Exploring the Relationship Between Parental Mental Health and Parental Perceptions of Infant Vulnerability

by
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DEDICATION

This thesis is dedicated to my parents; their hard work and support always inspire me to be the best version of myself.

EPIGRAPH

Wherever the art of medicine is loved, there is also a love of humanity.

— Hippocrates

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I am truly grateful to my mentors, who have guided me throughout my Senior Honors Thesis journey.

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ABSTRACT

A mismatch in vulnerability perception occurs when parents' perceptions of their children's medical vulnerability level differ from children's objective medical risk status, and such mismatch negatively affects children's health. The goal of this thesis is to determine how parental perceptions of infant vulnerability compare with objective infant vulnerability status and to identify the role of parental mental health in this relationship. This thesis fills the current gap in vulnerability-related research by elucidating parental perceptions of infant vulnerability across a broad range of infant health (NICU and well-baby nursery infants). Deidentified longitudinal data from the BabySeq Project was utilized for this study. Conducted between May 14, 2015 and May 21, 2019, the BabySeq Project was a randomized controlled trial that aimed to determine the psychosocial impact of newborn genomic sequencing results on families (519 parents of 325 infants). Data collected at 3 months and 10 months after disclosure of sequencing results were the focus of this present study. The data set included information regarding parental anxiety (GAD-7), depression (PHQ-9), perceptions of children's vulnerability (CVS), and reported medical history of infants. From the data set, two novel variables were developed, including the objective vulnerability score to identify infants' medical risk status and the Match/Mismatch score to determine parents' risk for misperceiving their infants' vulnerability. Parental mental health scores were significant predictors of Match/Mismatch scores and perceived vulnerability, and vice versa, within each timepoint at 3 and 10 months post-disclosure. When controlling for demographic variables, Match/Mismatch scores at 3 months, but not parental mental health at 3 months, longitudinally predicted Match/Mismatch scores at the 10-month timepoint. Additionally, parental mental health at 3 months, but not Match/Mismatch scores at 3 months, longitudinally predicted future parental mental health at the 10-month timepoint. There is a need for health care professionals to identify parents who are at risk for mismatch in infant vulnerability perception. By recognizing such at-risk parents, physicians can subsequently provide resources that will assist parents in better understanding their infant's objective health status, and physicians can allocate resources to help alleviate parents' potential mental health severity.

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Introduction

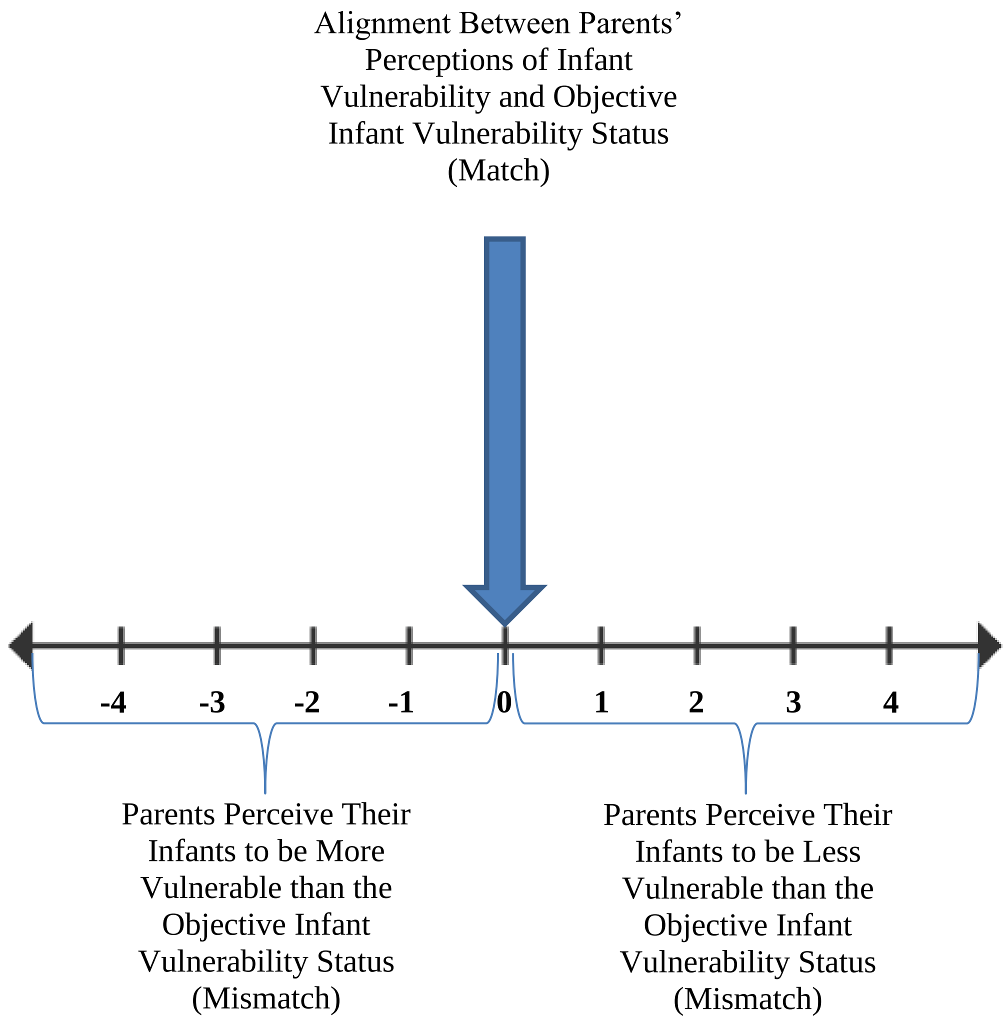
Parental Perceptions of Child Vulnerability

Parental perceptions of child vulnerability refer to parents' subjective evaluation of their children's risk for illnesses (Driscoll et al., 2018), and such perceptions have important implications for parents' behaviors towards their children (Gordo et al., 2018; Green & Solnit, 1964). A mismatch in vulnerability happens when parents perceive their children's vulnerability level to be different than children's objective health status, whereas a match represents an alignment between parental perceptions of children's vulnerability and their children's objectively measured medical risk status (Figure 1). In a study of pediatric clinics in Boston, results showed that 27% of parents believed that their children were highly vulnerable to severe illnesses; however, 40% of these children did not have any explanatory factors in their medical records regarding their parents' heightened fears (Levy, 1980; Pearson & Boyce, 2004).

