition, we compared the person's reported state and zip code to their longitude and latitude data, collected by Qualtrics.
Fill in response	A fill in response question asking participants to describe how people in their support network could be more helpful. Responses in these text boxes were flagged if they were an exact match to another response(s), they used suspicious phrasing that was identified in previously determined fraudulent response(s), or they were illegible.

Data Analysis

Aim 1. Comorbidity Network

To investigate the relationship between symptoms of postpartum depression and anxiety, we estimated a comorbidity network.

Aim 1.1. Topological Overlap. The issue of topological overlap resulting from nodes measuring the same construct was introduced by Fried and Cramer in 2017 as a challenge in network analyses. Most scales used in network studies are not specifically designed for them and many contain items that measure the same construct using several items (e.g., in the CES-D, there is a sadness item and a happiness item that is meant to be reverse-coded). And while this is not a problem for most statistical analyses because items are summed and only total scores are used, this poses a big threat to the accuracy of network parameters because individual scale items make up the nodes in a network. Therefore, if items that measure the same or highly similar constructs are included as nodes in a network, then network characteristics may become inaccurate (e.g., inflated centrality indices due to high item correlations; Hallquist et al., 2021; Levinson et al., 2018).

In response to the problem of topological overlap, Payton Jones created the goldbricker function, which is embedded in the *networktools* package (Jones, 2018). The goldbricker function compares pairs of nodes to determine whether the correlation between these nodes and all other nodes in the network is too similar, suggesting collinearity. If a pair's proportion of significantly different correlations with other variables is low (below a threshold defined by the researchers), then they would be identified by the program as a "bad pair." In this study, we set the threshold at .25 (i.e., bad pairs: have < 25% significantly different correlations) with a p-value of .05 to investigate redundant items across the CES-D and the PASS scales, as well as the adapted PHQ-9 suicidality item. After identifying bad pairs, we used the *best goldbricker* function in *networktools* to select the most unique node in a bad pair and removed the other node (Jones, 2018).

However, the goldbricker technique is relatively new and has only been used by a handful of researchers for investigating topological overlap in network nodes (e.g., Levinson et al., 2018; Martini et al., 2021). Vanzhula and colleagues (2020) recently investigated the goldbricker as an item selection technique for network analysis, found that the technique alone may not capture all problematic items, and recommended that researchers use a combination of statistical and theoretical item selection techniques. Therefore, given that goldbricker only compared an item pair's pattern of correlations with other items, we also ran inter-item correlations, to examine the extent to which an item's score correlated with the scores of other items. Furthermore, given that goldbricker and inter-item correlations only investigate collinearity, we calculated the variance inflation factor for each item to examine multicollinearity, when there are high intercorrelations across more than two variables.

We calculated inter-item correlations across all variables (CES-D, PASS, and PHQ item). The higher the inter-item correlation, the more likely that two items are measuring the same construct (Cohen & Swerdlik, 2005), and inter-item correlations of 0.7 or higher suggest that the items may be paraphrasing each other, and one of the items should be removed (Kline, 1979). To select the most unique item from each highly correlated pair, we chose the item we deemed most theoretically relevant to the disorder or one we believed represented the underlying construct better. The Statistical Package for the Social Sciences (SPSS) Version 28 was used for this analysis.

Finally, we calculated the variance inflation factor (VIF) for the variables retained following the goldbricker and inter-item correlation analyses via the R-package *car* (Fox et al., 2012). The VIF measures the extent to which a variable can be predicted by the other predictors in the model—that is, the extent to which its variance is explained by the other variables (James et al., 2013). In general, the more a variable's variance is explained by the other predictors, the higher the VIF will be. A VIF of 1 suggests that a variable is not correlated with other variables in the model, a VIF that is between 1 and 5 suggests moderate multicollinearity, and a VIF higher than 5 suggests high multicollinearity. There is no rule of thumb regarding when to remove a variable if its VIF is too high, but most researchers agree that a VIF of 10 warrants the removal of the item, or if it's indispensable, then it may need to be combined with similar items. In our study, we considered removing items with a VIF of 5-10.

Aim 1.2. Network Estimation. Following item selection, we estimated the comorbidity network using a regularized partial correlation network (Epskamp & Fried, 2018). Consistent with recommendations by Epskamp and Fried (2018), we used the Spearman correlation method because we expected that our network would be densely connected due to high correlations between psychological symptoms. To estimate our network, we used the regularization method, which includes "an extra penalty for model complexity" (Epskamp & Fried, 2018, p. 618). Specifically, our regularized model used the Least Absolute Shrinkage and Selection Operator or LASSO (Tibshirani, 1996) to reduce spurious correlations and produce parsimonious networks. The LASSO shrinks all edge-weights toward zero and reduces small edge-weights to zero, which leads to a sparse network structure that only highlights important relationships. Of note, the absence of an edge-weight does not necessarily mean a lack of a relationship between variables. In fact, in attempting to remove spurious relationships, the LASSO may omit true relationships (Tibshirani, 1996). The LASSO method will produce a collection of partial correlation networks that will range from a fully connected network to an empty network. The optimal network is then selected by minimizing the Extended Bayesian Information Criterion (EBIC; Chen & Chen, 2008; Foygel & Drton, 2010). The EBIC uses a hyperparameter γ (gamma) to specify the extent to which the EBIC will prefer a parse network. The γ is set by the researcher and typically ranges between 0, for an exploratory and hypothesis-generating approach, and 0.5, for a more conservative approach. We set the γ value to 0.5 as recommended by Foygel and Drton (2010).

We used the R-package *bootnet* (Epskamp & Fried, 2015) for network estimation and the R-package *qgraph* (Epskamp et al., 2012) to visualize the network structures.

Network Inference. The most popular and commonly used network inference indices are centrality measures. A centrality measure is used to assess a node's connectedness to all other nodes in the network. Traditionally, three measures of centrality were estimated: 1) node strength (the sum of the absolute value of all a node's positive and negative edges), 2) closeness (the inverse of the mean shortest distance between that particular node and all other nodes in the network), and betweenness (the number of times a node falls on the shortest path between pairs of nodes). Betweenness and closeness have been found to have poor stability and relevance to network studies, and as a result, are less utilized in recent studies (McNally, 2021). On the other hand, although node strength tends to have better stability, it has been criticized as a centrality measure, especially in networks with both positive and negative edges. Some have argued that taking the absolute value of negative edges and summing them with positive edges distorts the measure's interpretation (Robinaugh et al., 2016). In response to this, another centrality measure, expected influence, has been introduced and is now widely used in the literature in conjunction with or instead of node strength. Expected influence (EI) specifies a node's influence by considering its edges' magnitude and direction and is calculated by summing both negative and positive node edges (Robinaugh et al., 2016). Higher EI values in either direction suggest a higher influence: nodes with several positive edges will activate several nodes in the network, whereas nodes with several negative edges will diminish the activation of several nodes in the network.

Because our comorbidity network included both negative and positive edges between its nodes, we did not use traditional centrality indices that do not differentiate between edge valence (e.g., node strength). Instead, we used expected influence, an index calculated by summing both negative and positive node edges (Robinaugh et al., 2016) via the R package *networktools* (Jones, 2018).

Aim 1.3. Comorbidity Investigation. We investigated the comorbidity of anxiety and depression symptoms in two ways, a bridge analysis and a community analysis.

Bridge Analysis. Calculating bridge indices has become a popular technique for investigating how nodes from one community connect, or "spread," to nodes of another community. Before the development of this technique, researchers visually inspected networks to determine bridge symptoms, which often led to faulty conclusions (Jones et al., 2018, 2021). Bridge indices are extensions of the existing centrality measures (i.e., strength, betweenness, closeness, and expected influence). However, whereas centrality indices capture a node's connections to all other nodes in a network, bridge indices focus on a node's connection to nodes from other communities. In bridge analyses, a "community" is defined as a theoretical group of nodes determined by a researcher, rather than via community detection techniques (Khan & Niazi, 2017). For our bridge analysis, we defined the depression community as the (reduced) items of the CES-D scale and the adapted PHQ-9 suicidality item, and the anxiety community as the (reduced) items of the PASS scale. Given that our comorbidity network had negative and positive edges, we calculated the bridge expected influence by summing all edge weights from a given node to nodes of another community (Jones et al., 2021), using the R package *networktools* (Jones, 2018*).*

Community Analysis. We sought to investigate comorbidity without predefining communities, which would allow nodes to freely cluster together without delineating disorder-specific boundaries between them. Several analytic algorithms can be used to identify communities, which are groups of nodes fully connected to one another, in network models. However, most community detection methods will assign a node to only one community (e.g., walktrap random walk algorithm; Pons & Latapy, 2006), even if the node is connected to more than one community. In fact, it is not uncommon for nodes to belong to more than one community, akin to "cross-loading" in factor analysis, especially in psychological symptom networks. Therefore, we chose the overlapping community detection method, clique percolation analysis (CPA, Palla et al., 2005). CPA was first proposed to investigate comorbidity in network studies by Blanken and colleagues (2018). They proposed two novel definitions of symptoms 1) "stabilizing symptoms" are core symptoms that have multiple connections with symptoms within their community, 2) "communicating symptoms" are bridge symptoms that have multiple connections with symptoms of two or more communities. In this study, we specifically focused on "communicating symptoms"—nodes that connect two or more anxiety and depression communities to investigate the comorbidity between the two disorders.

We conducted our network community analysis using the clique percolation package in R (Lange, 2021). The clique percolation method defines a community as a group of adjacent "k-cliques." A k-clique is a subgroup of fully connecting k nodes, and the smallest possible k-clique is 3. In this study, we investigated 3- and 4-cliques. Further, k-cliques are considered "adjacent" when they share k-1 nodes. A related parameter, I or "intensity," refers to the average strength of connections between nodes required to detect a community. For weighted networks, such as ours, we needed to optimize the k and I parameters. The community structure with the optimal combination of the k and I parameters is one where the ratio threshold (i.e., ratio of the largest to second largest community) is approximately two and the chi-threshold is highest.

Aim 2. Expanded Network. We investigated the relationship between COVID-19 stressors and psychological symptoms in an expanded network model and explored how the relationship changed as we increased model complexity.

Aim 2.1. Baseline Networks. Given our plan to estimate an expanded network and increase our model's complexity by sequentially adding variables, we risked reducing the power of our analyses due to the high number of variables included. If we were to include all variables of interest without any item reduction techniques, we would have had a total of 90 items in our expanded network, 52 of which would have been psychological symptoms. Therefore, prior to estimating the expanded network, we used item selection techniques and community analysis to create subscales for the symptoms of anxiety and depression.

Creating Subscales. To create subscales for each disorder, we first began by eliminating redundant items within the CES-D and the PASS scales by using the *goldbricker* method via the R package *networktools* (Jones et al., 2018) and by calculating inter-item correlations on SPSS. Then, we investigated multicollinearity by calculating variance inflation factors for the retained variable. These techniques have been described in detail under the methods of Aim 1.1.

Next, we conducted a community analysis using the clique percolation (CPA) package in R (Lange, 2021) to identify communities within the depression network and within the anxiety network. Of note, this community analysis differed from the one conducted for the comorbidity network because it explored communities within each disorder rather than across both disorders. Whereas the goal of the community analysis conducted for the comorbidity network was to examine symptom spread, here the goal was to identify communities that will inform subscales within each disorder to reduce the overall number of nodes in the network. We specifically choose CPA even though it is not commonly used to psychometrically investigate the dimensionality of scales in network studies. The most popular technique is exploratory graphical analysis (EGA, Golino & Epskamp, 2017), which uses the Walktrap algorithm (Pons & Latapy, 2006). The Walktrap community detection technique identifies communities in networks via random walks that compute the distances between nodes. Nodes are then assigned to only one community based on the smallest intra-community distance. As previously mentioned, forcing nodes to only belong to one community may not be suitable for psychological data where nodes are often shared by more than one community. And so, psychometricians are considering using overlapping community detection techniques, such as the CPA, instead of EGA to investigate scale dimensionality (Lee et al., 2023). To our knowledge, only one study has used CPA to group nodes, and we have followed their approach closely in this study. Accordingly, for each disorder, we created subscales that corresponded to the communities identified in the clique percolation analysis. Specifically, we summed the scores of all nodes within a community to attain a total subscale score. Moreover, for nodes shared by more than one community, we calculated node connection strengths (the average of edge weights between a node and each community) and then, assigned these nodes to the communities with whom they shared the highest connection strength per the technique used by Vanzhula et al. (2023). We then converted the node connection strengths to node percentages for ease of interpretation.

Baseline Node Predictability. Over the past few years, several advances have been made in developing methodologies that obtain additional network characteristics. In 2017, Haslbeck and Fried introduced the node predictability measure, which is defined as the variance of each node explained by all its neighboring nodes. The predictability measure provides "an absolute measure of the controllability of each node" (Haslbeck & Fried, 2017, p. 2769), which would reveal how much intervening on the nodes connected to a given node would impact it. In a network graph, predictability is visualized by shaded areas in a circle around each node; the more area shaded, the higher the percentage of a node's explained variance. The interpretation of a node's predictability is similar to R^2, or the proportion of the variance explained by the model.

For all iterations of the expanded network in this study, we investigated node predictability. There are currently no established guidelines on interpreting predictability values beyond that a value of zero means that a node cannot be predicted by the other nodes in the network, while a value of one means that it's perfectly predicted by the other network nodes (Haslbeck & Waldorp, 2016). Therefore, the values will only be interpreted descriptively in our analyses. Node predictability measures were calculated using the R-package *mgm* (Haslbeck & Waldorp, 2016) and visualized via the R package *qgraph* (Epskamp et al., 2012). We examined the predictability of three baseline networks: a depression network, an anxiety network, and a joint depression and anxiety network, to establish the predictability of nodes prior to introducing external variables.

Aim 2.2. Estimating the Expanded Network.

Network Estimation. Prior to estimating the expanded network, we created 13 stress domains: 1) nine general COVID-19 stress nodes, which corresponded to the sum scores for each EPII subscale, and 2) four perinatal stress nodes, which corresponded to the sum scores of items included in the pregnancy, labor and delivery, and postpartum supplementary EPII scales. We also created nine subscales, 3 for depression and 6 for anxiety, which corresponded to the results of the clique percolation community analysis. Finally, a node capturing the PHQ-9 adapted suicidality item was also included in the network.

To investigate the expanded network, we estimated a regularized partial correlation network, which uses the least absolute shrinkage and selection operator (LASSO; Tibshirani, 1996), via the *bootnet* package in R (Epskamp et al., 2018). When estimating the network, we specified Spearman correlations, per recommendations for dense networks, and set the EBIC hyperparameter γ to 0.5. We then used the R-package *qgraph* (Epskamp et al., 2012) to visualize the network structures. This is the same approach we took to estimate the comorbidity network (Aim 1.2), see above for more details on this method.

Network Inference. We calculated both centrality and bridge indices for the expanded network. The edges of the expanded network were positive and negative, therefore, expected influence and bridge expected influence indices (Robinaugh et al., 2016) were calculated via the R package *networktools* (Jones, 2018). For the bridge analysis, we were interested in identifying the nodes that bridged the COVID-19 stressor community and the psychopathology community. Specifically, we designated the thirteen stress nodes as the “stress” community and the 9 symptom subscales plus the suicidality item as the “psychopathology” community. Finally, we calculated the node predictability of the expanded network to investigate changes in explained variance as a result of adding stress subscales to the baseline joint depression and anxiety network (Haslbeck & Waldorp, 2016).

Aim 2.3. Expanding the Expanded Network.

We aimed to add maternal functioning domains, positive experiences, and psychosocial predictors in a stepwise manner to the expanded network model and to examine how the relationship between COVID-19 stressors and psychological symptoms changes as the model increases in complexity.

Identifying Significant Predictors. We collected twenty psychosocial predictors of psychopathology, including, employment status, income, marital status, wanted/unwanted pregnancy, planned/unplanned pregnancy, gravida, baby blues, prenatal depression, prenatal anxiety, history of depression, history of anxiety, infant temperament, relationship satisfaction, relationship problems, baby health problems, baby sleep problems, baby feeding problems, partner social support, family social support, and friend social support. However, we sought to only include significant predictors in our network analyses. Accordingly, we used stepwise regression to identify significant predictors of depression and anxiety. Stepwise regression is a method of regressing multiple independent variables on an outcome variable, where variables are added or removed in sequence and statistical significance is tested after every iteration (Epskamp & Fried, 2018). Specifically, we ran two forward stepwise regressions, one where the total CES-D score was the outcome variable and the other where the total PASS score was the outcome variable. Nineteen predictors were entered as independent variables for each analysis sequentially, starting with the predictor with the highest correlation with the outcome variable. Marital status was not entered into the analyses due to limited variability (91% of participants were married). A final model was selected for each outcome variable when no more significant predictors could be added—that is all remaining predictors had a p-value >.05 if they were added to the model. All assumptions of multiple linear regression were met. SPSSVersion 28 was used for the analyses.

Stepwise Estimation of Expanded Network Models. We estimated three additional network models where we added external variables to the main expanded network in a stepwise manner. First, we estimated a network model that included the variables of the main expanded model (psychological symptoms and stressors) as well as two domains of maternal functioning: maternal competency and maternal self-care (expanded network 2). Next, we added three domains, which captured positive experiences during the COVID pandemic and the perinatal period, to expanded network 2 (expanded network 3). Finally, we added the eight significant predictors that were shared by both depression and anxiety to expanded network 3 (expanded network 4). We estimated Mixed Graphical Models (MGMs) because our variables were a mix of continuous and categorical variables using the R-package *mgm* (Haslbeck & Waldorp, 2016). We also examined the changes in node predictability for each iteration of the expanded network (Haslbeck & Waldorp, 2016).

Moderated Network Models (MNM). We were interested in examining how the relationship between COVID-19 stressors and psychological symptoms changed after adding domains of maternal functioning, positive experiences, and significant predictors of psychopathology to the expanded model. Of note, we cannot draw any conclusions about significant changes in the network structure by merely examining the edges of each estimated expanded network. Therefore, to investigate whether an edge-weight significantly changes as a result of adding variables to the network, we needed to conduct network comparison tests. Specifically, we chose to run MNMs over traditional network comparison techniques (e.g., Network Comparison Test; Van Borkulo et al., 2015b) because MNMs can be used with both categorical and continuous grouping variables.

Moderated Network Models with Categorical Moderators. For each categorical moderator (e.g., income level, prenatal anxiety, etc.), we ran a moderated Mixed Graphical Model (MGM) using the R-package *mgm* (Haslbeck & Waldorp, 2016). Traditionally, MGMs identify significant pairwise connections between two nodes that are independent of other nodes in the network. However, in moderated networks, we can investigate whether a pairwise connection between two nodes is moderated by another variable, that is, we can explore and identify significant three-way interactions. To estimate MNMs, several arguments must be specified in the *mgm* package: for the *type* argument, we specified that our moderator variable is "c" for categorical; for the *level* argument, we specified how many levels or sub-groups were in our moderator (e.g., for the income moderator, we specified three levels), and for the *moderator* argument, we specified that the first variable in our analysis is our grouping variable. As for the regularization arguments, we set the EBIC hyperparameter γ at .25 and used the OR-rule (only one of the subgroups needed to have a nonzero edge for a significant group difference to be found), to allow for more exploratory analyses.

Moderated Network Models with Continuous Moderators. To estimate MNMs with continuous moderators (e.g., maternal competency, positive experiences, etc.) using the R-package *mgm* (Haslbeck & Waldorp, 2016), we needed to change some of the estimation arguments. For the *type* argument, we specified that our moderator variable is "g" for gaussian, and for the *level* argument, we entered "1," which is the default for continuous variables. All other arguments remained the same.

Racial/Ethnic Network Comparisons.

Racial/Ethnic Differences in Stress and Psychopathology (Aim 3.1). Prior to investigating racial/ethnic differences in network models, we investigated whether there were significant differences between racial/ethnic groups across the following dependent variables: depression, anxiety, and suicidality, as well as the overall number of stressors and types of stressors. For the independent variables, we created five racial/ethnic groups: Asian American, Black/African American, Hispanic or Latino origin of any race, White non-Hispanic, and Other. The last group included participants who endorsed any of the five remaining racial/ethnic group options on our survey: Indigenous American/American Indian or Alaska Native, Middle-Eastern or North African origin of any race, Native Hawaiian or other Pacific Islander, Biracial or Multiracial, and Race not listed above.

After conducting preliminary tests for normality (Kolmogorov-Smirnov test, Shapiro–Wilk test, QQ plots), we found that all our dependent and independent variables were not normally distributed. Therefore, we used the nonparametric test, Kruskal-Wallis H, to investigate if mothers from different racial groups differed on the following dependent variables: depression (total CES-D score), anxiety (total PASS score), total stressors (sum of all general and perinatal EPII subscales), suicidality (adapted PHQ-9 item), and types of stressors (each EPII general and perinatal subscales). The Kruskal-Wallis H's null hypothesis is an omnibus test that assumes no difference between group means (Field, 2013). If Kruskal-Wallis H's null hypothesis is rejected, this suggests that at least one of the groups has a significantly different mean. We used the Mann-Whitney U test to conduct post hoc pairwise comparisons, with Bonferroni corrections applied to the p-values to adjust for multiple testing (Field, 2013). SPSS Version 28 was used for these analyses.

Aim 3.2 and Aim 3.3. Comparison of the Comorbidity Network and the Expanded Network, Across Racial/Ethnic Groups. We were interested in comparing the differences in network structures and network characteristics across racial/ethnic groups. Of note, we were limited in the analyses we could run because four out of the five racial/ethnic groups did not have sufficiently high sample sizes. Therefore, we were only able to estimate MNMs to compare network structures across the five racial/ethnic groups and were not able to estimate or compare any network characteristics, such as centrality indices, between the racial/ethnic groups.

We compared the comorbidity network and the main expanded network across the five racial/ethnic groups via MNMs. The moderating variable for both networks was Race/Ethnicity, a categorical variable. We ran two moderated Mixed Graphical Models using the R-package *mgm* (Haslbeck & Waldorp, 2016). We specified "c" for categorical under the *type* argument and

“5” under the *level* argument for the number of groups in our moderator. All other arguments were similar to the moderation analyses that we ran for other categorical variables –that is, we specified that the first variable is the grouping variable, set the EBIC hyperparameter γ at .25, and used the OR-rule. Finally, we used the R-package *qgraph* (Epskamp et al., 2012) to visualize a network for each racial group.

Network Stability (Cross-Cutting Method for All Aims). The stability of all network estimates, namely, edge-weights, centrality, and bridge indices, was investigated through the correlation stability coefficient (CS-coefficient), which is the correlation between the original indices and bootstrapped indices. Bootstrapping is a process where a network structure and its parameters are estimated many times (e.g., 500-1000), each time based on a different random sub-sample from the data with replacement (Efron & Tibshirani, 1993). The CS-coefficient calculates the maximum proportion of cases that can be dropped from the original sample to retain a correlation of 0.7 or higher between the bootstrapped indices and the original indices. It is generally recommended that the CS-coefficient is above 0.5 and not below 0.25 (Epskamp et al., 2018). In addition, we computed centrality difference tests, which are calculated by taking the difference between two bootstrapped centrality indices and constructing a 95% confidence interval around them. If a confidence interval does not include a value of zero, then we can conclude that there is a significant difference between the centrality indices of the two nodes—that is that the node with higher centrality is significantly different from the node with lower centrality (Epskamp et al., 2018). All stability indices were investigated using the *bootnet* R package (Epskamp et al., 2018).

Chapter 3: Results

Data Review and Clean Up

Three samples were collected from January 29 to April 26, 2022. Sample 1 was collected from January 29 to February 10, 2022. For Sample 1, a total of 1,030 participants were recruited via Reddit. For Phase 1, all submitted responses underwent an initial review and 476 participants were removed due to immediate disqualification. Five-hundred and fifty-four responses passed to the next phase of review (the RA review). Following the RA review and group consensus meeting, an additional 40 were removed for failing one or more eligibility, attention, or fraudulence checks. From Sample 1, 514 participants were compensated.

Sample 2 was collected from April 7 to 19, 2022. For Sample 2, 2,827 responses were received from the following platforms: Facebook, Reddit, Instagram, Listservs, and Discord forums. During Phase 1 of the review, a significant majority of the participants (n=2667) were removed. The Phase 1 review identified hundreds of duplicate responses and at least three bots in this sample. Of note, almost all problematic responses claimed to have heard about the study from Facebook, and almost all of those responses were submitted within the first 48 hours of recruitment. Therefore, only 160 participants from Sample 2 were reviewed by the RAs and of those, 26 were removed for failing the RA and group consensus reviews. From Sample 2, 134 participants were compensated.

Sample 3 was collected from April 16 to 26, 2022 from the following platforms: Reddit, Instagram, and Listservs. Of note, for this sample, we did not recruit from Facebook due to the significant proportion of fraudulent responses we received from this platform in the prior sample. For Sample 3, we recruited 629 participants, 475 of whom failed the Phase 1 review. One-hundred and fifty-four participants were then reviewed by RAs (Phase 2) and of those, 113 were removed for failing the RA and group consensus reviews. From Sample 3, 41 participants were compensated.

Finally, all compensated responses were reviewed using the data integrity scale, and an additional 59 participants were removed: 41 from Sample 1, 16 from Sample 2, and two from Sample 3. For a flowchart of the steps of the data review process and the associated sizes for each sample, see Figure 1. Of note, we checked for and confirmed that there were no significant differences in the rates of anxiety (total PASS score), depression (total CES-D score), and the total number of stressors (total EPII score) across the three samples, and thus, the three samples were combined for our analyses.

Figure 1

Flowchart of Participant Recruitment and Response Review Process

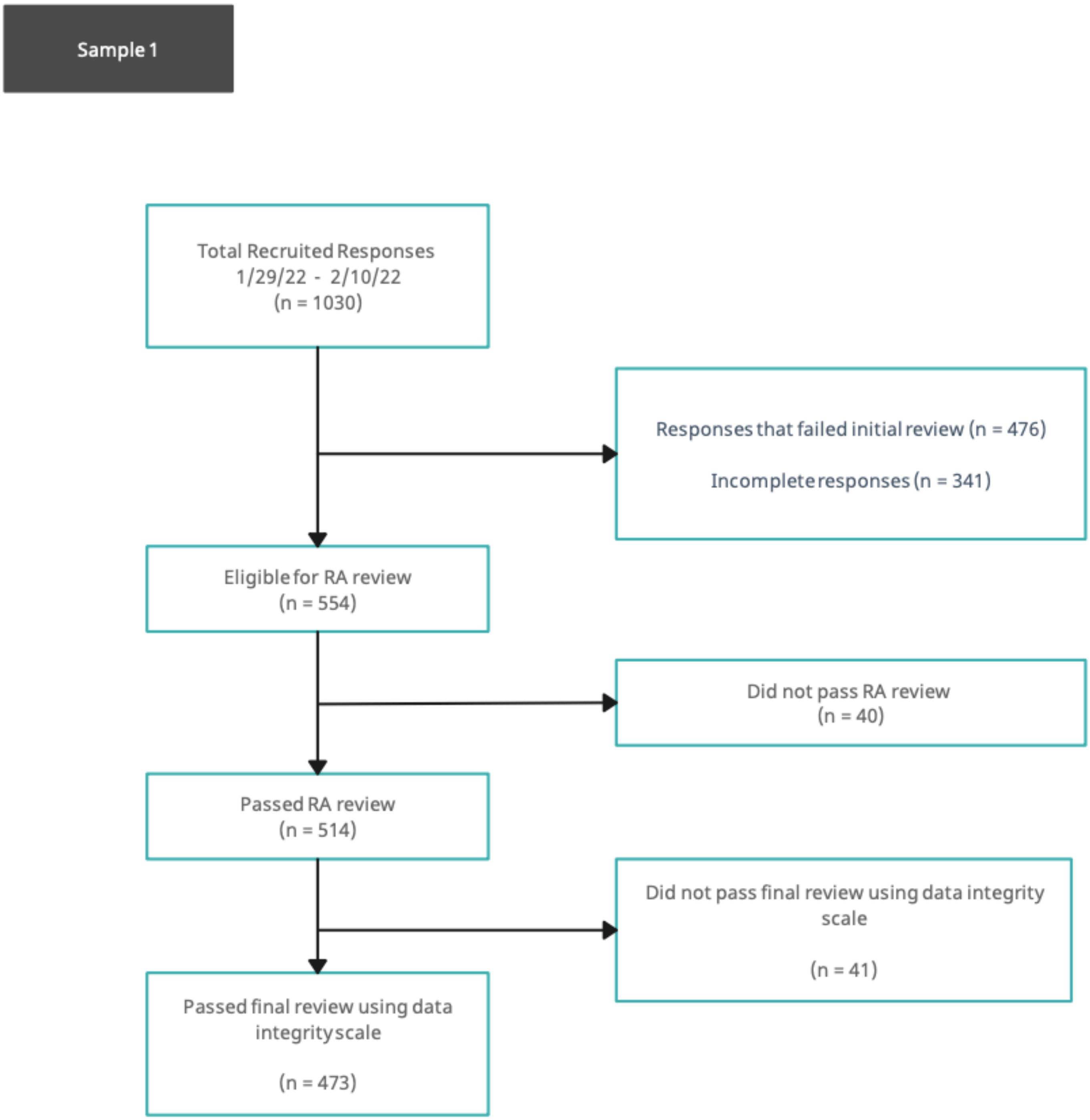


Figure 1 (Continued)

Flowchart of Participant Recruitment and Response Review Process

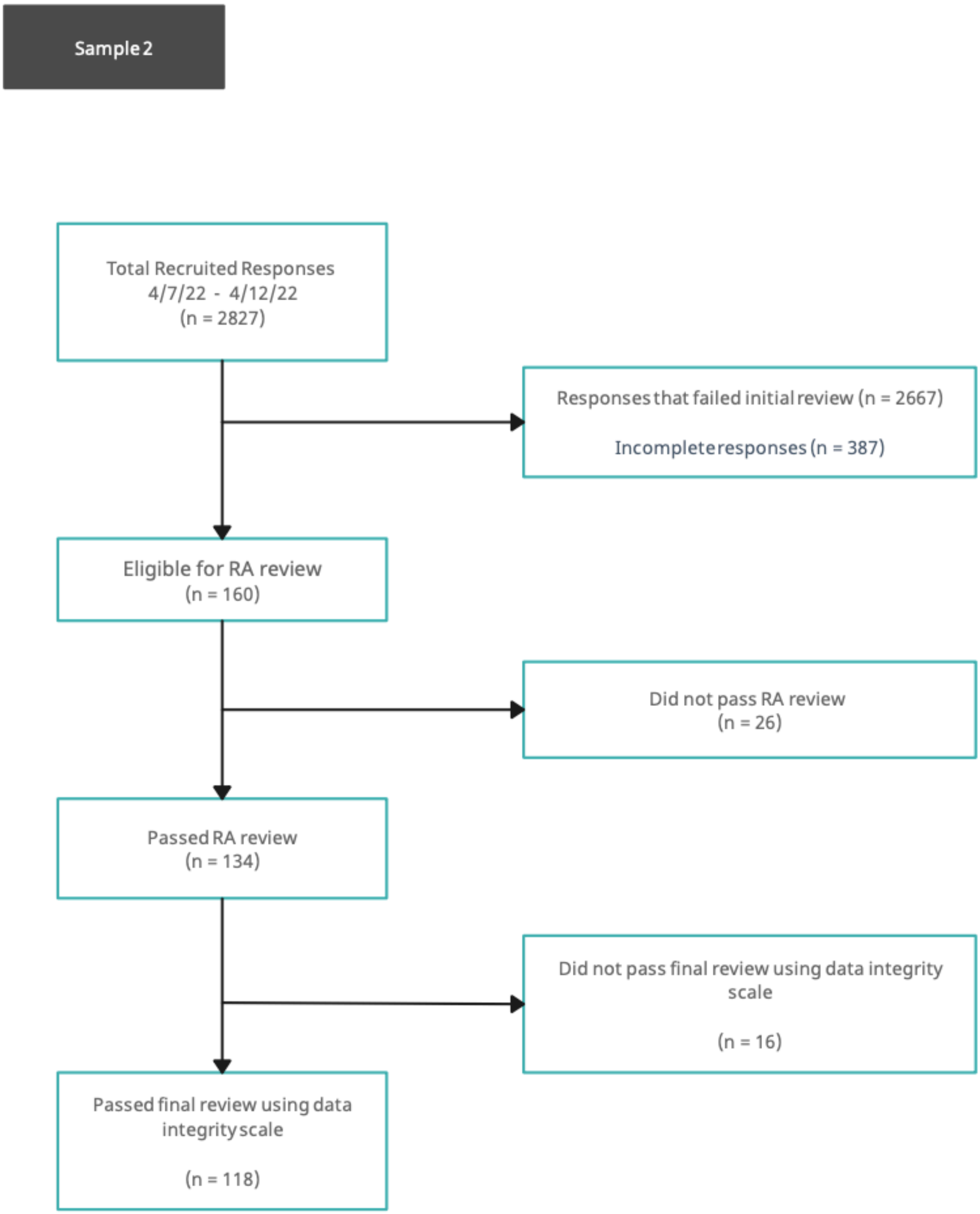
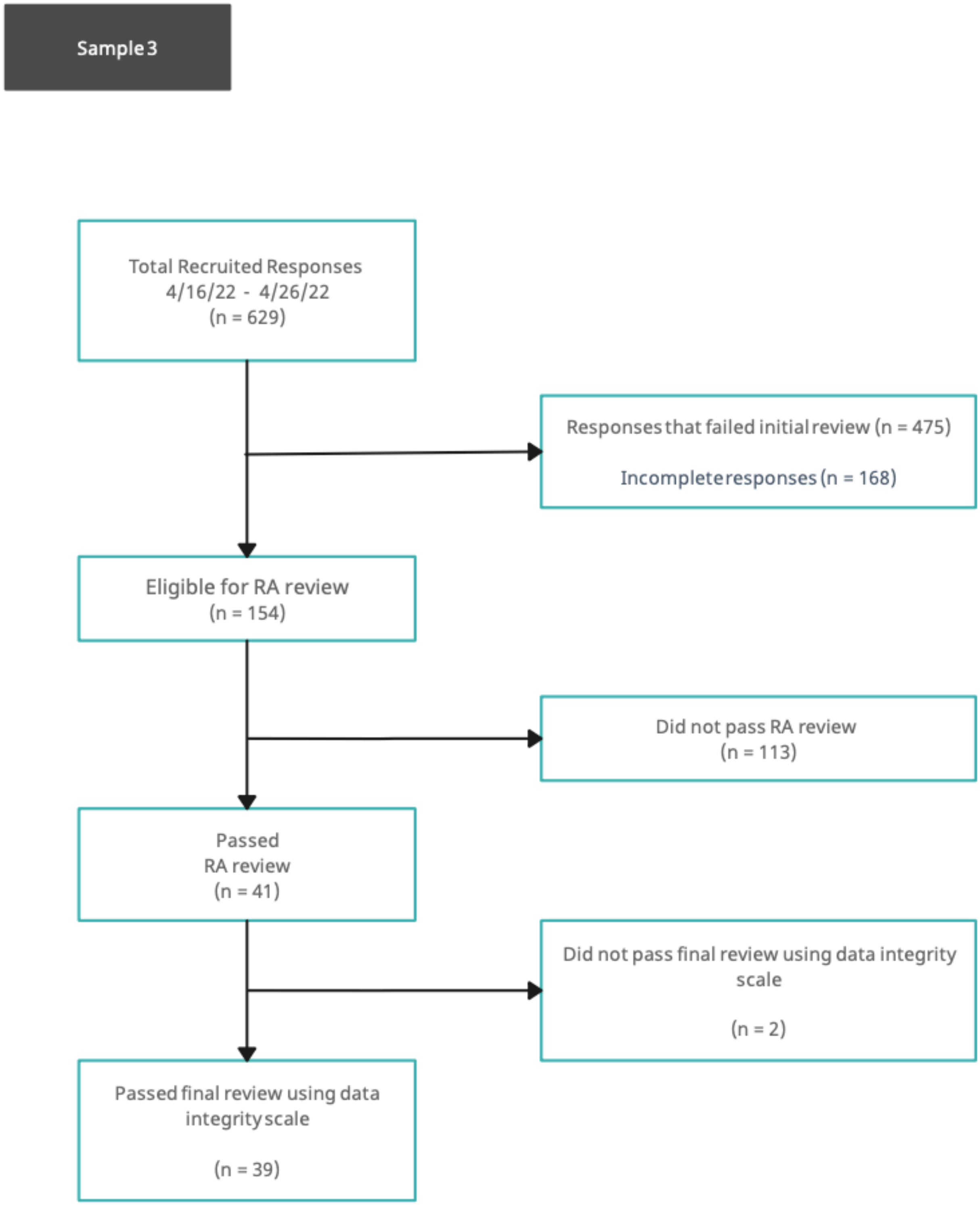


Figure 1 (Continued)

Flowchart of Participant Recruitment and Response Review Process



Participant Characteristics

Following the data review and clean-up phases, our total sample size was 630 participants (Mean age = 33.40, *SD* = 4.26). The majority of our participants were White, non-Hispanic (73.8%), married (91.1%), completed a four-year college degree or higher (85.5%), were not affiliated with any religion (59.9%), were employed full-time (56.6%), and had a combined household income of $100,000 or higher (61.1%). Most participants were fully vaccinated (85.9%) and boosted (79.5%). With regard to geographic location, our participants were evenly distributed across the continental U.S. For the full breakdown of sociodemographic information, see Table 2. Regarding obstetric information, almost all participants had a singleton pregnancy (98.9%), more than half were first-time mothers (59.7%), and less than half of the participants reported no pregnancy complications (45.6%). The average age of a participant's most recent child was 6.65 months (SD = 3.21). Additional obstetric information is provided in Table 3.

Table 2

Sociodemographic Variables

Variable	N=630, n (%)
Age of Mother	
Mean ± SD	33.40 ± 4.26
18 – 24	13 (2.2)
25 – 34	373 (59.2)
35 – 44	235 (37.1)
> 45	4 (0.7)
Missing	5 (0.8)
Race/Ethnicity	
Asian or Asian American	51 (8.1)

Variable	N=630, n (%)
Black or African American	34 (5.4)
Biracial or Multiracial	17 (2.7)
Hispanic or Latino origin of any race	47 (7.5)
Indigenous American/American Indian or Alaska Native	7 (1.1)
Middle-Eastern or North African origin of any race	6 (1.0)
Native Hawaiian or other Pacific Islander	2 (0.3)
Other	1 (0.2)
White, non-Hispanic	465 (73.8)
Geographic Location	
Northeast	180 (28.6)
Southeast	152 (24.1)
Midwest	133 (21.1)
Northwest	50 (7.9)
Southwest	115 (18.3)
Religious Affiliation	
Buddhist	6 (1.0)
Christian	107 (17.0)
Christian-Catholic	57 (9.0)
Christian-Protestant	39 (6.2)
Hindu	5 (0.8)
Jewish	24 (3.8)
Muslim	4 (0.6)
Atheist	131 (20.8)
Agnostic	90 (14.3)

Variable	N=630, n (%)
Nothing in particular	156 (24.8)
Other	11 (1.7)
Education	
High School/GED	14 (2.2)
Vocational/Trade school	2 (0.3)
Some College	49 (7.8)
2-year College	26 (4.1)
4-year College	239 (37.9)
Graduate Degree	300 (47.6)
Household Income Level	
< $35,000	31 (4.9)
$35,000 - $50,000	40 (6.3)
$50,000 - $75,000	75 (11.9)
$75,000 - $100,000	99 (15.7)
> $100,000	385 (61.1)
Relationship Status	
Single, never married	12 (1.9)
Partnered	44 (7.0)
Married	574 (91.1)
Divorced/Separated	0 (0)
Widowed	0 (0)
Other	0 (0)
Employment	
Full-time	356 (56.5)
Part-time	60 (9.5)
Self-employed	26 (4.1)

Variable	N=630, n (%)
Not Employed	137 (21.7)
Other (e.g., student, retired)	51 (8.1)
COVID-19 Vaccine Status	
Yes, I received the 1st of 2 doses	61 (9.7)
Yes, I received all necessary doses	541 (85.9)
No, but I plan to take vaccine	10 (1.6)
No, I do not plan to take vaccine	18 (2.9)
COVID-19 Vaccine Booster Status	
Yes, I received booster	501 (79.5)
No, but I plan to take booster	75 (11.9)
No, I do not plan to take booster	54 (8.6)

Table 3

Obstetric Demographic Variables

Variable	(N=630), n (%)
Pregnancy type	
Singleton	623 (98.9)
Twins	6 (1.0)
Multiples	1 (0.2)
Age of Most Recent Child	
< 3 months	68 (10.8)
3-6 months	184 (29.2)
6-9 months	160 (25.4)
9-12 months	196 (31.1)
Missing	22 (3.5)

Variable	(N=630), n (%)
Gravida	
Primigravida	376 (59.7)
Multigravida	254 (40.3)
Previous children	
0	376 (60.0)
1	199 (31.6)
2	49 (7.8)
3	3 (0.5)
≥4	1 (0.2)
Missing	2 (>0.01)
No. of Complications	0.93 ± 1.14
Complication Frequency	
NICU	70 (11.1)
Gave birth at <37 weeks gestation	46 (7.3)
Low birth weight baby	43 (6.8)
Gestational diabetes	64 (10.2)
High blood pressure	120 (19.0)
Preeclampsia/eclampsia	51 (8.1)
Hyperemesis gravidarum	49 (7.8)
Postpartum hemorrhage	44 (7.0)
Placental problems	37 (5.9)
Other	52 (8.3)
None	287 (45.6)
Pregnancy desirability	
Planned Pregnancy	532 (84.4)

Variable	(N=630), n (%)
Wanted Pregnancy	619 (98.3)
Prenatal Depression	
Yes	129 (20.5)
No	501 (79.5)
Prenatal Anxiety	
Yes	184 (29.2)
No	446 (70.8)
Baby blues	
Yes	454 (72.1)
No	176 (27.9)

Regarding stressors that participants experienced during COVID-19, the stressor subscale with the highest rate of endorsement was “Social Activities,” which included items such as separation from friends and family and canceled social and religious events. As for the stressor subscale with the lowest rate of endorsement, it was “Economics,” which included items such as the inability to access food or clean water and the inability to pay bills. Regarding perinatal stressors, the highest rate of endorsement was for changes during pregnancy (e.g., in-person prenatal visits were canceled or decreased, other people were not able to join in-person prenatal visit,s etc.), and the lowest rates of endorsement were for changes to the postpartum healthcare experience (e.g., a baby has not had any in-person well-baby visits, medical providers seemed to not listen to and hear their concerns, etc.),. The means and standard deviations of all stressor subscales are reported in Table 4. Regarding reported mental health symptoms, on average, participants reported moderate depression symptoms (CES-D Mean = 17.29, *SD* =11.60, total score ≥16 = 48.6%) and mild to moderate anxiety symptoms (PASS Mean = 27.26, *SD* =17.21, total score ≥26 = 47.6%). Additional information on depression and anxiety scores are presented in Tables 5 and 6. Pearson correlations between the main variables in the study are presented in Table 7.