Studies have shown that parental mismatch in the evaluation of children's vulnerability, in comparison to children's objective health status, has detrimental effects on parents' health-related behaviors towards their children and thus on children's health (Green & Solnit, 1964). As a result, I aim to explore whether parental perceptions of vulnerability are highly correlated with children's objective, medical risk status and whether such perceptions may be impacted by or attributed to preexisting parental factors, such as parental mental health severity.

Figure 1

Theoretical Model of the Match/Mismatch Variable Regarding Infant Vulnerability



Note. This figure presents a visual depiction of this study's novel vulnerability Match/Mismatch variable, which is equal to objective vulnerability – perceived vulnerability. Overperception refers to the negative Match/Mismatch values, which means the perceived vulnerability score > objective vulnerability score. Underperception refers to the positive Match/Mismatch values, which means the perceived vulnerability score < objective vulnerability score. A "match" occurs when the Match/Mismatch score is 0 since this means that the perceived vulnerability score = objective vulnerability score.

Vulnerable Child Syndrome

The term "Vulnerable Child Syndrome" was first used in a study conducted by Green & Solnit in 1964. Vulnerable Child Syndrome refers to parents' abnormal perception of their children as vulnerable (Forsyth, 2009). Green & Solnit (1964) noted that even after children had recovered from a life-threatening illness, their parents continued to view them as vulnerable and practiced excess overprotective parenting, ultimately leading to negative psychological effects in their children (Forsyth et al., 1996; Green & Solnit, 1964). Other studies have also attributed such overprotection to children's decreased self-esteem (Levy, 1966; Thomasgard, 1998). In Green & Solnit's study (1964), the time span between illness and recovery ranged between 17 months to 14 years later (Green & Solnit, 1964). Effects of the Vulnerable Child Syndrome also included suboptimal parent-child relationships, which comprised of infantilization, excessive parental concern regarding children's minor health issues, difficulty during times of separation, and children's decreased performance in school (Green & Solnit, 1964). Children reflected their parents' excessive concerns by adopting heightened anxiety about separating from their parents (Green & Solnit, 1964; Leslie & Boyce, 1996).

Green & Solnit's (1964) study concluded with recommendations for physicians to ensure that they appropriately communicate the objective status of the child to parents without any excess or reduced expression, (Green & Solnit, 1964). Such advice aimed to reduce the risk for parental mismatch in their perceptions of children's vulnerability compared to children's objective medical vulnerability (Green & Solnit, 1964). These recommendations further underscore the importance of parental match in their evaluation of children's vulnerability. More recent recommendations have also built upon this to recommend pediatricians to speak about the possibility for and implications of the Vulnerable Child Syndrome to families of children who have recovered from a severe illness (Pearson & Boyce, 2004). This includes physicians describing that a natural parental response to recovered children include overprotection and the Vulnerable Child Syndrome, which can negatively affect both the parents and the child (Pearson & Boyce, 2004). Additionally, physician management plans should include routine follow-up visits during which physicians assess parents' perceptions of their children's health and reassure parents of their children's healthy status without unnecessarily emphasizing the gravity of the illness that the child recovered from (Pearson & Boyce, 2004).

After Green & Solnit's (1964) description of the Vulnerable Child Syndrome, numerous studies have been conducted on parental perceptions of child vulnerability among children with chronic illnesses (Anthony et al., 2011; Anthony et al., 2003; Connelly et al., 2012; Driscoll et al., 2018) and similarly revealed that parental perceptions of higher child vulnerability were related to detrimental effects in children's health. A study of 69 children aged 7-14 years old with chronic illnesses from rheumatology (children with juvenile arthritis, mixed connective tissue disease, systemic lupus erythematosus, other rheumatic diseases) and pulmonary (children with asthma, cystic fibrosis, and other associated illnesses) clinics showed that high parental perceptions of child vulnerability were associated with children's development of social anxiety (Anthony et al., 2003). Furthermore, another study of 87 children aged 6-18 years old, who were experiencing long-term pain and were recruited from a chronic pain clinic, indicated that elevated parental perceptions of child vulnerability related to children's decreased functioning (Connelly et al., 2012). Furthermore, greater parental perceptions of child vulnerability were also associated with children's depressive and anxious symptomatology in a study of 51 children aged 8-16 years old with chronic arthritis (Anthony et al., 2011) and 43 children aged 8-12 years old with Type I Diabetes (Mullins et al., 2004).

Parental Perceptions of Infant Vulnerability

These studies examined children of the school-going age (Anthony et al., 2011; Anthony et al., 2003; Connelly et al., 2012; Driscoll et al., 2018). However, there remains a dearth of studies regarding parental perceptions of *infant* vulnerability and regarding children with a broader of range of medical diagnoses, rather than strictly limited to chronic illnesses only. It is essential to identify how parents perceive their infants' vulnerability status, which precedes and may even contribute to parental perceptions of child vulnerability. Additionally, it is important to explore whether parents may view their healthy infants as vulnerable due to their infants' tender, young age or whether parental perceptions of infant vulnerability function in the same way as in older childhood. Because of this question and because of parents' fear of their healthy infants' risk for sudden infant death syndrome, the Vulnerable Baby Scale was developed with three groups of Australasian mother-infant dyads in New Zealand: healthy infants, medically fragile infants, and jaundiced infants (Kerruish et al., 2005).

Only one study has been conducted regarding predictors of mothers' perceptions of infant vulnerability, but this study focused solely on 97 African-American mothers of preterm infants (Teti et al., 2005), so there is a need for a current study on parental perceptions of infant vulnerability among a more generalizable population of infants.

Objective Vulnerability

In their study, Green & Solnit (1964) did not utilize a measure of objective child vulnerability or objective medical status to compare with parental perceptions of child vulnerability (Green & Solnit, 1964). Instead, the authors stated that the children of the sample were previously experiencing a life-threatening illness and that they had recovered at the time of the study (Green & Solnit, 1964). Rather than noting the medical conditions of each child, the authors only reported the manifested symptoms, or the currently experienced issues (e.g., unsuccess in school. absence of discipline, tantrums, nervousness), that resulted from the "Vulnerable Child Syndrome" after children recovered from previous life-threatening illnesses (Green & Solnit, 1964).

As previously mentioned, Teti et al. (2005) explored predictors of parental perceptions of infant vulnerability. Unlike Green & Solnit's study (1964), this study included data collection on infant health status, including Apgar scores, gestational age, birth weight, number of days in the hospital, and the Brazy Neurobiological Risk Score (NBRS), which is a measure of total medical risk between birth and discharge (Teti et al., 2005). The adapted version of the NBRS is a scale that involves rating each child from 0 to 4 on the following measures: mechanical ventilation, seizures, intraventricular hemorrhage, periventricular leukomalacia, and infection. The scale was provided pre-discharge, and sum scores ranged from 0 to 20 to represent total medical risk. Only the number of days in the hospital and the NBRS scores were utilized in analyses regarding predictors of perceptions of infant vulnerability, but neither of these indices were significant (Teti et al., 2005). However, because the sample of this study was limited to solely African American mothers of preterm infants, who were mostly of low-income status (Teti et al., 2005), a study with a greater representative sample is necessary to understand the relationship between perceived and objective infant vulnerability.

Role of Parental Mental Health

Parent characteristics may influence their perceptions of child vulnerability, Specifically, Thomasgard (1998) expressed that there is a lack of research regarding the impact of parental mental health on parental perceptions of child vulnerability and their parenting behaviors (Thomasgard, 1998). In other words, studies are needed to understand parents' mental health status among parents who overperceive their children to be vulnerable (Thomasgard, 1998). He further proposed that parents who evaluated their children to be more vulnerable than their objective medical status have greater anxiety regarding their children's health, fear for complications in their children's health or for possible loss, and an absence of experiences of severe health events in the child's life (Thomasgard, 1998). Upon surveying 871 parents of children between the ages of 22-72 months, he noted that parents who had perceived their children as highly vulnerable had greater T-scores in all dimensions of the Brief Symptoms Inventory (BSI), which indicated greater psychological symptoms, than parents who had perceived their children to have lower vulnerability (Thomasgard, 1998). Furthermore, Green & Solnit (1964) expressed that the three risk factors for

Vulnerable Child Syndrome include severe sickness of the child, mothers' complications with conception, pregnancy, and childbirth, and parental psychological symptomatology (Green & Solnit, 1964; Pearson & Boyce, 2004). Additionally, Teti et al. (2005) noted that maternal depressive symptoms predicted future perceptions of infant vulnerability (Teti et al., 2005).

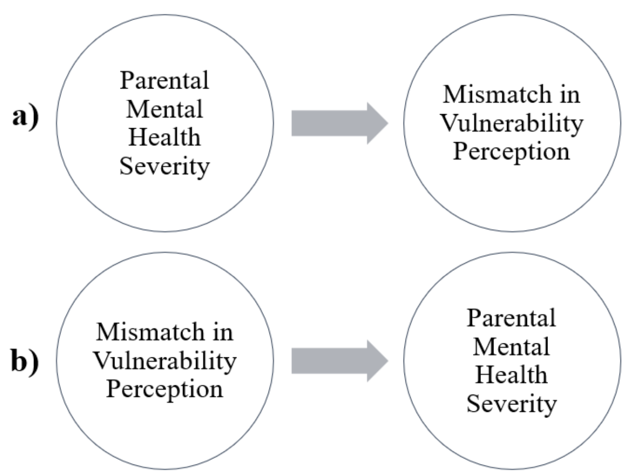
70% of parents and caregivers surveyed in the United States experience mental health symptomatology, including depressive and anxious symptomatology (Czeisler et al., 2021). Many instances of mental illnesses, such as depression, often remain undiagnosed or untreated upon diagnosis (Smith, 2004). Regardless of clinical diagnosis, adverse mental health significantly affects parents' daily lives and has far-reaching effects, including detrimental impacts on parenting and parent-child interactions. For instance, mothers with depressive symptomatology are at greater risk for exhibiting reduced sensitivity and lowered responsiveness with children, and prenatal anxiety increases their likelihood of exerting greater control with infants (Parfitt et al., 2013). Moreover, the presence of parental anxiety disorders also increases the risk for children's future development of both anxiety and depressive disorders (Lawrence et al., 2019). Because parental mental health symptomatology significantly affects parent-child interactions, it is essential to explore whether a mismatch between objective and perceived infant vulnerability levels increases parents' risk for anxiety and/or depression.

Thesis Aims and Goals

It remains unknown whether parental perceptions of infant vulnerability predispose parents to future mental health symptomatology or whether the presence of mental health symptomatology contributes to their perceptions of infant vulnerability. Furthermore, it remains unknown whether the match between perceptions of infant vulnerability and objective infant vulnerability is affected by parental mental health or affects parents' future risk for developing mental health symptomatology. Hence, I aim to understand whether parental perceptions of infant vulnerability are solely based upon the medical status of the infant or whether it is affected by parents' existing mental health status (Figure 2). There is a necessity to analyze the direction of this relationship with parents of infants (newborn – 10 months), especially since the current literature only focuses on parents of older children.

Figure 2

Theoretical Model of Potential Relationships Between Parental Mental Health and Parental Match/Mismatch Regarding Infant Vulnerability



Note. These figures visually express the relationships that I aim to assess in this thesis.

In order to explore factors that affect parental perceptions of infant vulnerability, particularly the role of parental mental health, I aim to analyze deidentified data from the BabySeq Project for my thesis. Genetic sequencing is becoming more accessible, cheaper, and common for newborns, thus warranting an exploration of the effects of genetic sequencing, such as the psychosocial effects of advanced results disclosure on parents (Frankel et al., 2016). Hence, the BabySeq Project was conducted to compare the effects of providing newborn genomic sequencing results to parents along with the current standard newborn screening results versus solely the standard newborn screening results (Pereira et al., 2021). The data collection occurred from 2015-2019, and participants were recruited from both NICU and well-baby nurseries at Boston Children's Hospital, Brigham and Women's Hospital, and Massachusetts General Hospital (Pereira et al., 2021). One hundred and fifty-nine infants were randomly assigned to the genomic sequencing group, and 166 infants were assigned to the standard newborn screening group (Pereira et al., 2021). Infants' ages ranged between 0-42 days old, and data was collected at four timepoints: baseline, post-disclosure of screening results, 3 months after disclosure, and 10 months after disclosure (Pereira et al., 2021).