Table 4

COVID-19-Related Stressors

	Mean	SD	%
COVID-19 Stressors			
Work & Employment[a]	3.06	1.97	27.8
Education & Training[b]	0.46	0.61	23.0
Home Life[c]	2.71	2.22	21.8
Social Activities[d]	5.15	2.12	51.5
Economic[e]	0.42	0.84	8.4
Emotional Health & Well-Being[f]	3.49	1.75	43.6
Physical Health Problems[g]	3.47	1.46	43.4
Physical Distancing & Quarantine[h]	3.08	1.80	44.0
Infection History[i]	0.87	1.12	10.9
Perinatal Stressors/Changes			
During Pregnancy[j]	3.74	1.91	46.8
During Labor and Delivery[k]	2.13	1.43	19.4
During The Postpartum (Healthcare)[l]	0.80	1.21	11.4
During The Postpartum (Home)[m]	3.39	1.92	22.6

Note. N=630. Item totals: [a]11 items, [b]2 items, [c]13 items, [d]10 items, [e]5 items, [f]8 items, [g]8 items, [h]7 items, [i]8 items, [j]8 items, [k]11 items, [l]7 items, [m]15 items.

Table 5

Center for Epidemiologic Studies Depression Scale (CES-D) Scores

	n (%)
CES-D Total Scores and Interpretation	
0-9: Not depressed	207 (32.9)
10-15: Mildly depressed	117 (18.6)
16-24: Moderately depressed	149 (23.7)
25-60: Severely depressed	157 (24.9)
Overall (Mean±SD)	17.29 ±11.60

Note. N=630

Table 6

Perinatal Anxiety Screening Scale (PASS) Scores

	n (%)
PASS Total Scores and Interpretations	
0-20: Asymptomatic	253 (40.2)
21-41: Mild-moderate symptoms	245 (38.9)
42-93: Severe symptoms	132 (21.0)
Overall	27.26 ± 17.21

Table 7

Pearson Correlations between the Stressor Domains, Depression, Anxiety, and Suicidality

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. EPII 1 – Work and Employment	1	0.16**	0.34**	0.28**	0.28**	0.23**	0.31**	0.22**	0.28**	0.20**	0.29**	0.30**	0.31**	0.23**	0.22**	0.14**
2. EPII 2 – Education and Training	0.16**	1	0.41**	0.12**	0.14**	0.23**	0.14**	0.19**	0.20**	0.04	0.09*	0.15**	0.23**	0.01	0.06	0.06
3. EPII 3 – Home Life	0.34**	0.41**	1	0.29**	0.38**	0.47**	0.38**	0.29**	0.32**	0.24**	0.35**	0.38**	0.45**	0.30**	0.36**	0.21**
4. EPII 4 – Social Activities	0.28**	0.12**	0.29**	1	0.23**	0.26**	0.36**	0.28**	0.18**	0.30**	0.31**	0.23**	0.40**	0.24**	0.20**	-0.01
5. EPII 5 – Economics	0.28**	0.14**	0.38**	0.23**	1	0.29**	0.36**	0.15**	0.31**	0.24**	0.36**	0.41**	0.39**	0.29**	0.27**	0.21**
6. EPII 6 – Emotional Health and Wellbeing	0.23**	0.23**	0.47**	0.26**	0.29**	1	0.42**	0.27**	0.23**	0.21**	0.26**	0.33**	0.36**	0.36**	0.43**	0.20**
7. EPII 7 – Physical Health Problems	0.31**	0.14**	0.38**	0.36**	0.36**	0.42**	1	0.27**	0.19**	0.32**	0.37**	0.34**	0.43**	0.32**	0.34**	0.11**
8. EPII 8 – Physical Distancing and Quarantine	0.22**	0.19**	0.29**	0.28**	0.15**	0.27**	0.27**	1	0.45**	0.20**	0.20**	0.13**	0.25**	0.21**	0.19**	0.01

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
9. EPII 9 - Infection History	0.28**	0.20**	0.32**	0.18**	0.31**	0.23**	0.19**	0.45**	1	0.13**	0.28**	0.29**	0.23**	0.16**	0.13**	0.17**
10. EPII – Pregnancy Changes	0.20**	0.04	0.24**	0.30**	0.24**	0.21**	0.32**	0.20**	0.13**	1	0.44**	0.36**	0.40**	0.21**	0.23**	0.06
11. EPII – Labor & Delivery Changes	0.29**	0.09*	0.35**	0.31**	0.36**	0.26**	0.37**	0.20**	0.28**	0.44**	1	0.48**	0.48**	0.27**	0.29**	0.22**
12. EPII – Post-partum Healthcare Changes	0.30**	0.15**	0.38**	0.23**	0.41**	0.33**	0.34**	0.13**	0.29**	0.36**	0.48**	1	0.53**	0.35**	0.37**	0.30**
13. EPII – Post-partum Home Changes	0.31**	0.23**	0.45**	0.40**	0.39**	0.36**	0.43**	0.25**	0.23**	0.40**	0.48**	0.53**	1	0.36**	0.36**	0.14**
14. PASS Total Score	0.23**	0.01	0.30**	0.24**	0.29**	0.36**	0.32**	0.21**	0.16**	0.21**	0.27**	0.35**	0.36**	1	0.77**	0.35**
15. CES-D Total Score	0.22**	0.06	0.36**	0.20**	0.27**	0.43**	0.34**	0.19**	0.13**	0.23**	0.29**	0.37**	0.36**	0.77**	1	0.49**
16. PHQ-9 Suicidality Item	0.14**	0.06	0.21**	-0.01	0.21**	0.20**	0.11**	0.01	0.17**	0.06	0.22**	0.30**	0.14**	0.35**	0.49**	1

Note. * *Correlation is significant at 0.05 level (2-tailed).* ** *Correlation is significant at 0.001 level (2-tailed).*

Comorbidity Network

Aim 1.1. Topological Overlap

We conducted two analyses to investigate collinearity, a *goldbricker* analysis and an inter-item correlation analysis. The *goldbricker* analysis was conducted with items from the CES-D scale, the PASS scale, as well as the adapted PHQ-9 suicidality item. The results revealed nine "bad pairs:" two CES-D pairs, six PASS pairs, and one pair that included an item from PASS and an item from the CES-D. After the identification of the bad pairs, we used the *best goldbricker* function to determine which item is removed from each bad pair. Accordingly, three CES-D items and four PASS items were removed. The results of the *goldbricker* analysis are presented in Table 8. Regarding the inter-item correlations, we identified five problematic pairs of items with an inter-item correlation of .7 or higher: three CES-D pairs and two PASS pairs. We found one PASS and CES-D pair with an inter-item correlation of .68 and decided to flag it as a problematic pair for the following reasons: 1) both items measured sleep problems, 2) the inter-item correlation was slightly lower than the cut-off, and 3) the inter-item correlation was higher than the general range of inter-item correlations of items from CES-D and PASS scales (range: -.09 to .56). Following the inter-item correlation analysis, we removed two CES-D items and three PASS items. The results of the inter-item correlation analysis are presented in Table 9. Following the item reduction analyses, the total items in the network were reduced from 51 to 39, namely 15 items from the CES-D, 24 items from the PASS, as well as the adapted suicidality item were retained and included in the comorbidity network. Following the goldbricker and inter-item correlation analyses, we investigated multicollinearity by calculating the retained items' variance inflation factor (VIF). Our analysis revealed that no item had a VIF between 5 and 10; therefore, no additional items were removed.

Table 8

Bad Pairs Revealed by Goldbricker Analysis of CES-D and PASS Scales

Item 1	Item 2	% of sig.[a] diff. correlations
CES-D 1. Was bothered by things that usually don't bother me.	**PASS 6. Feeling overwhelmed.**	24.5%
CES-D 1. Was bothered by things that usually don't bother me.	CES-D 17. I had crying spells.	24.5%
CES-D 3. I felt that I could not shake off the blues even with help from my family or friends.	**CES-D 18. I felt sad.**	22.4%
PASS 7. Really strong fears about things, e.g., needles, blood, birth, pain, etc.	PASS 15. Feeling jumpy or easily startled.	22.4%
PASS 9. Repetitive thoughts that are difficult to stop or control.	**PASS 16. Concerns about repeated thoughts.**	22.4%
PASS 22. Avoiding social activities because I might be nervous.	**PASS 23. Avoiding things which concern me.**	16.3%
PASS 22. Avoiding social activities because I might be nervous.	PASS 31. Feeling agitated.	22.4%
PASS 23. Avoiding things which concern me.	PASS 31. Feeling agitated.	22.4%
PASS 26. Difficulty adjusting to recent changes.	PASS 31. Feeling agitated.	22.4%

Note. Bolded items were retained in the network. All non-bolded items were removed.
[a]Significance level p=0.05

Table 9

Problematic Pairs Revealed by Inter-Item Correlation Analysis of CES-D and PASS Scales

Item 1	Item 2	Inter-item correlation
PASS 10. Difficulty sleeping even when there is the chance to sleep	**CES-D 11. My sleep was restless.**	.68
CES-D 3. I felt that I could not shake off the blues even with help from my family or friends.[a]	CES-D 6. I felt depressed.	.73
CES-D 6. I felt depressed.	**CES-D 18. I felt sad.**	.72
CES-D 12. I was happy.	**CES-D 16. I enjoyed life.**	.74
PASS 4. Worry about many things	PASS 5. Worry about the future	.74
PASS 19. Worry that I will embarrass myself in front of others.	PASS 20. Fear that others will judge me negatively.	.73

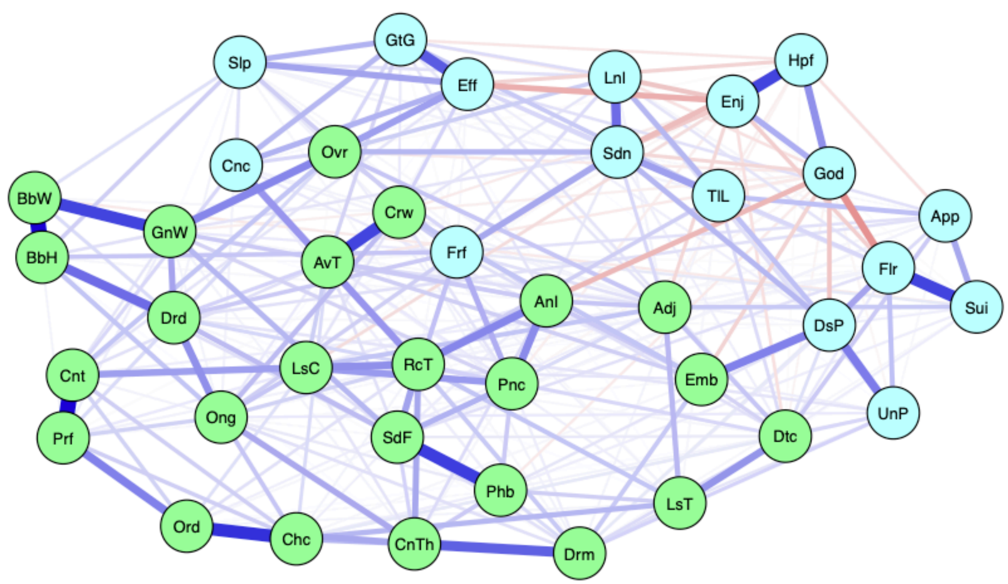
Note. Bolded items were retained in the network. All non-bolded items were removed.
[a.] This item was removed in the goldbricker analysis.

Aim 1.2. Network Estimation

The estimated comorbidity network is presented in Figure 2. In a comorbidity network, which is a partial correlation network, a connection or "edge" between two nodes represents a unique linear relationship between them after controlling for all other nodes in the network. Moreover, the edge weight and sign signify the strength and direction of the relationship, respectively. The edge-weight stability for the comorbidity network was very good (CS-coefficient = 0.67); therefore, edges between nodes can be interpreted with a reasonable degree of confidence. As expected, in the comorbidity network, symptoms of the same disorder had more significant connections, and overall stronger connections (i.e.: larger edge-weights), with each other than with symptoms from the other disorder. The strongest positive connections were between *"Worry about the baby"* (ANX) and *"Fear that harm will come to the baby"* (ANX), *"Needing to be in control of things"* (ANX) and *"Wanting things to be perfect"* (ANX), *"Difficulty stopping checking or doing things over and over"* (ANX) and *"Having to do things in a certain way or order"* (ANX), *"Really strong fears about things, eg needles, blood, birth, pain, etc"* (ANX) and *"Sudden rushes of extreme fear or discomfort"* (ANX), and, *"I thought that I would be better off dead, or I thought about hurting myself in some way"* (DEP) and *"I thought my life had been a failure"* (DEP). As for the strongest negative connections they were between *"I felt I was just as good as other people"* (DEP) and *"I thought my life had been a failure"* (DEP), and between *"I enjoyed life"* (DEP) and *"I felt that everything I did was an effort"* (DEP).

Figure 2

Comorbidity Network: Regularized Partial Correlation Network of Depression and Anxiety Symptoms



Note. Blue edges represent positive partial correlations and red edges represent negative partial correlations.

Depression Nodes:

- **App:** I did not feel like eating; my appetite was poor.
- **God:** I felt I was just as good as other people.
- **Sdn:** I felt sad.
- **Cnc:** I had trouble keeping my mind on what I was doing.
- **Eff:** I felt that everything I did was an effort.
- **Hpf:** I felt hopeful about the future.
- **UnP:** People were unfriendly.
- **Flr:** I thought my life had been a failure.
- **Frf:** I felt fearful.
- **Slp:** My sleep was restless.
- **TlL:** I talked less than usual.
- **Lnl:** I felt lonely.
- **Enj:** I enjoyed life.
- **DsP:** I felt that people dislike me.
- **GtG:** I could not get "going."
- **Sui:** I thought that I would be better off dead, or I thought about hurting myself in some way.

Anxiety Nodes:

- **BbW:** Worry about the baby.
- **BbH:** Fear that harm will come to baby.
- **Drd:** Sense of dread - something bad is going to happen.
- **GnW:** Worry about many things.
- **Ovr:** Feeling overwhelmed.
- **Phb:** Really strong fears about things eg blood, birth, pain, needles.
- **SdF:** Sudden rushes of extreme fear/discomfort.
- **Ord:** Having to do things in a certain way or order.
- **Prf:** Wanting things to be perfect.
- **Cnt:** Needing to be in control of things.
- **Chc:** Difficulty stopping checking or doing things over and over.
- **CnTh:** Concerns about repeated thoughts.
- **Ong:** Being 'on guard' or needing to watch out for things.
- **Drm:** Upset about repeated memories, dreams or nightmares.
- **Emb:** Worry that I'll embarrass myself in front of others.
- **Crw:** Feeling really uneasy in crowds.
- **AvT:** Avoiding things which concern me.
- **Dtc:** Feeling detached like watching yourself in a movie.
- **LsT:** Losing track of time and can't remember what happened.
- **Adj:** Difficulty adjusting to recent changes.
- **AnI:** Anxiety getting in the way of being able to do things.
- **RcT:** Racing thoughts making it hard to concentrate.
- **LsC:** Fear of losing control.
- **Pnc:** Feeling panicky.

As for connections between symptoms of depression and anxiety, of the 384 possible edge connections, 108 (28%) emerged as significant in the network and the majority of the edges were positive. The strongest positive connections between anxiety and depression were as follows: *"I felt that people dislike me"* (DEP) and "*Worry that I'll embarrass myself in front of others*" (ANX), *"I had trouble keeping my mind on what I was doing"* (DEP) and "*Racing thoughts making it hard to concentrate"* (ANX), "*I felt that everything I did was an effort"* (DEP) and "*Feeling overwhelmed"* (ANX), *and "I felt fearful"* (DEP) and "*Feeling panicky"* (ANX). Regarding the negative connections across the two disorders, most of the connections were between positively worded depression nodes and negatively worded anxiety nodes. For example, the strongest negative connection between depression and anxiety was between the following items: "*I felt I was just as good as other people"* (DEP) and "*Anxiety getting in the way of being able to do things"* (ANX). However, there was a notable exception wherein a negative connection was found between two negatively worded items: "*Worry about the baby"* (ANX) and *"I thought that I would be better off dead, or I thought about hurting myself in some way*" (DEP). This was the only negative connection in the network that did not include a positively worded item as one of the pair.

We sought to identify nodes that had the highest number of connections with nodes of the other disorder. We found that amongst the depression nodes, the *"I felt fearful"* and *"My sleep was restless"* nodes had the highest number of connections with the anxiety nodes, whereas the node *"I felt lonely"* had the lowest number of connections. Amongst the anxiety nodes, *"Feeling detached like watching yourself in a movie"* and *"Difficulty adjusting to recent changes"* symptoms had the highest number of connections with the depression nodes, whereas *"Concerns about repeated thoughts"* had no connections to any depression nodes.

Network Inference. The stability of the centrality indices for the comorbidity network was also very good (CS-coefficient = 0.67). The most central symptoms—that is, symptoms with the highest expected influence in the comorbidity network—were anxiety symptoms: "*Racing thoughts making it hard to concentrate," "Sudden rushes of extreme fear/discomfort," and "Being "on guard" or needing to watch out for things."* See Table 10 for the list of nodes with the highest expected influence indices in the comorbidity network, Figure 3 for a plot of the comorbidity network's expected influence indices, and Figure 4 for the bootstrapped centrality difference tests.

Table 10

List of the Nodes with the Highest Expected Influence in the Comorbidity Network

Nodes	Expected influence coefficient	Higher than % of other nodes
PASS 28. Racing thoughts making it hard to concentrate.	1.54	98%
PASS 8. Sudden rushes of extreme fear/discomfort.	1.29	90%
PASS 17. Being 'on guard' or needing to watch out for things.	.87	60%

Note. The values for this table were obtained from the bootstrapped centrality difference test, see Figure 3.

Figure 3

Plot of Expected Influence Indices for the Comorbidity Network

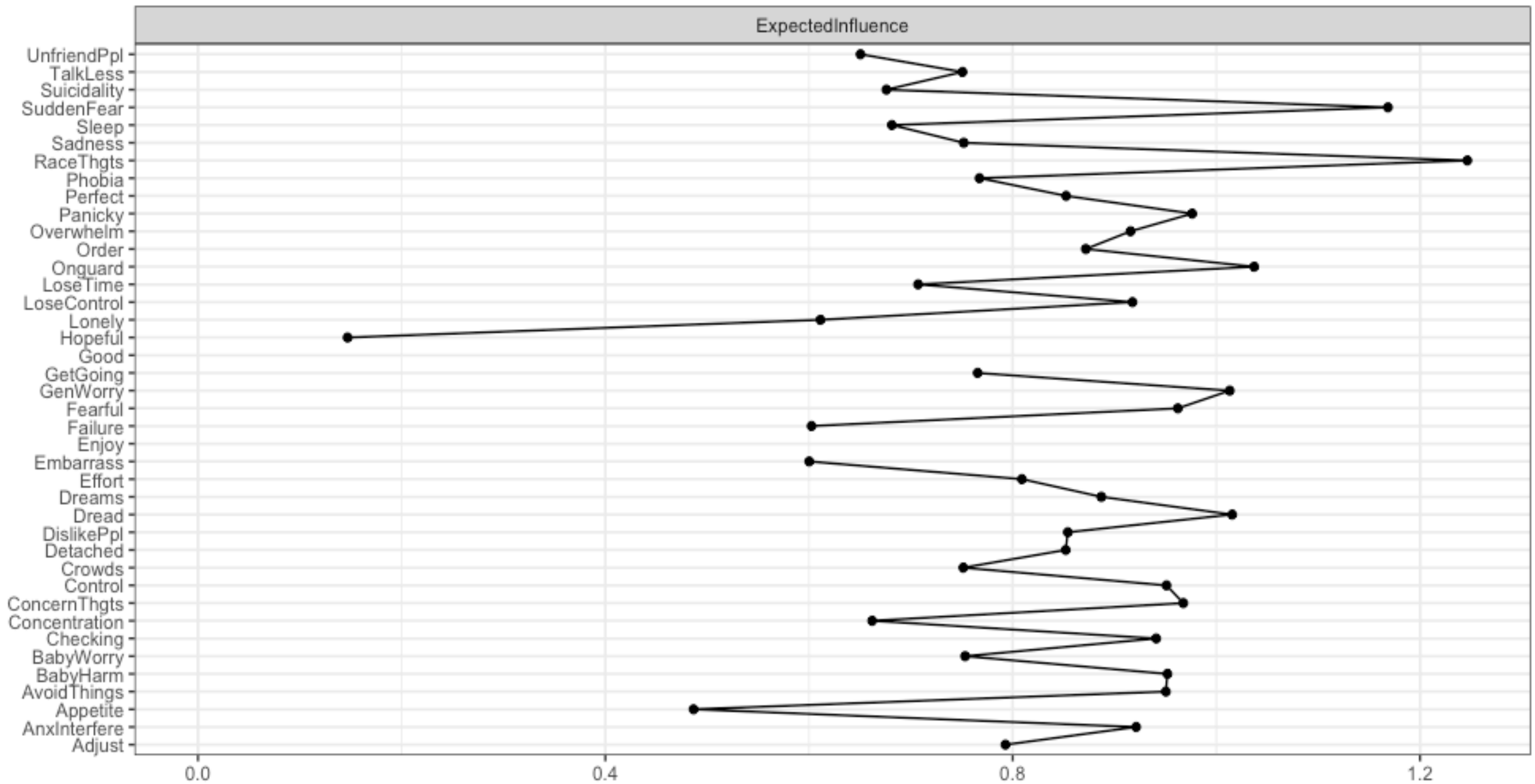
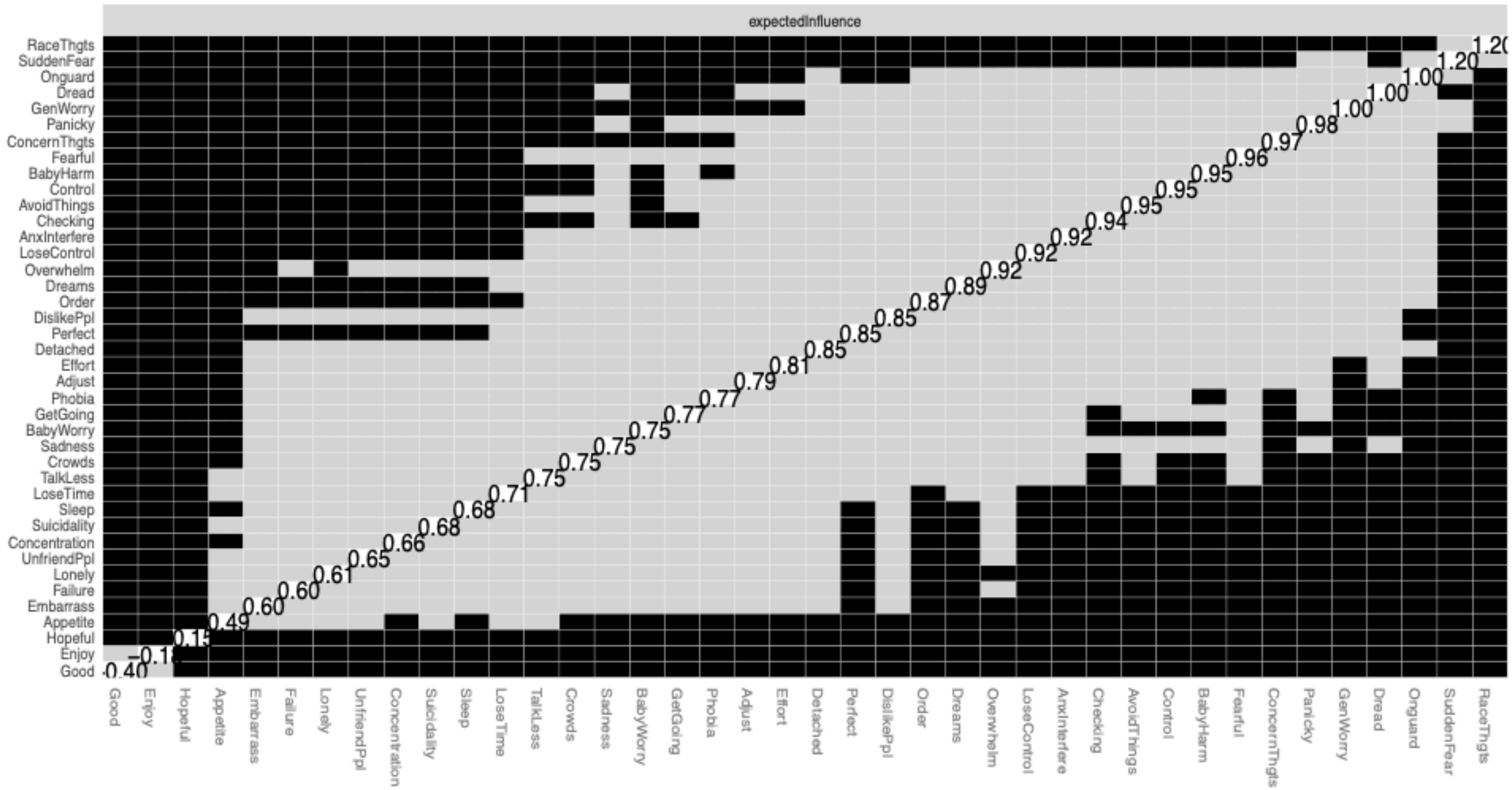


Figure 4

Plot of Bootstrapped Differences in Expected Influence Indices for the Comorbidity Network



Note. Black boxes signify significant differences at (p 0.05) level.

Comorbidity Investigation (Aim 1.3)

The comorbidity of depression and anxiety symptoms was investigated using the bridge analysis and the clique percolation community analysis.

Bridge Analysis. The bridge analysis revealed that the node with the highest bridge expected influence was the depression symptom, "*I felt fearful,*" which was higher (or more central) than 100% of other nodes in the network. The second highest bridge symptom was an anxiety symptom, "*Feeling overwhelmed,*" followed by the two depression symptoms, "*I had trouble keeping my mind on what I was doing*" and "*I felt that people dislike me.*" The stability of the centrality indices for the comorbidity network was very good (CS-coefficient = 0.67). See Table 11 for the list of the nodes with the highest bridge expected influence indices, Figure 5 for a plot of the comorbidity network's bridge expected influence indices, and Figure 6 for the bootstrapped bridge expected influence difference tests.

Table 11

List of the Nodes with the Highest Bridge Expected Influence in the Comorbidity Network

Nodes	Bridge expected influence coefficient	Higher than % of other nodes
CES-D 10. I felt fearful.	.62	100%
PASS 6. Feeling overwhelmed.	.44	73%
CES-D 5. I had trouble keeping my mind on what I was doing.	.37	78%
CES-D 19. I felt that people dislike me.	.33	65%

Note. The values for this table were obtained from the bootstrapped centrality difference test, see Figure 5.

Figure 5

Plot of Bridge Expected Influence Indices for the Comorbidity Network

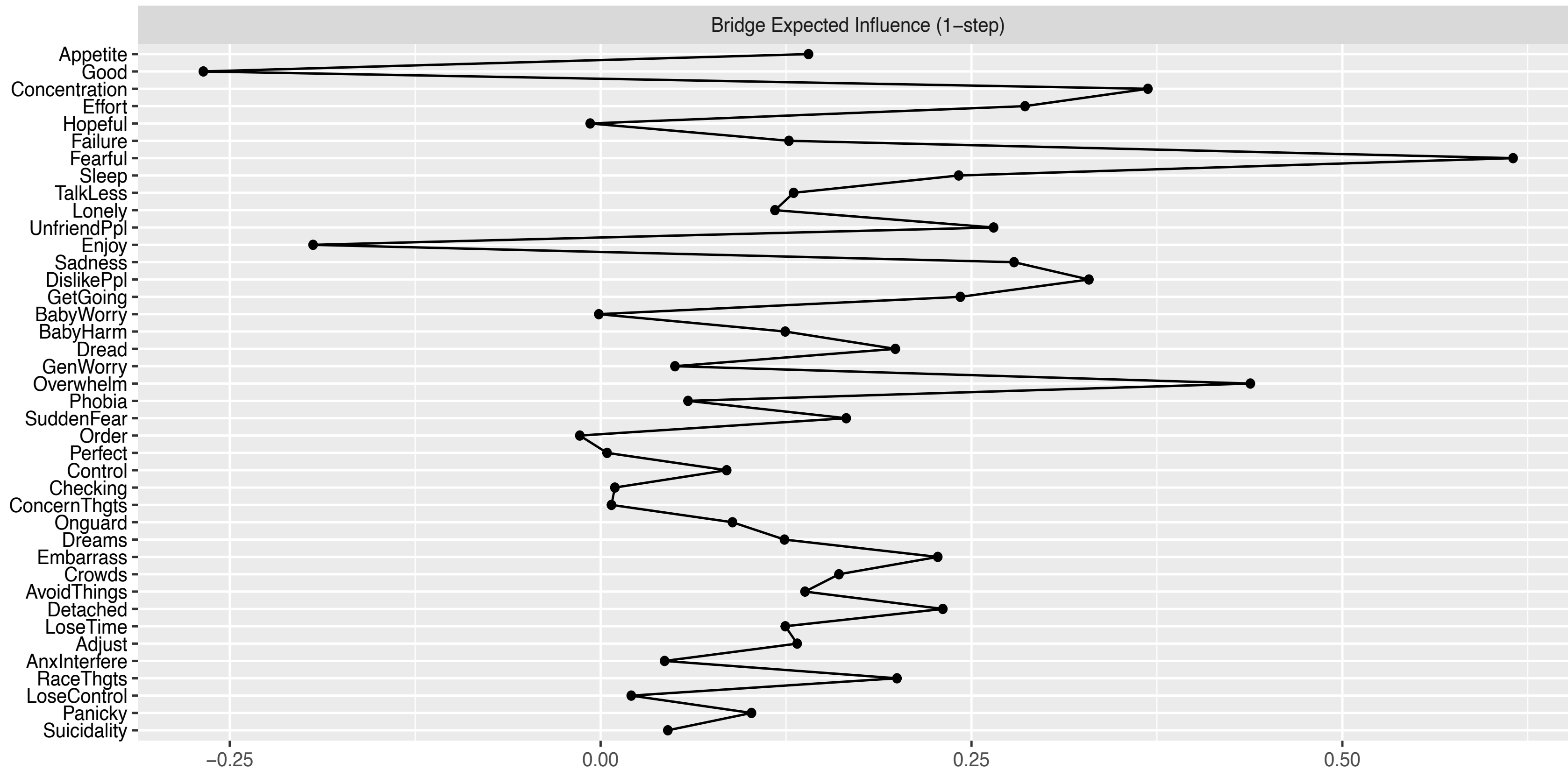
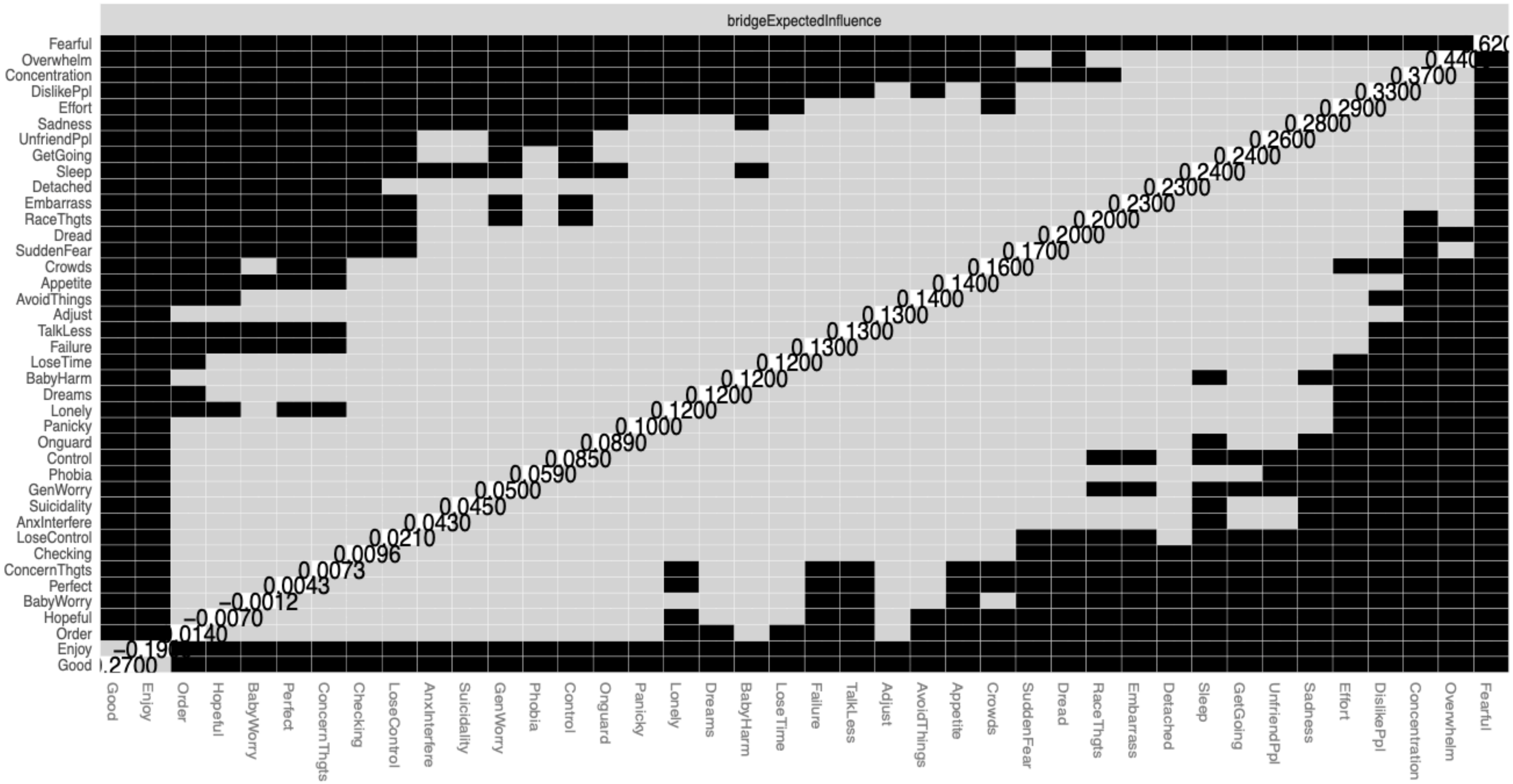


Figure 6

Plot of Bootstrapped Differences in Bridge Expected Influence Indices for the Comorbidity Network

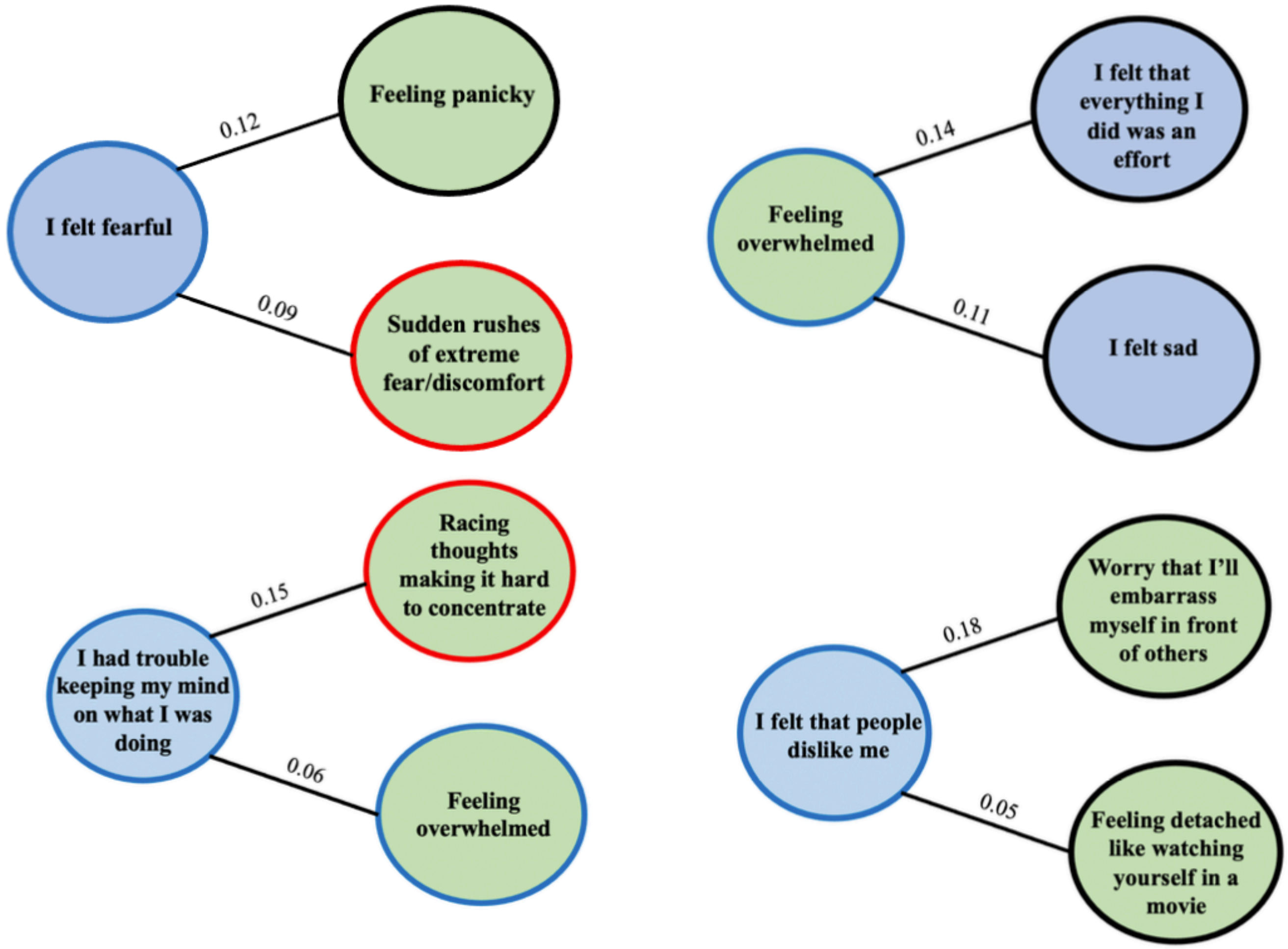


Note. Black boxes signify significant differences at (p 0.05) level.

We examined the strongest connections between a bridge symptom and the symptoms of the other disorder to identify specific "symptom spread" pathways that connected the two disorders. The bridge symptom *"I felt fearful"* (DEP) was most strongly connected to the anxiety symptoms "Feeling panicky" and *"Sudden rushes of extreme fear/discomfort",* the latter of which is a central item in the network. As for *"Feeling overwhelmed"* (ANX), it was most strongly connected to the depression symptoms *"I felt that everything I did was an effort"* and *"I felt sad."* As for the depression bridge node *"I had trouble keeping my mind on what I was doing,"* it was most strongly connected to the anxiety symptoms *"Racing thoughts making it hard to concentrate,"* a central symptom, and *"Feeling overwhelmed,"* a bridge symptom. And finally, *"I felt that people dislike me"* (DEP) was most strongly connected to the anxiety nodes "*Worry that I'll embarrass myself in front of others"* and *"Feeling detached like watching yourself in a movie"* See Figure 7 for symptom bridge pathways and partial correlation coefficients in the comorbidity network.

Figure 7

Bridge Pathways in the Comorbidity Network



Note. Blue nodes are depression nodes and green nodes are anxiety nodes. Nodes outlined in blue are bridge symptoms and nodes outlined in red are central symptoms in the comorbidity network. The values of the edges reflect partial correlation coefficients.

Community Analysis. The community threshold analysis (n = 630) revealed an optimal k = 3 and I = .108, with a ratio threshold of 1.50 and a Chi-threshold of 0.21. We also examined k = 4 but found many isolated nodes, or nodes that did not belong to any community. Therefore, at k = 3 and I = .108, the clique percolation analysis revealed nine communities with eight shared nodes and no isolated nodes. We found three depression communities that we labeled: General Depression, Somatic Depression, and Severe Depression. We also found six anxiety communities that we labeled: General Anxiety, Obsessive, Difficulty Adjusting, Panic, Social Anxiety, and Fear. We then examined the nodes that were shared by at least one depression community and one anxiety community to identify candidate symptoms that may lead to the spread of one disorder to the other. Namely, when these shared nodes (or symptoms) are activated, they would in turn activate the communities of more than one disorder. The first shared symptom was *"Feeling overwhelmed,"* which connected the General Depression, Somatic Depression, and Obsessive symptom communities. Another shared symptom across disorders was *"I felt fearful,"* which connected the General Depression and General Anxiety symptom communities. Importantly, these two symptoms were also the two highest bridge symptoms, and therefore, the findings of our clique percolation analysis triangulated the findings of our bridge analysis. See Table 12 for the list of node percentages based on the clique percolation community analysis and Figure 8 for a network model displaying the clique percolation community analysis of nodes in the comorbidity network.