In this project, I aim to utilize this deidentified dataset to compare parents' perceptions of infant vulnerability with infants' objective medical vulnerability via statistical analysis in SPSS. Within this overarching goal, analyses include an exploration of the effects of parental mental health status on parental perceptions of infant vulnerability as well as parents' predisposition for mental health symptomatology due to parental perceptions of infant vulnerability. In this data set, perceived infant vulnerability was measured with the Child Vulnerability Scale (CVS; Forsyth et al., 1996). Depression in parents was measured with the Patient Health Questionnaire (PHQ-9; Kroenke & Spitzer, 2002). Anxiety was measured with the Generalized Anxiety Disorder Screener (GAD-7; Spitzer et al., 2006). Objective vulnerability will be accounted for with the following measures: number of total ER visits, hospital visits, days in the hospital, ICU visits, days in the ICU, number of surgeries, number of medicines, number of primary care provider (PCP) visits, and number of specialist visits.

The goal of this study is to compare two prime variables: parental perceived infant vulnerability and infants' objective vulnerability levels. "Objective" refers to a measure of medical vulnerability that is based on past, concrete occurrences. Such measures, as mentioned, include infants' number of visits or admissions in the hospital, times in the ICU, and number of surgeries. In other words, these values are not subject to emotions and reflect previously occurred events that represent an infant's medical risk status. While these measures often vary between patients of different health care providers and different hospitals, we consider these measures to be objective in nature rather than subjective, as *perceptions* of infant vulnerability is, since the aforementioned objective measures are intended to be standard. The goal of this study is to compare perceived and objective infant vulnerability and to understand the role of parental mental health in this relationship. This involves the creation of a Match/Mismatch variable that represents the difference between infants' objective vulnerability levels and parental perceptions of infant vulnerability levels (Figure 3) and then the determination of the relationship between parental mental health and the

Match/Mismatch variable (Figure 2). The Match/Mismatch variable represents whether parents have overperceived, similarly perceived, or underperceived their infants' vulnerability levels in comparison to infants' objective medical vulnerability status (Figure 1).

Figure 3

Calculation Model of Match/Mismatch Score

Note. This figure visually expresses how the Match/Mismatch score is calculated to determine infants' risk for parental vulnerability misperception.

This exploration is novel since it is not limited to infants with chronic illnesses only or infants with the diagnosis of one particular disease only, which are limitations of previous, available studies on child vulnerability. Parents' mismatch in perceiving their infants as vulnerable, compared to objectively measured vulnerability, can negatively affect their infants' health and development. Thus, by understanding factors, such as anxious or depressive symptomatology, that limit or affect parents' match in their perceptions of infant vulnerability, we will better understand risk factors for mismatch in perceptions of infant vulnerability. Ultimately, this study may pave the way for future pediatricians, who are aware of infants' objective vulnerability, to routinely screen parents' perceived infant vulnerability levels and address any variations in perceptions, thus promoting optimal parental mental health, parent-child relationships, and child health. In other words, if we see that parental perceptions of infant vulnerability predispose parents to mental health symptomatology, which would subsequently affect parent-child interactions, then such screening may help to reduce parents' future risk for anxiety or depression. For instance, through screenings, physicians may realize that parents are overestimating their infants' vulnerability and can address such parental perceptions in order to help alleviate parental mental health symptomatology.

Chapter 2

Materials and Methods

The BabySeq Project & Study Procedures

The BabySeq Project, which ran between May 14, 2015 and May 21, 2019, was designed to understand how disclosing genomic sequencing results, in comparison to the currently established standard newborn screening results, impacts the care of infants (Holm et al., 2018; Pereira et al., 2021). As genomic sequencing is becoming increasingly accessible and affordable with advances in scientific technology, it is essential to understand how such genomic sequencing results, which can indicate the risk rather than the current presence of diseases, affect parents and parent-child relationships. As part of this larger project, newborns and their parents were enrolled as participants of the study (Holm et al., 2018). Among the enrollees, both well-baby and NICU newborns were randomly assigned into either the genomic sequencing or the standard newborn screening cohort, which represents the control group (Holm et al., 2018). Parents then filled out surveys at four timepoints: baseline, post-disclosure of results, 3 months after disclosure, and 10 months after disclosure, and parents were provided with monetary incentives upon completion (Holm et al., 2018). The surveys included a variety of questions regarding parenting, parent-child relationships, infant health, and infant care.

Although the BabySeq Project aimed to understand the impact of genomic sequencing reports on the care of infants, the goal of my thesis is to focus on parental perceptions of infant vulnerability. Because parental perceptions of child vulnerability affect parenting and parental mental health, it is salient to understand how parental perceptions of infant vulnerability compare with objective infant vulnerability and the role of parental mental health in this relationship. Thus, I am using the collected BabySeq Project deidentified data regarding parental perceptions of infant vulnerability, parental mental health, and objective infant medical status. The BabySeq Project data includes both NICU and well-baby samples; thus, it is representative of the general infant population. The BabySeq Project data does have an oversampling of NICU babies, and it does not focus solely on children with chronic illnesses. Studies on parents' perceptions of child vulnerability often center on children with chronic illnesses primarily, so this study with the BabySeq Project data is particularly unique. The BabySeq Project is a clinical study that was registered with the ClinicalTrials.gov identifier of NCT02422511.

Participants

Parents from well-baby nurseries were recruited from Brigham and Women's Hospital while parents from NICUs were enrolled from Boston Children's Hospital, Brigham and Women's Hospital, and Massachusetts General Hospital (Pereira et al., 2021). A total of 519 parents of 325 infants, which included 257 newborns from the well-baby nursery and 68 newborns from the NICU, were enrolled and randomized in this study (Pereira et al., 2021). At the time of enrollment, demographic features were surveyed and identified among the recruited sample (Pereira et al., 2021). With regards to race, 74.3% of parents were White, 9.1% were Asian, and 3.5% were Black or African American. In terms of ethnicity, 93.4% were non-Hispanic while 6.6% were Hispanic or Latino. Based on education level, 11.7% had less than a bachelor's degree while 88.2% had a bachelor's degree or higher. Furthermore, 19.4% of parents had a household income between $0 – $99,999 per year, 42.0% reported their household income to be between $100,000 - $199,999, and 38.6% reported household earnings of $200,000 or more per year.