Table 12

CES-D And PASS Node Percentages based on Clique Percolation Community Analysis

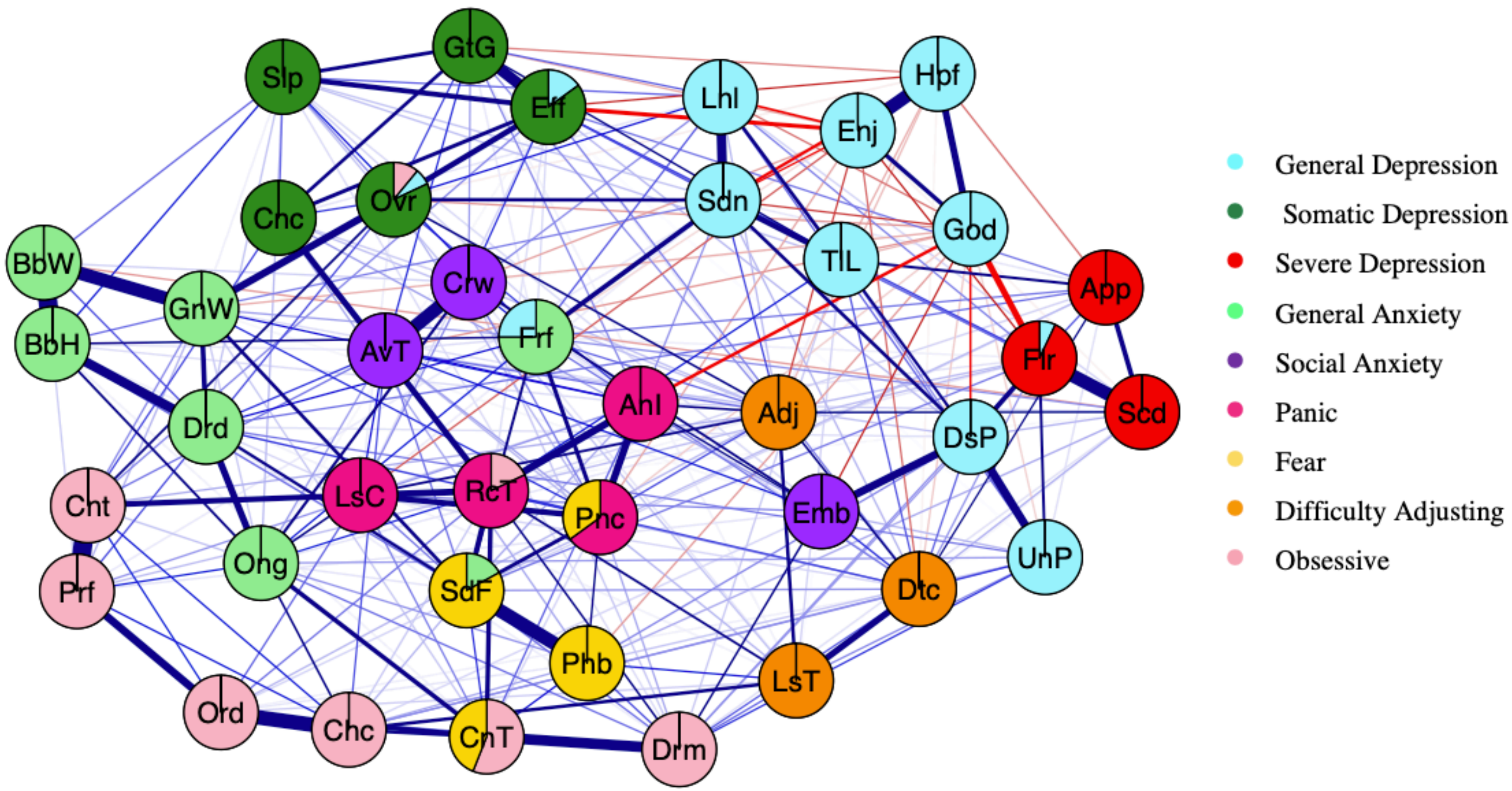
Node	1	2	3	4	5	6	7	8	9
PASS 1. Worry about the baby/pregnancy.	1								
PASS 2. Fear that harm will come to baby.	1								
PASS 3. A sense of dread that something bad is going to happen.	1								
PASS 4. Worry about many things.	1								
PASS 6. Feeling overwhelmed.		.11					.82	.07	
PASS 7. Really strong fears about things, eg needles, blood, birth, pain, etc.			1						
PASS 8. Sudden rushes of extreme fear or discomfort.	.17		.83						
PASS 11. Having to do things in a certain way or order.		1							
PASS 12. Wanting things to be perfect.		1							
PASS 13. Needing to be in control of things.		1							
PASS 14. Difficulty stopping checking or doing things over and over.		1							
PASS 16. Concerns about repeated thoughts.		.56	.44						
PASS 17. Being 'on guard' or needing to watch out for things.	1								
PASS 18. Upset about repeated memories, dreams or nightmares.		1							
PASS 19. Worry that I will embarrass myself in front of others.						1			
PASS 21. Feeling really uneasy in crowds.						1			
PASS 23. Avoiding things which concern me.						1			
PASS 24. Feeling detached like you're watching yourself in a movie.				1					

Node	1	2	3	4	5	6	7	8	9
PASS 25. Losing track of time and can't remember what happened.				1					
PASS 26. Difficulty adjusting to recent changes.				1					
PASS 27. Anxiety getting in the way of being able to do things.					1				
PASS 28. Racing thoughts making it hard to concentrate.		.18			.82				
PASS 29. Fear of losing control.					1				
PASS 30. Feeling panicky.			.35		.65				
CES-D 2. I did not feel like eating; my appetite was poor.									1
CES-D 4. I felt I was just as good as other people.								1	
CES-D 5. I had trouble keeping my mind on what I was doing.							1		
CES-D 7. I felt that everything I did was an effort.							.85	.15	
CES-D 8. I felt hopeful about the future.								1	
CES-D 9. I thought my life had been a failure.								.07	.93
CES-D 10. I felt fearful.	.75							.25	
CES-D 11. My sleep was restless.							1		
CES-D 13. I talked less than usual.								1	
CES-D 14. I felt lonely.								1	
CES-D 15. People were unfriendly.								1	
CES-D 16. I enjoyed life.								1	
CES-D 18. I felt sad.								1	
CES-D 19. I felt that people dislike me.								1	
CES-D 20. I could not get "going."							1		
SI. I thought that I would be better off dead, or I thought about hurting myself in some way.									1

Note. All item percentages are included to indicate if multiple communities shared an item.

Figure 8

Network Model of Clique Percolation Community Analysis of Nodes in the Comorbidity Network



Note. Blue edges represent positive partial correlations and red edges represent negative partial correlations.

Expanded Network

Baseline Networks (Aim 2.1)

Creating Subscales. The first step to creating the subscales was eliminating redundant items within the CES-D and the PASS scales. We conducted a *goldbricker* analysis with items from the CES-D scale, which revealed three "bad pairs:" CES-D 1 and CES-D 10, CES-D 14 and CES-D 10, and CES-D 14 and CES-D 19. The *best goldbricker* function was then used to remove one item from each "bad pair," and accordingly, CES-D 10 and CES-D 14 were removed. The results of the CES-D's goldbricker analysis are presented in Table 13. As for the inter-item correlations between the CES-D items, it revealed three problematic pairs: CES-D 3 and CES-D 6, CES-D 6 and CES-D 18, and CES-D 12 and CES-D 16. Subsequently, we removed CES-D 6 and CES-D 12. The results of the CES-D's inter-item correlation analysis are presented in Table 14.

Table 13

Bad Pairs Revealed by Goldbricker Analysis of CES-D Scale

Item 1	Item 2	% of sig.[a] diff. correlations
CES-D 1. was bothered by things that usually don't bother me.	CES-D 10. I felt fearful.	16.7%
CES-D 10. I felt fearful.	CES-D 14. I felt lonely.	16.7%
CES-D 14. I felt lonely.	**CES-D 19. I felt that people dislike me.**	16.7%

Note. Bolded items were retained in the network. All non-bolded items were removed.
[a] Significance level p=.05

Table 14

Problematic Pairs Revealed by Inter-Item Correlation Analysis of CES-D Scale

Item 1	Item 2	Inter-item correlation
CES-D 3. I felt that I could not shake off the blues even with help from my family or friends.	CES-D 6. I felt depressed.	.73
CES-D 6. I felt depressed.	**CES-D 18. I felt sad.**	.72
CES-D 12. I was happy.	**CES-D 16. I enjoyed life.**	.74

Note. Bolded items were retained in the network. All non-bolded items were removed.

As for the *goldbricker* analysis conducted with items from the PASS scale, we identified three bad pairs: PASS 22 and PASS 23, PASS 22 and PASS 31, and PASS 23 and PASS 31. Then, the *best goldbricker* function removed PASS 22 and PASS 31. The results of the PASS's goldbricker analysis are presented in Table 15. Next, we ran inter-item correlations between the PASS items and found two problematic pairs: PASS 4 and PASS 5 and PASS 19 and PASS 20. Subsequently, we removed PASS 5 and PASS 20. The results of the PASS's inter-item correlation analysis are presented in Table 16. Following the item reduction analyses, we retained 16 items from the CES-D scale and 27 items from the PASS scale. Following the goldbricker and inter-item correlation analyses, we investigated multicollinearity by calculating the VIFs of the retained items. Our analysis revealed that no item had a VIF between 5 and 10, and therefore, no additional items were removed.

Table 15

Bad Pairs Revealed by Goldbricker Analysis of PASS Scale

Item 1	Item 2	% of sig.[a] diff. correlations
PASS 22. Avoiding social activities because I might be nervous.	**PASS 23. Avoiding things which concern me.**	20.7%
PASS 22. Avoiding social activities because I might be nervous.	PASS 31. Feeling agitated.	20.7%
PASS 23. Avoiding things which concern me.	PASS 31. Feeling agitated.	24.1%

Note. Bolded items were retained in the network. All non-bolded items were removed.
[a] Significance level p=.05

Table 16

Problematic Pairs Revealed by Inter-Item Correlation Analysis of PASS Scale

Item 1	Item 2	Inter-item correlation
PASS 4. Worry about many things.	PASS 5. Worry about the future.	.74
PASS 19. Worry that I will embarrass myself in front of others.	PASS 20. Fear that others will judge me negatively.	.73

Note. Bolded items were chosen to be included in the network. All non-bolded items were removed.

Following the item reduction analyses, we conducted two clique percolation community analyses, one for each scale. The community threshold analysis for the sixteen items retained in the CES-D scale revealed optimal k = 4 and I = .089, with a ratio threshold of 2 and Chi-threshold of 2.69. We also examined k = 3 but found that the ratio-threshold was too low comparatively, and there were more isolated nodes. Therefore, at k = 4 and I = .089, the clique percolation analysis revealed three communities with six shared nodes and no isolated nodes. We labeled the three CES-D communities: Depressed Mood, Somatic Depression, and Interpersonal Sensitivity. Regarding the shared nodes, the nodes "*I was bothered by things that usually don't bother me*," "*I talked less than usual," "I felt that everything I did was an effort," and "I could not get "going,"* were shared by the Depressed Mood and Somatic Depression communities. Based on their node percentages, all four shared items were assigned to the Somatic Depression community. The nodes "*I thought my life had been a failure"* and *"I felt as good as other people"* were shared by the Depressed Mood and Interpersonal Sensitivity communities. Based on their node percentages, both shared items were assigned to the Interpersonal Sensitivity community. Following the community analysis, three depression subscales were created: Depressed Mood, Somatic Depression, and Interpersonal Sensitivity. See Table 17 for the list of node percentages based on the clique percolation community analysis and Figure 9 for a network model displaying the clique percolation community analysis for the CES-D scale items.

Table 17

CES-D Item Percentages Based on the Clique Percolation Community Analysis

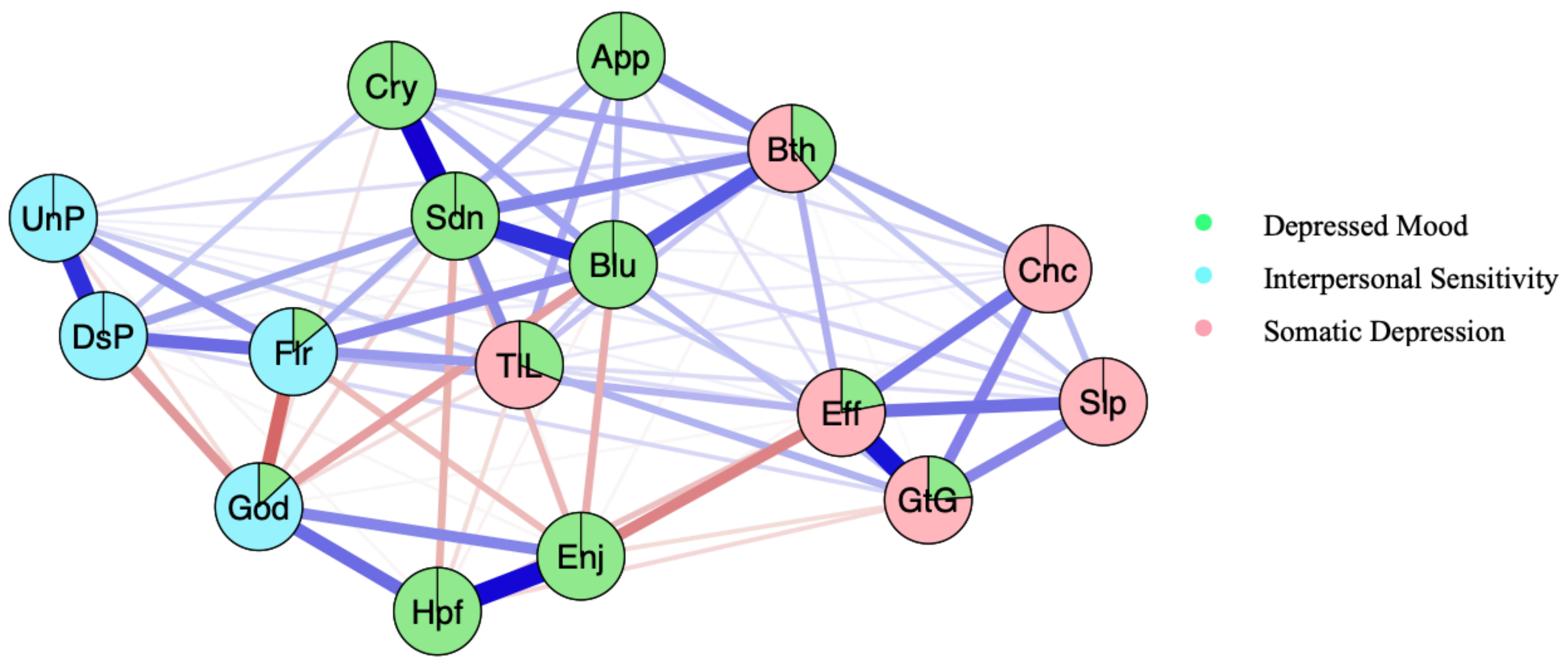
Item	1	2	3
CES-D 1. I was bothered by things that usually don't bother me.	.39	.61[a]	
CES-D 2. I did not feel like eating; my appetite was poor.	1		
CES-D 3. I felt that I could not shake off the blues even with help from my family or friends.	1		
CES-D 4. I felt I was just as good as other people.	.14		.86[a]
CES-D 5. I had trouble keeping my mind on what I was doing.		1	
CES-D 7. I felt that everything I did was an effort.		.78[a]	
CES-D 8. I felt hopeful about the future.	1		

Item	1	2	3
CES-D 9. I thought my life had been a failure.	.15		.85[a]
CES-D 11. My sleep was restless.		1	
CES-D 13. I talked less than usual.	.31	.69[a]	
CES-D 15. People were unfriendly.			1
CES-D 16. I enjoyed life.	1		
CES-D 17. I had crying spells.	1		
CES-D 18. I felt sad.	1		
CES-D 19. I felt that people dislike me.			1
CES-D 20. I could not get "going."	.24	.76[a]	

Note. Item percentages were calculated as the sum of the absolute values of a node's edges to each community divided by the number of nodes in that community.
[a] The item was assigned to this community prior to creating the subscales.

Figure 9

Network Model of Clique Percolation Community Analysis of CES-D Scale



Note. **Bth:** I was bothered by things that usually don't bother me. **App:** I did not feel like eating; my appetite was poor. **Cry:** I had crying spells. **Sdn:** I felt sad. **Blu:** I felt that I could not shake off the blues even with help from my family or friends. **Hpf:** I felt hopeful about the future. **Enj:** I enjoyed life. **Cnc:** I had trouble keeping my mind on what I was doing. **Eff:** I felt that everything I did was an effort. **Slp:** My sleep was restless. **TlL:** I talked less than usual. **GtG:** I could not get "going. **Flr:** I thought my life had been a failure. **DsP:** I felt that people dislike me. **God:** I felt I was just as good as other people. **UnP:** People were unfriendly.

As for the community threshold analysis for the twenty-seven retained items from the PASS scale, it revealed an optimal k = 3 and I = .097, with a ratio threshold of 1.63 and Chi-threshold of .41. We also examined k = 4 but found that there was a very high number of isolated nodes. Therefore, at k = 3 and I = .097, the clique percolation analysis revealed six communities with nine shared nodes and one isolated node. We labeled the six communities: Generalized Anxiety, Obsessive, Difficulty Adjusting, Fear, Panic, and Social Anxiety. Our analysis revealed nine nodes that were shared by more than one community. The node "*Worry about many things*" was shared by the Generalized Anxiety and Fear communities and was assigned to the latter based on its node percentage. The nodes "*Feeling overwhelmed*" and "*Concerns about repeated thoughts*" were shared by the Fear and Obsessive communities, and both were assigned to the latter based on their node percentages. The node "*Losing track of time and can't remember what happened*" was shared by the Difficulty Adjusting and Obsessive communities, and the node "*Difficulty adjusting to recent changes*" was shared by the Difficulty Adjusting and Fear communities. Based on their node percentages, both nodes were assigned to the Difficulty Adjusting community. The node "*Feeling jumpy or easily startled*" was shared by the Panic and Obsessive communities, the node "*Sudden rushes of extreme fear or discomfort*" was shared by the Panic, Generalized Anxiety, and Fear communities, and the node "*Racing thoughts making it hard to concentrate*" was shared by the Panic, Fear, and Difficulty Adjusting communities. All three nodes were assigned to the Panic community based on their node percentages. Finally, the node "*Being 'on guard' or needing to watch out for things*" was shared by the Generalized Anxiety, Fear, and Social Anxiety communities, and was assigned to Social Anxiety based on its node percentage.

As for the isolated node, which did not belong to any community, it was the PASS item: "*Difficulty sleeping even when I have the chance to sleep*." Accordingly, we did not assign this node to any subscale, and we removed it from the subsequent network analyses. Following the community analysis, we created six anxiety subscales: Generalized Anxiety, Obsessive, Difficulty Adjusting, Fear, Panic, and Social Anxiety. See Table 18 for the list of node percentages based on the clique percolation community analysis and Figure 10 for a network model displaying the clique percolation community analysis for the PASS scale items.

Table 18

PASS Item Percentages based on the Clique Percolation Community Analysis

Item	1	2	3	4	5	6
PASS 1. Worry about the baby/pregnancy.	1					
PASS 2. Fear that harm will come to baby.	1					
PASS 3. A sense of dread that something bad is going to happen.	1					
PASS 4. Worry about many things.	.79[a]		.21			
PASS 6. Feeling overwhelmed.		.62[a]	.38			
PASS 7. Really strong fears about things, eg needles, blood, birth, pain, etc.			1			
PASS 8. Sudden rushes of extreme fear or discomfort.	.15		.10			.75[a]
PASS 9. Repetitive thoughts that are difficult to stop or control.			1			
PASS 10. Difficulty sleeping even when I have the chance to sleep.[b]						
PASS 11. Having to do things in a certain way or order.		1				
PASS 12. Wanting things to be perfect.		1				
PASS 13. Needing to be in control of things.		1				

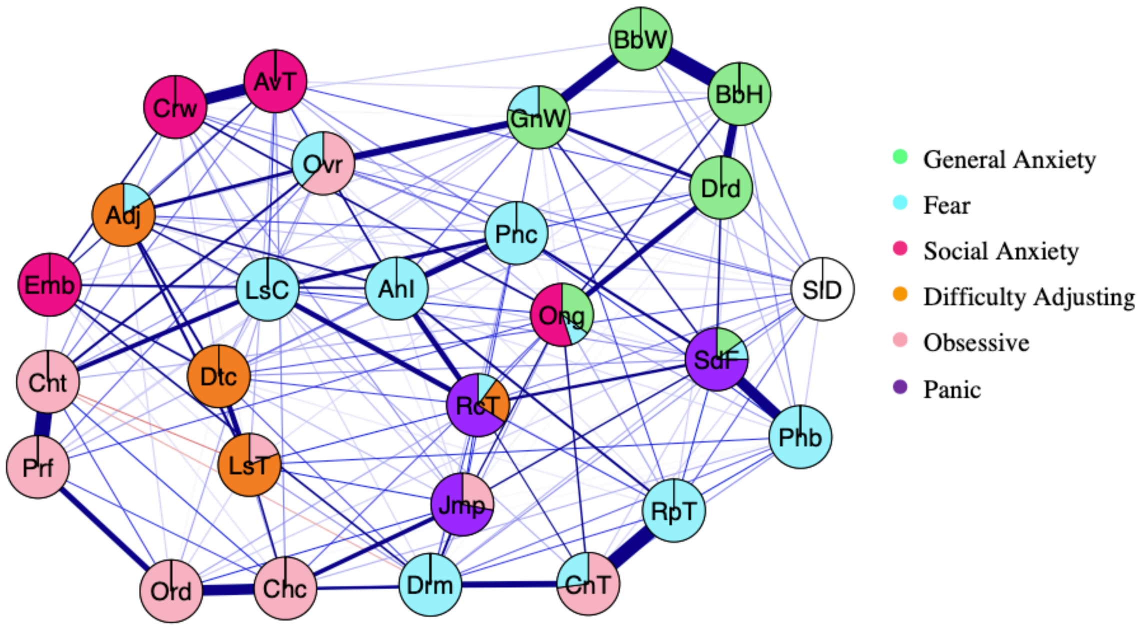
Item	1	2	3	4	5	6
PASS 14. Difficulty stopping checking or doing things over and over.		1				
PASS 15. Feeling jumpy or easily startled.		.28				.72[a]
PASS 16. Concerns about repeated thoughts.		.73[a]	.27			
PASS 17. Being 'on guard' or needing to watch out for things.	.36	.09			.55[a]	
PASS 18. Upset about repeated memories, dreams or nightmares.			1			
PASS 19. Worry that I will embarrass myself in front of others.					1	
PASS 21. Feeling really uneasy in crowds.					1	
PASS 23. Avoiding things which concern me.					1	
PASS 24. Feeling detached like you're watching yourself in a movie.				1		
PASS 25. Losing track of time and can't remember what happened.		.19		.81[a]		
PASS 26. Difficulty adjusting to recent changes.			.16	.84[a]		
PASS 27. Anxiety getting in the way of being able to do things.			1			
PASS 28. Racing thoughts making it hard to concentrate.		.10		.24		.66[a]
PASS 29. Fear of losing control.			1			
PASS 30. Feeling panicky.			1			

Note. Item percentages were calculated as the sum of the absolute values of a node's edges to each community divided by the number of nodes in that community.
[a]The item was assigned to this community prior to creating the subscales.

[b]Isolated node.

Figure 10

Network Model of Clique Percolation Community Analysis of PASS Scale



Note. **BbW:** Worry about the baby. **BbH:** Fear that harm will come to baby. **Drd:** Sense of dread - something bad is going to happen. **GnW:** Worry about many things. **Ovr:** Feeling overwhelmed. **AvT:** Avoiding things which concern me. **Emb:** Worry that I'll embarrass myself in front of others. **Crw:** Feeling really uneasy in crowds. **Dtc:** Feeling detached like watching yourself in a movie. **LsT:** Losing track of time and can't remember what happened. **Adj:** Difficulty adjusting to recent changes. **AnI:** Anxiety getting in the way of being able to do things. **Pnc:** Feeling panicky. **LsC:** Fear of losing control. **Ong:** Being 'on guard' or needing to watch out for things. **SdF:** Sudden rushes of extreme fear/discomfort. **Jmp:** Feeling jumpy or easily startled. **Phb:** Really strong fears about things eg blood, birth, pain, needles. **RpT:** Repetitive thoughts that are difficult to stop or control. **SlD:** Difficulty sleeping even when there is the chance to sleep. **Cnt:** Needing to be in control of things. **Prf:** Wanting things to be perfect. **Ord:** Having to do things in a certain way or order. **Chc:** Difficulty stopping checking or doing things over and over. **CnT:** Concerns about repeated thoughts. **Drm:** Upset about repeated memories, dreams or nightmares. **RcT:** Racing thoughts making it hard to concentrate.

Baseline Node Predictability. After the community analysis, we estimated three baseline networks, all of which had excellent stability (CS-coefficient = 0.75). The first baseline network was a depression network that included the three depression subscales as well as a suicidality node based on the adapted PHQ-9 item. Each depression subscale was moderately predicted by the other nodes in the depression network, namely, node predictability was 63.7% for Depressed Mood, 52.3% for Somatic Depression, and 53.0% for Interpersonal Sensitivity. On the other hand, the node predictability of the Suicidality item was 26.6%, indicating that more than a fourth of its variance was explained by the other nodes in the network.

The second baseline network included the six subscales of anxiety. The node predictability values of the subscales varied from 78.6% for the Fear subscale to 45.2% for Generalized Anxiety. We then combined the nodes from depression and anxiety networks in a joint network to examine the changes in node predictability values for each subscale. Our results revealed that all node predictabilities increased. The increases in the node predictability of the depression subscales ranged from 1.2% for the Depressed Mood subscale to 8.4% for Somatic Depression. Similarly, the increases in the node predictability of the anxiety subscales ranged from 0.5% for the Panic subscale to 5.1% for Difficulty Adjusting. As for the Suicidality item, the anxiety subscales explained an additional 4.4% of its variance. See Table 19 for the predictability values, and Figure 11 for the predictability network models, of the three baseline networks, the main expanded network, and the three additional expanded networks.

Table 19

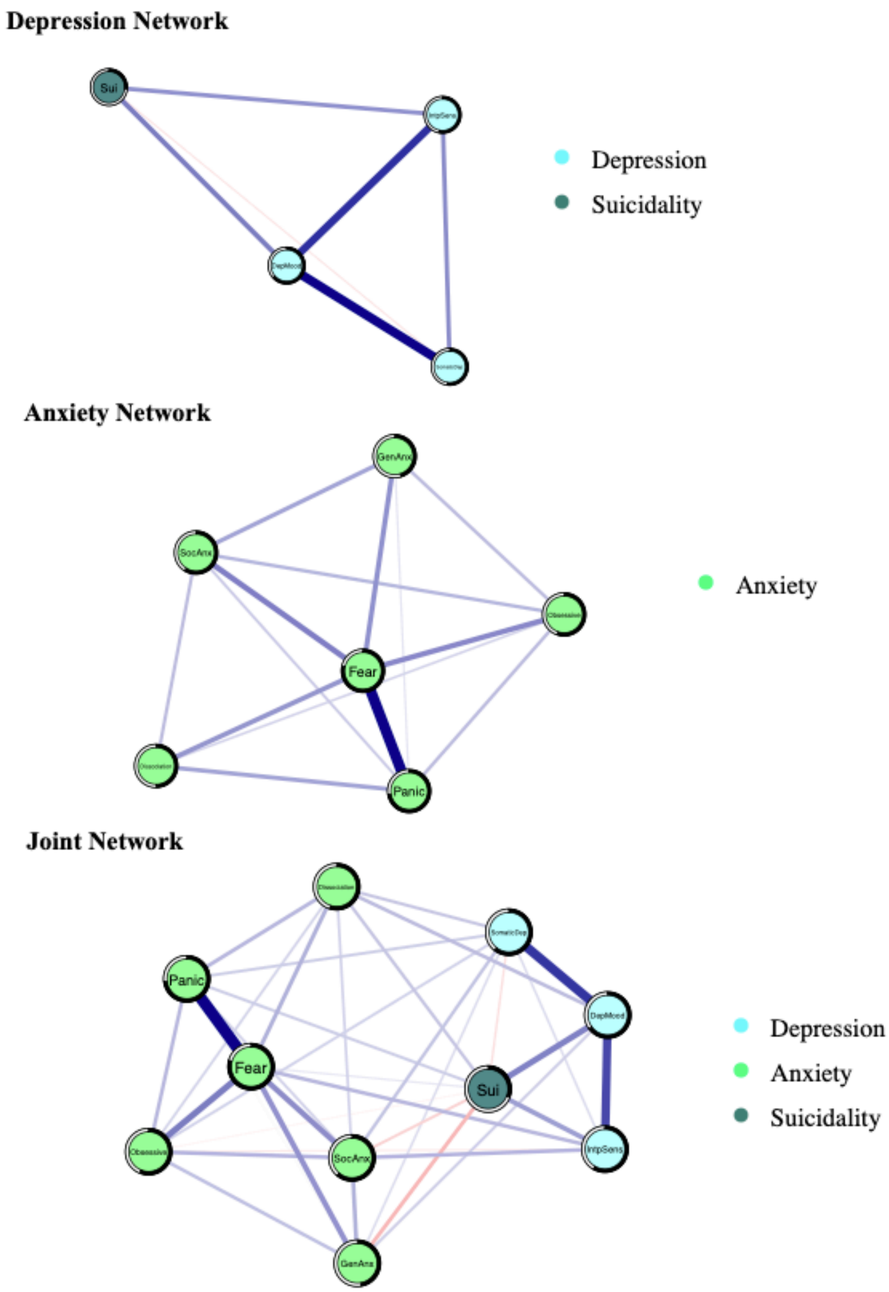
Node Predictability of Depression and Anxiety Symptom Domains Across Networks

Nodes	**Depression Network**	**Anxiety Network**	**Joint Depression and Anxiety Network**	**Expanded Network 1:** + Stressors	**Expanded Network 2:** + Maternal Functioning	**Expanded Network 3:** + Positive Experiences	**Expanded Network 4:** + Significant Predictors
Depressed Mood	63.7%		64.9%	65.4%	67.6%	67.8%	67.9%
Somatic Depression	52.3%		60.7%	63.2%	63.4%	63.5%	63.7%
Interpersonal Sensitivity	53.0%		58.3%	60.0%	59.2%	59.3%	59.9%
Suicidality[a]	26.6%		31.0%	35.0%	35.5%	36.0%	38.1%
Generalized Anxiety		45.2%	47.4%	48.7%	51.0%	51.7%	52.5%
Obsessiveness		55.5%	56.2%	57.8%	58.1%	58.9%	60.4%
Fear		78.6%	79.4%	79.4%	79.3%	79.4%	80.3%
Difficulty Adjusting		49.9%	55.0%	57.0%	56.9%	57.3%	58.4%
Social Anxiety		59.0%	61.2%	60.9%	61.1%	61.0%	63.5%
Panic		72.5%	73.0%	73.3%	73.0%	74.1%	74.4%

[a]This node is based on a single item, not a subscale.

Figure 11

Network Predictability Models

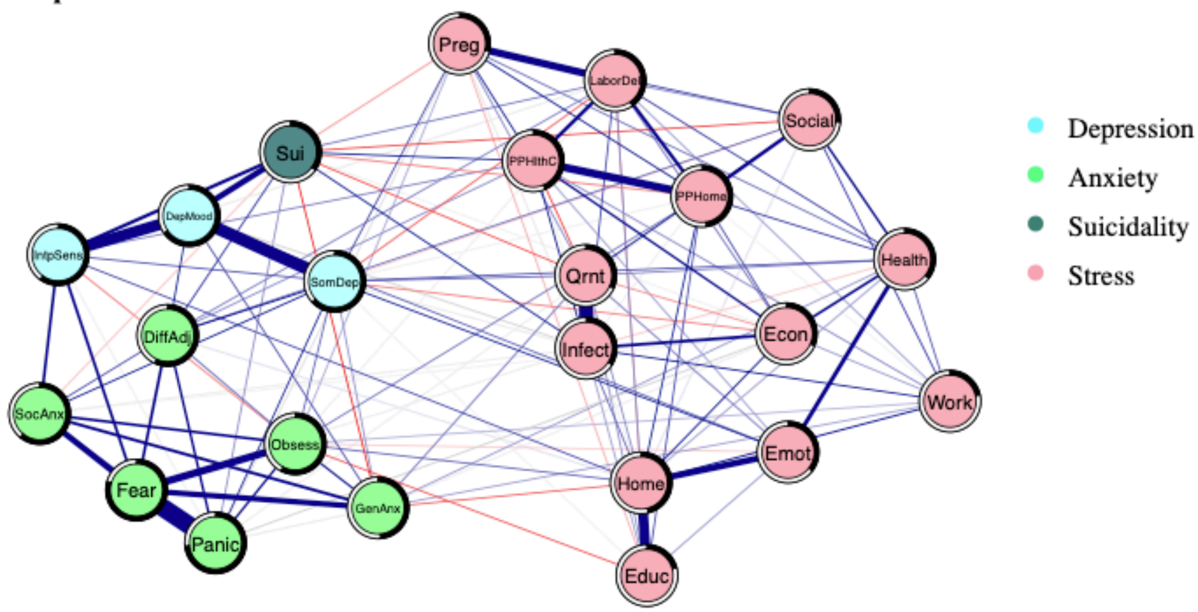


Note. Rings around the nodes represent node predictability. The dark portion of the ring corresponds to the percentage of a node's variance that is explained by the other nodes in the network.

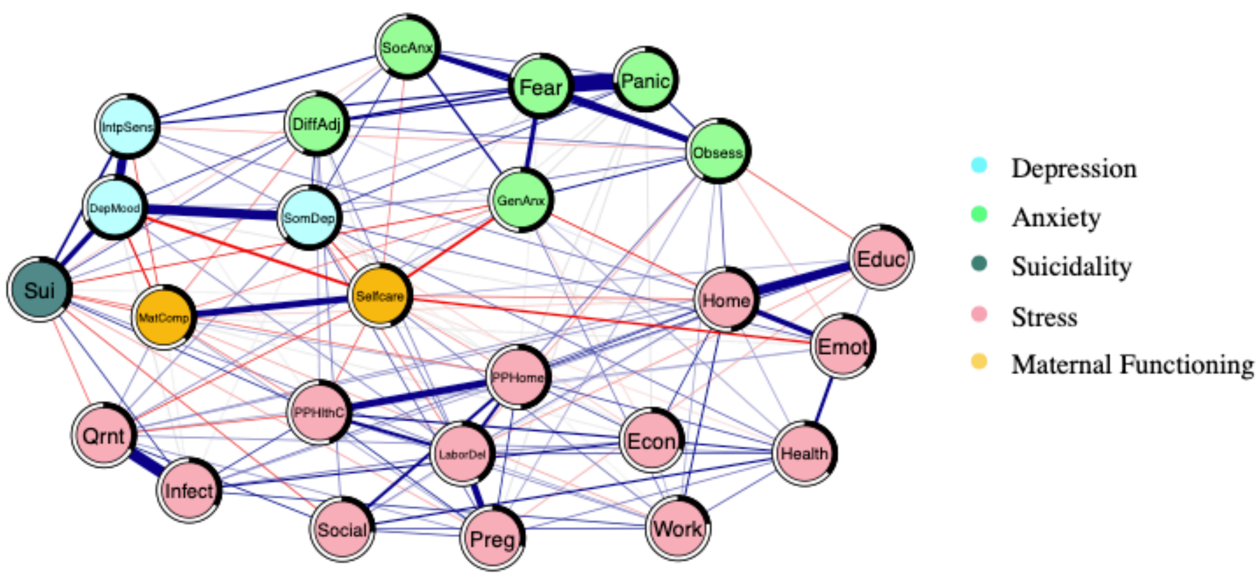
Figure 11 (Continued)

Network Predictability Models

Expanded Network 1



Expanded Network 2

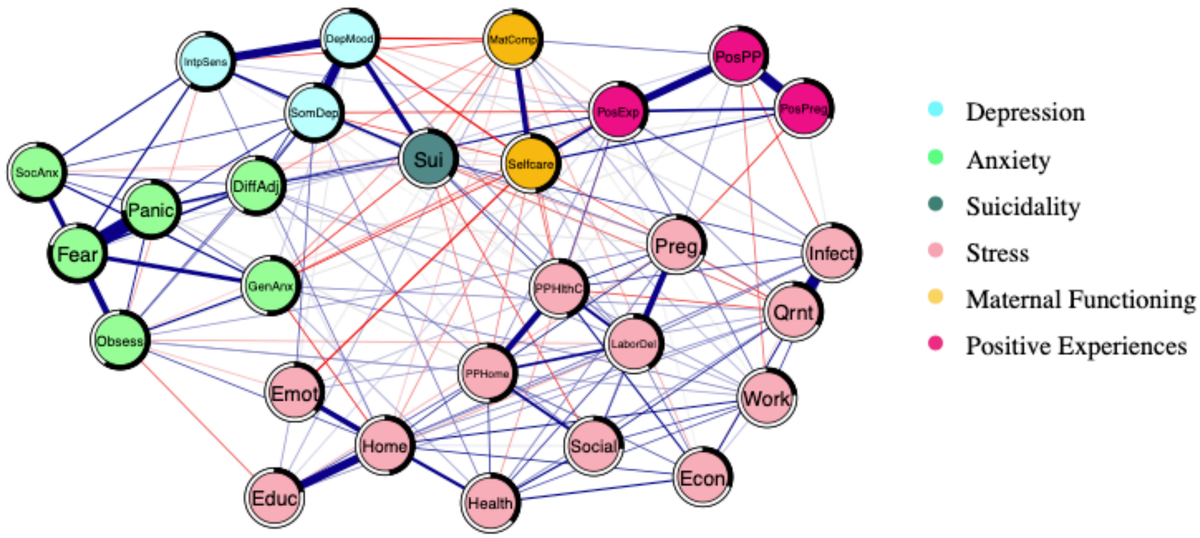


Note. Rings around the nodes represent node predictability. The dark portion of the ring corresponds to the percentage of a node's variance that is explained by the other nodes in the network.

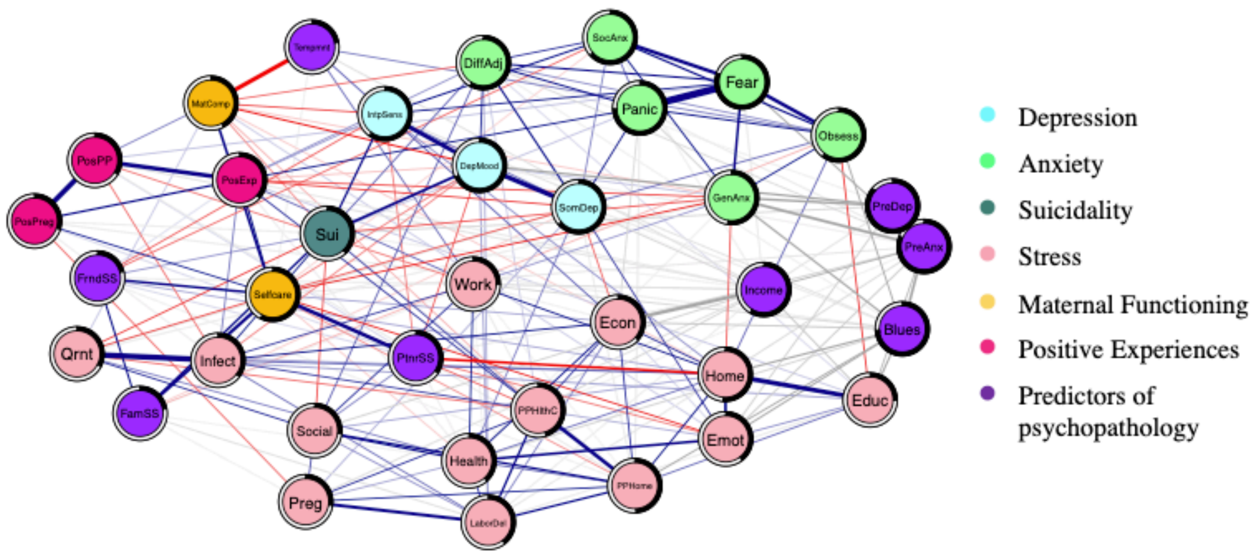
Figure 11 (Continued)

Network Predictability Models

Expanded Network 3



Expanded Network 4



Note. Rings around the nodes represent node predictability. The dark portion of the ring corresponds to the percentage of a node's variance that is explained by the other nodes in the network.

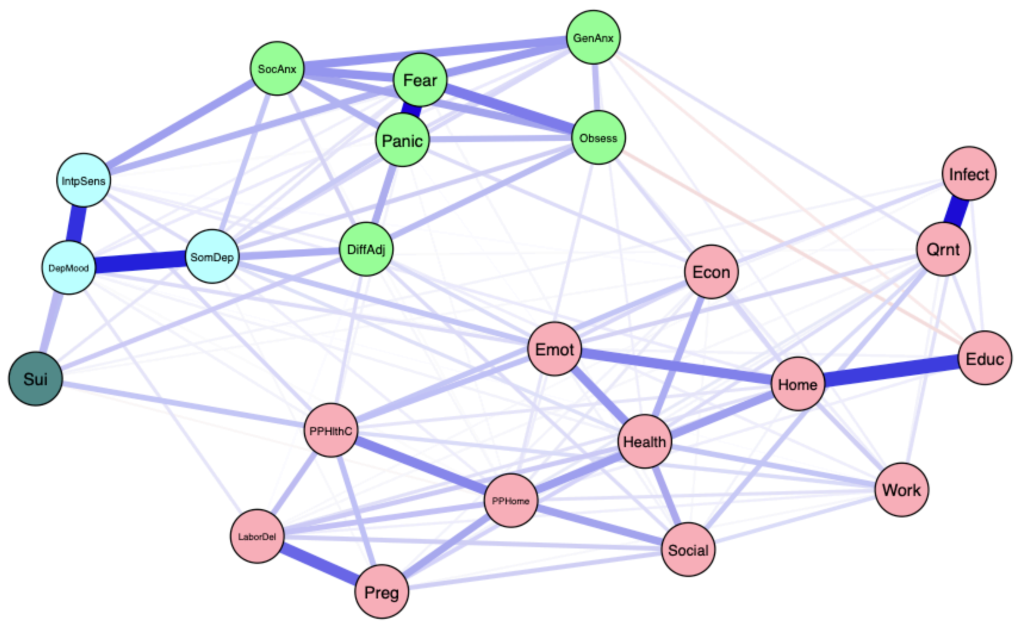
Expanded Network (Aim 2.2)

Network Estimation. The estimated expanded network is presented in Figure 12. Edge-weight stability for the expanded network was very good (CS-coefficient = 0.67), and therefore, edges between nodes can be interpreted with a degree of confidence. As expected, the expanded network had more significant and stronger symptom-symptom connections and stressor-stressor connections than symptom-stressor connections. Specifically, of the 130 possible connections between psychological symptoms and stressors, only 39 (30%) emerged as significant in the network and the majority of them were positive. The strongest positive relationships in the expanded network were between *Fear* and *Panic, Infection Stress* and Quarantine Stress, Somatic *Depression* and *Depressed Mood, Depressed Mood* and *Interpersonal Effectiveness,* and *Home Stress* and *Educational Stress.*

The strongest positive symptom-stressor relationships were between the *Emotional Stress* subscale and the *Somatic Depression* subscale, as well as between the *Postpartum Healthcare Stress* subscale and *Suicidality* item. Interestingly, the *Social Activities* stress subscale, which included items like being separated from family and friends, canceled family celebrations and religious activities, and inability to engage in enjoyable activities, was positively associated with symptoms of *Fear* and *Difficulty Adjusting* but negatively associated with *Suicidality*. As for the strongest negative connections, they were connections between the *Educational* Stress subscale and psychological symptoms, namely *General Anxiety* and *Obsessive* symptoms. This means that if participants endorsed that they or their children were out of school during the pandemic, they also reported less generalized anxiety and obsessive symptoms.

Figure 12

Expanded Network: Regularized Partial Correlation Network of Symptoms of Psychopathology and Stressors



Note. Blue edges represent positive partial correlations and red edges represent negative partial correlations.

Psychopathology Nodes:

- **GenAnx:** Generalized Anxiety subscale. (ANX)
- **Obssess:** Obsessive subscale. (ANX)
- **Fear:** Fear subscale. (ANX)
- **Panic:** Panic subscale. (ANX)
- **DiffAdj:** Dissociation subscale. (ANX)
- **SocAnx:** Social Anxiety subscale. (ANX)
- **DepMood:** Depressed Mood subscale. (DEP)
- **SomDep:** Somatic depression subscale. (DEP)
- **IntpSens:** Interpersonal Sensitivity subscale. (DEP)
- **Sui:** Suicidality item: I thought that I would be better off dead, or I thought about hurting myself in some way. (DEP)

Stressor Nodes:

- Infect: Infection Stress subscale.
- Qrnt: Quarantine Stress subscale.
- Educ: Education Stress subscale.
- Econ: Economic Stress subscale.
- Home: Home Stress subscale.
- Work: Work Stress subscale.
- Emot: Emotional Stress subscale.
- Health: Health Stress subscale.
- Social: Social Stress subscale.
- PPHome: Postpartum Home Stress subscale.
- PPHlthC: Postpartum Healthcare Stress subscale.
- Preg: Postpartum Home Stress subscale.
- LaborDel: Labor and Delivery Stress subscale.

With respect to the highest cross-disorder relationships, among the psychological symptom subscales, symptoms of *Depressed Mood* and *Difficulty Adjusting* had the highest number of connections with the stressor nodes, whereas the *Social Anxiety* subscale had the lowest number of connections. On the other hand, among the stressor subscales, the two postpartum stress subscales (*Healthcare and Home*) had the highest number of connections with the psychological symptoms, whereas the stress subscales of *Infection* and *Pregnancy* had the lowest number of connections.

Network Inference. Regarding the centrality indices, the node with the highest expected influence in the expanded network was the *Fear* symptom subscale, which was higher than 100% of other nodes in the network. The second node with the highest expected influence is the *Depressed Mood* symptom subscale*,* followed by the *Home Stress* subscale*,* and finally, the *Postpartum Home stress subscale.* The stability of the centrality indices for the expanded network was very good (CS-coefficient = 0.67). See Table 20 for the list of nodes with the highest expected influence indices in the expanded network, Figure 13 for a plot of the expanded network's expected influence indices, and Figure 14 for the bootstrapped centrality difference tests.

Table 20

List of the Nodes with the Highest Expected Influence in the Expanded Network

Nodes	Expected influence coefficient	Higher than % of other nodes
Fear subscale. *(PASS subscale)*	2.09	100%
Depressed mood subscale. *(CES-D subscale)*	1.22	83%
Home stress. *(stress subscale)*	1.19	69%
Postpartum home stress. *(stress subscale)*	.97	57%

Note. The values for this table were obtained from the bootstrapped centrality difference test, see Figure 14.

Figure 13

Plot of Expected Influence Indices for the Expanded Network

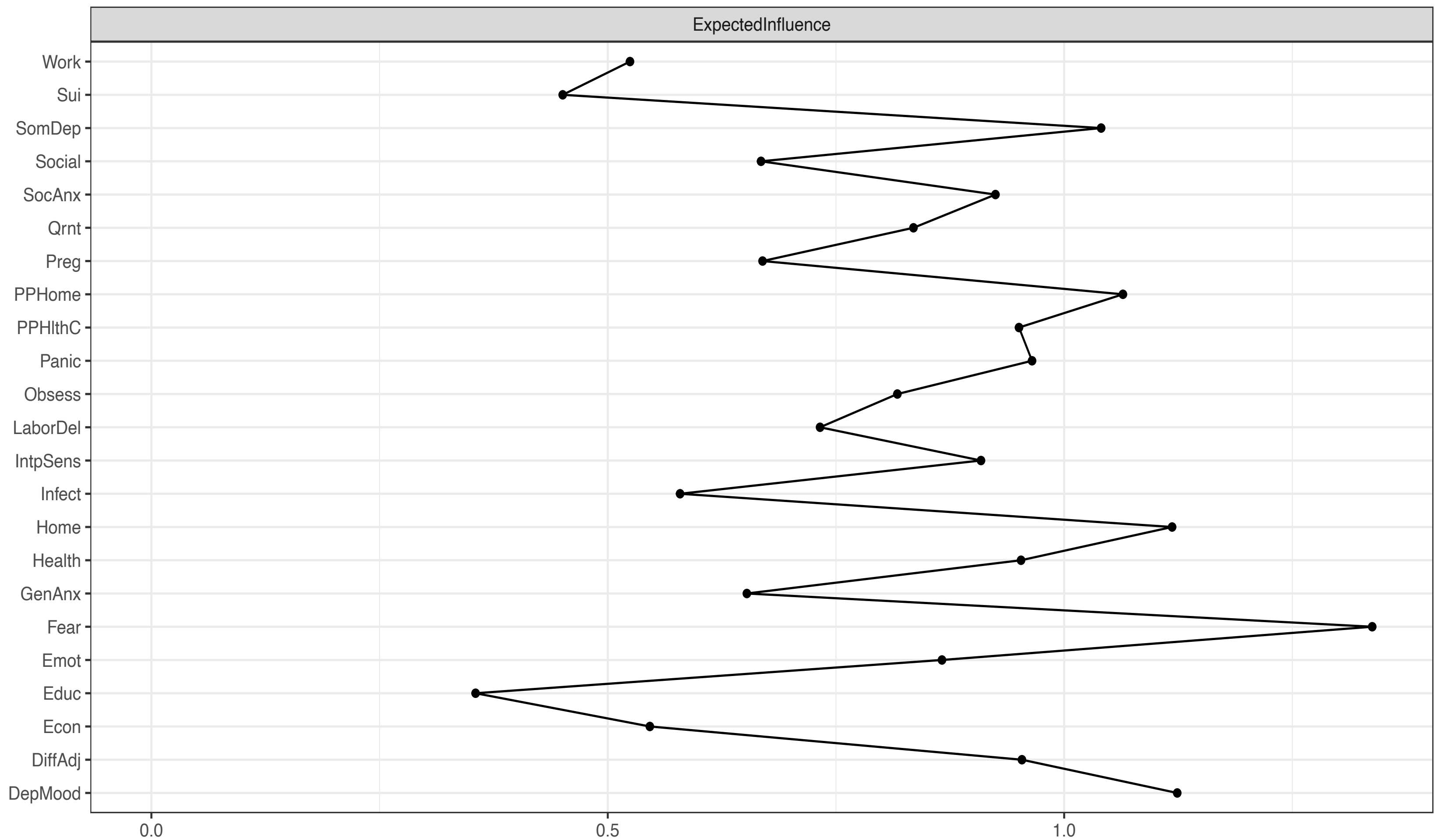
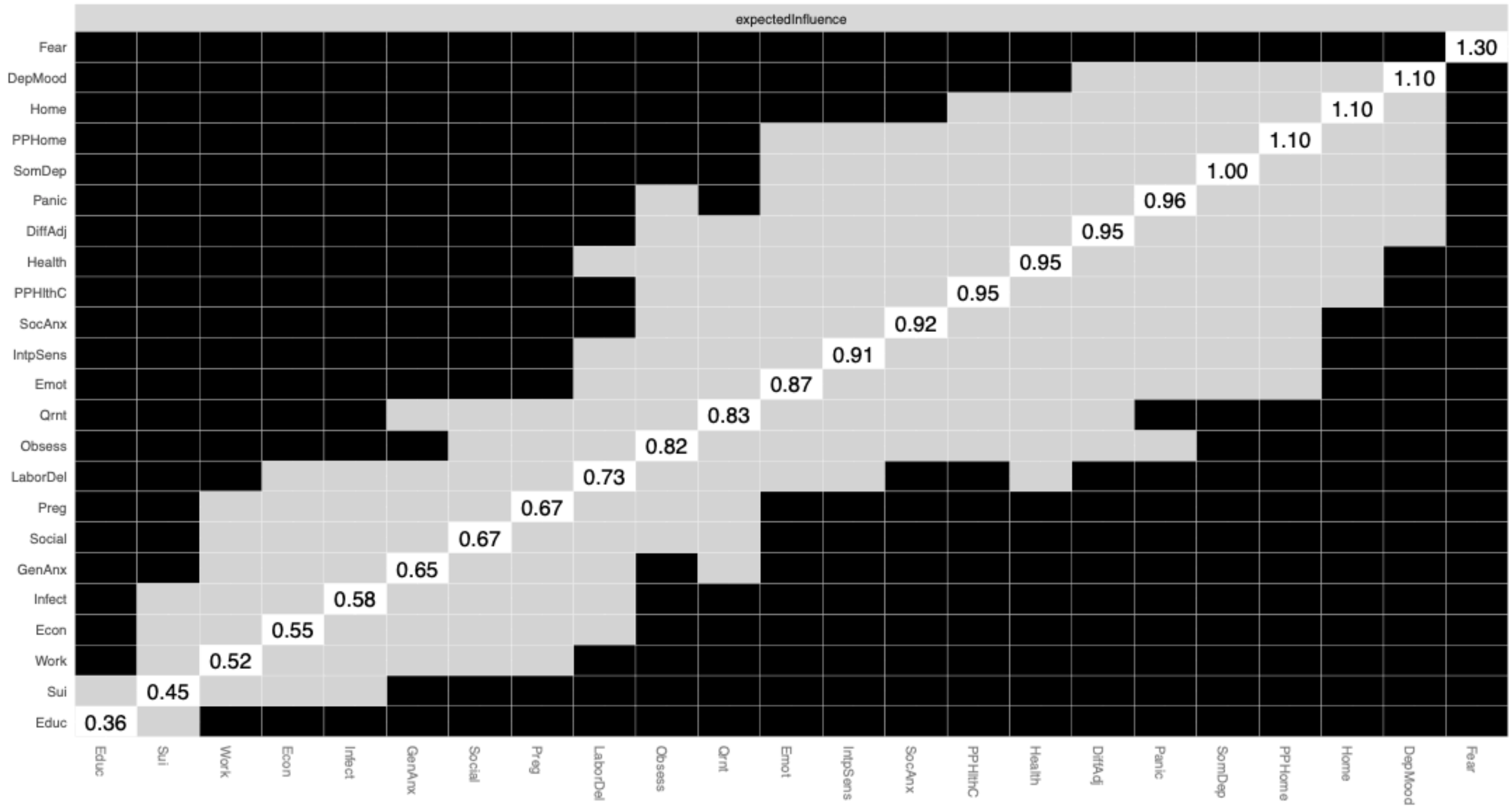


Figure 14

Plot of Bootstrapped Differences in Expected Influence Indices for the Expanded Network



Note. Black boxes signify significant differences at (p 0.05) level.

As for the bridge centrality indices, the two nodes with the highest bridge indices were stress subscales of *Postpartum Healthcare Stress* and *Emotional Stress,* followed by the *Difficulty Adjusting* symptom subscale. When we examined bridge pathways, we found that several of the bridge nodes were strongly connected to each other. The *Postpartum Healthcare Stress* subscale was most strongly connected to the symptoms of *Suicidality* and *Interpersonal Sensitivity*. The *Emotional Stress* subscale was most strongly connected to the symptoms of *Somatic Depression* and *Difficulty Adjusting*, the latter of which was a bridge node in the network. Finally, the *Difficulty Adjusting* subscale was most strongly connected to *Postpartum Healthcare Stress* and *Emotional Stress*, both of which are bridge symptoms in the network. The stability of the bridge centrality indices for the expanded network was good (CS-coefficient = 0.60). See Table 21 for the list of nodes with the highest bridge expected influence indices in the expanded network, Figure 15 for a plot of the expanded network's bridge expected influence indices, and Figure 16 for the bootstrapped centrality difference tests. See Figure 17 for symptom bridge pathways and partial correlation coefficients for the expanded network.

Table 21

List of the Nodes with the Highest Bridge Expected Influence in the Expanded Network

Items	Bridge expected influence coefficient	Higher than % of other nodes
Postpartum healthcare stress. *(stress subscale)*	.25	77%
Emotional stress. *(stress subscale)*	.21	73%
Difficulty adjusting subscale. *(PASS subscale)*	.20	41%

Note. The values for this table were obtained from the bootstrapped centrality difference test, see Figure 14.

Figure 15

Plot of Bridge Expected Influence Indices for the Expanded Network

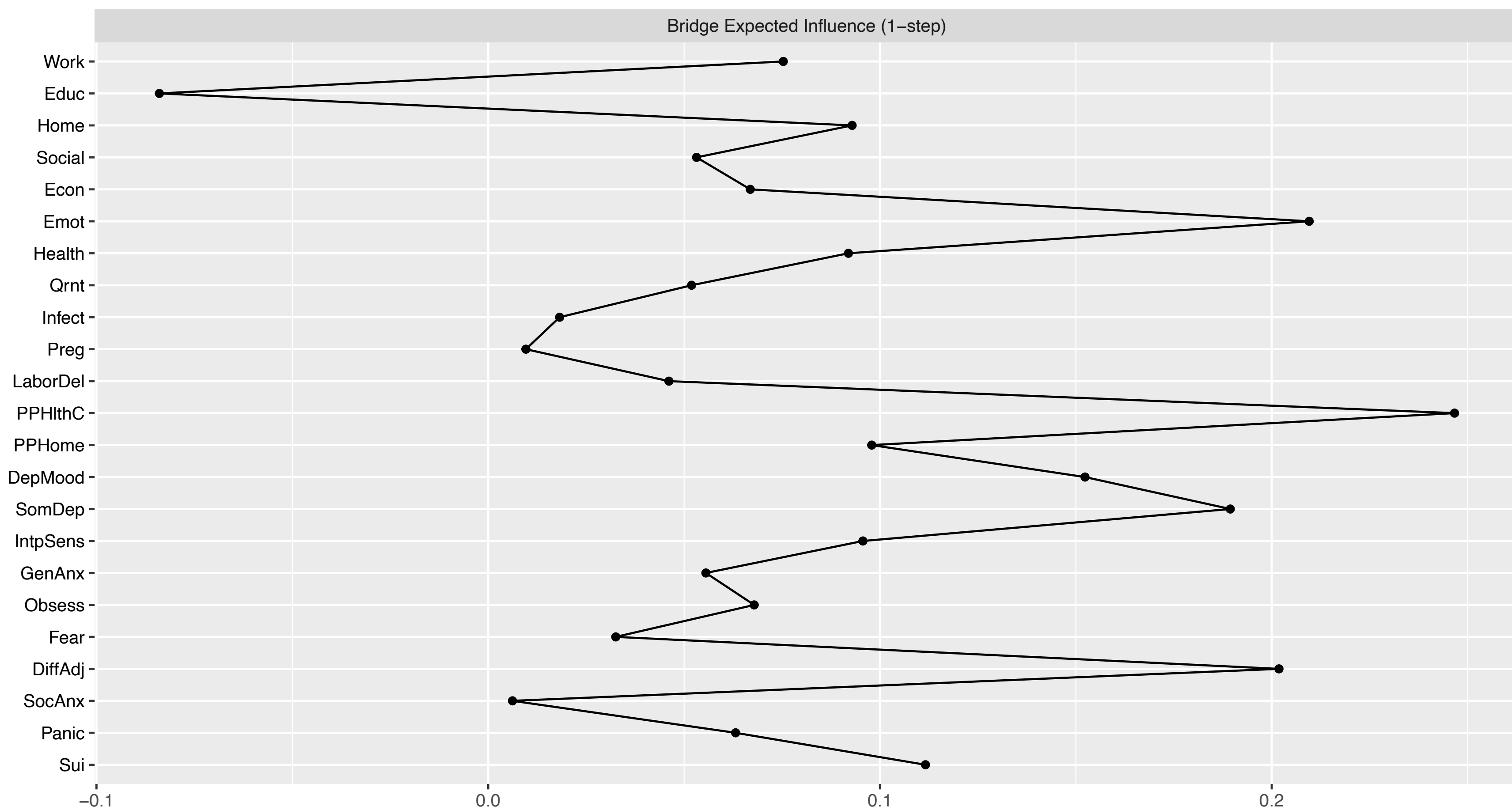


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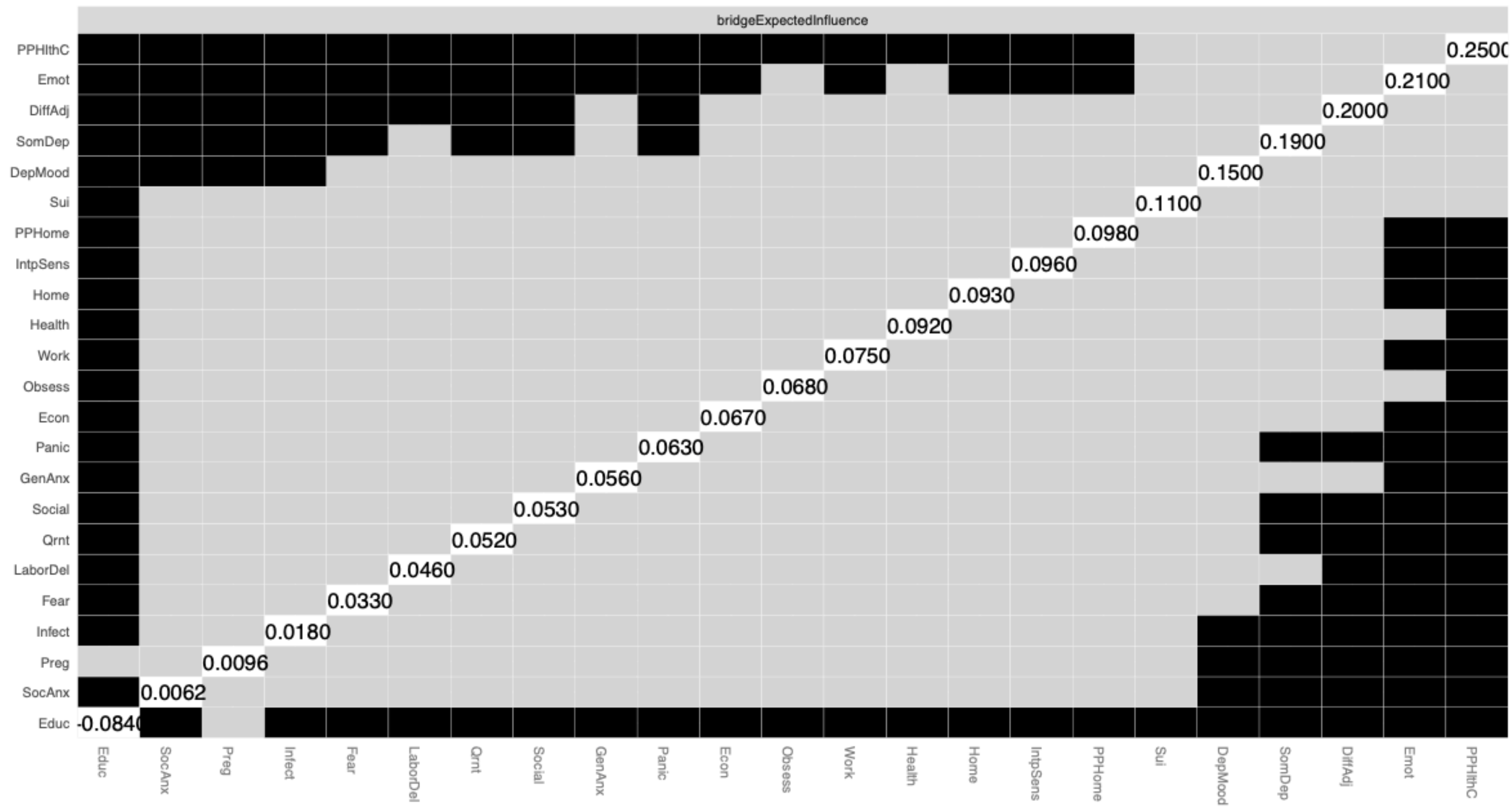
Figure 16

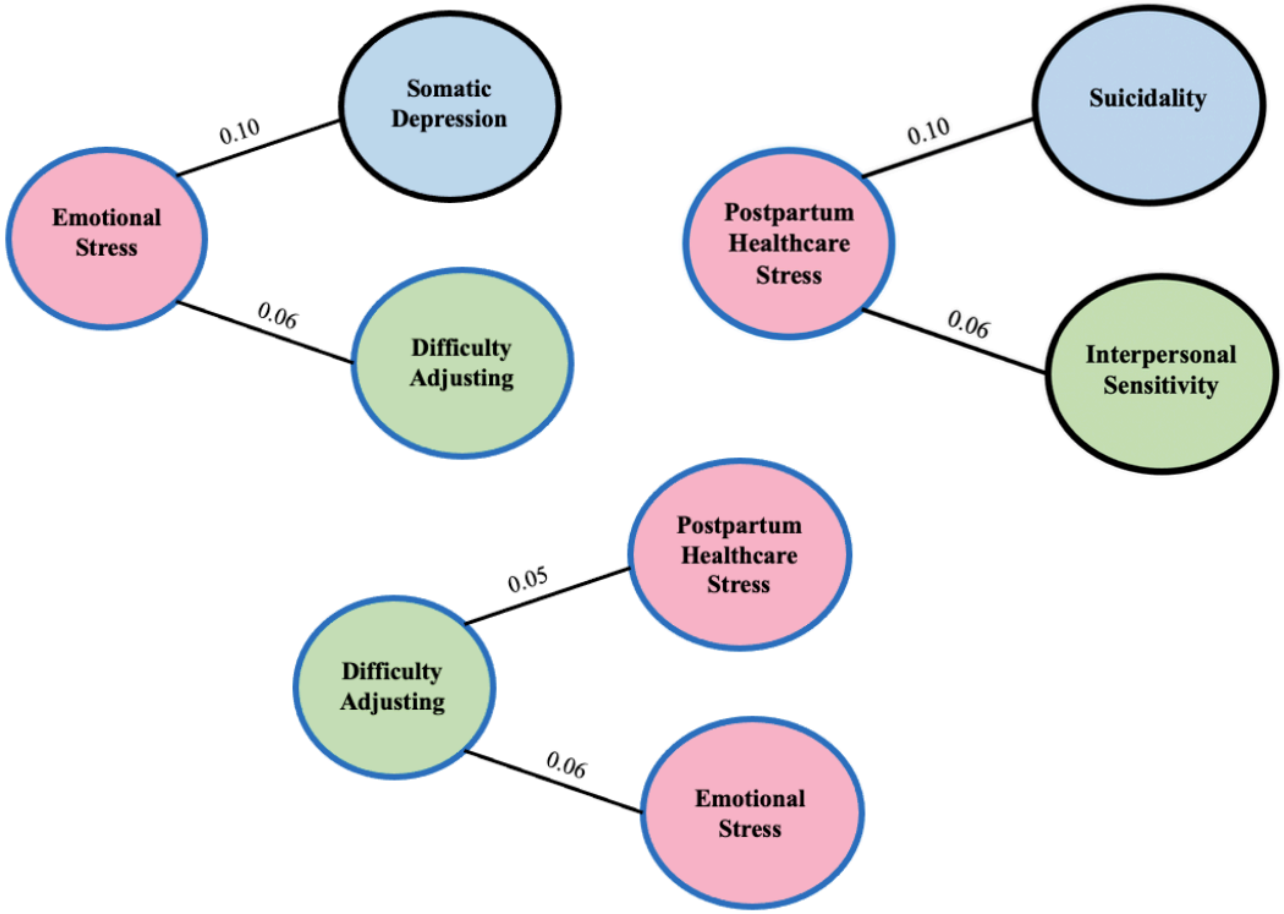
Plot of Bootstrapped Differences in Bridge Expected Influence Indices for the Expanded Network



Note. Black boxes signify significant differences at (p 0.05) level.

Figure 17

Bridge Pathways in the Expanded Network



Note. Blue nodes are depression nodes, green nodes are anxiety nodes, and pink nodes are stress nodes. Nodes outlined in blue are bridge symptoms in the expanded network. The values of the edges reflect partial correlation coefficients.

Predictability. We examined the predictability of the psychological symptom nodes after adding stressor subscales to the network and found that predictability values increased marginally. The highest increase in predictability was in the suicidality node (+ 4%). There was also no increase in the predictability of the *Fear* subscale and a drop in the predictability of the Social Anxiety subscale (-0.3%). See Table 19 for the predictability values and Figure 11 for the predictability network models of the three baseline networks, the main expanded network, and the three additional expanded networks.

Expanding The Expanded Network (Aim 2.3)

Identifying Significant Predictors. Nineteen predictors were entered into two forward stepwise regressions, one where the CES-D total score (depression) was the outcome variable and the other where PASS total score (anxiety) was the outcome variable. The final regression model for depression reduced the nineteen predictors to ten, including, *partner social support*, *prenatal depression, infant temperament, family social support*, relationship satisfaction, baby *blues, friends social support*, child sleep, *prenatal anxiety, and high income*. The final regression model for anxiety reduced the nineteen predictors to twelve, *prenatal anxiety, infant temperament, family social support, partner social support, baby blues, high income, friends social support*, child health problems, unplanned pregnancy, history of anxiety, *prenatal depression*, and gravida. Given that our network includes both symptoms of depression and anxiety, we only included the eight significant predictors (italicized above) that were shared by both in expanded network 4. See Tables 22 and 23 for summaries of the stepwise regression findings.

Table 22

Stepwise Regression Summary for Depression (Outcome Variable = Total CES-D Score)

Predictors (IVs)	B	β	S.E.	*t*	Sig.	R^2 Change	Cumulative R^2
(Constant)	21.41	-	4.34	4.93	<0.001	-	-
Partner social support	-1.60	-0.12	0.72	-2.21	0.027	0.16	0.16
Prenatal depression	5.99	0.21	1.06	5.63	<0.001	0.09	0.25
Infant temperament	0.53	0.14	0.13	3.97	<0.001	0.04	0.29
Family social support	-1.13	-0.12	0.31	-3.59	<0.001	0.03	0.31
Relationship satisfaction	2.31	0.18	0.69	3.34	0.001	0.02	0.33
Baby blues	2.36	0.09	0.86	2.75	0.006	0.01	0.34
Friends social support	-1.24	-0.12	0.39	-3.22	0.001	0.01	0.35
Child sleep	0.75	0.09	0.29	2.58	0.01	0.01	0.36
Prenatal anxiety	2.44	0.10	0.95	2.57	0.01	0.01	0.36
High Income	-1.72	-0.07	0.80	-2.16	0.031	0.01	0.37

Table 23

Stepwise Regression Summary for Anxiety (Outcome Variable = Total PASS Score)

Predictors (IVs)	B	β	S.E.	*t*	Sig.	R^2 Change	Cumulative R^2
(Constant)	40.55	-	4.24	9.56	<0.001	-	-
Prenatal anxiety	7.28	0.19	1.56	4.67	<0.001	0.13	0.13
Infant temperament	0.82	0.15	0.20	4.12	<0.001	0.06	0.19
Family social support	-1.89	-0.14	0.49	-3.85	<0.001	0.05	0.23
Partner social support	-2.92	-0.15	0.72	-4.07	<0.001	0.04	0.27
Baby blues	4.81	0.12	1.34	3.59	<0.001	0.02	0.29
High income	-4.04	-0.11	1.24	-3.26	0.001	0.02	0.31
Friends social support	-1.78	-0.11	0.59	-3.00	0.003	0.01	0.32
Child health problems	1.82	0.08	0.76	2.41	0.016	0.01	0.32
Unplanned pregnancy	4.51	0.09	1.68	2.68	0.008	0.01	0.33
History of anxiety	3.34	0.10	1.30	2.57	0.011	0.01	0.34
Prenatal depression	3.73	0.09	1.64	2.28	0.023	0.01	0.34
Gravida	-2.65	-0.08	1.22	-2.18	0.03	0.01	0.35

Predictability. We examined the predictability of the psychological symptom nodes after each additional expanded model was estimated. For expanded network 2, which included the addition of maternal functioning domains, there was a minimal increase in predictability which ranged from +.2% (for *Somatic Depression and Social Anxiety*) to + 2.3% (for *Generalized Anxiety*) as well as a minimal decrease in predictability that ranged from -.8% (for *Interpersonal Sensitivity*) to -.1% (for *Fear* and *Difficulty Adjusting*). Similar marginal changes in predictability were found for both expanded networks 3 and 4. For expanded network 3, which included the addition of positive experiences, predictability increased for some nodes (i.e., +1.1% for *Panic*) and decreased for other nodes (i.e., -.1% for *Social Anxiety*). Finally, for expanded network 4, which included the eight significant predictors of depressive and anxiety symptoms, node predictability increased for all nodes and ranged between +.1% (for *Depressed Mood*) and +2.5% (for *Social Anxiety*). The edge-weight stability of expanded network 2, expanded network 3, and expanded network 4, as measured by the CS-coefficient, were .75, .75, and .67, respectively.

Across all four expanded networks, predictability increased marginally from the baseline networks. It appears that psychological symptoms, especially those from the same disorder, predicted each other best. The nodes with the most predictability increases across all estimated networks were the *Suicidality* node (+11.5%) and the *Somatic Depression* node (+12.4%) Notably, the nodes with the highest predictability values in the baseline networks, *Fear* (78.6%) and *Panic* (72.5%), had the least predictability increases across all estimated networks (+1.7% and +1.9%, respectively). See Table 19 for the predictability values and Figure 11 for the predictability network models of the three baseline networks, the main expanded network, and the three additional expanded networks.

Moderation analyses. In addition to examining the impact of the above external variables on the predictability of the psychological symptom domains, we were interested in investigating the effect of these variables on the connections between psychological symptoms and stressors in the main expanded network, for which we ran moderation analyses.

Maternal Functioning. We first estimated a moderated expanded network based on the maternal competency subscale and found that nine edges differed between mothers with different levels of maternal competency. Given that this is a continuous moderator, we would examine how the relationship between two nodes, or their edge-weight, changed as the moderator's value increased. For example, the interpretation for row one of Table 24 would be: for each unit of increase in maternal competency, the relationship between *Home Stress* and *Economic Stress* weakened; specifically, the edge-weight between these two nodes decreased by .02. For seven out of the eight edges – that is, three stress-stress edges, three symptom-stress edges, and one symptom-symptom edge, the more a mother felt competent, the weaker these relationships were. The only edge that became stronger when a mother felt more competent was between *Pregnancy Stress* and *Labor/Delivery Stress*. For more information on the moderation effect of maternal competency on the nine node pairs and their edge weights, see Table 24.

We then estimated a moderated expanded network based on the self-care subscale and found that only one edge, between *Educational Stress* and *Interpersonal Sensitivity*, differed between mothers with different levels of self-care. Specifically, the more mothers engaged in self-care activities and had their needs met by others, the stronger the relationship was between their experiences of educational stressors (e.g., their kids being out of school) and their symptoms of interpersonal sensitivity. For more information on the moderation effect of maternal self-care, see Table 25.

Table 24

Moderation Analysis of Maternal Competency on Edges in the Expanded Network

Node 1	Node 2	Moderator Effect on Edge-weight[a]
Home Stress	Economic Stress	– .02
Home Stress	Infection Stress	– .06
Pregnancy Stress	Labor/Delivery Stress	+ .02
Economic Stress	Labor/Delivery Stress	– .01
Economic Stress	Panic	– .01
Infection Stress	Suicidality	– .03
PP Healthcare Stress	Suicidality	– .02
Interpersonal Sensitivity	Suicidality	– .02

[a]Changes in the relationship between the two nodes as maternal competency values increase: the mother feels more competent.

Table 25

Moderation Analysis of Maternal Self-Care on Edges in the Expanded Network

Node 1	Node 2	Moderator Effect on Edge-weight[a]
Educational Stress	Interpersonal Sensitivity	+ .01

[a]Changes in the relationship between the two nodes as maternal self-care values increase: the mother engages in self-care activities and has their needs met by others.

Positive Experiences. We examined the moderating effect of positive experiences during the pandemic on the main expanded network. Interestingly, the four edges that emerged as significantly different all included *Infection Stress* as one of the node pairs. That is, the more a participant or someone in their household engaged in positive experiences, the stronger the relationship between the *Infection Stress* node and the *Home Stress, Economic Stress, Health Stress, and Suicidality* nodes became. For more information on the moderation effect of positive experiences, see Table 26.

Table 26

Moderation Analysis of Positive Experiences on Edges in the Expanded Network

Node 1	Node 2	Moderator Effect on Edge-weight[a]
Infection Stress	Home Stress	+ .03
Infection Stress	Economic Stress	+ .03
Infection Stress	Health Stress	+ .01
Infection Stress	Suicidality	+ .03

[a]Changes in the relationship between the two nodes as positive experiences values increase: the participant or people in their home engage in positive experiences during the COVID-19 pandemic.

Predictors of Psychopathology. We estimated eight moderated expanded networks, one for each significant predictor of depression and anxiety symptoms, of which four were continuous variables and four were categorical variables. The moderated expanded network based on infant temperament revealed six significantly different edges, three stress-stress edges, two stress-symptom edges, and one symptom-symptom edge. Across all edges, the more challenging the mother perceived her infant, the stronger these relationships were. See Table 27 for the moderation analysis of infant temperament. For the moderated expanded network based on partner social support, we found that two edge connections strengthened, *Health Stress-Postpartum Home Stress* and *Health Stress-Fear*, and one edge connection weakened, *Depressed Mood-Suicidality,* with increased partner support. See Table 28 for the moderation analysis of partner social support. As for the moderated expanded network based on family social support, we found that the edges between the *Suicidality* node and the *Economic Stress* and *Interpersonal Sensitivity* nodes became stronger, with more familial social support. See Table 29 for the moderation analysis of family social support. Finally, moderating the expanded network based on friends' social support revealed no significant edge differences.

With regard to moderation analyses involving categorical variables, edges were calculated for each level of the variable. We estimated a moderated expanded network comparing mothers who reported experiencing baby blues during the first two weeks postpartum versus mothers who did not. Our analysis revealed that two edges, one stress-stress and one symptom-symptom edge, were stronger in the networks of mothers with postpartum baby blues. On the other hand, four edges, two stress-stress edges and two symptom-stress edges, only existed for mothers who reported baby blues. See Table 30 for edge-weight values for each moderation level. As for the moderated expanded network by prenatal anxiety, we found that for mothers who reported experiencing anxiety during pregnancy, ten edges were more strongly connected than mothers who did not experience prenatal anxiety: six stress-stress edges, one stress-stress edge, and two symptom-symptom edges. See Table 31 for edge-weight values for each group. Similarly, when the expanded network was moderated by prenatal depression, we found that for mothers who reported experiencing depression during pregnancy, twelve edges differed from mothers without prenatal depression: six stress-stress, four stress-symptom, and two symptom-symptom edges. Notably, of these edges, six edge connections became stronger and six edges only existed for mothers who experienced prenatal depression. See Table 32 for edge-weight values for each moderation level.

Finally, we estimated moderated expanded networks for mothers across three income classes, low, middle, and high income. Interestingly, mothers from low income and high income groups had identical edges. As for mothers from the middle income group, we found two edge connections that existed for them but not for the other two groups, *Emotional Stress-Quarantine Stress* and *Quarantine Stress-Somatic Depression.* Additionally, the edge between *Health Stress* and *Labor & Delivery Stress* was two times higher for mothers in the middle income group than for mothers in the other two groups. See Table 33 for edge-weight values for each moderation level.

Table 27

Moderation Analysis of Infant Temperament on Edges in the Expanded Network

Node 1	Node 2	Moderator Effect on Edge-weight[a]
Work Stress	Economic Stress	+ .03
Home Stress	Infection Stress	+ .02
Economic Stress	Labor/Delivery Stress	+ .03
Work Stress	Generalized Anxiety	+ .02
Economic Stress	Panic	+ .01
Panic	Suicidality	+ .02

[a]Changes in the relationship between the two nodes as infant temperament values increase: the mother perceives her infant's temperament as challenging.

Table 28

Moderation Analysis of Partner Social Support on Edges in the Expanded Network

Node 1	Node 2	Moderator Effect on Edge-weight[a]
Health Stress	Postpartum Home Stress	+ .02
Health Stress	Fear	+ .01
Depressed Mood	Suicidality	– .03

[a]Changes in the relationship between the two nodes as partner social support values increase: the participant reports receiving emotional and practical support from their partner.

Table 29

Moderation Analysis of Family Social Support on Edges in the Expanded Network

Node 1	Node 2	Moderator Effect on Edge-weight[a]
Economic Stress	Suicidality	+ .01
Interpersonal Sensitivity	Suicidality	+ .01

[a]Changes in the relationship between the two nodes as family social support values increase: the participant reports receiving emotional and practical support from their family.

Table 30

Moderation Analysis of Baby Blues on Edges in the Expanded Network

Baby Blues	Pregnancy Stress *and* PP. Healthcare Stress	Social Stress *and* Health Stress	Quarantine Stress *and* Health Stress	Quarantine Stress *and* Somatic Depression	Work Stress *and* General Anxiety	Interpersonal Sensitivity *and* Suicidality
No	0	0.09	0	0	0	0.09
Yes	**0.07**	**0.11**	**0.03**	**0.03**	**0.03**	**0.14**

Table 31

Moderation Analysis of Prenatal Anxiety on Edges in the Expanded Network

Prenatal Anxiety	Home Stress *and* Work Stress	Home Stress *and* Economic Stress	Home Stress *and* Infection Stress	Social Stress *and* Health Stress	Economic Stress *and* L&D Stress	Economic Stress *and* PP. Healthcare Stress	Economic Stress *and* PP. Home Stress	Economic Stress *and* Difficulty Adjusting	Depressed Mood *and* Suicidality	Interpersonal Sensitivity *and* Suicidality
No	0.04	0.08	0	0.10	0.02	0.08	0.02	0	0.14	0.11
Yes	**0.13**	**0.10**	**0.06**	**0.14**	**0.04**	**0.14**	**0.05**	**0.04**	**0.21**	**0.12**

Table 32

Moderation Analysis of Prenatal Depression on Edges in the Expanded Network

Prenatal Depression	Home Stress *and* Economic Stress	Home Stress *and* Emotional Stress	Home Stress *and* Infection Stress	Economic Stress *and* Health Stress	Economic Stress *and* PP. Healthcare Stress	Health Stress *and* PP Healthcare Stress
No	0.06	0.20	0	0.08	0.10	0
Yes	**0.14**	**0.25**	**0.07**	**0.10**	**0.13**	**0.03**
Prenatal Depression	Economic Stress *and* Depressed Mood	Economic Stress *and* Obsessive	Economic Stress *and* Depressed Mood	Pregnancy Stress *and* Obsessive	Depressed Mood *and* Suicidality	Interpersonal Sensitivity *and* Suicidality
No	0	0	0	0	0.11	0.11
Yes	**0.02**	**0.03**	**0.02**	**0.04**	**0.23**	**0.16**

Table 33

Moderation Analysis of Income on Edges in the Expanded Network

Income	Emotional Stress *and* Quarantine Stress	Health Stress *and* L&D Stress	Quarantine Stress *and* Somatic Depression
Low Income	0	0.03	0
Middle Income	**0.04**	**0.06**	**0.03**
High Income	0	0.03	0

Racial/Ethnic Network Comparisons

Aim 3.1. Racial/Ethnic Differences in Stress and Psychopathology

The Kruskal-Wallis test revealed significant mean differences in anxiety ($\chi^2(4) = 12.10$, p = .016) and suicidality ($\chi^2(4) = 39.92$, p < .001) between the five racial/ethnic groups, but not in depression ($\chi^2(4) = 4.52$, p = .340). Post hoc pairwise comparisons revealed that Black mothers reported significantly higher rates of anxiety than Asian American mothers (Mann–Whitney *U*= -125.89, p = .018) and higher rates of suicidality than White mothers (Mann–Whitney *U*= 112.29, p <.001), Hispanic mothers (Mann–Whitney *U*= 102.94, p <.001), Asian American mothers (Mann–Whitney *U*= -117.81, p <.001), and mothers from other races (Mann–Whitney *U*= 104.48, p <.001). See Table 34 for a summary of the Kruskal Wallis tests, and Table 35 for a summary of the Post Hoc Mann Whitney U tests, for the main domains of psychopathology.

Table 34

Kruskal Wallis H Tests – Domains of Psychopathology

Race		Mean rank	*df*	x^2	Sig.
Anxiety (PASS Total Score)			4	12.10	**.016**
Asian or Asian American	51	262.80			
Black or African American	34	388.69			
Hispanic or Latino origin	47	354.53			
White, non-Hispanic	465	311.66			
Other	33	320.03			
Depression[a] (CES-D Total Score)			4	4.52	.340
Asian or Asian American	51				
Black or African American	34				
Hispanic or Latino origin	47				
White, non-Hispanic	465				
Other	33				
Suicide (PHQ-9 Item)					
Asian or Asian American	51	303.26	4	39.92	**< .001**
Black or African American	34	421.07			
Hispanic or Latino origin	47	318.14			
White, non-Hispanic	465	308.78			
Other	33	316.50			

[a]No mean rank values because the test was not significant.

Table 35

Mann Whitney U Post Hoc Comparisons – Domains of Psychopathology.