Measures

Measures in this section were included in the surveys that were administered to parents, and these outcome variables are used for the data analyses in this present study.

Infant Vulnerability

Child Vulnerability Scale. The Child Vulnerability Scale (CVS) is used as a measure to determine parental perceptions of child vulnerability (Forsyth et al., 1996). The responses for each of the 8 items range on a Likert scale from 0 – 4, where "Definitely False" = 0 and "Definitely True" = 4 (Forsyth et al., 1996). The 8 items in the scale are summed to give a total score, and a cutoff score of 10 has been established, meaning that a score equal to or higher than 10 indicates that parents perceive their children to be vulnerable (Forsyth et al., 1996). This measure was created and validated among mothers of children between 4-8 years old who were visiting their pediatrician's office (Cronbach $\alpha = 0.74$; Forsyth et al., 1996). The goal was to develop a measure that can quantify parental perceptions of child vulnerability (Forsyth et al., 1996). Most of the mothers in the original validation sample were Caucasian, married, and had at least a high school diploma (Forsyth et al., 1996). Using the cutoff score of 10, 10.1% of children (in a sample of 1095 children) were deemed to be perceived as vulnerable by their mothers, and these children had significantly greater behavioral issues (indication of the Vulnerable Child Syndrome) and medical visits for short-term issues compared to children whose mothers reported a CVS score below 10 (Forsyth et al., 1996). For this present sample, the Cronbach's alpha for the CVS was 0.779 and 0.785 at the 3-month and 10-month timepoints, respectively, thus signifying high internal consistency.

Although the Vulnerable Baby Scale (VBS) has been validated for use among infants about 12 weeks of age (Kerruish et al., 2005), I used the CVS as the measure for parental perceptions of infant vulnerability, in comparison to the VBS, because the administered surveys included all items of the CVS but did not include all items of the VBS. The surveys included only 5 out of the 10 questions from the VBS scale. In order to better understand the published cutoff values and to utilize the validated scoring method for the collected data, it was necessary to statistically analyze the scale that had all of the items available for parents' responses. Also, the 10-month timepoint is equivalent to when infants are about 15 months of age (mean infant age is 458 days), which is beyond the 12-week age for which the VBS was validated. Although the CVS was originally developed and validated using a sample of children who were between 4-8 years old (α = .74; Forsyth et al., 1996), the CVS has been utilized among infants ages 1-30 months (which includes the newborn – 15 months age range of this present study) with good internal consistency (α = .71; Dogan et al., 2009).

Objective Vulnerability Status. The objective vulnerability status variable is a novel measure that I created for this study. It was constructed and intended to represent the infant's overall cumulative medical vulnerability level. In other words, this measure is an indicator of cumulative medical risk status, or how medically fragile the infant is. This variable is a sum score of the following 9 components of objectively measured health risk indicators collected through self-report by female caregivers: number of total ER visits, hospital visits, days in the hospital, ICU visits, days in the ICU, number of surgeries, number of medicines, number of PCP visits, and number of specialist visits. These values are reported by parents as the total number of occurrences between the post-disclosure timepoint and the time of survey, which is either 3 months or 10 months later. The practice of utilizing cumulative scores of a set of items to create a sum variable is an accepted practice for representing a particular measure. For instance, the Adverse Childhood Experiences Questionnaire (ACE-Q) is a 10-item, accepted cumulative score that is calculated by summing individual items (Felitti et al., 1998). In this sample, these 9 components together have a Cronbach's alpha of 0.636 (good internal consistency) and 0.278 (low internal consistency) at the 3-month and 10-month timepoints, respectively.

Match/Mismatch in Vulnerability. The Match/Mismatch in Vulnerability variable is a novel measure that I created for this study. This variable represents the difference between objective vulnerability status and parental perceptions of infant vulnerability. This variable represents a difference score (*z-score of objective vulnerability sum – z-score of perceived vulnerability sum*) in order to represent the match versus mismatch status in vulnerability perception. Greater absolute values of this difference score indicate greater mismatch while scores closer to 0 represent greater match. Although not formally validated, this variable is constructed and intended to represent parents' differences in their perceptions of infant vulnerability, compared to infants' objectively measured health status.

Parental Mental Health

Patient Health Questionnaire (PHQ-9). The Patient Health Questionnaire – 9 (PHQ-9) is a 9-item survey that is utilized to measure parents' levels of depression (Kroenke & Spitzer, 2002). Each response ranges on a Likert scale from 0 – 3 where "Not at all" = 0 and "Nearly every day" = 3 (Kroenke & Spitzer, 2002). All 9 items are summed together to create a PHQ-9 score (Kroenke & Spitzer, 2002). A cutoff score of 10 or more represents parents' presence of depression, which has a specificity and sensitivity score of 88% for major depression (Kroenke & Spitzer, 2002). The PHQ-9 has been validated among 3000 patients across 8 different primary care clinic settings, among which 585 patients were interviewed by mental health professionals, (Cronbach $\alpha = 0.89$) as well as 3000 patients across 7 different obstetrics-gynecology clinic settings, among which 149 patients were interviewed by psychologists (Cronbach $\alpha = 0.86$; Kroenke & Spitzer, 2002; Kroenke et al., 2001). The benefits of the PHQ-9 measure for depression are that it is short, easily self-administered, and simple to quickly take in any setting (Kroenke & Spitzer, 2002). In this current sample, the Cronbach's alpha for this scale was 0.829 and 0.821 at the 3-month and 10-month timepoints, respectively, which indicates high internal consistency.

Generalized Anxiety Disorder Screener (GAD-7). The Generalized Anxiety Disorder Screener (GAD-7) represents a 7-item survey that is utilized to assess parents' level of anxiety (Spitzer et al., 2006). Each response ranges on a Likert scale from 0 – 3 where "Not at all" = 0 and "Nearly every day" = 3 (Spitzer et al., 2006). All 7 items are summed together to create a GAD-7 score (Spitzer et al., 2006). A cutoff score of 10 or more indicates the presence of parents' anxiety (Löwe et al., 2008), and this cutoff value has a specificity score of 82% and sensitivity score of 89% (Spitzer et al., 2006). The GAD-7 was developed and validated among a sample of 2740 adults across 15 different primary care clinic settings, of which 965 patients were interviewed by a mental health professional to determine the clinical presence of anxiety (Cronbach $\alpha = 0.92$; Spitzer et al., 2006). Like the PHQ-9, the benefit of the GAD-7 is that it is short and simple for self-administration (Spitzer et al., 2006). In this sample, the Cronbach's alpha for this scale was 0.876 and 0.869 at the 3-month and 10-month timepoints, respectively, thus showing high internal consistency.