	Race group (J)	Race group (I)	*U*	S.E.	Adj. Sig.[a]
Anxiety (PASS Total Score)					
	Asian or Asian American	White, non-Hispanic	-48.86	26.84	0.687
	Asian or Asian American	Other	-57.23	40.65	1.000
	Asian or Asian American	Hispanic or Latino origin	-91.73	36.79	0.127
	Asian or Asian American	Black or African American	-125.89	40.29	**0.018**
	White non-Hispanic	Other	-8.37	32.78	1.000
	White non-Hispanic	Hispanic or Latino origin	42.87	27.85	1.000
	White non-Hispanic	Black or African American	77.03	32.33	0.172
	Other	Hispanic or Latino origin	34.50	41.33	1.000
	Other	Black or African American	68.66	44.47	1.000
Suicide (PHQ-9 item)					
	Asian or Asian American	White, non-Hispanic	-5.52	14.91	1.00
	Asian or Asian American	Other	-13.24	22.58	1.00
	Asian or Asian American	Hispanic or Latino origin	-14.87	20.44	1.00

Race group (J)	Race group (I)	*U*	S.E.	Adj. Sig.[a]
Asian or Asian American	Black or African American	-117.81	22.38	**< 0.001**
White, non-Hispanic	Other	-7.72	18.21	1.00
White, non-Hispanic	Hispanic or Latino origin	9.35	15.47	1.00
White, non-Hispanic	Black or African American	112.29	17.96	**< 0.001**
Other	Hispanic or Latino origin	1.64	22.96	1.00
Other	Black or African American	104.57	24.70	**< 0.001**

[a]Significance values have been adjusted by the Bonferroni correction for multiple comparisons

We also ran Kruskal-Wallis tests to investigate significant mean differences in the total number and types of stressors. The Kruskal-Wallis test revealed significant mean differences in the number of stressors between the racial/ethnic groups ($\chi^2(4) = 12.40$, p = .015), and post hoc pairwise comparisons found that Black mothers reported a significantly higher number of stressors than White mothers (Mann–Whitney *U*= 96.04, p = .03). Of the fourteen different types of stressors, Kruskal-Wallis tests revealed significant mean differences in work and employment stressors ($\chi^2(4) = 10.49$, p = .033), education and learning stressors ($\chi^2(4) = 21.00$, p <.001), home life stressors ($\chi^2(4) = 18.21$, p = .001), economic stressors ($\chi^2(4) = 32.37$, p <.001), labor and delivery stressors ($\chi^2(4) = 10.98$, p = .027), and post-partum healthcare stressors ($\chi^2(4) = 16.11$, p = .003). Post hoc pairwise comparisons showed that Black mothers reported significantly higher rates of work stressors (Mann–Whitney *U*= 97.39, p = 0.023), educational stressors (Mann–Whitney *U*= 104.29, p = .002), home life stressors (Mann–Whitney *U*= 99.90, p = .018), economic stressors (Mann–Whitney *U*= 131.23, p <.001), labor and delivery stressors (Mann–Whitney *U*= 90.45, p = .039), and post-partum healthcare stressors (Mann–Whitney *U*= 99.70, p = .005) than White mothers. Black mothers also reported significantly higher rates of educational stressors (Mann–Whitney *U*= 122.88, p = .005) and economic stressors (Mann–Whitney *U*= - 116.64, p = .003) than Hispanic mothers. Finally, Black mothers reported significantly higher rates of economic stressors (Mann–Whitney *U*= - 9.58, p = .016) than Asian American mothers. Finally, Asian American mothers reported significantly higher home stressors than White mothers (Mann–Whitney *U*= 79.74, p = .026). See Table 36 for a summary of the Kruskal Wallis tests, and Table 37 for a summary of the Post Hoc Mann Whitney U tests, for domains of stress.

Table 36

Kruskal Wallis H Tests –Stress Domains

Race	n	Mean rank	*df*	x^2	Sig.
Total Stressors			4	12.340	**0.015**
Asian or Asian American	51	345.66			
Black or African American	34	398.94			
Hispanic or Latino origin	47	319.03			
White, non-Hispanic	465	302.90			
Other	33	355.47			
EPII 1 - Work and Employment			4	10.49	**0.033**
Asian or Asian American	51	312.97			
Black or African American	34	403.29			
Hispanic or Latino origin	47	339.34			
White, non-Hispanic	465	305.91			
Other	33	330.17			
EPII 2 - Education and Training			4	21.01	**<0.001**
Asian or Asian American	51	365.51			
Black or African American	34	409.69			
Hispanic or Latino origin	47	286.81			
White, non-Hispanic	465	305.41			
Other	33	324.27			
EPII 3 - Home Life			4	18.21	**0.001**
Asian or Asian American	51	379.24			
Black or African American	34	399.40			
Hispanic or Latino origin	47	334.91			

Race	n	Mean rank	*df*	x^2	Sig.
White, non-Hispanic	465	299.50			
Other	33	328.36			
EPII 4 - Social Activities[a]			4	2.57	0.633
Asian or Asian American	51				
Black or African American	34				
Hispanic or Latino origin	47				
White, non-Hispanic	465				
Other	33				
EPII 5 - Economics			4	32.37	**<0.001**
Asian or Asian American	51	333.11			
Black or African American	34	432.69			
Hispanic or Latino origin	47	316.05			
White, non-Hispanic	465	301.46			
Other	33	364.56			
EPII 6 - Emotional Health and Wellbeing[a]			4	1.70	0.792
Asian or Asian American	51				
Black or African American	34				
Hispanic or Latino origin	47				
White, non-Hispanic	465				
Other	33				
EPII 7 - Physical Health Problems[a]			4	1.53	0.822
Asian or Asian American	51				
Black or African American	34				

Race	n	Mean rank	*df*	x^2	Sig.
Hispanic or Latino origin	47				
White, non-Hispanic	465				
Other	33				
EPII 8 - Physical Distancing and Quarantine[a]			4	5.20	0.268
Asian or Asian American	51				
Black or African American	34				
Hispanic or Latino origin	47				
White, non-Hispanic	465				
Other	33				
EPII 9 - Infection History[a]			4	8.30	0.081
Asian or Asian American	51				
Black or African American	34				
Hispanic or Latino origin	47				
White, non-Hispanic	465				
Other	33				
EPII – Pregnancy Changes[a]			4	3.50	0.478
Asian or Asian American	51				
Black or African American	34				
Hispanic or Latino origin	47				
White, non-Hispanic	465				
Other	33				
EPII – Labor & Delivery Changes			4	10.98	**0.027**
Asian or Asian American	51	333.75			

Race	n	Mean rank	*df*	x^2	Sig.
Black or African American	34	395.01			
Hispanic or Latino origin	47	317.96			
White, non-Hispanic	465	304.56			
Other	33	355.95			
EPII – Post-partum Healthcare Changes			4	16.11	**0.003**
Asian or Asian American	51	316.17			
Black or African American	34	404.38			
Hispanic or Latino origin	47	319.02			
White, non-Hispanic	465	304.68			
Other	33	370.32			
EPII – Post-partum Home Changes[a]			4	9.34	0.053
Asian or Asian American	51				
Black or African American	34				
Hispanic or Latino origin	47				
White, non-Hispanic	465				
Other	33				

[a]No mean rank values because the test was not significant.

Table 37

Mann Whitney U Post Hoc Comparisons – Stress Domains

	Race group 1	Race group 2	*U*	S.E.	*Adj. Sig.*[a]
Total Stressors					
	White, non-Hispanic	Hispanic or Latino origin	16.13	27.85	1.000
	White, non-Hispanic	Asian or Asian American	42.76	26.84	1.000
	White, non-Hispanic	Other	-52.57	32.77	1.000
	White, non-Hispanic	Black or African American	96.04	32.32	**0.03**
	Hispanic or Latino origin	Asian or Asian American	26.63	36.79	1.000
	Hispanic or Latino origin	Other	-36.44	41.32	1.000
	Hispanic or Latino origin	Black or African American	79.91	40.96	0.511
	Asian or Asian American	Other	-9.81	40.64	1.000
	Asian or Asian American	Black or African American	-53.28	40.28	1.000
	Other	Black or African American	43.47	44.46	1.000
EPII 1 - Work and Employment					
	White, non-Hispanic	Asian or Asian American	7.06	26.52	1.000
	White, non-Hispanic	Other	-24.26	32.38	1.000
	White, non-Hispanic	Hispanic or Latino origin	33.43	27.51	1.000

	Race group 1	Race group 2	*U*	S.E.	*Adj. Sig.*[a]
	White, non-Hispanic	Black or African American	97.38	31.94	**0.023**
	Asian or Asian American	Other	-17.20	40.16	1.000
	Asian or Asian American	Hispanic or Latino origin	-26.37	36.35	1.000
	Asian or Asian American	Black or African American	-90.32	39.80	0.232
	Other	Hispanic or Latino origin	9.17	40.83	1.000
	Other	Black or African American	73.12	43.93	0.96
	Hispanic or Latino origin	Black or African American	63.95	40.47	1.000
EPII 2 - Education and Training					
	Hispanic or Latino origin	White, non-Hispanic	-18.60	24.03	1.000
	Hispanic or Latino origin	Other	-37.46	35.66	1.000
	Hispanic or Latino origin	Asian or Asian American	78.70	31.75	0.132
	Hispanic or Latino origin	Black or African American	122.88	35.35	**0.005**
	White, non-Hispanic	Other	-18.86	28.28	1.000
	White, non-Hispanic	Asian or Asian American	60.10	23.16	0.094
	White, non-Hispanic	Black or African American	104.28	27.89	**0.002**
	Other	Asian or Asian American	41.24	35.08	1.000
	Other	Black or African American	85.42	38.37	**0.26**

	Race group 1	Race group 2	*U*	S.E.	*Adj. Sig.*[a]
	Asian or Asian American	Black or African American	-44.18	34.76	1.000
EPII 3 - Home Life					
	White, non-Hispanic	Other	-28.86	32.39	1.000
	White, non-Hispanic	Hispanic or Latino origin	35.41	27.52	1.000
	White, non-Hispanic	Asian or Asian American	79.74	26.52	**0.026**
	White, non-Hispanic	Black or African American	99.90	31.95	**0.018**
	Other	Hispanic or Latino origin	6.55	40.84	1.000
	Other	Asian or Asian American	50.88	40.17	1.000
	Other	Black or African American	71.04	43.94	1.000
	Hispanic or Latino origin	Asian or Asian American	44.33	36.36	1.000
	Hispanic or Latino origin	Black or African American	64.49	40.48	1.000
	Asian or Asian American	Black or African American	-20.16	39.81	1.000
EPII 5 - Economics					
	White, non-Hispanic	Hispanic or Latino origin	14.59	21.76	1.000
	White, non-Hispanic	Asian or Asian American	31.65	20.97	1.000
	White, non-Hispanic	Other	-63.1	25.61	0.137
	White, non-Hispanic	Black or African American	131.23	25.25	**< 0.001**
	Hispanic or Latino origin	Asian or Asian American	17.06	28.74	1.000

	Race group 1	Race group 2	*U*	S.E.	*Adj. Sig.*[a]
	Hispanic or Latino origin	Other	-48.51	32.28	1.000
	Hispanic or Latino origin	Black or African American	116.64	32.00	0.003
	Asian or Asian American	Other	-31.45	31.75	1.000
	Asian or Asian American	Black or African American	-99.58	31.47	**0.016**
	Other	Black or African American	68.13	34.73	0.498
EPII – Labor & Delivery Changes					
	White, non-Hispanic	Hispanic or Latino origin	13.40	27.01	1.000
	White, non-Hispanic	Asian or Asian American	29.19	26.03	1.000
	White, non-Hispanic	Other	-51.39	31.79	1.000
	White, non-Hispanic	Black or African American	90.45	31.35	**0.039**
	Hispanic or Latino origin	Asian or Asian American	15.79	35.68	1.000
	Hispanic or Latino origin	Other	-37.99	40.07	1.000
	Hispanic or Latino origin	Black or African American	77.05	39.73	0.524
	Asian or Asian American	Other	-22.20	39.42	1.000
	Asian or Asian American	Black or African American	-61.26	39.07	1.000
	Other	Black or African American	39.06	43.12	1.000
EPII – Postpartum Healthcare Changes					

Race group 1	Race group 2	*U*	S.E.	*Adj. Sig.*[a]
White, non-Hispanic	Asian or Asian American	11.49	23.90	1.000
White, non-Hispanic	Hispanic or Latino origin	14.34	24.79	1.000
White, non-Hispanic	Other	-65.64	29.18	0.245
White, non-Hispanic	Black or African American	99.70	28.78	**0.005**
Asian or Asian American	Hispanic or Latino origin	-2.86	32.75	1.000
Asian or Asian American	Other	-54.15	36.19	1.000
Asian or Asian American	Black or African American	-88.22	35.87	0.139
Hispanic or Latino origin	Other	-51.30	36.79	1.000
Hispanic or Latino origin	Black or African American	85.36	36.47	0.193
Other	Black or African American	34.06	39.58	1.000

[a]Significance values have been adjusted by the Bonferonni correction for multiple comparisons.

Aim 3.2. Comparison of the Comorbidity Network Across Races

We estimated a comorbidity network moderated by the five racial/ethnic groups in the study and found four edges that significantly differed between them. The edge between the symptoms of *Failure* and *Suicidality* was present for all groups except for Hispanic mothers and was stronger for Black mothers compared to the other racial/ethnic groups. The edge between the symptoms of *Order* and *Perfectionism* was identical across all groups, except for White mothers, for which the edge was stronger. Interestingly, two edges, *Sudden Fear-Suicidality* and *Order-Lonely,* were present only for Black mothers and were not found in any other racial/ethnic group. See Table 38 for edge-weight values for each racial/ethnic group and Figure 18 for the moderated comorbidity networks.

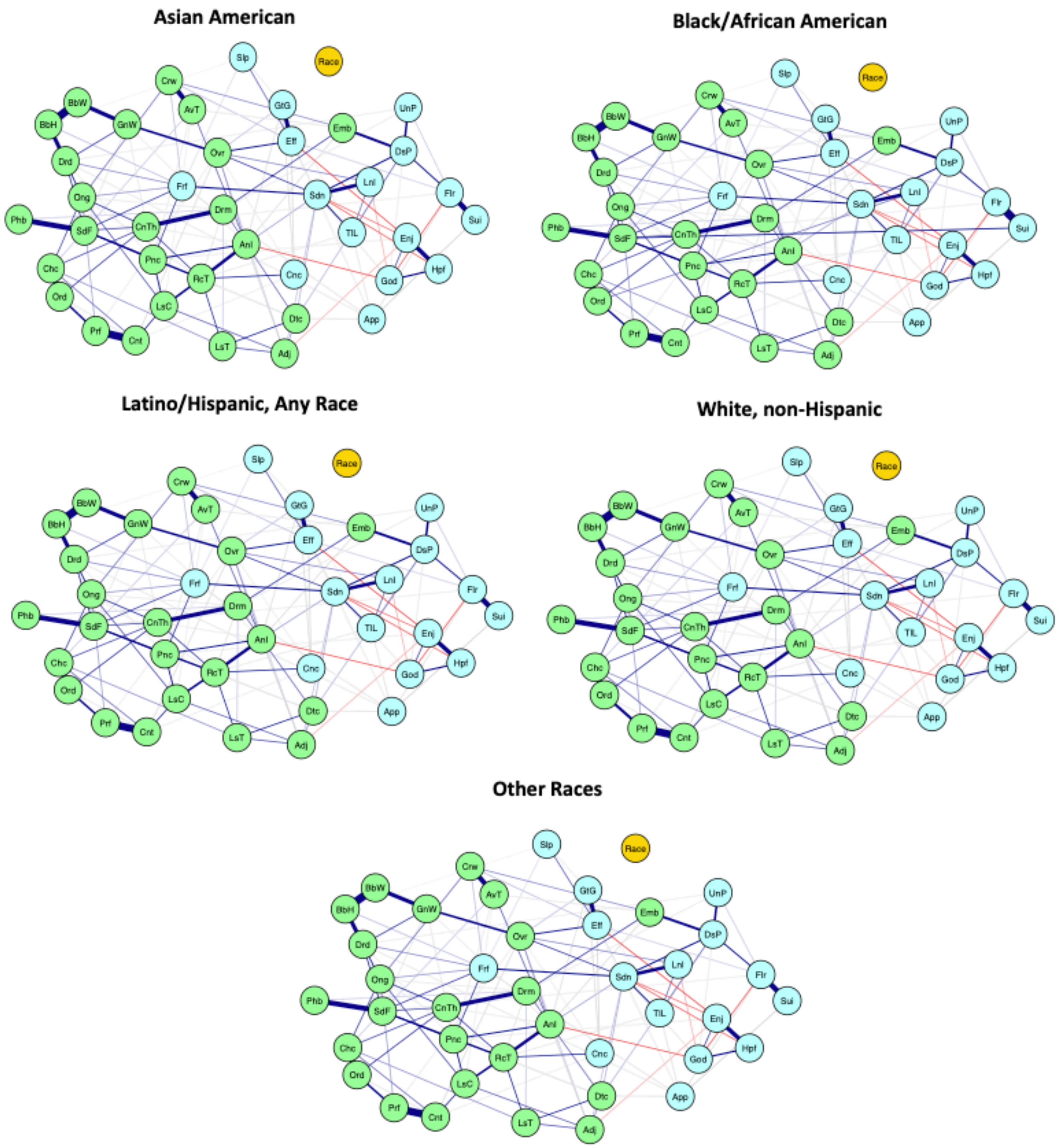
Table 38

Moderation Analysis of Race on Edges in the Comorbidity Network

Race	Failure *and* Suicidality	Sudden Fear *and* Suicidality	Order *and* Lonely	Order *and* Perfectionism
Asian American	0.29	0	0	0.17
Black or African American	**0.40**	**0.14**	**0.06**	0.17
Hispanic or Latino origin of any race	0	0	0	0.17
White, Non-Hispanic	0.29	0	0	**0.20**
Other	0.29	0	0	0.17

Figure 18

Moderation Analyses of the Comorbidity Network by Racial/Ethnic Groups



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We also examined the edges that were identical in all racial/ethnic groups' comorbidity networks. Like the main comorbidity network, in these comorbidity networks, symptoms of the same disorder had more significant connections, and overall stronger connections, with each other than with symptoms from the other disorder. The strongest positive connections were between *"Worry about the baby"* (ANX) and *"Fear that harm will come to the baby"* (ANX), *"Needing to be in control of things"* (ANX) and *"Wanting things to be perfect"* (ANX), *"Really strong fears about things, eg needles, blood, birth, pain, etc"* (ANX) and *"Sudden rushes of extreme fear or discomfort"* (ANX), and, *"I thought that I would be better off dead, or I thought about hurting myself in some way"* (DEP) and *"I thought my life had been a failure"* (DEP). As for the strongest negative connections they were between *"I felt I was just as good as other people"* (DEP) and *"I thought my life had been a failure"* (DEP), and between *"I enjoyed life"* (DEP) and *"I felt that everything I did was an effort"* (DEP).

As for cross-disorder connections, we found that there were fewer connections between symptoms of depression and anxiety in the comorbidity networks estimated for the five racial groups than there were in the main comorbidity network. In addition, of the 384 possible connections between the two disorders, thirty (7.8%) emerged as significant in the network. In addition, similar to the main comorbidity network, among the depression nodes, the *I felt fearful* node had the highest number of edges with the anxiety nodes. On the hand, the node *I felt hopeful about the future* had no connections with the anxiety nodes. Amongst the anxiety nodes, the *Overwhelm* symptom had the highest number of edges with the depression symptoms, whereas 10 anxiety symptoms had no connections with the depression nodes.

Aim 3.3. Comparison of the Expanded Network Across Races

We estimated an expanded network moderated by the five racial/ethnic groups in the study and found seven edges that significantly differed between them. The two edges *Home Stress-Education Stress* and *Home Stress-Emotional Stress* were identical across all racial groups, except for White mothers, for which they were stronger. In addition, the edge between *Emotional Stress* and *Postpartum Healthcare Stress* only existed for White mothers. As for Black mothers, their network had a stronger connection between *Depressed Mood* and *Suicidality* than all other racial/ethnic groups. Moreover, four edges were present for Black mothers only: *Home Stress-Health Stress, Home Stress-Infection Stress, Economic Stress-Labor & Delivery Stress*, and *Panic-Suicidality.* See Table 39 for edge-weight values for each racial/ethnic group and Figure 19 for the moderated expanded networks.

As for the edges that were found in all racial/ethnic groups' expanded networks, we found that like the main expanded network, there were more significant and stronger symptom-symptom connections and stressor-stressor connections than symptom-stressor connections. As for symptom-stressor connections, of the 130 possible connections, only four (3%) emerged as significant, which is less than those found in the main expanded network model. In addition, we found that only depression subscales had connections with stressor subscales, specifically with the *Home Stress, Emotional Stress,* and *Health Stress* subscales. Specifically, among the psychological symptom subscales, the *Somatic Depression* node had the highest number of edges with the stressor nodes. As for stressor subscales, *Emotional Stress* had the highest number of edges with psychological symptoms.

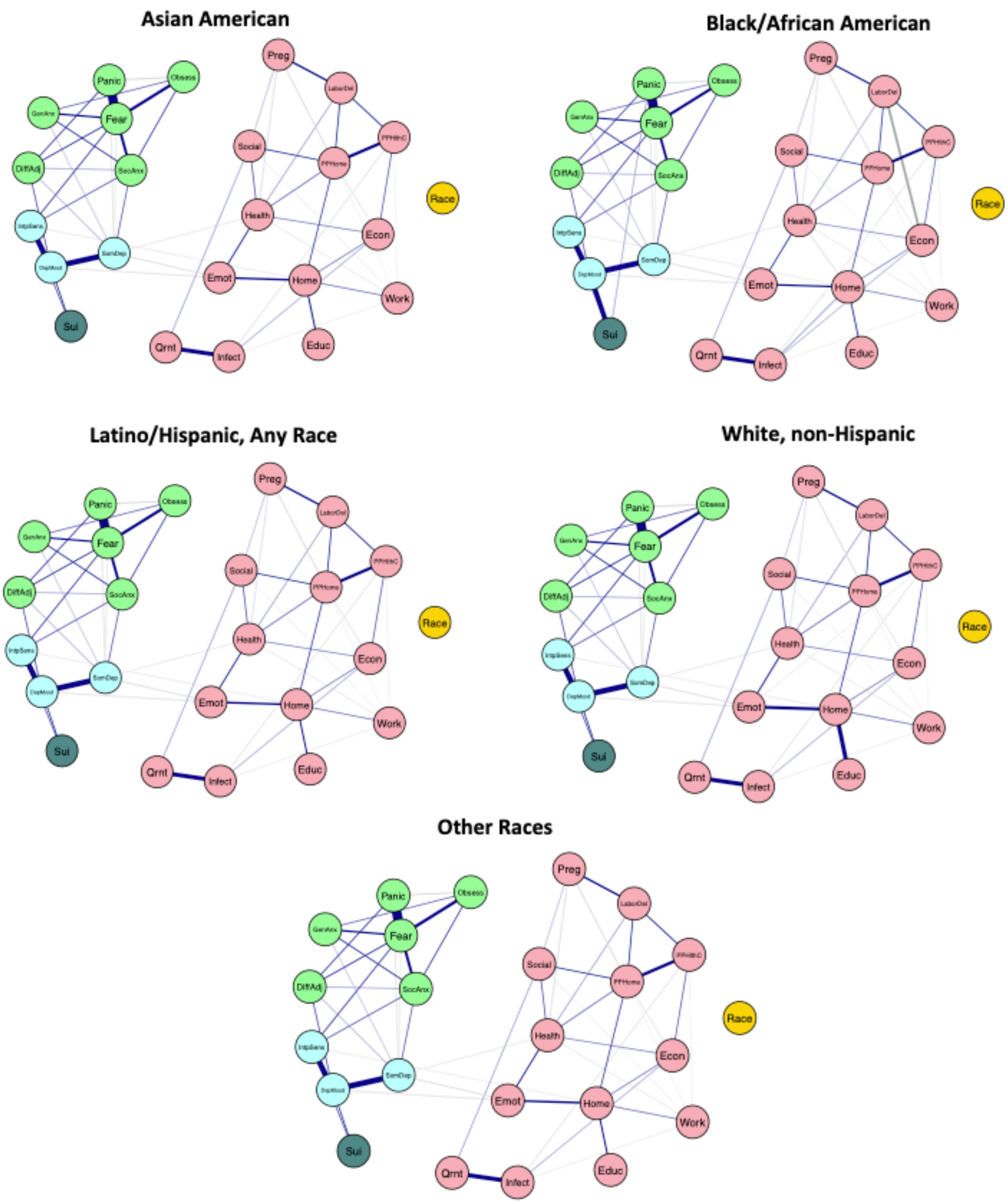
Table 39

Moderation Analysis of Race on Edges in the Expanded Network

Race	Home Stress *and* Education Stress	Home Stress *and* Emotional Stress	Emotional Stress *And* PP Healthcare Stress	Home Stress *and* Health Stress	Home Stress *and* Infection Stress	Economic Stress *and* L&D Stress	Depressed Mood *and* Suicidality	Panic *and* Suicidality
Asian American	0.16	0.18	0	0	0	0	0.12	0
Black or African American	0.16	0.18	0	**0.05**	**0.06**	**0.21**	**0.31**	**0.05**
Hispanic or Latino origin of any race	0.16	0.18	0	0	0	0	0.12	0
White, Non-Hispanic	**0.28**	**0.23**	**0.02**	0	0	0	0.12	0
Other	0.16	0.18	0	0	0	0	0.12	0

Figure 19

Moderation Analyses of the Expanded Network by Racial/Ethnic Groups



Chapter 4: Discussion

Sample Characteristics

The study sample was not representative of the general population in the U.S. Specifically, 73.8% of our sample identified as White, non-Hispanic, which is higher than the national average (59.7%; U.S. Census Bureau, 2021b; Vespa et al., 2018), and 91% were married, which is also higher than the percentage of mothers who are married in the US (71.2%; U.S. Census Bureau, 2020). In addition, more than 60% of our sample reported a combined household income of $100,000 or higher, which is higher than the median US household income of $70,784 (U.S. Census Bureau, 2021b). Finally, the largest discrepancies between our sample and national rates were the following: 1) our sample was highly educated, with 85.5% having completed a four-year college degree or higher, compared to the national average of 37.9% (U.S. Census Bureau, 2021a); 2) more than half of the participants in our sample were not affiliated with any religion, which is more than double the national average of 22.8% (Cooperman et al., 2015). Therefore, generalizations of our findings to mothers who are different from our study participants should be made with caution.

Regarding mental health rates, 48.6% of our sample participants scored above the cut-off for postpartum depression (CES-D $\geq$16) and 47.6% scored above the cut-off for anxiety (PASS $\geq$26), indicating significant rates of psychopathology. According to meta-analyses of postpartum mental health symptoms during the pandemic, postpartum depression rates were approximately 26%, which is lower than the rate in our sample, whereas the anxiety rates reported (41.9% and 55%) were comparable to ours (Gao et al., 2022; Racine et al., 2022). Given that, prior to the pandemic, the rate of postpartum depression and anxiety were roughly 17% and 15%, respectively (Dennis, 2004; McCue Horwitz et al., 2007; Shorey et al., 2018), it is evident that the pandemic has substantially increased postpartum psychopathology. Notably, meta-analyses have identified more mixed effects of the pandemic on prenatal anxiety and depression, with some studies reporting that the pandemic did not significantly affect rates of prenatal depression and anxiety (Cevik et al., 2022), while other studies did report an increase (Tomfohr-Madsen et al., 2021). Nevertheless, studies reported rates of prenatal mental health symptoms ranging from 22.6 to 26.5% for depression and from 22.3 to 33.5% for anxiety (Cevik et al., 2022; Tomfohr-Madsen et al., 2021), which were similar to the rates found in this study. Finally, approximately 72% of our sample reported experiencing a period of tearfulness during the first two weeks postpartum, otherwise known as "baby blues," which is comparable to the longstanding pre-pandemic rates of 75-80% (Langdon, 2023; March of Dimes, 2021b).

Data Quality

Consistent with a recent trend recognized in research data collected online, we found that our online survey was infiltrated by bots and professional survey takers (e.g., Bybee et al., 2022; Griffin et al., 2021; Singh & Sagar, 2021; Storozuk et al., 2020). We found a high number of fraudulent responses, particularly in Samples 2 and 3. Specifically, 31.3% of the responses in Sample 1, 95.2% in Sample 2, and 91.5% in Sample 3 were identified as potentially fraudulent and removed from the data. The data protection methods embedded into the survey design played a critical role in identifying these problematic responses. In Sample 1, we found that the most effective indicators of fraudulence were IP addresses, geolocation information, and survey start and end times, all of which are consistently identified as strong indicators by researchers (Storozuk et al., 2020; Teitcher et al., 2015). On the other hand, the bot protection measures recommended by Qualtrics (e.g., reCAPTCHA, honeypots) as well as attention checks were less successful in identifying problematic responses. This is in line with other studies (Griffin et al., 2021; Storozuk et al., 2020). Attention checks, which had long been purported as a means of protecting the integrity of online surveys, seem to be losing their effectiveness. Namely, although attention checks may catch participants who are not reading the survey closely, they are no match to the experienced survey takers who utilize more sophisticated fraudulence strategies and are able to maintain (or program) their attention and pass these checks. In fact, although platforms like Qualtrics are continuously updating their bot detection methods, studies have found that this has led to an ongoing game of cat and mouse (Orabi et al., 2020), wherein fraudulent survey takers are also continuously updating their methods to circumvent new detection methods.

In our study, Sample 1 had the lowest fraud rate. This may be due to several factors. First, the indicators used with Sample 1 were missing some key indicators that were included in later samples, chief of which was the open-ended question. Second, the Reddit post that was used to recruit Sample 1 had a very high engagement rate (e.g., over a hundred upvotes by unique Reddit users and tens of replies under the post), which increases the chances of non-fraudulent participation in the survey.

As for Sample 2, the primary platform of recruitment was Facebook. This recruitment choice was intentional because, unlike Reddit, Facebook contained several motherhood groups that represented key racial subgroups that we aimed to recruit from. However, we found that Facebook was particularly vulnerable to bots and fraudulent survey takers, which resulted in us closing recruitment after only five days due to the high volume of fraudulent responses submitted. Also, as a result, we chose not to recruit from Facebook in the subsequent sample. Further, we included an open-ended question in the survey used with Sample 2, which turned out to be a very powerful data quality indicator that helped us more easily identify fraudulent responses in the initial review phase with Sample 2 (94% of participants failed). Specifically, the open-ended responses revealed duplicate participant responses (i.e., identical response phrases or sentences) as well as illogical or illegible responses, all of which contributed to the disqualification of a participant. Akin to our study, other researchers who have used open-ended questions were able to effectively identify a high number of fraudulent responses. For example, in a study by Iachini and colleagues (2022), the authors found that only 90.6% of the responses submitted to their survey were fraudulent (Xu et al., 2022). Similarly, in a study by Simone (2019), wherein the survey included a series of open-ended questions, the author found that 97% of the submitted responses were fraudulent. Therefore, the author recommended that research studies incorporate two to three open-ended questions to minimize the risk of missing fraudulent responses in their data (Simone, 2019).

As for Sample 3, the data quality was slightly better than Sample 2, primarily due to not recruiting from Facebook, as well as another indicator that was added for this Sample to identify deceit in responses. For Sample 3, a unique survey link was created for each platform. We then included an additional question that said: “Where did you hear about our study?” Although we did not go with the recommendation of generating unique survey links for each participant (Simone, 2019), which would have been burdensome on our research team due to our desired sample size, we found that a unique survey link for each platform conferred several benefits compared with using a single survey link for all platforms as we had done in prior samples. For example, another benefit beyond detecting deceitful responses was that in the event that one of our links was compromised due to being attacked by a bot that flooded the survey with numerous fraudulent responses, we could shut the link down without disrupting recruitment from other survey links. Further, the unique links helped us identify if particular groups or platforms were especially problematic or conversely, if they yielded higher-quality responses.

A key finding from our data quality process across all samples is that "across response" indicators—that is, comparing IPs, start and end times, geolocation mismatches, open-ended responses *between* participants, and keeping track of indicators that have been identified as associated with fraudulent responses—were more powerful than *within* response indicators (e.g., consistency checks, attention checks). Nonetheless, we found that combining multiple indicators is the best protection against fraudulent responses, as "no single method" can do that effectively (Lawlor et al., 2021). Based on our experience and a growing number of research studies, we believe that fraud in research should be expected and, therefore, needs to be considered by researchers throughout the various stages of their research, including study design, data collection, and analysis. Protecting against bots and survey takers goes beyond ensuring that participants who qualify for the study are properly targeted, recruited, and compensated. It is a critical and necessary step towards safeguarding research from false findings that may arise from random, inaccurate, or careless responses that may increase Type I and Type II errors (Credé, 2010; Huang et al., 2015; McGonagle et al., 2016; McGrath et al., 2010) and translate into biased and misinformed treatment interventions or policy changes (Chandler et al., 2020; Kennedy et al., 2020).

Topological Overlap

The goldbricker and inter-item correlation analyses that were conducted prior to estimating the comorbidity and expanded networks revealed several problematic pairs that would have inflated network parameters. This underscores the importance of item selection as a step preceding network estimation to help ensure more precise network indices and valid interpretations. Moreover, it was notable that there was no overlap between the pairs identified through the goldbricker and the inter-item correlation methods and that each analysis yielded a unique set of pairs—likely due in part to the different statistics underlying each method. Therefore, our findings support the use of a combination of methods to investigate topological overlap, as one method does not substitute the other.

Further, to our knowledge, this is the first network analysis study to utilize inter-item correlations to investigate item redundancy. As mentioned above, this technique revealed problematic pairs that were missed by the goldbricker function, including pairs that captured very similar constructs (e.g., I felt sad and I felt depressed). Therefore, we encourage other researchers to use inter-item correlations to augment goldbricker analyses or to develop an equivalent network tool.

Aim 1. Comorbidity Network

Following the item reduction analyses, we estimated a comorbidity network that included 15 items from the CES-D, 24 items from the PASS, as well as the adapted PHQ-9 suicidality item. The network was densely connected with more significant, and overall stronger, connections between symptoms of the same disorder than between symptoms across disorders. Generally, within network theory, there is a greater emphasis on reporting and intervening on the central nodes of a network due to their significant impact and influence on the whole network. Nonetheless, peripheral nodes should not be overlooked, especially if they cause functional impairment, psychological distress, or adverse outcomes. Within our network, two connections are worth highlighting, namely the strongest positive and negative edge connections with the suicidal ideation node, which are *Failure-Suicidality* and *Baby Worry-Suicidality,* respectively. These connections are indicative of crucial potential risk and protective factors for suicidal ideation in postpartum mothers. Suicide is the leading cause of maternal mortality during pregnancy and the first-year post-partum (Orsolini et al., 2016; Trost et al., 2021), accounts for up to 20% of maternal deaths (Campbell et al., 2021; Lindahl et al., 2005) and is more common than maternal deaths resulting from postpartum hemorrhage or hypertensive disorders (Palladino et al., 2012). Therefore, understanding maternal suicidality and the factors that influence it is critical to reducing maternal mortality.

The link between failure and suicidality found in our study was well supported by past research (Miller, 1995; Reid et al., 2022; Vanessa, 2023). In a pre-COVID qualitative study investigating perinatal suicide, Reid and colleagues (2022) found that perinatal suicidal ideation and behaviors were triggered by the perinatal woman's feelings of failure and her self-identification as a "bad mother," which arose when she felt "attacked by motherhood" and struggled to cope (p. 9). The authors argue that the perinatal period requires accelerated learning, wherein a mother must navigate conflicting information from varying sources, which may lead to feelings of uncertainty, overwhelm, and a lack of confidence when mothering (Reid et al., 2022). During the pandemic, mothers navigated the aforementioned challenges inherent to the perinatal period, while also dealing with heightened stressors and diminished support systems. Yet, it is worth noting that despite the increased challenges faced by mothers during the pandemic, our research demonstrated that, in line with previous studies, maternal suicidal ideation continues to be driven by feelings of failure.

On the other hand, the only negative relationship between two negatively worded items within our network was between the following nodes: *Worry about the baby* and *I thought that I would be better off dead, or I thought about hurting myself in some way*. This finding was surprising and noteworthy because we would expect that anxiety and suicidality have a positive relationship. Research has found that anxiety is a significant, albeit weak, predictor of suicidal ideation and attempts, but not deaths (Bentley et al., 2016). Yet, it appears that worrying about the baby may function differently than typical anxiety. Namely, worry about her baby may increase the mother's sense of responsibility towards her baby as well as her concern for how her behavior may negatively impact them, both of which may demotivate a mother from considering suicide (Luo et al., 2016). This is consistent with domains within the Reasons for Living (RFL) inventory, a self-report scale that assesses a person's reasons for living if they are considering suicide that includes two subscales capturing "Responsibility to family" and "Child-related concerns," both of which can buffer against the risk of suicide (Linehan et al., 1983). Therefore, beyond the documented protection from suicide that comes with parenthood (Dehara et al., 2021; Driver & Abed, 2004), a mother's worry about her baby may confer further protection against acting on her suicidal ideation.

Taken together, these findings suggest that empowering a mother with information that is adequate and accurate without fearmongering, while also offering support that cultivates her sense of competency and confidence and fosters her responsibility towards her baby, may mitigate the risk of maternal suicide. Moreover, to enhance the fit of cognitive-behavioral treatments for postpartum depression, adapting the treatment materials to incorporate cognitive restructuring techniques focused on cognitive distortions about feelings of failure. Additionally, incorporating the RFL within treatments that target postpartum depression may help to identify and foster a mother's "reasons for living" that can safeguard against maternal suicidality and be used as a more precise and adequate assessment of maternal suicidal risk. Finally, clinicians treating mothers for postpartum anxiety should differentiate between typical worry that stems from a mother's sense of responsibility for and concern towards her child, which may be protective against suicidal ideation and promote a future orientation for a mother, and more extreme or distorted worry that stems from health anxiety and obsessive-compulsive disorder. Overall, maternal suicide is a complex and nuanced topic, and network analysis provides a powerful tool to delineate the differential symptom-to-symptom connections that may inform and increase the success of current detection and intervention methods.

Central Symptoms

The top three central symptoms in the comorbidity network were *racing thoughts making it hard to concentrate, sudden rushes of fear,* and *being "on-guard,"* all of which captured symptoms of panic and fear. Although these findings are not consistent with network studies conducted prior to the COVID-19 pandemic, they are in line with numerous network studies conducted during the pandemic (Hoffart et al., 2021; Taylor et al., 2021; Zhang et al., 2021). For example, in a study that investigated maternal and paternal depression during COVID-19, the authors found that fear/panic was a central node in both the networks of mothers and their partners (Zhang et al., 2021).

Notably, the most central symptom, *racing thoughts making it hard to concentrate*, also captures concentration issues along with panic. This is consistent with several network studies, including those conducted with perinatal women, both before and during the pandemic that have found concentration issues to be central in depression and anxiety networks (e.g., Fried & Nesse, 2014; Kaiser et al., 2021; Santos et al., 2018). There are two ways in which the centrality of concentration issues within our could be interpreted. First, our results would indicate that concentration problems are a core symptom of both depression and anxiety that keep the system in a pathological state for longer—making them key target symptoms for intervention. This interpretation is in line with studies that have found concentration problems to be a core symptom of adult depression (Kammerer et al., 2009) and found that it is linked to worse social and interpersonal impairment (Fried & Nesse, 2014). This is also consistent with research on postpartum depression. In a study conducted by Beck and colleagues (2002) that aim to create an assessment tool for postpartum depression (PPD) based on two meta-analytic studies and one qualitative investigation, which revealed cognitive impairment and difficulty concentrating as key symptom indicators of PPD. Conversely, because our network is undirected—meaning the link between two symptoms is bidirectional—a central symptom could be providing many outputs to other symptoms and is influencing them, or receiving many inputs from symptoms and is *influenced by them*. This is true for all central symptoms but may be particularly applicable to this node (*racing thoughts making it hard to concentrate)* because its content specifies that panic and anxiety lead to concentration issues. Specifically, it may be that the changing nature of the pandemic and the bombardment of information that mothers received increased their worry and panic, which in turn led to diminished attention, processing speed, and mental energy, all of which make it difficult to concentrate and focus (Robinson et al., 2013).

The second most central symptom in the comorbidity network was *Sudden rushes of fear/discomfort*, which is not surprising given that this data was collected during a global pandemic and specifically, during the omicron wave of the COVID-19 pandemic. The omicron wave reignited many people's fears because it saw record-high cases, surpassing even the pandemic's first wave (Taylor, 2022). Network studies investigating depression and anxiety during the pandemic found COVID-19-specific fears and worries, namely fear of dying, worrying about the dangerousness of COVID-19, and fear of infection, to be central symptoms (Hoffart et al., 2021; Taylor et al., 2021). The centrality of these symptoms found in both our study and other COVID-19 network studies indicates that increased fear may have contributed to the activation of psychological symptoms during the pandemic. Similar findings were found in non-network studies conducted with perinatal women during the pandemic (Gluska et al., 2022; Jones et al., 2022; Orsolini et al., 2022). For example, in a study by Gluska and colleagues (2022), the authors found that fear of COVID-19 predicted 73% of potential postpartum depression cases. Interestingly, numerous studies found that the *fear* of infection with COVID-19 predicted a diagnosis of depression, anxiety, and suicidal ideation, irrespective of a COVID-19 diagnosis (Ahorsu et al., 2020; Bo et al., 2021; Ding et al., 2021; He et al., 2020; Liang et al., 2020; Matsushima & Horiguchi, 2022; Moyer et al., 2020; Preis et al., 2020b; Salehi et al., 2020). This indicates that the fear of COVID-19 had more of an adverse effect on perinatal mental health than actual exposure to COVID-19.

Finally, the third most central symptom, *being on-guard or needing to watch out for things*, captured the hypervigilance aspect of feeling fearful. Our finding is consistent with a cross-cultural network study conducted during the pandemic that found hyperarousal (i.e., physiological reactivity resulting from hypervigilance) to be a central symptom (Tsur et al., 2021). During the pandemic, people became more alert to safety concerns and the possibility of getting sick, which in turn increased their cautiousness around other people and situations that can increase their risk of infection, and also made them hyper-aware of small changes in their bodies. This increased vigilance may have led to an increase in health anxiety and "respiratory" panic disorder, wherein people become more vigilant about their breathing symptoms, which in turn leads to panic attacks and panic disorder (Coulombe et al., 2020). Moreover, people consumed the media in record numbers, usually to get information about the pandemic, which actually exacerbated people's anxiety rather than eased it.

Bridge Symptoms

The top bridge symptom revealed by the bridge expected influence and clique percolation analyses was *I felt fearful.* Once again, feeling fearful was a highly influential symptom and as a bridge symptom, it activated both depression and anxiety symptoms and triggered symptom spread. Of note, although the central symptoms captured the panic and trauma domains of fear, the fearful symptom from the CES-D scale captures a more general experience of feeling fear. Akin to network studies prior to the pandemic not finding fear to be central in depression and anxiety networks, it was not found to be a bridge symptom either (e.g., Kaiser et al., 2021; Phua et al., 2020). Yet, consistent with our findings, network studies conducted during the pandemic identified fear as a bridge symptom (e.g., Tao et al., 2022). All three central symptoms and the top bridge symptom highlight the influence of context (e.g., global pandemic, natural disasters, etc.) on the development of mental health symptoms. To our knowledge, prior to the pandemic, fear, panic, and hypervigilance were not influential symptoms in psychopathology networks outside of PTSD networks. However, during the pandemic, these symptoms became the most influential ones in anxiety and depression networks (Bogaerts et al., 2021; Taylor et al., 2021; Zhang et al., 2021). This is in line with studies of other epidemics that found that fear preceded symptoms of anxiety and depression (Hall et al., 2008). Therefore, when choosing interventions during major contextual changes and large-scale events (e.g., disease outbreaks, natural disasters, etc.), it is important that we do not rely on targeting previously established central and bridge symptoms as they may no longer play an influential role in activating/deactivating psychopathology.

The second highest bridge symptom revealed by the bridge expected influence and clique percolation analyses was *feeling overwhelmed.* The symptom of overwhelm was found to be both a central and bridging symptom in a pre-pandemic network analysis study with perinatal women (Phua et al., 2020) as well as a COVID-19 parental network study (Skjerdingstad et al., 2021). Therefore, feeling overwhelmed appears to be a core maintaining symptom as well as a disorder-spreading symptom irrespective of contextual changes, such as a pandemic. This is consistent with research that has identified the symptom of overwhelm as a key predictor of the diagnosis of postpartum depression (O′hara et al., 2012). The transition to motherhood during the postpartum period, wherein a mother undergoes major biological, psychological, and social changes, necessitates significant adjustment and requires a huge learning curve (Miller, 2007).

Our findings suggest that when a mother feels overwhelmed, such as when she perceives that the demands of a situation or task (e.g., childcare) outweigh her internal and external resources, it increases her risk of developing both depression and anxiety. Given that postpartum women diagnosed with comorbid anxiety and depression face more adverse outcomes (e.g., lower functioning; higher suicidality rates) compared to women diagnosed with depression or anxiety only (Pollack et al., 2008), a bridge symptom, such as overwhelm, that activates both disorder networks becomes crucial for assessment and intervention efforts aiming to reduce maternal mental morbidity. Moreover, by examining the cross-disorder symptoms' connections with the bridge symptom, feeling overwhelmed, we can identify the illness pathway that connects the symptoms of postpartum anxiety and depression. For the symptom of overwhelm, which is part of the anxiety community, its strongest connection to the depression community is with the following symptom: *I felt that everything I did was an effort*. This pathway indicates that when a postpartum mother feels overwhelmed, she then feels that everything she is doing is effortful, or vice versa—when a mother feels like everything she is doing is an effort, she becomes overwhelmed. Both interpretations are viable in an undirected network, but irrespective of the direction of the relationship it indicates that the connection between these two symptoms may explain how comorbidity between postpartum depression and anxiety develops and is maintained. This connection is consistent with some of the earliest research on postpartum depression—a qualitative study by Wood and colleagues (1997)—wherein a mother struggling with postpartum depression stated, “Even the smallest task just felt monumental . . . even to change a diaper was just overwhelming” (p. 310).

Finally, no more bridge symptoms were identified in the clique percolation analysis, but two additional symptoms, *I felt that people dislike me* and *I had trouble keeping my mind on what I was doing (concentration difficulty),* were identified via bridge expected influence. Both of these symptoms were found to be central in a pre-pandemic perinatal depression network analysis study by Santos and colleagues (2018). However, to our knowledge, neither symptom was identified as a central or bridge symptom in maternal/parental network analysis studies conducted during the pandemic. The symptom of concentration difficulty, which is an item from the depression scale CES-D, was most strongly connected to the central symptom *racing thoughts making it hard to concentrate, which is an* item from the anxiety scale PASS. Although these two symptoms capture somewhat different constructs, they both encompass concentration issues. Akin to the fear-based symptoms, concentration symptoms were found to be both central and bridge symptoms in our network, underscoring their influence on keeping the network system in a pathological state. Therefore, concentration symptoms would be key targets that can enhance the effectiveness of treatment.

As for the symptom of feeling disliked by others, it sheds light on the pathway through which depression and anxiety co-activate. Although this symptom is not routinely screened for in postpartum depression, it may be capturing a phenomenon that has been well-linked to the disorder, mom guilt/shame (Beck & Indman, 2005; Kim et al., 2011; Lee, 1997). Shame differs from guilt because it involves failing to live up to personal ideals rather than doing something wrong (Teroni & Deonna, 2008). Several studies have found that mothers experience guilt and shame when they have an idealized image of how they should be mothering, fear that their parenting will be scrutinized or criticized (especially by other moms), or feel that they have not lived up to societal and cultural standards (Elvin-Nowak, 1999; Liss et al., 2013; Rotkirch & Janhunen, 2010). Moreover, in our network, feeling disliked by others was connected with the anxiety community through the social anxiety symptom *worry that I'll embarrass myself in front of others.* This illness pathway indicates that mothers struggling with depression and feelings of inadequacy may fear embarrassment or judgment from those around them leading to symptoms of social anxiety. Conversely, this pathway may indicate that mothers who already have social anxiety may be particularly sensitive to criticism or advice about their parenting, which can cause them to feel disliked and trigger feelings of depression.

Clinical Implications

Taken together, the findings of our study, along with the findings of network studies conducted prior to and during the COVID-19 pandemic, can provide insight regarding which symptoms may be generally significant and pertinent to postpartum psychopathology, as well as those that may become so specific during large-scale events. In this study, all central symptoms and the top bridging symptom were related to fear. Therefore, our findings indicate that fear-based symptoms are likely to become more influential and activate both postpartum depressive and anxiety symptoms when there are large-scale events or contextual changes that threaten the safety of the mother and her infant, such as a global pandemic, local epidemic, war, or natural disaster. Regarding treatment options, evidence-based treatments for postpartum depression do not typically address fear, while those for postpartum anxiety do—but they are usually tailored to specific anxiety disorders (e.g., CBT for panic). Also, usually, when clinicians treat perinatal patients with comorbid disorders, they prioritize and select a disorder to address first. However, based on our results, fear-based symptoms can be viewed as a transdiagnostic target for both conditions because they were implicated in activating symptoms of postpartum depression and anxiety. Further, targeting fear-based behavioral urges such as avoidance may be helpful for the reduction of both anxiety and depressed mood. Moreover, perceived threats can be tested in behavioral experiments to accurately appraise if a patient's predictions come true, although this may be tricky in the context of an objective threat such as COVID-19. Several researchers adapted CBT interventions to address fear symptoms related to the COVID-19 pandemic, which included strategies such as cognitive restructuring for catastrophic thinking, overestimation of danger, and misinterpretation of bodily sensations (Arnold & Skillings, 2020; Curtiss et al., 2021).

As for the three remaining bridge symptoms, feeling overwhelmed, experiencing concentration difficulties, and feeling disliked by others, these appear to be important in the postpartum comorbidity network irrespective of changes in context as evidenced by network studies prior to and during the pandemic. According to network theory, prioritizing the treatment of bridge symptoms is critical to the interruption of symptom maintenance loops between two comorbid conditions (Cramer et al., 2010; Jones et al., 2021). Akin to the first bridge symptom, all three remaining bridge symptoms are cognitive-affective symptoms of postpartum depression and anxiety, which is consistent with research indicating that these types of symptoms are important. Therefore, cognitive behavioral interventions that target the above symptoms may be effective (Fitelson et al., 2010). However, our findings indicate that interventions that focus on interpersonal and social aspects of the perinatal experience may also be helpful. Specifically, an interpersonal focus would be helpful for the perinatal mother's experience of being disliked by others, but also for alleviating symptoms of overwhelm and concentration strain. Social support, including emotional and childcare support, may help reduce a mother's sense of overwhelm. Additionally, social support would likely be helpful with concentration issues, as these symptoms are related to a mother's struggle with decision-making and bearing the mental load of motherhood, all of which may be alleviated if the mother has adequate social support. There are several evidence-based interventions that may be beneficial, chief amongst them is interpersonal psychotherapy (IPT), a time-limited, solution-focused therapy that links depressive symptoms with interpersonal issues and focuses on building stronger social connections and facilitating coping with the demands of new motherhood (Markowitz & Weissman, 2004). IPT is a well-established and effective treatment for postpartum depression (Fitelson et al., 2010). Beyond IPT and CBT, other potentially beneficial interventions that may target these include incorporating partner and familial support in therapy through psychoeducation, shared activities, problem-solving assistance, and emotional support (Fitelson et al., 2010).

Aim 2. Expanded Network

To our knowledge, this is the first study to use the EPII scale and perinatal subscales (Briggs-Gowan et al., 2020a, 2020b, 2020c; Grasso et al., 2020) in a network study. However, some network studies conducted during the pandemic examined the influence of COVID-19 on symptom networks by including nodes in the network that captured COVID-19 infection status, COVID-19-related events such as lost income, COVID-19-related behaviors such as hand washing and avoidance of supermarkets, and COVID-19-related fears and worries (Karim et al., 2021; Taylor et al., 2020; Zavlis et al., 2022). Therefore, comparing our findings with other network study findings was limited to what is available in the current literature. Moreover, while some COVID-19 network studies revealed similar central and bridge symptoms to our study, none found similar central and bridge stress domain variables. This is likely due to the different variables and scales included in our study compared to the other studies. Nevertheless, our study adds to the growing body of COVID-19 network research, particularly in the area of perinatal network studies, by incorporating domains that have not been included in published studies. As a result, our findings offer valuable insights into the perinatal experience during the COVID-19 pandemic.

In the main expanded network, we investigated the relationship between 13 stress domains (nine general COVID-19 stress nodes and four perinatal stress nodes), nine symptom domains (three for depression and six for anxiety), and one suicidal ideation node. In this study, we conceptualized stress domains to have an adverse impact on mental health symptoms, based on stress theories such as the dose-response theory (Kendler et al., 1999). Therefore, we expected that the stress domains would be positively related to psychopathology domains. However, our results revealed several negative connections between stress and psychopathology nodes. Therefore, to better understand these unexpected results, we inspected these connections in more depth.

The educational stress domain *only* had negative connections with the psychopathology domains; specifically, its connections were with the general anxiety and the obsessive symptoms subscales. There are two possible explanations for this finding. The first is that the education stress domain is an incomplete domain and did not capture items that may have had a negative effect on psychopathology. This domain only included two items: *Had a child in home who could not go to school* and *Adult unable to go to school or training for weeks or had to withdraw.*

Therefore, this domain only captured the impact of the pandemic related to missing school, which limits its comprehensiveness as an "education stress" domain. For example, notably, this domain did not capture the impact of switching to remote learning for children who missed school, which may have been a critical aspect of education stress during the pandemic. Indeed, studies found that parents who had to step in and teach their children felt overwhelmed, emotionally and physically exhausted, and as though they were "going crazy" (Burns et al., 2023; Garbe et al., 2020; Nyanamba et al., 2021). It should be noted that there was an item in the Home Life stress domain that read *Had to take over teaching or instructing a child,* which had an endorsement rate of 14.6% within our sample. Therefore, even if participants had children at home due to school closures, it appears that a small percentage needed to be involved in the schooling of their children.

Moreover, within our sample, approximately 34.3% of participants reported having a child at home who could not go to school and 6.9% were unable to attend school themselves or had to withdraw. Of note, our data was collected during the first four months of 2022 and captured stressors up to 12 months before then, when the majority of schools were open or in a hybrid model (Hale et al., 2021). Therefore, the time period relevant to our data did not include enforced school closures. Rather, parents in our sample who kept their children out of school long-term or stayed out of school themselves may have done so due to not being comfortable with the risk of COVID-19, whereas those who stayed out of school for a short term might have done so due to surges or suspected infection. However, because we do not have information on the length of absence from school, both situations are plausible. Therefore, theoretically, participants who endorsed the items under the Education Stress domain experienced a reduction in their general anxiety symptoms and obsessive symptoms, and vice versa, participants who experienced these symptoms preferred to keep themselves and their children out of school.

The only other negative relationship in the expanded network was between the *Social Activities* stress domain and *Suicidality*—that is, the more social activities stress items a participant endorsed, the lower their suicidal ideation was and vice versa. The *Social Activities* stress domain includes 10 items related to being separated from family or close friends; canceled family celebrations, travel, and religious activities; and inability to engage in other social activities. We inspected the endorsement rates and found that the highest rates were for the following items: family celebrations canceled or restricted (88.4%), unable to do enjoyable activities (69.5%), and being separated from family or close friends (67.5%). Given research that revealed the pandemic's negative impact on extended familial interactions, including heated conversations around seeing each other safely and increased conflicts due to diverged opinions about the seriousness of the virus, it is unsurprisingly that reduced social engagement may have reduced mental health symptoms (Brugiavini et al., 2022; Feinberg et al., 2022a; Gilligan et al., 2020; Hernandez & Colaner, 2021; Lee et al., 2022). Based on our findings, it is possible that when a participant reduced familial contact, their depressive symptoms–and ultimately their suicidal ideation–decreased. This notion is supported by studies that found that intergenerational conflict fueled by divergent beliefs leads to higher rates of depression (Peng et al., 2021; Suitor et al., 2017, 2018). Additionally, this is further supported by the two other positive connections with the *Social Activities* stress domain, which are the *Fear* and *Difficulty Adjusting* symptom domains. This seems to corroborate that people who reduced social activities during the COVID-19 pandemic also experienced increased levels of anxiety and thus may have chosen to reduce their perceived risk during the pandemic by limiting their social interactions. These findings, along with other results within this study related to social domains, highlight that during a global pandemic (where disease is spread via social contact) the impact of disrupted social networks, supports, and events on a person's mental health is nuanced and complex.

Central Symptoms

Fear and Depressed Mood. The two most central nodes in the expanded network were the *Fear* and *Depressed Mood* symptom domains. Once again, even with the addition of stressors to the network, fear symptoms played the most influential role in activating the overall network, further underscoring the importance of this symptom for postpartum women during the COVID-19 pandemic. The second most central node was *Depressed Mood*, which included symptoms related to sadness such as sad mood, crying spells, feeling blue, and lack of enjoyment amongst others. Sadness or depressed mood is a well-supported central symptom in depression and depression-anxiety maternal networks both before and during COVID-19 (Phua et al., 2020; Santos et al., 2017a; Zhang et al., 2021). This highlights the importance of continuing to screen for sadness/depressed mood (e.g., PHQ-2 scale; Kroenke et al., 2003) in the maternal population even in the light of large-scale events, as these symptoms may play an important role in triggering and maintaining postpartum depressive and anxiety disorders.

Home Stress and Postpartum Home Stress. The third and fourth most central nodes in the expanded network were related to stressors that the mother experienced at home. The *Home Life* stress domain included a variety of stressors, from challenges related to childcare to relocation and homelessness to an increase in physical and verbal abuse. Therefore, we examined endorsement rates to better understand which stressors were more prevalent. We found that the highest endorsement rates were for an increase in verbal arguments or conflict with a partner or spouse (58.7%), childcare or babysitting is unavailable when needed (55.8%), and difficulty taking care of children in the home (55.3%). Similarly, the *Postpartum Home Life* stress domain included a variety of items. Upon examining the endorsement rates, we found that the highest endorsement rates were for family, friends, or other support people being unable to help with the new baby (68.4%), having a hard time balancing work and caring for baby (51%), and having a hard time balancing taking care of the baby and taking care of another person (or people) in the home (36.2%).

For our participants, it appears that proximal stressors (related to the home environment) were generally more impactful to their mental health compared to distal stressors. Importantly, our findings support that while staying at home during the COVID-19 pandemic may have been protective of infections for new mothers and their babies, it also brought about a rise in childcare stressors, work disruptions, and interpersonal conflicts, along with a decrease in support. Specifically, the vast majority of the highest endorsed items in both the *Home Stress* and *Postpartum Home Stress* domains were related to childcare stress. Before the pandemic, the majority of young children were cared for by an adult other than their parents during working hours (e.g., daycare, babysitter, other family members; RegionTrack, Inc., 2019) However, the pandemic disrupted these sources of formal and informal support, and parents had to balance work and childcare at home. This resulted in increased demands on parents, with mothers often bearing the brunt of the extra burden in household and childcare tasks (H. C. Lin et al., 2022; Petts et al., 2021; Zamarro & Prados, 2021). This was especially true for working mothers who carried a heavier load of childcare compared to their male partners while continuing to work, which increased the likelihood that they would have to cut back on their work hours or leave their jobs entirely (Zamarro & Prados, 2021). This stress was amplified for multigravida mothers who struggled to divide their time and attention between their newborn and older children with different needs (e.g., bonding with the newborn versus taking on the role of educator for the older child; Davis et al., 2022). Consequently, overburdened mothers experienced higher levels of childcare stress and psychological distress and a decline in their well-being. On the other hand, mothers with uninterrupted childcare relished the increased time with their children during the pandemic (Anderson et al., 2022; Calarco et al., 2020; Vicari et al., 2022).

It is unsurprising that the highest endorsed item in the *Home Stress* domain was an increase in verbal conflict with a spouse or partner. This is in line with multiple studies that reported a significant increase in verbal arguments during the pandemic (Alzueta et al., 2021; Chung et al., 2023; Lee et al., 2022; McMillan et al., 2021; Schokkenbroek et al., 2021). Several reasons accounted for this spike in verbal disagreements during the pandemic, including increased proximity and inability to isolate from other members of the household due to lockdowns and sheltering-in-place orders; loss of pay or employment; differing opinions on how to deal with COVID-19 risk; academic challenges for children; and increases in family members' mental health struggles or substance use (Schokkenbroek et al., 2021; Sinko et al., 2022). Also, a major contributor to the increase in verbal disputes, which is consistent with the second and third most endorsed items in this domain, was the division of childcare responsibilities between parents, especially working parents (Chung et al., 2023; Kotlar et al., 2021; McMillan et al., 2021). The gendered divide in childcare responsibilities coupled with the loss of support from formal and informal sources likely contributed to the escalation of interpersonal conflicts between couples. A global study across 59 countries found that the rise in verbal conflict contributed to increased rates of mental health symptoms, including depression and anxiety, during the pandemic (Alzueta et al., 2021). This, in turn, led to the exacerbation of familial conflict (Sinko et al., 2022), creating a dangerous cycle that risked the mental and physical health of family members, especially mothers and their children. Therefore, it is crucial that protections go beyond the outside world to safeguard the home as a secure environment for families during crisis situations.

Bridge Symptoms

Postpartum Healthcare Stress. The highest bridge node in the expanded network was the stress domain, *Postpartum Healthcare Stress*. We examined the endorsement rates of the items included in this domain to identify which stressors were prevalent and found that the highest endorsement rates were for the items *I have not been able to get some services I have wanted for myself (for example, lactation specialist, visiting nurse)* (23.7%) and *I have not been able to get the help I have wanted for feeling down, worried or overwhelmed* (21.3%) and the lowest was for *My baby has not had any in-person well-baby visits due to COVID-19* (2.4%). At the time of data collection, the omicron wave was surging throughout the U.S. and was, once again, straining the healthcare system and forcing institutions to choose which "essential" services to continue providing while forgoing what they considered were "non-essential" services (e.g., preventative reproductive care, lactation support, mental health support, etc.) that may have provided critical postpartum care to new mothers (Rice & Williams, 2022; Weigel et al., 2020). Therefore, maternal mental health associations were raising alarms and asking healthcare institutions to continue to provide these services. For example, the Canadian Perinatal Mental Health Collaborative (CPMHC) urged the federal government to keep its promise to ensure timely access to perinatal mental health services during the Omicron wave. The CPMHC stated, "At a time when everyone is feeling a loss of hope from yet another lockdown, we cannot forget our most vulnerable families: pregnant and postpartum women and birthing people who are already struggling with a mood or anxiety disorder" (CPMHC, 2022, para. 2). A similar plea was made for continuing lactation support by the Association of State and Territorial Officials (ASTHO) in the U.S. who urged state health agencies to go beyond 60 days postpartum to 12 months postpartum as well as integrate lactation support and mental health services, including via telehealth, pediatric providers, or existing early childhood programs such as home visits (ASTHO, 2022).

Throughout the pandemic, and especially during the surges, perinatal women reported feeling neglected by the healthcare system and as though they could no longer rely on their providers (Jackson et al., 2021; Jin & Murray, 2023; Ollivier et al., 2021). For example, support services such as birthing, breastfeeding, and motherhood groups were reduced or eliminated to decrease the risk of transmission, leaving mothers feeling alone and "dumped by the system" (Ashby et al., 2022; Jacob et al., 2022; Jin & Murray, 2023). Further, the loss of instrumental support from the healthcare system compounded the loss of social support from family and friends that many mothers experienced during the COVID-19 pandemic. In fact, the provision of formal services (e.g., lactation consultants) may be particularly critical to alleviating maternal distress during a pandemic because of the reduction of informal social support (e.g., grandmother, mother; Jin & Murray, 2023). Of note, although online alternatives were provided and did improve engagement with services for some mothers, many mothers reported several barriers to accessing these services (e.g., poor internet or phone connection, lack of privacy; Morgan et al., 2022; Paul et al., 2022; Wilson et al., 2021).

The item endorsement rates of the Postpartum Healthcare Stress domain also revealed the critical impact of not accessing mental health services as evidenced by the second highest endorsed item, I have not been able to get the help I have wanted for feeling down, worried, or overwhelmed (21.3%). Research indicates that the notable increase in mental health rates during the pandemic, and the resulting increased need for mental health services, exacerbated pre-pandemic barriers to accessing mental health care (e.g., long wait lists; McDonnell et al., 2022). This is consistent with research conducted with pregnant and postpartum women (McDonnell et al., 2022). Further, in a study by Masters and colleagues (2021), the authors found that participants who endorsed symptoms of perinatal depression, anxiety, and/or PTSD were more likely to perceive changes in their access to care – that is, those who needed these services most, were more likely to struggle with accessing them.

Finally, we found that the most prominent pathway through which the Postpartum Healthcare Stress domain activated the postpartum psychopathology community is by way of activating the suicidality node. This pathway underscored the critical impact of accessing health and mental health care services on maternal mental health morbidity—and potentially, mortality—during the COVID-19 pandemic.

Emotional Health and Well-being Stress Domain and Difficulty Adjusting Symptom Domain. The next two nodes with the highest bridge expected influences were the *Emotional Health and Well-being Stress* domain (Emotional Stress) and *the Difficulty Adjusting* symptom domain. The *Emotional Stress* domain included eight items that covered increases in mental health symptoms for adults and children in the home, problems with access or changes to mental health treatment, and increases in screen time. Endorsement rates revealed that 90.3% of our sample reported that they or people in the household spent more time on screens and devices, 73.8% reported an increase in mental health symptoms for themselves and/or others in the household, 23.4% reported an increase in child behavioral or emotional problems, and 19.2% reported an increase in child's sleep difficulties or nightmares. It is unsurprising that the *Emotional Health and Well-being Stress* domain bridges strongly with the psychopathology community given the overlap in the content (e.g., items related to mental health symptoms in adults and children, substance use, sleep problems, etc.). Importantly, this domain also revealed that the mental health problems of children and other adults in the home also contributed to the activation of the participants' own symptoms of depression and anxiety. Of course, due to the undirected nature of our network, the opposite is also possible. A perinatal mother's mental health struggles may be negatively impacting the mental health of people in the household, particularly children. Further, theoretically, a bidirectional feedback loop may be in place where maternal mental health symptoms lead to an increase in children's behavioral problems, which in turn exacerbates maternal mental health symptoms. This strong relationship between parents' depression, anxiety, and stress symptoms and children's internalizing and externalizing behavior has been well-established in pre-COVID research and confirmed during the COVID-19 pandemic (Kwon et al., 2022; Riahi et al., 2022; Stallard et al., 2004; Westrupp et al., 2023; Whittle et al., 2020).

Of all the symptom domains, the *Difficulty Adjusting* symptom domain had the strongest connections with the stress community. This suggests that it is not merely being exposed to stressors that may trigger psychopathology, but rather a person's struggle to adjust and adapt to these stressful changes. This domain includes two severe forms of maladjustment to and rejection of changes in one's life—*Feeling detached like I'm watching myself in a movie* and *Losing track of time and can't remember what happened*—which capture symptoms of dissociation, depersonalization, and emotional numbing. Studies indicate that individuals may employ strategies such as fantasizing, avoidance, and emotional numbing as a means of managing feelings of apprehension and overwhelm in response to a perceived threat to their physical or psychological well-being, such as the COVID-19 pandemic (Bansal, 2021;

Kolozsvári et al., 2023; Thompson et al., 2022). The concept of psychic numbing, first introduced by psychologist Paul Slovic, suggests that individuals' emotional responses to traumatic events do not escalate as they are subjected to greater suffering; instead, their emotions may plateau or diminish over time (Slovic et al., 2013). This was demonstrated by studies that showed that a person's emotional reaction to something traumatic may be intense after the initial exposure to it, but subsequently declined with repeated exposure, eventually reaching a level of indifference (Bhatia et al., 2021; Hoffman & Kaire, 2020). The findings of these studies can shed light on the rise of depersonalization (i.e., person feels detached from themselves) and derealization (i.e., person feels detached from their external environment) experiences reported during the COVID-19 pandemic (Fearn, 2022; Hunter et al., 2004; Mental Health America, n.d.).

Further, data collection for this study occurred two years into the pandemic and individuals were facing yet another surge in COVID-19 cases along with an uptick in COVID-19 restrictions. This resulted in increased time spent indoors, limited interactions with others, and an "overly-sedentary hyper-digitalized" lifestyle, which likely contributed to a heightened sense of detachment and dissociation (Ciaunica et al., 2022). However, whereas mild dissociation may be harmless and resemble daydreaming, zoning out, or losing track of a couple of hours, employing excessive avoidance as a coping mechanism to deal with the unmanageable stress caused by the pandemic can be detrimental to a mother's mental health (Mental Health America, n.d.; Thompson et al., 2022). Therefore, *Difficulty Adjusting* is a crucial symptom domain for prevention efforts that aim to safeguard against stressors triggering mental health symptoms. Moreover, given that this symptom domain was most strongly connected to the two other bridge nodes, *Postpartum Healthcare Stress* and *Emotional Health and Well-being Stress,* this reveals a crucial system activation loop between these three nodes that maintains the connection of the stressor and psychopathology communities (Cramer et al., 2010; Jones et al., 2021). As such, this connection highlights that the Difficulty Adjusting domain is a crucial candidate symptom cluster for intervention.

Moderation Effect of External Variables on the Main Expanded Network

It should be noted that all moderation analyses in this study are exploratory and therefore, no specific edge will be examined closely. Moderation analyses are a relatively newer technique for group comparisons and are still not as widely used as other established methods (i.e., Network Comparison Test) despite its several advantages (e.g., comparing more than two groups; using both categorical and continuous grouping variables). Importantly, for moderation analyses, there are currently no established guidelines on the number or the percentage of edges that need to be different for two networks to be considered significantly different from each other. Therefore, we will describe the pattern of edge differences and the overall impact of a moderator on the network structure and its edge connections.

Maternal Functioning. We explored the moderation effect of the two subscales of maternal functioning—maternal competency and maternal self-care—on the edges of the main expanded network. The analyses revealed that maternal competency moderated eight out of 253 (3.2%) edges and had a generally negative effect on edge connections—that is the more a mother felt competent, the weaker the edges were between the nodes of the expanded network. On the other hand, the self-care subscale only moderated one edge out of 253 (0.4%) and therefore, had minimal impact on the network. Maternal competence pertains to a mother's trust that she is effectively meeting the needs of her child, as well as feeling satisfied with the job she's doing (Ngai et al., 2010). As a mother transitions to motherhood, it is critical that her sense of competency increases over time due to its impact on the quality of her parenting and the bond between her and her infant. Research indicates that if a mother feels competent, she is more likely to provide skillful, nurturing, and sensitive care to her infant and be more attuned to her infant in a way that helps them thrive developmentally (Bornstein, 2005; Harwood et al., 2007; Ngai et al., 2010; Oruç & Kukulu, 2022; Sanders & Woolley, 2005).

During the COVID-19 pandemic, the transition to motherhood became more challenging due to increased stressors and decreased support. This transition was further exacerbated by mothers assuming a larger caretaking role during the pandemic, while attempting to balance their other responsibilities and maintain their high standards of parenting (Chartier et al., 2021; Zamarro & Prados, 2021). Our findings suggest that maternal competency may buffer the impact of the pandemic on maternal mental health. This is in line with studies that found that maternal competency was inversely related to psychological distress, mental health symptoms, and the reported impact of pandemic-related stressors (Gholizadeh Shamasbi et al., 2020; Gordo et al., 2018; Lax et al., 2023; H. C. Lin et al., 2022). Therefore, we can consider maternal competency as a proficiency that can be fostered through maternal interventions that may include enhancing positive social support, teaching infant care skills, and reframing unrealistic maternal expectations (Mirzaki et al., 2022; Saeieh et al., 2017). Therefore, as mothers feel more capable, competent, and confident about their parenting, the adverse effects of stress on their mental health may be mitigated.

Positive Experiences. The variable “Positive Experiences,” which is a sum score of the positive experiences subscales of the EPII, the EPII-P, and the EPII-I scales, was explored as a moderator of the expanded network model. The analysis revealed that this variable moderated four out of 253 edges (1.6%). Interestingly, each of the four edges included *Infection Stress* as one of the nodes in the pair and its relationship with the other nodes became stronger with higher levels of the moderator. This suggested that the more participants, or people in their households, engaged in positive experiences, the stronger the relationship became between *Infection Stress* and three stress domains, as well as with the suicidality node. This is an interesting and unexpected finding. We initially theorized that positive experiences would weaken the connections between COVID-19 stressors and psychopathology given that several COVID-19 studies cited this variable as associated with maternal mental health symptoms during the pandemic (Farewell et al., 2020; Lebel et al., 2020).

We examined the endorsement rates of the *Positive Experiences* domain as well as the literature to better understand these unexpected findings. The highest endorsed items were: spending more quality time with their children (86.5%), their partner or spouse (76.5%), their baby (74%), and with family or friends in person or from a distance (e.g., on the phone, email, social media, video conferencing, online gaming) (72.1%). Given these rates, it is reasonable to conclude that when the participants or people in their households became infected and separated from loved ones in the household, including their newborn infant, they experienced elevated levels of stress and suicidal ideation (Fioretti et al., 2020). Moreover, the positive experiences domain includes other items such as engaging in enjoyable activities or starting new hobbies, volunteering or donating time and goods for pandemic relief, exercising, and spending more time outdoors. It is plausible that two years into the pandemic, people may have become accustomed to a “new normal” and found ways to continue engaging in positive experiences. And although these activities may have provided a much-needed reprieve from the strains of the pandemic for mothers and people in their households, it likely came with an increased risk of infection. However, as the Omicron wave spread and cases spiked, those who were infected or knew some who did had to come to terms with the fact that the pandemic was still very present and continues to affect their lives. On the other hand, people who continued to adhere to restrictions that were common at the beginning of the pandemic (e.g., limited social interactions, avoiding enclosed spaces, etc.) may not have been as significantly impacted by the renewed constraints of the Omicron wave.

During the Omicron wave, several studies and news articles highlighted how people experienced renewed fears and frustrations with yet another lockdown after a period of relative normalcy (Gollom, 2021; Mackovich-Rodriguez, 2022). Relatedly, studies reported that most people had “pandemic fatigue” leading them to resist adopting additional precautions or infection-reducing behaviors with the emergence of a new variant (Murphy, 2020; Williams & Dienes, 2021). Nevertheless, despite the easing of restrictions (i.e., lockdowns) as well as the non-adherence of many people during Omicron, people were still advised to isolate themselves from others and cancel social engagements if they tested positive—which was especially painful during the holiday season (Centers for Disease Control and Prevention (CDC), n.d.-b; Yuko, 2022). And given that a record number of people were infected during the Omicron surge and most people were either infected or knew someone who was, the impact of this wave was felt by everyone (Tayag, 2022). As a result, Omicron brought a surge of resignation that COVID-19 is “never going away” and significantly worsened depression, anxiety, stress, or suicidal ideation symptoms in people, including perinatal women (Bauer et al., 2022; Hadjistavropoulos & Asmundson, 2022; Matić et al., 2023; Moghadam & Moghadam, 2022).

Predictors. We explored the moderation effects of eight significant predictors of postpartum depression and anxiety, as identified by our preliminary analyses.

Infant Temperament. We expected that infant temperament would adversely impact the network, that is, make the network connections stronger given the established pre-pandemic literature showing that infant temperament has strong associations with postpartum depression and anxiety (Beck, 1996; Britton, 2011; Coplan et al., 2005; McGrath et al., 2010). As expected, the moderation analysis revealed that the *Infant Temperament* variable, which was a sum variable of three questions from the PDPI, moderated six out of 253 edges (2.4%). That is, the more a mother perceived her infant's temperament as challenging, the stronger the connections between stressors and psychopathology symptoms became and thus, the network was more likely to remain in a pathological state if activated. These findings are in line with most research during the pandemic. Several studies examined the relationship between COVID-19-related stress and infant temperament and found that mothers who reported high rates of COVID-19-related life disruptions and stress also reported that their children had negative emotionality, lower positive affectivity, and emotional regulation problems (Bianco et al., 2023; Buthmann et al., 2022; MacNeill et al., 2023; Morris & Saxbe, 2023). Interestingly, maternal infection with COVID-19 during pregnancy was not associated with infant temperament (Bianco et al., 2023).

On the other hand, the picture is less clear regarding the link between perinatal mental health symptoms and infant temperament during the pandemic. During the pandemic, some studies found that higher rates of postpartum depression were associated with increases in difficulties in infant temperament, while other studies did not find an association (Buthmann et al., 2022; Fiske et al., 2022; Morris & Saxbe, 2023). Of note, even prior to the pandemic, there was a debate among researchers regarding the relationship between maternal mental health and infant temperament with various explanatory models proposed to describe the nature and direction of this relationship. For example, some researchers have claimed that 1) mothers who are anxious or easily stressed tended to have infants with similar predispositions; 2) infants may become more fussy and irritable in response to maternal anxiety; 3) mothers who are depressed or anxious more likely to perceive their children as more problematic; or 4) caring for a challenging infant lowers maternal efficacy which increases the risk for maternal depression (e.g., Calkins, 2002; Edhborg et al., 2000; Field et al., 1990). Regardless of the directionality of the relationship between infant temperament and maternal mental health, equipping mothers with tools to respond to their children's emotional reactivity (e.g., responsive and attuned parenting techniques; Dombrowski et al., 2005) or providing them with support when they feel overwhelmed with childcare, could alleviate postpartum depression and anxiety and the effect of life stressors on these symptoms.

Prenatal Anxiety, Prenatal Depression, and Baby Blues. As for the three categorical variables, prenatal anxiety, prenatal depression, and baby blues, we theorized that they would make the edges of the network stronger for participants who endorsed them. Our prediction was based on multiple studies that have established these variables as predictors of postpartum anxiety and depression as well as studies that reported an increase in these symptoms during the COVID pandemic (Beck, 1996; Grant et al., 2008; Radoš et al., 2018; Reck et al., 2009; Roomruangwong et al., 2016). Additionally, COVID-19 studies found an increase in the reported rates of prenatal anxiety, prenatal depression, and baby blues (Tomfohr-Madsen et al., 2021), which may partly explain the increase in the rates of perinatal depression and anxiety during the pandemic. As anticipated, *Prenatal Anxiety* moderated ten edges out of 253 (4.0%), *Prenatal Depression* moderated twelve edges out of 253 (4.7%), and *Baby Blues* moderated six edges out of 253 (2.4%). Thus, if a participant endorsed any of these variables, the connections between COVID-19-related stressors and postpartum symptoms in the expanded network became stronger and new connections were made. Specifically, *Prenatal Anxiety* added two new edges, *Prenatal Depression* added six new edges, and *Baby Blues* added four new edges to the network.

Importantly, compared to all other moderating variables, these three predictors were responsible for the highest number of moderated edges in the expanded network. Indeed, if present, these variables resulted in "denser" networks, which will increase the likelihood of triggering and maintaining postpartum mental health problems (Van Borkulo et al., 2015a). Our study suggests that the impact of COVID-19-related stressors on postpartum mothers is not uniform. Specifically, our findings indicate that those who previously experienced depression or anxiety during pregnancy, or experienced baby blues, were more susceptible to developing postpartum psychopathology when facing stressors. Therefore, it is crucial that postpartum women are continually screened for a history of prenatal depression, prenatal anxiety, and baby blues during large-scale events (e.g., a pandemic) because it will aid in the identification of women who are at a greater risk of developing postpartum mood and anxiety disorders.

Social Support. All three domains of social support did not have the "buffering" effect (Cohen & Wills, 1985) we expected between stressors and mental health symptoms. We expected that as social support increases, the connections between the nodes of the expanded network would weaken. Instead, of the five moderated edges, four became stronger, suggesting that with higher levels of social support the connections between stressors and symptoms became stronger. Specifically, *Family Social Support* moderated two out of 253 edges (0.8%), both of which became stronger and included the *Suicidality items as* one of the nodes in both pairs, As for *Partner Social Support, it* moderated three edges out of 253 (1.2%), with two edges that became stronger with higher levels of support and one edge, between *Depressed Mood* and *Suicidality,* that weakened with more partner support. Conversely, Friends Social Support did not moderate any network edges.

Several theories may explain these unusual and unexpected findings. Given the pandemic's unique circumstances, the nature of social support may have been different. For example, if social support persons (e.g., family, partner) were present to help the mother with childcare, then, they likely resided in the same household due to social distancing practices. It is plausible that with increased help came increased proximity, amplified tension, and an inability to separate from members of the household—all of which may have led to more conflict and contributed to an exacerbation of stress and mental health symptoms for the mother. Moreover, research indicates that if there was a conflict in a mother's romantic or marital relationship, the presence of other sources of social support does not buffer against emotional distress (Coburn et al., 2016). This also underscores the crucial influence of partner support and the necessity of an overall supportive partnership for the mental health of the postpartum mother. This is consistent with our finding that with more partner social support, the link between depressed mood and suicidality weakens and the inverse is also true, with lower levels of partner support, this dangerous link becomes stronger. In fact, research indicates that above all other types of support, partner support is the most predictive of perinatal psychopathology outcomes (Yim et al., 2015). Further, consistent with our findings, friends' social support is not associated with postpartum psychopathology when controlling for other risk factors (Dennis, 2004; Secco et al., 2007; Siu et al., 2012).

Another equally plausible explanation for our findings may be that social support does not buffer against stress's effect on maternal mental health, but rather, that both social support and stress have independent relationships and effects on maternal mental health (Schwab-Reese et al., 2017). Given this, it would mean that merely increasing social support would not be enough to reduce symptoms of postpartum depression and anxiety, and instead, equal effort should be exerted toward reducing stressors (e.g., if a mother is experiencing economic or employment stress, social support may not mitigate its adverse effect on her mental health). Ultimately, all these theories are plausible. Therefore, more research is needed to understand the nuances of social support, including the quality, type, and context (e.g., global pandemic) of the support, to better harness it in a way that would be most beneficial for perinatal mothers.

Income. We examined the moderating effects of income level by comparing the networks of mothers with a reported low, middle, or high household income. Given that low income and low socioeconomic status tend to be associated with increased postpartum mental health problems (Beck, 2001; Belle, 1990; Chaudron et al., 2005) and were identified as risk factors for postpartum psychopathology during the pandemic (Gao et al., 2022), we expected that the networks of mothers in the lowest income group to have a higher number of edges and/or stronger edges. However, surprisingly, we found that mothers in the low and high-income groups had identical networks. Moreover, compared to the other two income groups, the middle-income group had one stronger edge as well as two additional edges—both of which included *Quarantine Stress* as one of the nodes in a pair.

To investigate this unexpected finding, we began by exploring how low-income mothers, a traditionally at-risk income group, can be similar to high-income mothers, a traditionally lower-risk group. The answer may lay in increased systemic support for low-income mothers during the pandemic. For example, in a study that found that mothers with low SES reported improved postpartum mood when social restrictions were implemented in New York City, the authors posited that systemic support, in the form of social and health policies, may have eased the work-family balance for low-income mothers resulting in an improved quality of life (Silverman et al., 2020). Similarly, in a study of low-income mothers in the US, all of whom were receiving some form of government assistance, the authors found that even mothers with higher reported stress levels were able to name positive aspects of their life during the pandemic's peak (e.g., spending more family time, slower pace of life, and reduced expense from daycare closures; Haskett et al., 2022). Additionally, the Coronavirus Aid, Relief, And Economic Security (CARES) Act, which was enacted during the pandemic, provided financial support of $1,200 per adult and $500 per child for households with an annual income of $75,000 or less (Coronavirus Aid, Relief, and Economic Security [CARES] Act, 2020). Moreover, unemployment benefits were extended to people who do not usually qualify for them, such as contractors and self-employed individuals, if they lost employment due to the pandemic (CARES Act, 2020). Therefore, people in lower income brackets were receiving more government financial support than they usually do. On the other hand, it is likely that people in higher income brackets, who did not receive government assistance, were less in need of this support (Mollard et al., 2021). And so, middle-income families were lost in between without the assistance of the government or the security of their own financial resources.

Regarding the middle-income group's two additional edges that included the node Quarantine Stress, the household living situation may have been more stressful for these mothers compared to their low-income counterparts due to the latter residing in households with a higher number of individuals (e.g., multigenerational homes) long before the pandemic (Cohn et al., 2022). Theoretically, the lockdowns and quarantines may put a strain on middle-income households who may not have the financial means to reside in larger homes with fewer occupants, like higher-income individuals but were less accustomed to these living arrangements compared to low-income households. Interestingly, our findings were comparable to a study in

China that identified middle-income status as an additional risk factor for developing depressive and anxiety symptoms during the COVID-19 pandemic (Wu et al., 2020).

Aim 3. Racial Network Comparisons

Based on the findings of the preliminary analyses (i.e., investigation of racial/ethnic differences in stress and psychopathology), we expected that the comorbidity and the expanded networks of Black mothers would differ from the other racial groups. The findings from the moderation analyses generally confirmed our expectations and revealed additional differences between the networks of White mothers and other racial groups. The moderation analyses revealed that race moderated four out of 780 comorbidity network edges (0.5%), of which Black mothers had two unique edges and one edge that was stronger compared to the other racial groups. On the other hand, White mothers had one edge that was stronger compared to the other racial groups. The moderation analyses revealed that race moderated eight of 253 expanded network edges (3.2%), of which Black mothers had four unique edges and one edge that was stronger compared to the other racial groups. As for White mothers, they had two edges that were stronger and one unique edge compared to the other racial groups. Once again, we note that all moderation analyses in this study are exploratory, and therefore, only patterns in edge differences will be discussed.