If parents reported clinical levels of depression or anxiety or expressed thoughts related to suicidal ideation, then the study team ensured that these parents were contacted and supported by a clinical psychologist (Holm et al., 2018).

Statistical Analyses

In this study, the statistical analyses were centered on addressing the following research questions:

- RQ1 How does perceived infant vulnerability compare with objective vulnerability and health status?
    - The branches within this overarching research question included:
        - RQ2 How does parental mental health status affect parents' concurrence between perceived infant vulnerability and objective infant vulnerability?
        - RQ3 Does 1) perceived infant vulnerability and 2) concurrence in perceptions affect parents' mental health status or do they predispose parents to future mental health conditions?

I hypothesized that parental mental health status would affect parents' Match/Mismatch status in perceptions of infant vulnerability. Match/Mismatch status refers to the difference between perceived and objective infant vulnerability status. I also hypothesized that perceived infant vulnerability and Match/Mismatch status would affect parents' mental health status and that perceived infant vulnerability and mismatch in perceptions may contribute to parents' risk for mental health severity. The analyses were conducted using IBM SPSS Statistics 28. I primarily used data from the 3-month and 10-month timepoints for the statistical analyses since the PHQ-9 scale and CVS measure were used only at these timepoints but not at the baseline or post-disclosure timepoints of the larger BabySeq Project.

To address RQ1, the Match/Mismatch variable was created to represent the degree of dissonance between objective and perceived levels of vulnerability. In other words, this score represented how perceived infant vulnerability compared with objective vulnerability status. Then, independent samples *t*-tests were conducted to compare the perceptions of vulnerability levels, objective vulnerability levels, and Match/Mismatch scores between parents of NICU babies and babies in the well-baby nurseries at the 3-month and 10-month timepoints, especially since hospital status (well-baby nursery vs. NICU) is a form of objective health status. To show stability over time in the variables, which indicated test-retest reliability, I first utilized bivariate correlations to determine whether the 3-month and 10-month timepoints of Match/Mismatch were correlated together and whether the parental mental health variables at both timepoints were correlated together. High correlations would indicate stability, test-retest reliability, and internal validity over time in these variables. I also performed a Fisher's *r*-to-*Z* transformation to further underscore stability in the mental health and vulnerability variables' relationships over time by determining if the size of the difference in correlation coefficients (1. between mental health variables at 3 months and 10 months and 2. between vulnerability variables at 3 months and 10 months) was significantly different. In this test, the 3-month and 10-month timepoints represented independent samples; hence, the Fisher's *r*-to-*Z* transformation was conducted here. If the correlation between anxiety and depression was high and if there was no significant difference in the mental health variables' correlations between 3 months and 10 months, this would indicate stability in the strong correlation between anxiety and depression over time. Furthermore, if the correlation between objective and perceived vulnerability was low and if there was no significant difference in the vulnerability variables' correlations between 3 months and 10 months, this would show consistency in the low correlation between objective and perceived vulnerability over time.

To first understand RQ2, I explored whether depression and anxiety could be combined into a composite variable. Because multiple, highly correlated variables can be organized into a composite variable (Song et al., 2013), if depression and anxiety variables were correlated above 0.6, then I planned to create a composite variable to represent parents' mental health. If the correlation was not greater than 0.6, then I would have kept depression and anxiety separate in my analyses. If the correlation was higher than 0.6, then composite mental health scores would be calculated by determining the average of the GAD-7 and PHQ-9 scores.

Continuing to address RQ2, I ran a bivariate linear regression to determine the relationship between composite mental health values and Match/Mismatch scores (measure of parents' concurrence between perceptions of vulnerability and objective infant vulnerability). This was a salient test to determine the directionality between parental mental health and Match/Mismatch scores across time. For instance, if significant, the results would elucidate whether composite mental health at 3 months or 10 months was a significant predictor of Match/Mismatch scores at 3 months or 10 months, and vice versa. Furthermore, the results would indicate whether current mental health status would affect current Match/Mismatch status and/or long-term Match/Mismatch status.

Using independent samples *t*-tests, the composite mental health scores were compared between parents of NICU babies and babies in the well-baby nurseries at the 3-month and 10-month timepoints. I also used an independent samples *t*-test to compare the mental health variables between parents who perceived their infants to be vulnerable (at/above the CVS cutoff score of 10) and parents who did not (below the cutoff score). Additionally, I compared the perceptions of vulnerability, objective vulnerability, and Match/Mismatch scores between parents who were at risk for depression and/or anxiety and parents who were not (based on each scale's respective cutoff scores) at the aforementioned timepoints.

To address RQ3, I ran a bivariate linear regression to determine the relationships between 1) composite mental health values and perceptions of infant vulnerability scores 2) composite mental health values and objective infant vulnerability scores and 3) composite mental health and Match/Mismatch scores. Then, I conducted two stepwise hierarchical linear regressions. The goal of these stepwise regressions was to determine the potential directionality associated with the relationship between parental mental health and Match/Mismatch scores. In the first regression, the predictor was Match/Mismatch at the 10-month timepoint, and the first step of the regression involved controlling for demographic variables. These variables included the infant's gender, parent's gender, experimental versus control group status, race, ethnicity, parent's educational level, household income, whether the infant was the parent's first child, whether the child was biologically related to the parent, parent age, and infant's age. The selection of these demographic variables was based on the collected data and the denoted demographic variables in Genetti et al. (2019), a publication regarding the BabySeq Project data. I first controlled for all of these demographic variables in order to then explore the sole relationship between Match/Mismatch scores and parental mental health without the influence of potential confounding factors. The second step controlled for Match/Mismatch at the 3-month timepoint. The third step controlled for composite mental health at the 3-month timepoint. In the second stepwise hierarchical regression, the predictor was composite parental mental health at the 10-month timepoint. The first step again involved controlling for the aforementioned demographic variables. This time, the second step controlled for composite mental health at the 3-month timepoint, and the third step controlled for Match/Mismatch at the 3-month timepoint.