The pandemic exacerbated pre-existing racial health disparities in the U.S.; prior to the pandemic, the Black perinatal population suffered alarmingly and disproportionally worse pregnancy and postpartum health outcomes, including higher rates of maternal mortality, pre-term births, and infant mortality (March of Dimes, 2020). And, during the pandemic, the schism grew wider and Black mothers suffered both physically and mentally (U.S. Commission on Civil Rights, 2021). Therefore, the differences we found in the symptom and stressor-symptom networks echo the disproportionate impact of the pandemic on Black individuals generally, and Black mothers especially, but also, offer a new lens through which we can understand this phenomenon at the symptom and stressor level.

Suicidal Ideation

The moderation analyses revealed that Black mothers had both stronger edges and unique edges with the suicidal ideation node. Specifically, the *Suicidality-Failure* edge was stronger and the *Suicidality-Sudden Fear* edge was unique to them in the comorbidity network, and the *Depressed Mood-Suicidality* edge was stronger and the *Suicidality-Panic* edge was unique to them in the expanded network. These symptom-level differences echo the significantly higher rates of suicidal ideation reported by Black mothers in the preliminary analyses. These findings align with studies that found that Black women experience higher rates of perinatal depression, perinatal anxiety, and suicidal ideation (Atkins, 2016; Biaggi et al., 2016; Gur et al., 2020; Salihu et al., 2022). Furthermore, research has found that Black mothers' postpartum depression may worsen due to underreporting, as they often engage in denying, masking, or suppressing their symptoms instead of seeking mental health treatment (Atkins, 2016; Dwarakanath et al., 2023). This causes Black mothers' untreated symptoms to persist, which results in a range of adverse outcomes, including suicidal ideation.

Why might Black mothers underreport their suicidal ideation? The answer to this may lie in Black mothers' unique links to *Suicidality*—that is, its connection with *Fear* and *Panic*. In a qualitative study of Black mothers, of the eleven participants who experienced postpartum depression, only two participants informed their healthcare provider, of which only one was connected to services. Importantly, participants cited a fear of being reported to Child Protective Services as a major deterrent to them disclosing their symptoms to their providers (Dwarakanath et al., 2023). Therefore, theoretically, experiencing symptoms of suicidal ideation may result in fear and panic for Black mothers causing them to mask their symptoms in front of their providers. Of course, the inverse is also true, feelings of fear and panic may be triggering suicidal ideation for Black mothers. In addition to experiencing significantly poorer outcomes during the perinatal period compared to other racial groups, Black mothers are at a heightened risk of experiencing "traumatic childbirths" with approximately one-third developing PTSD symptoms. This, in turn, can lead to comorbid depression and suicidal ideation (Ayers et al., 2006). What is more likely is that there is a cyclical loop between suicidality and fear and panic that may be at play here, which would be consistent with some maternal studies conducted pre-pandemic. For example, in a qualitative study of childbirth-related PTSD, a participant recounted how her traumatic birth led to her spiraling into severe depression and suicidality (Ayers et al., 2006). Yet, she reported that the more severe her symptoms became, the more terrified she became of revealing it to anyone for fear of her child being taken away from her (Ayers et al., 2006).

Healthcare-Associated Stressors

All the unique edges for Black mothers in the expanded model were related to interacting with the healthcare system, such as *Health Stress, Infection Stress*, and *Labor and Delivery Stress*. On the other hand, White mothers had a unique link between *Postpartum Healthcare Stress* and *Emotional Stress,* which appeared related to their inability to access postpartum support for their physical and mental health needs due to the pandemic's strain on the healthcare system. Healthcare interactions have always been challenging for Black mothers, long before the pandemic, because of systemic racism. There are several barriers to accessing quality maternal healthcare, including not having insurance coverage and living in areas with provider shortages

(Henry J. Kaiser Family Foundation, 2013; Strauss, 2020). However, implicit bias and systemic racism are likely the prime culprits for Black mothers receiving poorer perinatal care even within the same hospital (FitzGerald & Hurst, 2017; Holroyd et al., 2016; Yearby & Mohapatra, 2020). Several studies have found that mothers of color are more likely to experience longer wait times, reduced communications with their families, and discrepancies in treatment recommendations (e.g., excessive reliance on c-sections) compared to White mothers, all of which increase the likelihood of maternal morbidity and mortality. For example, one study found that Black mothers experienced worse maternal morbidity compared to their white counterparts within the same hospital, even after controlling for maternal age, obesity, hypertension, and diabetes (Howell et al., 2020). Therefore, becoming infected as Black mothers came with an amplified risk of worse outcomes due to the intersection of their race and their perinatal status.

Home Stress

Interestingly although differences in *Home Stress* connections came up for both White and Black mothers, the links to this node differed. For Black mothers, *Home Stress* was connected to *Health Stress* and *Infection Stress* while for White mothers, it was connected to *Educational Stress* and *Emotional Stress.* We examined endorsement rates and the literature to better understand this divergence in stressors experienced within the home. Intriguingly, although Black mothers had the lowest rate of employment in this study (56%), 55.9% of them or people in their households continued to work in close contact with people who might be infected, 26.5% worked in close contact with patients with COVID, and 20.6% took care of people who died from COVID—all of which were higher than all other racial groups. Therefore, the elevated risk of infection that came with their employment may have increased stress at home. Moreover, the fears of infection may not only be related to their occupation because research shows that Black communities had higher rates of infection during the pandemic (e.g., Millett et al., 2020).

Conversely, for White mothers, the increased stress at home was related to their children staying out of school as well as being in close proximity to family members during lockdowns. This is in line with research that found that White mothers tended to endorse hegemonic ideals of motherhood and, therefore, tend to rely less on kin for childcare support and are the primary caretakers of their children even if they are working (Dow, 2016; Hays, 1996; Uttal, 1999). These findings are further supported by studies during the pandemic that revealed that mothers from different racial groups had dissimilar sources of stress. White mothers cited working from home without childcare, remote learning, and losing support with household tasks and newborn care as sources of stress (e.g., Calarco et al., 2020; Gildner et al., 2021). On the other hand, in these same studies, Black mothers reported less impact on domestic and childcare support at home and considered increased time with their child at home as a positive impact of the pandemic because their full-time jobs had previously kept them away from their homes for prolonged periods of time (Calarco et al., 2020; Gildner et al., 2021).

Implications and Recommendations

Based on our findings along with findings from other studies, it is clear that the pre-existing racial disparities that impacted Black mothers prior to the pandemic were exacerbated during the pandemic. Through the use of network analyses, we were able to delve deeper into the node connections that diverged for Black mothers to better understand why their experiences during the pandemic were more adverse than mothers from other racial/ethnic groups. Our main findings highlight that Black mothers experienced higher rates of stressors and psychopathology, including suicidal ideation. Moreover, the network moderation analyses revealed the unique contributors—that is, fear and panic symptoms—to the exacerbation of suicidal ideation for Black mothers. Finally, we found that stressors related to health and healthcare interactions were amplified for Black mothers and spilled into their experiences at home.

The following is a list of recommendations for reducing inequalities in physical and mental healthcare and increasing trust between Black mothers and the healthcare system. It should be noted that there are several existing reports and briefs to reduce Black maternal physical and mental morbidity and mortality (e.g., "2021 March of Dimes Report Card"; March of Dimes, 2021a; "Black Women's Maternal Health: A Multifaceted Approach to Addressing Persistent and Dire Health Disparities"; National Partnership for Women and Families, 2018) that provide an inclusive and exhaustive list of evidence-based recommendations. However, in this section, we will highlight some of the recommendations that are related to our findings. In addition to a chief recommendation, the recommendations are organized at the systemic, institutional, and provider levels.

Chief Recommendation.

1. Addressing disparities in healthcare for Black mothers must begin with consulting with and gaining insight from Black mother stakeholders. Black mothers should be considered and treated as experts on this topic as their lived experiences can shed light on priorities, challenges, and solutions that would otherwise be missed if their input is overlooked.

Recommendations at a Systemic Level.

1. Increasing private and Medicaid insurance coverage for non-traditional birth workers such as midwives and doulas, is a critical step to combating inequities within healthcare interactions for Black mothers (March of Dimes, 2021a). Doulas provide vital physical, emotional, and informational support as well as guidance and advocacy throughout

pregnancy, labor and delivery, and postpartum (Dona International, n.d.). Midwives are less likely to overuse medical interventions that may elevate the risk of maternal and infant morbidity and mortality as well as reduce healthcare costs (Högberg, 2004).

2. Expanding Medicaid can help uninsured pregnant mothers access and utilize healthcare as well as lessen the elevated risk that is associated with reduced prenatal and postpartum healthcare visits, which disproportionately impact people of color and people below the poverty line (de Bocanegra et al., 2017; Hill et al., 2022; March of Dimes, 2021a).
3. Expanding paid family and medical leave would allow Black mothers to continue earning a portion of their income while on leave, as currently, only 30% of them are qualified for and able to afford to take unpaid time off under the Family and Medical Leave Act (National Partnership for Women and Families., 2018). Research suggests that 25% of Black workers, including Black mothers, are unable to take parental, family, or medical leaves when they needed to and that only 15% of Black? workers are able to access paid family leave through their employers (Horowitz et al., 2017). Given these inadequate leave policies, Black mothers are more likely to be forced to quit, be fired, or be forced to return to work before they have fully recovered compared to their White counterparts (Laughlin, 2011).
4. Ensuring that all maternal death during pregnancy and the year after childbirth are investigated. By expanding the Maternal Mortality Review Committees (MMRCs), which are multidisciplinary committees at the local or state level that are funded by the Centers for Disease Control and Prevention that review perinatal deaths, we can establish baseline data, identify patterns of morbidity and mortality, and track changes (CDC,

2023b; March of Dimes, 2021a). More importantly, recommendations can be made to prevent future incidences. Currently, MMRCs are only available in 39 states.

5. More broadly, social determinants of health must be addressed through policies to truly improve Black maternal health outcomes. These include but are not limited to policies that grow household incomes; increase access to clean, safe, and affordable housing; improve the quality of education; improve the reliability of public transportation; and reduce the cost of healthy food (National Partnership for Women and Families., 2018).
6. Passing legislation that specifically addresses the Black maternal health crisis such as the Black Maternal Health Momnibus Act, which encompasses 13 bills aimed at reducing Black maternal morbidity and mortality in the U.S. by building on existing legislation (e.g., 12-month postpartum Medicaid coverage; Underwood & Booker, 2020).

Recommendations at an Institutional Level.

1. Implementing antiracist policies and initiatives, such as hiring Black and POC providers and administrators at all levels of hospital management, integrating antiracism lectures into the curricula of medical schools and continuing education lectures in training hospitals, consulting with experts in institutional racism in healthcare and medical education, and forging meaningful relationships with surrounding underserved and marginalized communities (Carryl, 2021).
2. Implicit bias training and education for healthcare providers are crucial to reducing embedded racism in clinical practices, dispelling common misconceptions, and increasing providers' awareness of their negative impact on the treatment of Black individuals, especially Black mothers (Omeish & Kiernan, 2020).

3. Implementing quality initiatives in hospitals can reduce incidences of severe maternal morbidity and mortality—of which up to 60% are preventable (Building U.S. Capacity to Review and Prevent Maternal Deaths, 2020; Howell et al., 2020). These initiatives can investigate these events and determine whether provider-level factors, such as delays or errors in diagnosis or treatment or policy non-adherence, or system-level, communication breakdown or inadequate policies or procedures, were implicated (Berg et al., 2005; Lawton et al., 2014). Crucially, establishing accountability pathways to hold providers and hospital systems responsible if they fail to provide unbiased, high-quality, and evidence-based care is equally important (National Partnership for Women and Families., 2018)
4. Reducing barriers to accessing healthcare, especially for hard-to-reach communities such as rural residents, through the use of mobile clinics or telehealth (Gibson et al., 2014).
5. Engaging in mental health awareness and anti-stigma efforts in BIPOC and minoritized communities as well as collaborating with spiritual and community stakeholders to enhance the credibility and trust in the healthcare institutions as well as increase the buy-in of minoritized community members (Dempsey et al., 2016; Taylor et al., 2000).

Recommendations at a Provider Level.

1. Establishing clinical checklists that require the provider to initiate a set of screening, monitoring, and treatment interventions if a Black mother reports or displays high-risk symptoms (Omeish & Kiernan, 2020). This systematic approach to decision-making would help ensure that Black mothers receive care that is up to standards and that minimizes provider bias.

2. Providing patient-centered care that emphasizes cultural competency and humility, incorporates holistic approaches to care, and is inclusive of diverse beliefs and values (Matthews et al., 2021; National Partnership for Women and Families, 2018). At its core, this approach to service provision should be responsive to Black mothers' needs and provide them with a sense of respect and safety when engaging with healthcare systems. Relatedly, providers should utilize culturally-adapted mental health interventions, when appropriate, because they have been found to improve outcomes for a variety of mental health conditions (Griner & Smith, 2006).
3. Increasing the BIPOC provider workforce and when possible, offer racial/ethnic matching between providers and patients, especially non-native English speakers (Cabral & Smith, 2011). This may not always be possible, as minoritized mental health providers currently make up a small segment of the provider population (U.S. Department of Health and Human Services, 2007). Therefore, incorporating case consultations and cultural competency training may offset some of this deficit.
4. Listening to and believing Black mothers. There are several tragedies, such as the death of Johns Hopkins-trained epidemiologist Shalon Irving, that could have been prevented had providers taken the words of these mothers seriously and believed their symptoms (Purnell et al., 2022). A critical step to preventing severe maternal morbidity and mortality is active listening, communicating with and answering the patient's questions, acknowledging implicit bias and patient-provider power dynamics, and practicing responsive care (Matthews et al., 2021).

Chapter 5: Strengths and Limitations

The findings of this study must be considered with respect to its limitations. First, the total sample of participants combined three samples collected over the course of two months. While the larger combined sample size helped increase the power and confidence of our analyses, it risked biasing our parameters due to the potential of significant between-sample differences. To address this limitation, we investigated whether there were significant differences in the main outcome variables across the samples. Our findings revealed no statistically significant differences in the reported rates of depression, anxiety, and the total number of stressors. Second, the majority of our sample was White, non-Hispanic, married postpartum individuals who completed a four-year college degree or higher, were not affiliated with any religion, were employed full-time, and had a combined household income of $100,000 or higher. Therefore, our findings may have limited generalizability and may not be representative of postpartum mothers who have different characteristics than our participants. Third, given that our survey data came from self-reports, which are inherently subjective, we cannot rule out that participants' responses may have been biased by social desirability, exaggeration or minimization of one's distress, or stigma related to reporting on mental health symptoms. Finally, given that our networks were undirected (i.e., the relationship between two nodes is bidirectional and not causal) a symptom may be central because it is influencing many nodes or it is receiving input from many nodes. Therefore, we must be careful about assuming that intervening in central symptoms will "deactivate" a network. Accordingly, research using longitudinal data can help determine whether these central symptoms are viable targets for intervention. Relatedly, given this study's cross-sectional design, we cannot establish directionality or causality between variables. Thus, longitudinal and experimental studies are necessary to ascertain the causal influence of the central, bridge, and moderating variables in this study.

The current study has several strengths. To this author's knowledge, this is the first study to investigate the relationship between COVID-19-related stressors and postpartum psychological symptoms of women who were pregnant and gave birth during the COVID-19 pandemic using network modeling techniques. Perinatal mental health symptoms have only been investigated via network analysis in four studies (Phua et al., 2020; Santos et al., 2017a; Santos et al., 2018), one of which was during the pandemic (Zhang et al., 2021), which means that this study will contribute significantly to the limited literature on the symptom networks of the perinatal population. Furthermore, this study will contribute to the growing literature examining perinatal and maternal psychopathology during the COVID-19 pandemic by utilizing a novel statistical technique that offers new insights into the impact of the pandemic-related stressors on the development and maintenance of postpartum psychological disorders. Additionally, to this author's knowledge, this study is the first to compare the network configuration and characteristics of mothers of color. No other network analysis study has compared the network of mothers from different racial and ethnic groups. By disaggregating the network investigation, this study gleans new insights into racial/ethnic variability in symptom networks, which can help provide nuanced recommendations that cater to these subgroups' needs.

Finally, a key strength of our study was the utilization of novel and cutting-edge network methods, such as goldbricker, clique percolation, node predictability, and moderated network analyses. However, a related limitation is that there are a limited number of published studies that have applied these methods. As more studies utilize these techniques, guidelines related to interpretations, cut-offs, and statistical significance may be developed or modified. As such, caution should be exercised when interpreting the findings of these analyses, and findings should be considered exploratory and hypothesis-generating. Therefore, in an attempt to increase trust in our data, especially when using these methods, we often combined multiple methods. For example, to investigate topological overlap, we combined three methods: goldbricker, inter-item correlations, and variance inflation factor. Similarly, we combined clique percolation, a relatively newer method to investigate comorbidity, with bridge analysis, a well-established and often-used comorbidity technique to corroborate our findings. We recommend that researchers use these novel techniques with caution and combine them with other methods in order to triangulate their results, as we did with our comorbidity investigation. On the other hand, when findings diverge, we recommend that all results be reported equivalently, as we did with our topological overlap investigation.

Chapter 6: Implications and Future Directions

This study revealed key insights about the psychological experiences of the perinatal population during the COVID-19 pandemic and demonstrated the effectiveness of network methodology in examining these experiences.

During data collection and preparation of the data for analysis, as predicted, we found within our data set a significant occurrence of fraudulence. This is consistent with many research studies, especially those with data collected online, making this issue a common and significant threat to the integrity of scientific data (e.g., Bybee et al., 2022; Griffin et al., 2021; Singh & Sagar, 2021; Storozuk et al., 2020). Indeed, with the increased use of online recruitment for research, it is crucial that data integrity and data quality measures are routinely integrated within research protocols and reported in the method section of published studies. Furthermore, research directed towards testing the effectiveness of these quality measures as well as developing new measures must continue since the challenge of dealing with fraudulent survey takers will likely remain an ongoing game of cat and mouse for researchers (Orabi et al., 2020). For example, in our study, we identified that the most effective measure for identifying potentially fraudulent responses was asking a complex, open-ended question. However, with the recent widespread availability and use of generative artificial intelligence (AI) tools (e.g., chat GPT), this metric may no longer be as effective in distinguishing between fraudulent and real responses. Another potential avenue for exploration may be augmenting online research with in-person data collection (e.g., completing one of the study tasks in person) or collecting sensitive and identifying information that can aid in additional authentication processes (e.g., calling participants to screen them for a study). Although these measures have several disadvantages, such as restricting access to certain populations, increasing the burden on researchers, and reducing anonymity of the participants in research, we believe that the benefits gained in data integrity outweigh the costs.

Our study revealed several interesting and unexpected findings that point to the impact of major contextual changes the network dynamics of stress and psychopathology. First, we identified the pivotal role of fear-based symptoms in both the depression-anxiety and stress-psychopathology networks of perinatal women. Notably, these symptoms previously held marginal influence in pre-pandemic symptom networks of depression and anxiety but emerged as the key activators of psychopathology in our study. Moreover, several moderating variables did not perform as expected. For example, social support did not have a universal buffering effect on the connection between stressors and psychopathology. Similarly, engaging in a higher number of positive experiences did not mitigate stress connections and instead exacerbated them. Importantly, our findings revealed that the main stressor-related drivers of postpartum psychopathology were not related to the direct impact of the pandemic, such as the risk of infection or death from COVID-19. Rather, influential stressors were related to the indirect impact of the pandemic. These stressors resulted from measures implemented to stem the spread of COVID-19, such as increased proximity with household members, balancing work and childcare responsibilities, and reduced informal and formal sources of social support due to social distancing measures. These findings underscore that major contextual changes and large-scale events (e.g., pandemics, natural disasters, war) necessitate a flexible approach to assessment, prevention, and intervention to avoid the misdirection of efforts. Specifically, regarding central symptoms, we cannot assume that previously established influential symptoms will continue to be so, as doing so may lead to inaccurately targeting less influential variables and failing to recognize current drivers of psychopathology. The same notion applies to psychosocial determinants of psychopathology, such as stressors and predictors. We cannot assume that factors conferred risk or protection will continue to do so when there is such a large contextual change.

Through our research, we have identified several valuable lessons that can inform future studies, especially during major contextual changes. These changes can happen on a local or national scale, such as epidemics, natural disasters, or wars, or at a global scale, such as a global pandemic. We found that fear-based symptoms play a crucial role in triggering symptoms of postpartum depression and anxiety during large-scale events that risk increased morbidity and mortality, which is consistent with numerous cross-sectional studies conducted during the pandemic for both perinatal and non-perinatal populations (Bogaerts et al., 2021; Karim et al., 2021; Taylor et al., 2021; Y. Zhang et al., 2021). However, a key future direction for network research would be investigate these findings longitudinally. That is, in order to determine the true prognostic power of these central symptoms, collecting data over multiple times points within the same sample is necessary to establish whether their influence on driving psychopathology is fleeting or sustained.

Finally, our study was consistent with findings from several studies and reports during the pandemic (Flannery et al., 2020; Gur et al., 2020; Mackey et al., 2021; March of Dimes, 2021a) that revealed the amplified negative impact of the COVID-19 pandemic on Black mothers, who were at the intersection of multiple vulnerabilities (i.e., postpartum and racial statuses). As such, Black mothers need targeted psychosocial, health, and psychological interventions that are catered for their unique needs and experiences, especially during large-scale events that threaten to worsen their morbidity and mortality. Moreover, policies that cut across multiple levels, including the systemic, institutional, and individual level, need to be in place to support these interventions. With regards to future research directions, although we were able to reveal important findings about the differential, deleterious effects of the pandemic on Black mothers, this study was only able to conduct exploratory investigations due to the limited sample of BIPOC mothers. For example, we were unable to identify central symptoms in the racial/ethnic networks and as a result, we were could not reveal potential key drivers of psychopathology for these subgroups. Moreover, due to the small sample sizes for each racial group, significant differences in psychopathology and stress-symptom connections between the racial groups may have been missed. Relatedly, although our survey included nine different racial and ethnic groups, we had to combine five racial groups under the category of “Other” because these groups had extremely small sample sizes. Hence, the unique experiences of individuals in these five racial groups were likely underrepresented when they were combined. Therefore, our findings about the differential experiences, and resulting network configuration and characteristics, of BIPOC mothers during the pandemic, are limited. To address this issue, future network studies should oversample for people of color in order to investigate their unique and comparative experiences. This is especially relevant during devastating events, such as the COVID-19 pandemic, where the most vulnerable people pay the largest price. However, if a specific racial group’s sample size remains small despite researchers’ efforts, as was the case in this study, a potential solution may be to use sampling weights to reduce sampling bias and parameter estimation bias (Pfeffermann, 1996).

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Appendix A

The Pregnancy, Postpartum, and Parenting During a Pandemic Study

The P4 Study

Did you have a baby during the last 12 months?

We want to hear from you!

Our research team at Teachers College, Columbia University is interested in learning more about the experiences that pregnant, laboring, and postpartum women went through **during the COVID-19 pandemic.**

PARTICIPATION INVOLVES:	• Completing a **45-60 minute** online survey. • All eligible participants will be paid up to **$15 via online gift card**.

YOU MAY QUALIFY IF YOU:

- Gave birth to a child in the last 12 months.
- Live in the United States.

To access the survey, click the link below or scan the QR-code.

P-4 Survey Link

Your experience is valuable.
Help us learn more about how the pandemic impacted mothers like you.

If you have any questions, please contact us at: thep4study@gmail.com

IRB ID: 21-389

Appendix B.

CAPTCHA

Welcome

Welcome to the The Pregnancy, Postpartum, and Parenting during a Pandemic Study (The P-4 Study)!

Please note that there is a limit of one response per participant. You can only take this survey once.

Before you proceed to the survey, please complete the Captcha below.

CAPTCHA-1

Import from library

Add new question

Eligibility

Eligibility_start

Please answer the following questions to help us determine if you are eligible for this study.

E1

Can you read and understand English?

- ○ Yes
- ○ No

E2

Are you 18-years-old or older?

○ Yes
○ No

E3_check_a1

Have you given birth to a live child who is currently younger than 12 months old?

○ Yes
○ No

E4

Have you given birth to a live child who is currently younger than 2 weeks old?

○ Yes
○ No

E5

Are you currently pregnant?

○ Yes
○ No

E6_check_b1

In which state do you currently live?

I do not live in the United States

E7_reference

*

Where did you hear about our study?

○ Facebook
○ Reddit
○ Instagram
○ Twitter
○ Listserv
○ Other

Eligibility_end

Display this question

If Are you 18-years-old or older? No Is Selected

Or Have you given birth to a live child who is currently younger than 12 months old? No Is Selected

Or Have you given birth to a live child who is currently younger than 2 weeks old? Yes Is Selected

Or Are you currently pregnant? Yes Is Selected

Or Can you read and understand English? No Is Selected

Or In which state do you currently live? I do not live in the United States Is Selected

Skip to

End of Survey If Thank you for your interest... Is Displayed

Thank you for your interest in our study. Based on your responses, it appears that the study is not suitable for you.

Import from library | Add new question

consent

consent form

INFORMED CONSENT

Protocol Title:

The Pregnancy, Postpartum, and Parenting during a Pandemic Study (The P-4 Study)

Principal Researcher:

Dalal Alhomaizi, M.A., Teachers College, Columbia University (dma2162@tc.columbia.edu)

INTRODUCTION

You are invited to participate in this research study called "The Pregnancy, Postpartum, and Parenting during a Pandemic Study (The P-4 Study)." You may qualify to take part in this research study because you are over 18-years-old, currently live in the United States (U.S.), and have given birth to a live baby who is currently older than two weeks, but younger than 12-months-old. If you are currently pregnant or have a child who is two-weeks-old or younger, you cannot be part of this study. Approximately 2000 participants will take part in this study, and all participant responses will be aggregated and analyzed as a group. Please note that you can only participate in this study once. The survey should take you about 45-60 minutes to complete. However, you are able to pause and resume the survey on your own time as long as it is within one week of starting the survey.

The Kuwait Foundation for the Advancement of Sciences has provided funding for this study.

WHY IS THIS STUDY BEING DONE?

Our research group is dedicated to amplifying mothers' voices and to ensuring the inclusion of maternal needs in research related to the mental health effects of the COVID-19 pandemic. Being pregnant and caring for a child during a global pandemic presents mothers with unique challenges and experiences. Our study seeks to learn more about the relationship between major life changes due to the COVID-19 pandemic and the emotional well-being of mothers. Additionally, we aim to include mothers from diverse racial groups in our study to see if there are differences in maternal experiences in the U.S. during the COVID-19 pandemic based on demographic data (e.g., race, ethnicity, etc.). Our goal is to promote the well-being of mothers and their families during this challenging time. We believe that the key to achieving this goal is through understanding and highlighting a diversity of experiences. We value your participation and we are eager to learn more about how the pandemic impacted mothers like you.

WHAT WILL I BE ASKED TO DO IF I AGREE TO TAKE PART IN THIS STUDY?

If you decide to participate, you will be asked to recall how life has been for you and your family during the pandemic. You will have to fill out an online survey of questions that include 1) background information about you and your most recent child who is currently younger than 12-months-old, 2) experiences that you may have gone through during the COVID-19 pandemic, including your experiences of being pregnant, giving birth, and taking care of your baby, and 3) your current emotional well-being. Importantly, during the survey, there will be periodic attention checks to ensure that you are paying attention to the survey questions. You will be alerted if you fail any of the attention checks.

WHAT POSSIBLE RISKS OR DISCOMFORTS CAN I EXPECT FROM TAKING PART IN THIS STUDY?

This is a low risk study, which means that the harms or discomforts that you may experience are not greater than you would ordinarily encounter while taking routine psychological examinations or tests. However, there are some minimal risks to consider, including the psychological discomfort of thinking about experiences during the COVID-19 pandemic that may have occurred to you or someone in your household; your pregnancy, delivery, and postpartum experiences; and your current emotional well-being. If you're experiencing any psychological discomfort or distress, we have compiled a list of mental health and supportive services that you can reach out to for support.

Please click **here** to download our resource list.

In addition, breach of confidentiality is a minimal risk to consider in this study. However, our research team is committed to keeping your information confidential and we are taking precautions to ensure this. To safeguard against this risk, we are taking thorough steps to protect your data by separating your personal information from your survey responses. For more information on this process, please see the "Protection of your confidentiality" section below.

WHAT POSSIBLE BENEFITS CAN I EXPECT FROM TAKING PART IN THIS STUDY?

While there may be no direct benefit to you for participating in this study, your participation may benefit other mothers and help us understand their needs. Your responses will help us learn more about how the pandemic has affected mothers and ultimately, ensure that policies and services during and after the COVID-19 pandemic are tailored to the needs and priorities of mothers.

WILL I BE PAID FOR BEING IN THIS STUDY?

You will be paid up to $15 for your participation in our study. Please note that reimbursement is conditional on completing the survey and on passing our internal checks for data quality. To protect against fraudulent responses that are common in online surveys, we have embedded data quality checks in our survey to assess for consistency, eligibility, as well as attention. The checks will be explained in the next page, please take the time to review them carefully because failing them may result in a prorated payment or no payment at all. Also, please note that because your responses will first be reviewed for data quality, you will not know immediately if you qualify for compensation when you complete the survey. Upon passing the review, participants will be sent an electronic Amazon gift card with the appropriate amount via email within 6 to 8 weeks of completing the survey. Participants who do not pass the review, and therefore, do not qualify for compensation, will not be contacted via email.

WHEN IS THE STUDY OVER? CAN I LEAVE THE STUDY BEFORE IT ENDS?

The study is over when you have completed the online survey. You will have the option to pause and resume the survey on your own time, so long as you complete it within a week of starting the survey. However, you can stop participating in the study and exit the survey at any time, even if you have not finished. Unfortunately, if you decide not to complete the survey within a week of starting it, you will not be eligible for compensation.

PROTECTION OF YOUR CONFIDENTIALITY

Our research team is committed to keeping your information confidential and is taking precautions to ensure this. First, all electronic information will be stored locally in a password-protected folder on a password-protected computer and electronically in a password-protected folder on Teachers College's Google Drive. The data will be transferred to these protected folders via a Virtual Private Network (VPN) for secure data transfer. In addition, after your responses have been evaluated for eligibility for compensation, you will be assigned a unique study ID, and then all your identifying information (e.g., your email) will be separated from your survey responses. The data will then be split into two password-protected spreadsheets: 1) a spreadsheet containing only unique identifiable information (e.g., email address, birth year, etc.) with your unique study ID, 2) a spreadsheet containing only survey responses with your unique study ID. Please note that for quality assurance, the study team and/or members of the Teachers College Institutional Review Board (IRB) may review the data collected from you as part of this study. Otherwise, all information obtained from your participation in this study will be held strictly confidential and will be disclosed only with your permission or as required by U.S. or State law.

HOW WILL THE RESULTS BE USED?

The results of this study may be published in journals and/or presented at academic conferences. All participant responses will be aggregated and analyzed as a group. Any identifying information about you will not be published. This study is being conducted as part of the dissertation of the principal investigator.

WHO CAN ANSWER MY QUESTIONS ABOUT THIS STUDY?

If you have any questions about taking part in this research study, you should contact the principal investigator, Dalal Alhomaizi, at dma2162@tc.columbia.edu, or our research team at thep4study@gmail.com. You can also contact the faculty advisor of this research study, Dr. Helen Verdeli, at verdeli@tc.columbia.edu or at 212-678-3099. This research study is part of the Global Mental Health Lab at Teachers College, Columbia University under the direction of Dr. Verdeli.

If you have questions or concerns about your rights as a research subject, you should contact the Institutional Review Board (IRB) (the human research ethics committee) at 212-678-4105 or email IRB@tc.edu. Or you can write to the IRB at Teachers College, Columbia University, 525 W. 120th Street, New York, NY 10027. The IRB is the committee that oversees human research protection for Teachers College, Columbia University.

PARTICIPANT'S RIGHTS

- I have read the Informed Consent Form and have been provided with the principal investigator's email to ask questions and discuss the study if I would like.
- I have had ample opportunity to read about the purposes, procedures, risks, and benefits regarding this research study.
- I understand that my participation is voluntary. I may refuse to participate or withdraw participation at any time.
- The researcher may withdraw me from the research at his or her professional discretion, such as not meeting eligibility criteria, an incomplete survey, or failing the internal checks for data quality specified above.
- If, during the course of the study, significant new information that has been developed becomes available which may relate to my willingness to continue my participation, the researcher will provide this information to me.
- Any information derived from the research study that personally identifies me will not be voluntarily released or disclosed without my separate consent, except as specifically

required by law.

- Identifiers will be removed from the data for this study. De-identified data may be used for future research studies.
- I should receive a copy of the Informed Consent Form document.

Page Break

statement

Thank you for reviewing our consent form, before you proceed please review the following information carefully to ensure that you receive full compensation for your participation.

It is our goal to accurately capture the unique experiences of perinatal women during the COVID-19 pandemic and more importantly, to ensure that the mothers who take the time to contribute to our study are compensated. Therefore, to protect against fraudulent responses that are common in online surveys, we have embedded data quality checks in our survey to assess for eligibility, consistency, and attention. If a participant submits fake or fraudulent responses, then their data will be removed from our analysis and they will not be eligible for payment. Protecting against fake and fraudulent responses will ensure that the findings we report are trustworthy and are representative of maternal experiences.

Back button: Please note that there is no back button in our survey. Once you click the "next" button at the bottom of each survey block, you cannot go back to a previous block to edit your answers. Please be mindful of this feature while you're filling in your responses.

Attention checks: In our survey, we have included a few simple, straightforward questions that are designed to check for attention. The only purpose of these questions is to make sure that you're paying attention while filling in the survey. They will not be testing any specific knowledge. Please take your time when answering the survey questions in order to avoid missing our attention checks.

- You are permitted to miss **two** attention checks throughout this survey and still receive full compensation ($15).
- If you miss **more** than two attention checks, you will not receive full compensation and if you miss all attention checks, you will not be eligible for compensation.

Please remember, you can only participate in this study once and that taking the survey more than once may disqualify you from compensation. This survey should take you approximately 45-60 minutes to complete. Please note that you are able to pause and resume the survey as many times as you'd like as long as you **complete the survey within one week** of starting it.

- To return to your survey, you must access the survey via the same internet browser on the same device.
- If you face any issues when attempting to return to complete your survey, please contact us via email at **thep4study@gmail.com** and we can provide the correct survey link to continue.

Consent y/n

Skip to

End of Survey If I do not consent   Is Selected

By clicking **"I consent"** and providing us with **your email address** below, you are indicating that you have read and understood our consent form as well as our data quality review process and agree to participate in the P-4 Study.

○ I consent

Email :

○ I do not consent

Page Break

Consent email

Display this question

If By clicking "I consent" and providing us with your email address below, you are indicating that y... I consent <div> </div><span style="font-size:16px;"><span style="color:#003366;"><span style="font-family:Georgia,serif;">Email : Is Selected

Click here to download a copy of the consent form for your records.

Import from library

Add new question

intro

The Pregnancy, Postpartum, and Parenting during a Pandemic Study (The P-4 Study)

Since COVID-19 was declared a global pandemic, it has significantly impacted most people's lives in the United States, especially mothers. Being pregnant and caring for a child during a pandemic presents mothers with unique challenges. We are interested in understanding how the experiences you've had during your pregnancy and postpartum in the pandemic have impacted your current emotional well-being. Your responses will help us learn more about how the pandemic has affected mothers and ultimately, ensure that policies and services during and after the COVID-19 pandemic are tailored to the needs and priorities of mothers.

Thank you in advance for your time and participation.

Survey sections: **Please note, you might get these three sections in any order.**

- Demographics and background information
- Experiences during the COVID-19 pandemic
- Current emotional well-being and functioning

Import from library | Add new question

Demographic questions

</>

Demographic and Background Information Section

In this section, you will be asked for background information about yourself and your most recent child (who is currently younger than 12-months-old).

Page Break

Demographics title

Demographics

Q1_check_c1

What is your birth YEAR? (yyyy)

Q2

What is your highest level of education?

Less than high school

Q3

Which ethnicity/race do you most identify with? Please select one.

- Asian or Asian American
- Black or African American
- Hispanic or Latino origin of any race
- Indigenous American/American Indian or Alaska Native
- Middle-Eastern or North African origin of any race
- Native Hawaiian or other Pacific Islander
- White, non-Hispanic
- Biracial or Multiracial
- Race not listed above

Q4

What is your religious affiliation?

Buddhist

Q5

(x)

Which category best describes your current relationship status?

- Single, never married
- Partnered
- Married
- Divorced/Separated
- Widowed
- Other

E6_check_b2

Please enter the first three digits of your zip code.
(Example: if your zip code is 12345, enter 123)

Q6

Which answer best represents your current employment status?

- ○ Full-time employment
- ○ Part-time employment
- ○ Self-employed
- ○ Unemployed and currently looking
- ○ Unemployed and not currently looking
- ○ Other (e.g., student, retired)

Q7_TEXT

If you're employed, please state your occupation. (Please leave blank if unemployed)

Q8

Which category best describes your annual household income before taxes?

Less than $10,000

Q9

Have you received a COVID-19 vaccine?

- ○ Yes, I received the 1st of 2 doses of a COVID-19 vaccine.
- ○ Yes, I received both doses, or the only dose, of a COVID-19 vaccine.
- ○ No, but I plan to take a COVID-19 vaccine.
- ○ No, I do not plan to take a COVID-19 vaccine.

Q10

Have you received a COVID-19 vaccine booster shot?

○ Yes, I received a COVID-19 vaccine booster shot.

○ No, but I plan to take a COVID-19 vaccine booster shot.

○ No, I do not plan to take a COVID-19 vaccine booster shot.

Page Break

Background Information: Child

The following questions are related to your most recent child who is currently older than two-weeks-old, but younger than 12-months-old.

E3_check_a2.1

What is your most recent child's birth YEAR? (yyyy)

E3_check_a2.2

What is your most recent child's birth MONTH? (mm)

Q11

What would best describe your pregnancy with your most recent child?

○ Singleton

○ Twins

○ Multiples

Q12

Was your pregnancy with your most recent child planned?

○ Yes

○ No

Q13

Was your pregnancy with your most recent child unwanted?

- ○ Yes
- ○ No

Q14

Before the birth of your most recent child, did you ever have any other children who were born alive?

- ○ If yes, how many?
- ○ No

Page Break

mrc-preg

Most Recent Child: Pregnancy and Delivery

The following questions are related to your most recent child who is currently older than two-weeks-old, but younger than 12-months-old.

Q15

During your pregnancy and delivery with your most recent child, did you experience any of the following? (Click all that apply)

- ☐ Exogena Puermorbus
- ☐ Gestational diabetes
- ☐ Placental problems (e.g., placental abruption, placenta previa, placenta accreta)
- ☐ Hyperemesis gravidarum
- ☐ High blood pressure
- ☐ Preeclampsia/eclampsia
- ☐ Postpartum hemorrhage
- ☐ Gave birth at <37 weeks gestation
- ☐ Low birth weight baby
- ☐ Baby received treatment at the Neonatal Intensive Care Unit (NICU)
- ☐ Other
- ☐ None

Q16

During your pregnancy with your most recent child, were you diagnosed with depression or did you suspect that you were experiencing symptoms of a depressive disorder?

- ○ Yes
- ○ No

Q17

During your pregnancy with your most recent child, were you diagnosed with an anxiety disorder or did you suspect that you were experiencing symptoms of an anxiety disorder?

- ○ Yes
- ○ No

Q18

During the first two weeks after the birth of your most recent child, did you experience a brief period of tearfulness and mood swings?

- ○ Yes
- ○ No

Page Break

mrc-care

Most Recent Child: Care and Temperament

The following questions are related to your most recent child who is currently older than two-weeks-old, but younger than 12-months-old.

Please rate the degree to which you agree or disagree with each of the following statements.

Q19

My child is irritable/fussy.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
○	○	○	○	○

Q20

My child cries a lot.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
○	○	○	○	○

Q21

My child is difficult to console or soothe.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
○	○	○	○	○

Q22

I am currently having problems feeding my child.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
○	○	○	○	○

Q23

I am currently having problems with my child's sleep.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
○	○	○	○	○

Q24

Please choose the response that most closely describe your child for the following question.

How frequently does your child experience health problems?

Never	Rarely	Sometimes	Often	Always
○	○	○	○	○

Import from library

Add new question

PDPI-revised

PDPI-background-self

Background Information: Self

Q1_check_c2

What is your age?

PDPI-mentalhx

Mental Health History

PDPI-1

Before your most recent pregnancy, have you ever been diagnosed with depression or suspected that you're experiencing symptoms of a depressive disorder?

○ Yes

○ No

PDPI-2

Before your most recent pregnancy, have you ever been diagnosed with an anxiety disorder or suspected that you're experiencing symptoms of an anxiety disorder?

○ Yes

○ No

honeypot1

</>

Skip to

End of Survey If Yes Is Selected

Skip to

End of Survey If No Is Selected

Before your most recent pregnancy, do you define yourself as a human?

- Yes
- No

Page Break

PDPI-instructions

Instructions:

For the following questions:

- Please **rate the degree** to which you agree or disagree with each of the following statements.
- For some questions, you can choose **N/A** if the statement does not apply to you.

PDPI-self-image

Self-Image

PDPI-3

I feel good about myself as a person.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
○	○	○	○	○

PDPI-4

I feel worthwhile.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
○	○	○	○	○

PDPI-5

I believe that I have a number of good qualities as a person.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
○	○	○	○	○

Attention_check_1

It is important that you pay attention during this survey. Please select the response "Cheddar" when you are asked to choose what is not a vegetable.

Based on what you read above, what is not a vegetable?

- ○ Table
- ○ Cellphone
- ○ Strawberry
- ○ Cheddar
- ○ Dog

Page Break

Attention_message

Display this question

If It is important that you pay attention during this survey. Please select the response "Cheddar" w... Table Is Selected

Or It is important that you pay attention during this survey. Please select the response "Cheddar" w... Cellphone Is Selected

Or It is important that you pay attention during this survey. Please select the response "Cheddar" w... Strawberry Is Selected

Or It is important that you pay attention during this survey. Please select the response "Cheddar" w... Dog Is Selected

ATTENTION:

It appears that you have **failed** one of our attention checks. Please take your time when answering the questions in order to avoid missing our attention checks, which may result in reduced or no payment.