Chapter 3

Results

Preliminary Analyses

Objective Vulnerability Data

Mean infant age was 245 and 458 days at the 3-month and 10-month timepoints, respectively. Because data regarding infants' objective vulnerability were only collected from female caregivers while data about parents' perceptions of vulnerability were collected from both female and male caregivers, I duplicated the female caregivers' objective vulnerability data to, if applicable, the infant's corresponding male caregivers in order to calculate Match/Mismatch scores for both parents.

Each component of the objective vulnerability scale has varying frequencies in infants. For instance, on average, the number of medicines that an infant consumes may be of higher frequency than the number of surgeries than an infant experiences. In an attempt to represent the true weighting and severity of each component of objective vulnerability, I converted each objective vulnerability component into fractional percentiles within each timepoint (e.g., converted the reported data on hospital days to fractional percentiles). This way, an individual infant's score for each component is a percentile compared against the remaining sample of infants at the same timepoint. For instance, because three surgeries are not equivalent to three PCP visits in terms of a child's medical vulnerability level, the parent-reported scores for the objective vulnerability components were converted to fractional percentiles.

Afterwards, I summed the nine components' fractional percentiles together to obtain an overall objective vulnerability score at each timepoint. Then, I subsequently calculated the Match/Mismatch score through the following formula: *z-score of objective vulnerability sum – z-score of perceived vulnerability sum*.

To probe whether PCP visits should be included in the measure of objective vulnerability, I created a new "dummy" objective vulnerability variable without including PCP visits. Then, I correlated the 1) objective vulnerability score with the perceived vulnerability score and the 2) "dummy" objective vulnerability score with the perceived vulnerability score at both timepoints to determine whether or not including the PCP score significantly affected the objective vulnerability measure.

The Pearson correlation values between the original parent-reported objective vulnerability variable and perceptions of vulnerability variable were 0.24 at 3 months and 0.11 at 10 months. The Pearson correlations between the "dummy" objective vulnerability variable and the perceptions of vulnerability variable were 0.25 at 3 months and 0.12 at 10 months. After doing a Fisher's r-to-Z transformation to compare the correlations of perceived vulnerability with the objective vulnerability variable that included versus did not include PCP visits, the data revealed that there was no statistically significant difference in the correlations at both timepoints (p = 0.898 at 3 months and p = 0.947 at 10 months) between when PCP visits were and were not included (Weiss, 2011). This indicated that PCP visits may be kept in the objective vulnerability measure since the correlation between objective and perceived vulnerability did not change significantly when PCP visits were removed from the objective vulnerability measure.

Winsorization

Through the boxplot charts produced by SPSS, I noted that there were two far outliers in the 3-month Match/Mismatch variable. Upon further inspection of the data, I observed that these values either represented parents of infants who were very sick and hospitalized long-term or parents of infants with high mismatch between perceived infant vulnerability and the infant's objective vulnerability status. For instance, between post-disclosure and the 3-month timepoints, the first infant spent 33 days in the hospital and 12 days in the ICU. The second infant had experienced many components included in the objective medical vulnerability score, including two ER visits, two visits in the hospital, two days in the hospital, one medicine, and three visits to specialists, yet the parents reported a sum score of zero on the CVS. For these reasons (notable characteristics and experiences of these outlier infants), I did not want to exclude these values from the dataset. Notable *characteristics* include the parents' perceptions of infant vulnerability while *experiences* include the infants' incidences of objective vulnerability components. Because these two infants' Match/Mismatch values were several standard deviations away from the mean, these outliers would skew the data to the right (overinflating the match/mismatch scores) and prevent a normalized distribution of the data. Hence, the 3-month Match/Mismatch variable was winsorized, meaning that the two far upper outliers were replaced with the next highest score (Osborne & Overbay, 2004). There were no far outliers noted in the 10-month Match/Mismatch variable.

Missing Value Analysis

To understand the missing data further, I ran the Little's Missing Completely at Random (MCAR) test for the objective vulnerability components at the 3-month and 10-month timepoints, and the results at both timepoints indicated that the data were not completely missing at random ($p = 0.000$). Furthermore, Little's MCAR test revealed that the data for the items of the perceived vulnerability scale were also not completely missing at random at the 3-month timepoint ($p = 0.037$) but were completely missing at random at the 10-month timepoint ($p = 0.661$).

To further probe the missing data, I created "missingness" variables for each of the components of objective vulnerability, such that missing values were coded as 0 and present values were coded as 1. Doing so elucidated that, for instance, at the 3-month timepoint, missing ER visit data were highly correlated with missing data regarding times in the hospital ($r = 0.98$; $p = 0.000$), times in the ICU ($r = 0.99$; $p = 0.000$), days in the ICU ($r = 0.99$; $p = 0.000$), number of surgeries ($r = 0.98$; $p = 0.000$), number of medications ($r = 0.99$; $p = 0.000$), and number of PCP visits ($r = 0.96$; $p = 0.000$). The missingness of the components of objective vulnerability were similarly highly correlated with one another at both timepoints. However, the missingness of the objective vulnerability components were not statistically significantly correlated with parents' perceptions of their infants' vulnerability at either timepoint.

At the 10-month timepoint, the mean perception of vulnerability value was marginally significantly greater among parents who reported the number of visits to the ER ($p = 0.055$), the number of infant's medications ($p = 0.055$), and the number of PCP visits ($p = 0.054$) compared to parents who did not report the aforementioned data. Furthermore, at the same timepoint, the mean perception of vulnerability was significantly greater among parents who reported the number of times and days in the ICU ($p = 0.037$). Such results imply a potential relationship between parental perceptions of infant vulnerability and specific components of the infant's objective vulnerability.

Missing data were handled through listwise deletion. For instance, for the cumulative medical risk (objective vulnerability) variable, I only counted parents who responded to *all* of the components of the medical risk indicator/objective vulnerability score (i.e., ER visits, hospital visits, days in hospital, ICU visits, days in ICU, number of surgeries, number of medicines, number of PCP visits, number of specialist visits). In other words, SPSS coded parent-reported 0s as valid values but excluded parents who did not respond to at least one of the medical risk questions, which drastically reduced the sample size for the statistical analyses. Therefore, there were only 6 NICU parents and 304 non-NICU parents who answered all of the medical risk questions at the 10-month timepoint. At the 3-month timepoint, there were 298 non-NICU and 62 NICU parents who responded to all of the medical risk questions.