You are permitted to miss **two** attention checks throughout this survey. Please note that if you miss more than two attention checks, you will not receive full compensation and if you miss all attention checks, you will not be eligible for compensation.

If you would like to keep going with the survey, click the "next" button at the bottom of the page. Thank you.

Page Break

PDPI-relationship

Marital/Relationship Satisfaction

PDPI-6

I am satisfied with my marriage (or living arrangement).

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

PDPI-7

Things are going well between me and my partner.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

PDPI-8

Are you currently experiencing any marital/relationship problems?

Yes	No	N/A
▢	○	▢

Page Break

PDPI-social-partner

Social Support: Partner

PDPI-9

I feel like I receive adequate emotional support from <u>my partner.</u>

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

PDPI-10

I feel like I can confide in my partner.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

PDPI-11

I feel like I can rely on my partner when I need help.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

PDPI-12

I feel like I receive adequate practical support from my partner (e.g., help with household chores or childcare).

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

Page Break

PDPI-social-fam

Social Support: Family

PDPI-13

I feel like I receive adequate emotional support from my family.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

PDPI-14

I feel like I can confide in my family.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

PDPI-15

I feel like I can rely on my family when I need help.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

PDPI-16

I feel like I receive adequate practical support from my family (e.g., help with household chores or childcare).

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

Page Break

PDPI-social-friend

Social Support: Friends

PDPI-17

I feel like I receive adequate emotional support from my friends.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

PDPI-18

I feel like I can confide in my friends.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

PDPI-19

I feel like I can rely on my friends when I need help.

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

PDPI-20

I feel like I receive adequate practical support from my friends (e.g., help with household chores or childcare).

Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	N/A
○	○	○	○	○	○

social-support-fill

How could people in your support network be more helpful with you or with your baby?

Import from library | Add new question

EPII

EPII-intro

Experiences During the COVID-19 Pandemic Section

In this section, you will be presented with a list of different experiences that you may have encountered during the COVID-19 pandemic. For this section, please reflect on ***the last 12 months.***

Page Break

EPII-instruction

Instructions:

We would like to learn how the coronavirus disease (COVID-19) pandemic impacted people's lives.

For each statement below, please indicate whether the COVID-19 pandemic has impacted you or a person in your home in the way described.

- Check **YES (Me)** if you were impacted.
- Check **YES (Person in Home)** if another person (or people) in your home were impacted.
- Check **NO** if you and the people in your home were not impacted.
- Check **N/A** if the statement does not apply to you or someone in the home.
- If both **YES (Me)** and **YES (Person in Home)** are true, check both.

Page Break

EPII-1

1. Work and employment

During the last 12 months, did you (or someone in your household) experience any of the following?

	Yes (Me)	Yes (Person in Home)	No	N/A
1. Laid off from job or had to close own business.	☐	☐	☐	☐
2. Reduced work hours or furloughed.	☐	☐	☐	☐
3. Had to lay-off or furlough employees or people supervised.	☐	☐	☐	☐
4. Had to continue to work even though in close contact with people who might be infected (e.g., customers, patients, co-workers).	☐	☐	☐	☐
	Yes (Me)	Yes (Person in Home)	No	N/A
5. Spent a lot of time disinfecting at home due to close contact with people who might be infected at work.	☐	☐	☐	☐
6. Increase in workload or work responsibilities.	☐	☐	☐	☐
7. Hard time doing job well because of needing to take care of people in the home.	☐	☐	☐	☐
8. Hard time making the transition to working from home.	☐	☐	☐	☐
	Yes (Me)	Yes (Person in Home)	No	N/A
9. Provided direct care to people with the disease (e.g., doctor, nurse, patient care assistant, radiologist).	☐	☐	☐	☐
10. Provided supportive care to people with the disease (e.g., medical support staff, custodial, administration).	☐	☐	☐	☐
11. Provided care to people who died as a result of the disease.	☐	☐	☐	☐

EPII-1-distress

Overall, how upset were you by how the COVID-19 pandemic impacted your (and your family's) work and employment in the past 12 months?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset
○	○	○	○	○

Page Break

EPII-2

2. Education and Training

During the last 12 months, did you (or someone in your household) experience any of the following?

	Yes (Me)	Yes (Person in Home)	No	N/A
1. Had a child in home who could not go to school.	☐	☐	☐	☐
2. Adult unable to go to school or training for weeks or had to withdraw.	☐	☐	☐	☐

EPII-2-distress

Overall, how upset were you by how the COVID-19 pandemic impacted your (and your family's) experiences related to education and training in the past 12 months?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset
○	○	○	○	○

Page Break

EPII-3

3. Home Life

During the last 12 months, did you (or someone in your household) experience any of the following?

	Yes (Me)	Yes (Person in Home)	No	N/A
1. Childcare or babysitting unavailable when needed.	☐	☐	☐	☐
2. Difficulty taking care of children in the home.	☐	☐	☐	☐
3. More conflict with child or harsher in disciplining child or children.	☐	☐	☐	☐
4. Had to take over teaching or instructing a child.	☐	☐	☐	☐
5. Family or friends had to move into your home.	☐	☐	☐	☐
	Yes (Me)	Yes (Person in Home)	No	N/A
6. Had to spend a lot more time taking care of a family member.	☐	☐	☐	☐
7. Had to move or relocate.	☐	☐	☐	☐
8. Became homeless.	☐	☐	☐	☐
9. Increase in verbal arguments or conflict with a partner or spouse.	☐	☐	☐	☐
10. Increase in physical conflict with a partner or spouse.	☐	☐	☐	☐
	Yes (Me)	Yes (Person in Home)	No	N/A
11. Increase in verbal arguments or conflict with other adult(s) in home.	☐	☐	☐	☐
12. Increase in physical conflict with other adult(s) in home.	☐	☐	☐	☐
13. Increase in physical conflict among children in home.	☐	☐	☐	☐

EPII-3-distress

Overall, how upset were you by how the COVID-19 pandemic impacted your (and your family's) home life in the past 12 months?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset
○	○	○	○	○

Page Break

EPII-4

4. Social Activities

During the last 12 months, did you (or someone in your household) experience any of the following?

	Yes (Me)	Yes (Person in Home)	No	N/A
1. Separated from family or close friends.	☐	☐	☐	☐
2. Did not have the ability or resources to talk to family or friends while separated.	☐	☐	☐	☐
3. Unable to visit loved one in a care facility (e.g., nursing home, group home).	☐	☐	☐	☐
4. Family celebrations cancelled or restricted.	☐	☐	☐	☐
5. Planned travel or vacations cancelled.	☐	☐	☐	☐
	Yes (Me)	Yes (Person in Home)	No	N/A
6. Religious or spiritual activities cancelled or restricted.	☐	☐	☐	☐
7. Unable to be with a close family member in critical condition.	☐	☐	☐	☐
8. Unable to attend in-person funeral or religious services for a family member or friend who died.	☐	☐	☐	☐
9. Unable to participate in social clubs, sports teams, or usual volunteer activities.	☐	☐	☐	☐
10. Unable to do enjoyable activities or hobbies.	☐	☐	☐	☐

EPII-4-distress

Overall, how upset were you by how the COVID-19 pandemic impacted your (and your family's) social activities in the past 12 months?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset
○	○	○	○	○

Page Break

EPII-5

5. Economics

During the last 12 months, did you (or someone in your household) experience any of the following?

	Yes (Me)	Yes (Person in Home)	No	N/A
1. Unable to get enough food or healthy food.	☐	☐	☐	☐
2. Unable to access clean water.	☐	☐	☐	☐
3. Unable to pay important bills like rent or utilities.	☐	☐	☐	☐
4. Difficulty getting places due to less access to public transportation or concerns about safety.	☐	☐	☐	☐
5. Unable to get needed medications (e.g., prescriptions or over-the-counter).	☐	☐	☐	☐

Attention_check_2

	Yes (Me)	Yes (Person in Home)	No	N/A
6. It's important that you are paying attention in this survey. Please select "Yes (Person in Home)" to show that you are paying attention.	☐	☐	☐	☐

Page Break

Attention_message

Display this question

If - Yes (Me) Is Selected

Or - No Is Selected

Or - N/A Is Selected

ATTENTION:
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Page Break

EPII-5-distress

Overall, how upset were you by how the COVID-19 pandemic impacted your (and your family's) economic situation in the past 12 months?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset
○	○	○	○	○

Page Break

EPII-6

6. Emotional Health and Well-being

During the last 12 months, did you (or someone in your household) experience any of the following?

	Yes (Me)	Yes (Person in Home)	No	N/A
1. Increase in child behavioral or emotional problems.	☐	☐	☐	☐
2. Increase in child's sleep difficulties or nightmares.	☐	☐	☐	☐
3. Increase in mental health problems or symptoms (e.g., mood, anxiety, stress).	☐	☐	☐	☐
4. Increase in sleep problems or poor sleep quality.	☐	☐	☐	☐
	Yes (Me)	Yes (Person in Home)	No	N/A
5. Increase in use of alcohol or substances.	☐	☐	☐	☐
6. Unable to access mental health treatment or therapy.	☐	☐	☐	☐
7. Not satisfied with changes in mental health treatment or therapy.	☐	☐	☐	☐
8. Spent more time on screens and devices (e.g., looking at phone, playing video games, watching TV).	☐	☐	☐	☐

EPII-6-distress

Overall, how upset were you by how the COVID-19 pandemic impacted your (and your family's) emotional health and well-being in the past 12 months?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset
○	○	○	○	○

Page Break

EPII-7

7. Physical Health Problems

During the last 12 months, did you (or someone in your household) experience any of the following?

	Yes (Me)	Yes (Person in Home)	No	N/A
1. Increase in health problems not related to COVID-19.	☐	☐	☐	☐
2. Less physical activity or exercise.	☐	☐	☐	☐
3. Overeating or eating more unhealthy foods (e.g., junk food).	☐	☐	☐	☐
4. More time sitting down or being sedentary.	☐	☐	☐	☐
5. Important medical procedure canceled (e.g., surgery).	☐	☐	☐	☐
6. Unable to access medical care for a serious condition (e.g., dialysis, chemotherapy).	☐	☐	☐	☐
7. Got less medical care than usual (e.g., routine or preventive care appointments).	☐	☐	☐	☐
8. Elderly or disabled family member not in the home unable to get the help they need.	☐	☐	☐	☐

EPII-7-distress

Overall, how upset were you by how the COVID-19 pandemic impacted your (and your family's) physical health in the past 12 months?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset
○	○	○	○	○

Page Break

EPII-8.1

8. Physical Distancing and Quarantine

During the last 12 months, did you (or someone in your household) experience any of the following?

	Yes (Me)	Yes (Person in Home)	No	N/A
1. Isolated or quarantined due to possible exposure to this disease.	☐	☐	☐	☐
2. Isolated or quarantined due to symptoms of this disease.	☐	☐	☐	☐
3. Isolated due to existing health conditions that increase risk of infection or disease.	☐	☐	☐	☐
4. Limited physical closeness with child or loved one due to concerns of infection.	☐	☐	☐	☐
5. Moved out or lived away from family due to a high-risk job (e.g., health care worker, first responder).	☐	☐	☐	☐
6. Close family member not in the home was quarantined.	☐	☐	☐	☐
7. Family member was unable to return home due to quarantine or travel restrictions.	☐	☐	☐	☐

EPII-8.2

	Yes	No	N/A
8. Entire household was quarantined for a week or longer.	○	○	○

EPII-8-distress

Overall, how upset were you by how the COVID-19 pandemic impacted your (and your family's) experiences related to physical distancing and quarantine in the past 12 months?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset
○	○	○	○	○

Page Break

EPII-9

9. Infection History

During the last 12 months, did you (or someone in your household) experience any of the following?

	Yes (Me)	Yes (Person in Home)	No	N/A
1. Currently have symptoms of this disease but have not been tested.	☐	☐	☐	☐
2. Tested and currently have this disease.	☐	☐	☐	☐
3. Had symptoms of this disease but never tested.	☐	☐	☐	☐
4. Tested positive for this disease but no longer have it.	☐	☐	☐	☐
	Yes (Me)	Yes (Person in Home)	No	N/A
5. Got medical treatment due to severe symptoms of this disease.	☐	☐	☐	☐
6. Hospital stay due to this disease.	☐	☐	☐	☐
7. Someone died of this disease while in our home.	☐	☐	☐	☐
8. Death of close friend or family member from this disease.	☐	☐	☐	☐

EPII-9-distress

If you or a member of your household were infected with COVID, how upset were you by this experience?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset	N/A
○	○	○	○	○	○

Page Break

EPII-10

10. Positive Change

During the last 12 months, did you (or someone in your household) experience any of the following positive changes?

	Yes (Me)	Yes (Person in Home)	No	N/A
1. More quality time with family or friends in person or from a distance (e.g., on the phone, Email, social media, video conferencing, online gaming).	☐	☐	☐	☐
2. More quality time with partner or spouse.	☐	☐	☐	☐
3. More quality time with children.	☐	☐	☐	☐
4. Improved relationships with family or friends.	☐	☐	☐	☐
5. New connections made with supportive people.	☐	☐	☐	☐
6. Increase in exercise or physical activity.	☐	☐	☐	☐
7. More time in nature or being outdoors.	☐	☐	☐	☐
	Yes (Me)	Yes (Person in Home)	No	N/A
8. More time doing enjoyable activities (e.g., reading books, puzzles).	☐	☐	☐	☐
9. Developed new hobbies or activities.	☐	☐	☐	☐
10. More appreciative of things usually taken for granted.	☐	☐	☐	☐
11. Paid more attention to personal health.	☐	☐	☐	☐
12. Paid more attention to preventing physical injuries.	☐	☐	☐	☐
13. Ate healthier foods.	☐	☐	☐	☐
14. Less use of alcohol or substances.	☐	☐	☐	☐
	Yes (Me)	Yes (Person in Home)	No	N/A
15. Spent less time on screens or devices outside of work hours (e.g., looking at phone, playing video games, watching TV).	☐	☐	☐	☐
16. Volunteered time to help people in need.	☐	☐	☐	☐
17. Donated time or goods to a cause related to COVID-19 (e.g., made masks, donated blood, volunteered).	☐	☐	☐	☐
18. Found greater meaning in work, employment, or school.	☐	☐	☐	☐
19. More efficient or productive in work, employment, or school.	☐	☐	☐	☐

P-instruction

Instructions:

We would like to learn how the coronavirus disease (COVID-19) pandemic affected your experiences during your most recent pregnancy.

For each statement below, please answer whether the COVID-19 pandemic specifically impacted you in the way described. Some of the statements are about changes to your healthcare:

- If a change happened, whether it was because of your choice or your medical team's choice, you should check '**YES**'.
- If the statement is not true for you, check '**NO**.'
- Checking "**N/A**" means that the item is not applicable or it did not apply to any of your experiences.

Page Break

P-1

We would like to know how the COVID-19 pandemic affected you during your pregnancy. Please check "yes" if the statement is true.

When I was pregnant during the COVID-19 pandemic...

	Yes	No	N/A
1. My prenatal care changed.	○	○	○
2. I had less support from my prenatal team.	○	○	○
3. My in-person prenatal visits were canceled or decreased during my pregnancy.	○	○	○
4. People were not able to come to my in-person prenatal visits with me.	○	○	○
5. I had to take my own blood pressure and/or weight at home instead of having it done by a medical provider.	○	○	○
6. I had trouble getting the care I needed for a health problem.	○	○	○
7. I was not able to go to in-person prenatal or breastfeeding classes.	○	○	○
8. Because I was pregnant, I stopped working or seeing friends and family to protect myself from getting COVID-19.	○	○	○

Page Break

P-2

Overall, how upset were you by how the COVID-19 pandemic affected your experiences during your pregnancy?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset
○	○	○	○	○

Page Break

P-3

We are also interested in **positive changes** due to the pandemic. Please check "yes" if the statement is true.

When I was pregnant during the COVID-19 pandemic...

	Yes	No	N/A
1. I got to spend more time taking care of myself.	○	○	○
2. I had more support from other people at home.	○	○	○
3. I had more support from other pregnant women via phone, video, messaging or social media.	○	○	○
4. I had more support from my prenatal team.	○	○	○
5. It was easier to have my healthcare appointments when I wanted.	○	○	○
6. My medical providers made sure I knew what to expect being pregnant and delivering during the COVID-19 pandemic.	○	○	○

Page Break

Attention_check_3

It is important that you pay attention during this survey. Please enter the word "floit" in the space below. *Please make sure that the word "floit" has not been autocorrected by your device.*

Based on what you read above, what word were you asked to enter?

honeypot2

Skip to

End of Survey If It is important that you pa... Is Not Empty

It is important that you pay attention during this survey. Please tell us who is your favorite poet in the open space below.

Attention_message

Display this question

If It is important that you pay attention during this survey. Please enter the word "floit" in the s... Text Response Does Not Contain floit

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Import from library

Add new question

EPII-LD

LD-instruction

We would like to learn how the coronavirus disease (COVID-19) pandemic affected your experiences during the labor and delivery of your most recent child.

For each statement below, please answer whether the COVID-19 pandemic specifically impacted you in the way described. Some of the statements are about changes to your healthcare:

- If a change happened, whether it was because of your choice or your medical team's choice, you should indicate '**YES**'.
- If the statement is not true for you, check '**NO**.'
- Checking '**N/A**' means that the item is not applicable or it does not apply to any of your experiences.

Page Break

LD-1-birth location

Where did you give birth?

- ○ Hospital
- ○ Birthing Center
- ○ Home
- ○ Other

LD-1.1

Display this question

If Where did you give birth? Hospital Is Selected

If you have delivered your baby at the hospital...

Please check "yes" if the statement is true.

	Yes	No
1. I had an unplanned C-section because I had a confirmed or suspected case of COVID-19.	○	○
2. I was discharged less than 24 hours after delivery to reduce risk of getting COVID-19.	○	○
3. My baby did not receive the care I wanted them to get in the hospital.	○	○

LD-1.2

Display this question

If Where did you give birth? Birthing Center Is Selected

If you have delivered your baby at a birthing center...

Please check "yes" if the statement is true.

	Yes	No
1. I had an unplanned C-section because I had a confirmed or suspected case of COVID-19.	○	○
2. I was discharged less than 24 hours after delivery to reduce risk of getting COVID-19.	○	○
3. My baby did not receive the care I wanted them to get in the birthing center.	○	○
4. I delivered the baby at a birthing center due to fear of getting COVID-19 in a hospital.	○	○
5. I had the baby at a birthing center due to changes in delivery practices at my hospital due to COVID-19.	○	○

LD-1.3

Display this question

If Where did you give birth? Home Is Selected

If you have delivered your baby at home...

Please check "yes" if the statement is true.

	Yes	No
1. I delivered the baby at home due to fear of getting COVID-19 in a hospital.	○	○
2. I had the baby at home due to changes in delivery practices at my hospital due to COVID-19.	○	○

Page Break

LD-2

Please check "yes" if the statement is true.

Due to giving birth during the COVID-19 pandemic...

	Yes	No	N/A
1. I had to be tested for COVID-19 before I delivered.	○	○	○
2. My medical provider (for example, doctor, doula, midwife) was not available for my baby's birth due to COVID-19.	○	○	○
3. My medical provider changed when I was scheduled to have an induction or C-section (due to the pandemic or due to having a confirmed or suspected case of COVID-19).	○	○	○
4. The person who I wanted with me the most could not be there when I had the baby due to COVID-19.	○	○	○
	Yes	No	N/A
5. I had trouble getting the care that was needed for a health problem for me or my baby.	○	○	○
6. I had less choice about medications before or after delivery (e.g., nitrous oxide, pain medicine, epidural).	○	○	○
7. I was separated from my baby immediately after delivery because I had confirmed or suspected COVID-19.	○	○	○
8. I had no contact with my baby for 24 hours or longer because I had confirmed or suspected COVID-19.	○	○	○
	Yes	No	N/A
9. The people I wanted with me the most could not visit us in the place where I delivered.	○	○	○
10. I felt confused about what would be best for my baby if I had COVID-19.	○	○	○
11. I have not been able to get the kind of contraception I want since my baby was born.	○	○	○

Page Break

LD-3

Skip to

The next few questions will help us t... If No Is Selected

Before the baby was born, were you planning to breastfeed?

- Yes
- Maybe
- No

Page Break

LD-4

Please check "yes" if the statement is true.

	Yes	No	N/A
1. Because I have (or had) confirmed or suspected COVID-19, I have pumped breastmilk instead of nursing my baby.	○	○	○
2. Because I have (or had) confirmed or suspected COVID-19, I decided not to breastfeed my baby.	○	○	○
3. I have not been able to get the help I have wanted for breastfeeding. (For example, lactation specialist).	○	○	○

Page Break

LD-5

Skip destination

Go to skip origin

The next few questions will help us to understand how you feel about the care you received during labor and delivery.

	Yes	No	N/A
1. My medical providers made sure that I knew what to expect having a baby during the COVID-19 pandemic.	○	○	○
2. I feel that I was treated with respect and compassion during my labor and delivery.	○	○	○
3. I feel that my medical providers seemed to listen to and hear my concerns during labor and delivery.	○	○	○

Page Break

LD-6

Overall, how upset were you by how the COVID-19 pandemic affected your labor and delivery experience with your most recent child?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset
○	○	○	○	○

EPII-I

I-instruction

Instructions:

We would like to learn how the coronavirus disease (COVID-19) pandemic has impacted your experiences since your baby was born and has been at home.

For each statement below, please answer whether the COVID-19 pandemic specifically impacted you in the way described. Some of the statements are about changes to your healthcare:

- If a change happened, whether it was because of your choice or your medical team's choice, you should indicate '**YES**'.
- If the statement is not true for you, check '**NO**.'
- Selecting '**N/A**' means that the item is not applicable or it does not apply to any of your experiences.

Page Break

I-1

We would like to learn about how the COVID-19 pandemic affected your **healthcare** experiences in the time since your baby was born. Please check "yes" if the statement is true.

Due to the COVID-19 pandemic...

	Yes	No	N/A
1. My baby has not had any in-person well-baby visits due to COVID-19.	○	○	○
2. Some of my baby's immunizations have been postponed. (If unsure, check N/A)	○	○	○
3. I have not been able to get some services I have wanted for myself (for example, lactation specialist, visiting nurse).	○	○	○
4. I have not been able to get some services I have wanted for my baby (for example, developmental specialist, visiting nurse).	○	○	○
5. I have not been able to get the help I have wanted for feeling down, worried or overwhelmed.	○	○	○
6. My medical providers seemed to not listen to and hear my concerns since my baby was born.	○	○	○
7. I feel that my healthcare providers have not treated me with respect and compassion since my baby was born.	○	○	○

Page Break

I-2

We are also interested in understanding how the COVID-19 pandemic has affected you and your home life with your baby.

Due to the COVID-19 pandemic...

	Yes	No	N/A
1. Loved ones could not "meet" the new baby in person.	○	○	○
2. Family, friends, or other support people could not help with the new baby.	○	○	○
3. Religious ceremony or special event for my baby was canceled or postponed.	○	○	○
4. Trouble getting baby supplies, like diapers, wipes, clothes and formula.	○	○	○
5. I have not been able to breastfeed how I wanted due to COVID-19.	○	○	○
	Yes	No	N/A
6. My baby had to take a bottle from someone else because I had confirmed or suspected COVID-19.	○	○	○
7. I have breastfed my baby even though I had not planned to.	○	○	○
8. Only one person is allowed to take care of my baby to protect my baby from getting COVID-19.	○	○	○
9. I am not able to work because there is nobody to watch my baby.	○	○	○
10. I have had a hard time balancing working and caring for my baby.	○	○	○
	Yes	No	N/A
11. I have had a hard time balancing taking care of my baby and taking care of another person (or people) in my home.	○	○	○
12. I was hospitalized due to COVID-19 and had no contact with my baby for 24 hours or longer.	○	○	○
13. I was separated from my baby for a week or longer due to the COVID-19 crisis.	○	○	○
14. My baby's other parent was hospitalized due to COVID-19 and had no contact with my baby for 24 hours or longer.	○	○	○
15. My baby had to stay overnight with someone they don't know well.	○	○	○

Page Break

I-3

Overall, how upset have you been by how the COVID-19 pandemic has affected your experiences since your baby was born?

Not at all upset	A little upset	Somewhat upset	Very upset	Extremely upset
○	○	○	○	○

Page Break

I-4

The next questions will help us understand things you may have done to protect your baby from getting COVID-19 at home.

There was a period of time when I...

	Yes	No	N/A
1. Usually wore gloves when I held or touched my baby.	○	○	○
2. Usually wore a mask when I fed or changed my baby.	○	○	○
3. Spent as little time as possible holding or being near my baby.	○	○	○
4. Kept other people (or person) who live with me away from my baby.	○	○	○

Page Break

I-5

Please indicate how your feel about caring for your baby during this time. "N/A" means the item is not applicable to you.

	Very True	Somewhat True	Not True	N/A
1. My fears about COVID-19 interfere with enjoying my baby.	○	○	○	○
2. I feel like I can't touch or hold my baby as much as I want.	○	○	○	○
3. I feel that it is harder than it should be to bond with my baby.	○	○	○	○
4. I wish that my baby had been born at a different time.	○	○	○	○
5. I get angry or irritable because I have to limit my interactions with my baby or change what I want to do with my baby.	○	○	○	○

Attention_check_4

	Very True	Somewhat True	Not True	N/A
6. It's important that you are paying attention in this survey. Please select "Not True" to show that you are paying attention.	○	○	○	○

Display this question

If - Very True Is Selected

Or - Somewhat True Is Selected

Or - N/A Is Selected

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Page Break

I-6

We are also interested in **Positive Changes** due to the COVID-19 pandemic. Please check "yes" if the statement is true.

Due to the COVID-19 pandemic...

	Yes	No	N/A
1. I get to spend more time with my baby.	○	○	○
2. I have more support from other people at home.	○	○	○
3. I have had an easier time breastfeeding because I have more time at home.	○	○	○
4. I have had more support from other parents with babies by phone, video, messaging or social media.	○	○	○
5. It has been easier to have my healthcare appointments when I want.	○	○	○

CESD-intro

Current Emotional Well-Being and Functioning Section

In this section, we are interested in learning about your current emotional well-being and functioning. For this section, please report how you have been feeling in **the past two weeks only.**

Page Break

CESD-1

Over the past two weeks, how often have you experienced any of the following feelings or behaviors?

Please choose the response that most closely describes your experience for every item.

	Rarely or none of the time	Some or a little of the time	Occasionally or a moderate amount of time	Most or all of the time
1. I was bothered by things that usually don't bother me.	○	○	○	○
2. I did not feel like eating; my appetite was poor.	○	○	○	○
3. I felt that I could not shake off the blues even with help from my family or friends.	○	○	○	○
4. I felt I was just as good as other people.	○	○	○	○
5. I had trouble keeping my mind on what I was doing.	○	○	○	○
6. I felt depressed.	○	○	○	○
	Rarely or none of the time	Some or a little of the time	Occasionally or a moderate amount of time	Most or all of the time
7. I felt that everything I did was an effort.	○	○	○	○
8. I felt hopeful about the future.	○	○	○	○
9. I thought my life had been a failure.	○	○	○	○
10. I felt fearful.	○	○	○	○
11. My sleep was restless.	○	○	○	○
12. I was happy.	○	○	○	○
	Rarely or none of the time	Some or a little of the time	Occasionally or a moderate amount of time	Most or all of the time
13. I talked less than usual.	○	○	○	○
14. I felt lonely.	○	○	○	○
15. People were unfriendly.	○	○	○	○
16. I enjoyed life.	○	○	○	○
17. I had crying spells.	○	○	○	○
18. I felt sad.	○	○	○	○
	Rarely or none of the time	Some or a little of the time	Occasionally or a moderate amount of time	Most or all of the time
19. I felt that people dislike me.	○	○	○	○
20. I could not get "going."	○	○	○	○
21. I thought that I would be better off dead, or I thought about hurting myself in some way.	○	○	○	○

CESD-2

If you checked off ***any of the above items***, when did you **first** begin feeling/behaving this way?

- **Before becoming pregnant** with my most recent child
- **1st trimester** of my most recent pregnancy
- **2nd trimester** of my most recent pregnancy
- **3rd trimester** of my most recent pregnancy
- **0-4 weeks** following the birth of my most recent child
- **1-3 months** following the birth of my most recent child
- **More than 3 months** following the birth of my most recent child
- Not applicable to me (N/A)

PASS-1

Over the past two weeks, how often have you experienced any of the following feelings or behaviors?

Please choose the response that most closely describes your experience for every item.

	Not at all	Sometimes	Often	Almost always
1. Worry about the baby.	○	○	○	○
2. Fear that harm will come to the baby.	○	○	○	○
3. A sense of dread that something bad is going to happen.	○	○	○	○
4. Worry about many things.	○	○	○	○
5. Worry about the future.	○	○	○	○
	Not at all	Sometimes	Often	Almost always
6. Feeling overwhelmed.	○	○	○	○
7. Really strong fears about things (e.g., needles, blood, birth, pain, etc.).	○	○	○	○
8. Sudden rushes of extreme fear or discomfort.	○	○	○	○
9. Repetitive thoughts that are difficult to stop or control.	○	○	○	○
10. Difficulty sleeping even when I have the chance to sleep.	○	○	○	○
	Not at all	Sometimes	Often	Almost always
11. Having to do things in a certain way or order.	○	○	○	○
12. Wanting things to be perfect.	○	○	○	○
13. Needing to be in control of things.	○	○	○	○
14. Difficulty stopping checking or doing things over and over.	○	○	○	○
15. Feeling jumpy or easily startled.	○	○	○	○

PASS-1

Over the past two weeks, how often have you experienced any of the following feelings or behaviors?

Please choose the response that most closely describes your experience for every item.

	Not at all	Sometimes	Often	Almost always
1. Worry about the baby.	○	○	○	○
2. Fear that harm will come to the baby.	○	○	○	○
3. A sense of dread that something bad is going to happen.	○	○	○	○
4. Worry about many things.	○	○	○	○
5. Worry about the future.	○	○	○	○
	Not at all	Sometimes	Often	Almost always
6. Feeling overwhelmed.	○	○	○	○
7. Really strong fears about things (e.g., needles, blood, birth, pain, etc.).	○	○	○	○
8. Sudden rushes of extreme fear or discomfort.	○	○	○	○
9. Repetitive thoughts that are difficult to stop or control.	○	○	○	○
10. Difficulty sleeping even when I have the chance to sleep.	○	○	○	○
	Not at all	Sometimes	Often	Almost always
11. Having to do things in a certain way or order.	○	○	○	○
12. Wanting things to be perfect.	○	○	○	○
13. Needing to be in control of things.	○	○	○	○
14. Difficulty stopping checking or doing things over and over.	○	○	○	○
15. Feeling jumpy or easily startled.	○	○	○	○

PASS-2

	Not at all	Sometimes	Often	Almost always
16. Concerns about repeated thoughts.	○	○	○	○
17. Being 'on guard' or needing to watch out for things.	○	○	○	○
18. Upset about repeated memories, dreams, or nightmares.	○	○	○	○
19. Worry that I will embarrass myself in front of others.	○	○	○	○
20. Fear that others will judge me negatively.	○	○	○	○
21. Feeling really uneasy in crowds.	○	○	○	○
	Not at all	Sometimes	Often	Almost always
22. Avoiding social activities because I might be nervous.	○	○	○	○
23. Avoiding things which concern me.	○	○	○	○
24. Feeling detached like I'm watching myself in a movie.	○	○	○	○
25. Losing track of time and can't remember what happened.	○	○	○	○
26. Difficulty adjusting to recent changes.	○	○	○	○
27. Anxiety getting in the way of being able to do things.	○	○	○	○
	Not at all	Sometimes	Often	Almost always
28. Racing thoughts making it hard to concentrate.	○	○	○	○
29. Fear of losing control.	○	○	○	○
30. Feeling panicky.	○	○	○	○
31. Feeling agitated.	○	○	○	○

PASS-3

If you reported experiencing ***any of the above items***, when did you <u>**first**</u> begin feeling/behaving this way?

- ○ **Before becoming pregnant** with my most recent child
- ○ **1st trimester** of my most recent pregnancy
- ○ **2nd trimester** of my most recent pregnancy
- ○ **3rd trimester** of my most recent pregnancy
- ○ **0-4 weeks** following the birth of my most recent child
- ○ **1-3 months** following the birth of my most recent child
- ○ **More than 3 months** following the birth of my most recent child
- ○ Not applicable to me (N/A)

BIMF

BIMF-1

Below is a list of the ways you might have felt or behaved **over the past two weeks.**

Please choose the response that most closely describes your experience for every item.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewha Agree
1. I am a good mother.	○	○	○	○	○
2. I feel rested.	○	○	○	○	○
3. I am comfortable with the way I've chosen to feed my baby (either bottle or breast, or both).	○	○	○	○	○
4. My baby and I understand each other.	○	○	○	○	○
5. I am able to relax and enjoy time with my baby.	○	○	○	○	○
	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewha Agree
6. There are people in my life that I can trust to care for my baby when I need a break.	○	○	○	○	○
7. I *am comfortable* allowing a trusted friend or relative to care for my baby (can include baby's father or partner).	○	○	○	○	○
8. I am getting enough adult interaction.	○	○	○	○	○
9. I am getting enough encouragement from other people.	○	○	○	○	○
10. I trust my own feelings (instincts) when it comes to taking care of my baby.	○	○	○	○	○

BIMF-2

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewha Agree
11. I take a little time each week to do something for myself.	○	○	○	○	○
12. I am taking good care of my baby's physical needs (feedings, changing diapers, doctor's appointments).	○	○	○	○	○
13. I am taking good care of my physical needs (eating, showering, etc).	○	○	○	○	○
14. I make good decisions about my baby's health and well-being.	○	○	○	○	○
15. My baby and I are getting into a routine.	○	○	○	○	○
	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewha Agree
16. I worry about how other people judge me (as a mother).	○	○	○	○	○
17. I am able to take care of my baby and my other responsibilities.	○	○	○	○	○
18. Anxiety or worry often interferes with my mothering ability.	○	○	○	○	○
19. *As time goes on*, I am getting better at taking care of my baby.	○	○	○	○	○
20. I *am satisfied* with the job I am doing as a new mother.	○	○	○	○	○

BSIS-1

Over the past two weeks, how often have you experienced any of the following feelings or behaviors?

Please choose the response that most closely describes your experience for every item.

	Not at all	A little or some of the time	Often	Most or all of the time
1. I have been feeling mad.	○	○	○	○
2. I have been feeling ready to explode.	○	○	○	○
3. I have yelled at others.	○	○	○	○
4. I have been irritable when someone touched me.	○	○	○	○
5. I have been easily off the handle.	○	○	○	○
	Not at all	A little or some of the time	Often	Most or all of the time
6. It feels like there has been a cloud of anger over me.	○	○	○	○
7. I have been rather sensitive.	○	○	○	○
8. I have been quick to criticize others.	○	○	○	○
9. Noises have seemed louder.	○	○	○	○
10. I have been getting annoyed with myself.	○	○	○	○
	Not at all	A little or some of the time	Often	Most or all of the time
11. I have been so angry that I lost control.	○	○	○	○
12. There has been a flood of tension through my body.	○	○	○	○
13. I said nasty things to others that I did not mean.	○	○	○	○
14. It took very little for things to bother me.	○	○	○	○

BSIS-2

If you reported experiencing **any of the above items**, when did you **first** begin feeling/behaving this way?

- ○ **Before becoming pregnant** with my most recent child
- ○ **1st trimester** of my most recent pregnancy
- ○ **2nd trimester** of my most recent pregnancy
- ○ **3rd trimester** of my most recent pregnancy
- ○ **0-4 weeks** following the birth of my most recent child
- ○ **1-3 months** following the birth of my most recent child
- ○ **More than 3 months** following the birth of my most recent child
- ○ Not applicable to me (N/A)

Page Break

BSIS-3

In the past **two weeks**, how has feeling irritable affected your...

	Not at all affected	Slightly affected	Somewhat affected	Moderately affected	Extremely affected
1. Relationships with family.	○	○	○	○	○
2. Daily activities.	○	○	○	○	○
3. Ability to deal with frustration.	○	○	○	○	○
4. Self-esteem.	○	○	○	○	○
5. Social relationships.	○	○	○	○	○

BSIS-4

How would you rate yourself **at this moment**?

Not at all irritable	Slightly irritable	Somewhat irritable	Moderately irritable	Extremely irritable
○	○	○	○	○

BSIS-5

How would you rate your **usual self**?

Not at all irritable	Slightly irritable	Somewhat irritable	Moderately irritable	Extremely irritable
○	○	○	○	○

Attention_check_5

It's important that you pay attention to the survey. Based on the text below, what would you select as your favorite food?

This is a simple attention question. When asked for your favorite food, please select Nachos.

- ○ Pasta
- ○ Nachos
- ○ Sushi
- ○ Burgers
- ○ Pizza
- ○ Other

Attention_message

Display this question

If It's important that you pay attention to the survey. Based on the text below, what would you sele... Pasta Is Selected

Or It's important that you pay attention to the survey. Based on the text below, what would you sele... Sushi Is Selected

Or It's important that you pay attention to the survey. Based on the text below, what would you sele... Burgers Is Selected

Or It's important that you pay attention to the survey. Based on the text below, what would you sele... Pizza Is Selected

Or It's important that you pay attention to the survey. Based on the text below, what would you sele... Other Is Selected

ATTENTION:
It appears that you have **failed** one of our attention checks. Please take your time when answering the questions in order to avoid missing our attention checks, which may result in reduced or no payment.

You are permitted to miss **two** attention checks throughout this survey. Please note that if you miss more than two attention checks, you will not receive full compensation and if you miss all attention checks, you will not be eligible for compensation.

If you would like to keep going with the survey, click the "next" button at the bottom of the page. Thank you.

Q47_check_email

Thank you for taking the time to share your experience with us!

If you're experiencing any psychological discomfort or distress and would like to access supportive services, **click here for our resource list**.

As a reminder, your responses will be reviewed for data quality. Participants who pass the review will receive an electronic gift card (up to $15) via email in 4 to 6 weeks.

Please re-enter your email address in the box below.

Contact_study_2

Are you interested in participating in another research study (and possibly receiving additional compensation)?

We value your input and would like to reach out to you for other surveys conducted by our team in the upcoming months.

- **Yes**, I would like to be contacted for a future study.
- **No**, I do not want to be contacted for a future study.

CAPTCHA2

Import from library

Add new question

Add Block

End of Survey

We thank you for your time spent taking this survey.

Your response has been recorded.

Appendix C.

P-4 Data Quality Scale

Legend
Between response measures
Within response measures
Combination of between and within response measures

Data Category	Data Piece	Problem	Points
Device	IP Address	**Identical: exactly the same as 1+ other IP addresses across all batches**	3
		Truncated identical: only the last (1) number is different	2
		Truncated identical: only the last 2 numbers are different	2
		Truncated identical: only the last 3 numbers are different	1
		Truncated identical: 2+ additional responses with a truncated IP	1
		Truncated identical: only the last 1-3 numbers are different	1
Bot Detection	Captcha	reCaptcha <0.5	3
		invisible reCAPTCHA <0.5	3
		reCaptcha between .5 and .8	1
	Ballot Stuffing	Fail if marked	3
	Honeypot	Fail if marked	3
Email	Email Address	Repeated email address or fake email address	3
		Blurry picture of any kind linked to email	-0.5
		Clear picture of female linked to email	-1
Location	Country	Outside the US	3
	State, Zip Code Geo Mismatch	Qualtrics and self-report states and/or zip code are different	1
	Latitude & Longitude	The longitude & latitude match one of our identified sus batches AND there is a geo-mismatch	1
Demographics		Child is older than 12 months at time of survey	3

	Child's Birth Month, Year & Age	Child's age is unidentifiable based on the reported information	1
	Mother's Birth Year & Age	Calculated age lands in the reported age range, +/- 2 years	1
		Job description matches another response with a matching truncated IP	1
		Job description does not make sense or uses words that are uncommon (ex. Supermarket manager)	1
	Employment	Belongs to a suspicious employment group	0.5
	Education, ethnicity, child's birth month and year, religion, relationship status, employment status, income level, vaccine status, singleton+, other children, complications	Five of 13 (5/13) questions are the same as another response	1
		Hypermesis is marked as a complication	0.25
	Pregnancy Complications	Exogena Puermorbus is marked as a complication	3
	Duration of Survey	Survey completed in less than 600 seconds	3
	Survey Links	Referral source did not match link used	1
		Start time is within 1-3 minutes of another response	1
		Start time is within 1-3 minutes of another response and they also end within a few minutes	1
		The response start time is within 0-1 min of the end time of another response that failed eligibility	1
		Start time is identical AND end time is within 5-10 minutes	0.5
		Start and end time identical with one other response	2
		Start and end time identical with 2+ responses	3
		Start time is 0-1 minute after a response that failed eligibility but they did not have similar IP addresses	0.5
		Start time is 0-1 minute after a response that failed eligibility AND they had similar IP addresses	1
Survey Details	**Start / End Time**	Start time is between 1a and 5a local time	1
		Suspicous answer (Twitter or Instagram anytime before 4/8/22)	2
	Referral Source	Unique referral source entered	-1
Other	**Pregnancy Complications**	Unique pregnancy complication(s) entered	-1

		Duplicate response	3
		Suspicious language or "on edge": the response contain suspicious language that was used by identified fraudulent & failed responses	.5-2
		Gramatical mistakes (esp. if similar to other suspicious responses)	.5-2
		Illegible or response does not make sense	3
		Reported number of children and plurality of children mentioned in free response do not match	2
		Unique response (detailed explanations, context, or examples)	-2
		Brief/Weak Response	0.5
	Free Response	Refusing to answer	1
		Primary answer selection: only selecting the first answer of each question	Q[a]
		Positive answer selection (Acquiescence response bias): only selecting *yes* and *strongly agree*	Q
		Neutral answer choices: only chooses neutral answers (e.g., *N/A*)	Q
	Answer Quality	**Straight lining: only chooses the same point for every scale (e.g., answer A)**	Q
		Failed 1-2 attention checks	1
	Attention Checks	Failed 3+ attention checks	3
		Participant age and birth year did not align	1
		Infant birthday was over 12 months before the survey start date	1
Checks	**Consistency Checks**	State chosen did not match geolocation pulled from longitude and latitude	2

[a]Qualitative assessment: these items were not scored but can be used to strengthen the argument for failing a response.