I considered the use of pairwise deletion to preserve the data. However, with pairwise deletion, I was worried that it might create an unfair comparison since parents who filled out more questions regarding objective vulnerability may naturally have a higher objective infant vulnerability value compared to parents who filled out, for instance, just one of the nine components. In other words, it would not be fair to compare parents who filled out all of the questions to parents who only filled out one or two of the questions related to objective vulnerability. If we do pairwise deletion, we might suddenly see a spike in parents with low objective vulnerability only because they filled out less questions rather than truly having infants with a low medical risk status. With listwise deletion, only parents who have filled out all nine components of objective vulnerability would be compared to each other in the analyses. Hence, I decided to handle the missing data in this study via listwise deletion.

Hypothesis Testing

Addressing RQ1: Bivariate Correlations and Fisher's r-to-Z Transformation

Bivariate correlations were conducted to assess a variable's stability over time. The Pearson correlation between Match/Mismatch at 3 months and 10 months was 0.59 (moderate; Schober et al., 2018). The Pearson correlation between PHQ-9 scores at 3 months and 10 months was 0.73 (strong; Schober et al., 2018), and the correlation between GAD-7 scores at 3 months and 10 months was 0.59 (moderate; Schober et al., 2018).

To determine whether the measures of depression and anxiety could be averaged together into a composite mental health variable, I conducted bivariate correlations between these two measures at both timepoints. The Pearson correlation between PHQ-9 and GAD-7 scores was 0.65 (moderate) at the 3-month timepoint and

0.71 (strong) at the 10-month timepoint (Schober et al., 2018). When comparing the correlation between PHQ-9 and GAD-7 scores at 3 months and 10 months, the two-tailed p-value for the Fisher's *r*-to-*Z* transformation was 0.178 (Weiss, 2011).

In terms of bivariate correlations, the parent-reported objective and perceived vulnerability values had weak Pearson correlations of 0.24 at 3 months and 0.11 at 10 months (Schober et al., 2018). When comparing the correlation between these objective and perceived vulnerability scores at 3 months and 10 months, the two-tailed p-value for the Fisher's *r*-to-*Z* transformation was 0.122 (Weiss, 2011).

Addressing RQ1 and RQ2: Independent Samples T-Tests

Z-scores of the objective vulnerability percentile sums and perceived vulnerability scores were first individually calculated. Then, the difference (Match/Mismatch) scores were subsequently calculated for this study's statistical analyses. By calculating the z-scores of both variables, I similarly characterized the two variables by their relative data positions. Then, Welch's independent samples *t*-tests were conducted among objective vulnerability scores, perceptions of vulnerability scores, and Match/Mismatch scores between babies in the NICU and well-baby nurseries. Compared to Student's *t*-test, Welch's *t*-test is more reliable and robust to use when there are unequal sample sizes between groups (Delacre et al., 2017). In the Welch's independent samples *t*-test, the same group of parents (same analytic group) is analyzed within each timepoint. Such analyses (Table 1) revealed that Match/Mismatch scores ($p = 0.026$), objective vulnerability scores ($p < 0.001$), and perceived vulnerability scores ($p = 0.038$) at the 3-month timepoint were all significantly greater among NICU infants. None of the vulnerability-related measures were significantly different between the NICU infants and well-baby nursery infants at the 10-month timepoint.

Table 1

Independent (Welch's) T-Tests Between Infants in Well-Baby Nurseries Versus NICUs

Variable	*N*	*M*	*SD*	Range	*t*	*p*	Cohen's *d*
Objective Vulnerability at 3 Months	238 54	-.162 .728	.754 1.365	-1.23 – 5.33	-4.634	<.001***	-.992
Perceived Vulnerability at 3 Months		-.067 .337	.909 1.337	-1.58 – 3.71	-2.114	.038*	-.404
Match/Mismatch at 3 Months		-.097 .373	1.082 1.431	-2.78 – 2.96	-2.272	.026*	-.408
Objective Vulnerability at 10 Months	236 4	.041 -.159	1.019 .610	-1.53 – 2.88	.641	.563	.197
Perceived Vulnerability at 10 Months		-.072 .408	.938 .860	-1.61 – 2.22	-1.104	.347	-.512
Match/Mismatch at 10 Months		.113 -.567	1.267 .736	-2.79 – 3.61	1.801	.161	.539

Note. For N, M, and SD, the first value represents parents of well-baby nursery infants whereas the second value represents parents of NICU infants. Match/Mismatch = Objective Vulnerability – Perceived Vulnerability. * = < 0.05 ** = < 0.01 *** = < 0.001.

Next, I compared the composite mental health scores between parents of NICU babies and parents of babies in the well-baby nurseries at the 3-month and 10-month timepoints. These tests indicated that there were no significant differences in parental mental health between parents of NICU babies and parents of babies in the well-baby nurseries at the 3-month (p = 0.079) and 10-month (p = 0.316) timepoints (Table 2).

Table 2

Independent (Welch's) T-Test of Parental Mental Health Between NICU and Well-Baby Nursery Infants

Variable	*N*	*M*	*SD*	Range	*t*	*p*	Cohen's *d*
Composite Parental Mental Health at 3 Months	263 67	2.312 3.157	2.574 3.667	.00 – 19.00	-1.778	.079	-.299
Composite Parental Mental Health at 10 Months	256 70	2.492 2.979	2.588 3.803	.00 – 23.00	-1.008	.316	-.168

Note. For N, M, and SD, the first value represents parents of well-baby nursery infants whereas the second value represents parents of NICU infants. * = < 0.05 ** = < 0.01 *** = < 0.001.

When comparing parents' composite mental health scores between those who perceived their infants to be vulnerable (at/above the CVS cutoff score of 10) and those who did not (below the cutoff score), the Welch's independent samples *t*-test results showed that parents who perceived their infant to be vulnerable had significantly greater mental health severity (p = 0.004 at the 3-month timepoint and p < 0.001 at the 10-month timepoint for composite mental health), including both anxiety and depression at the 3-month (p = 0.013 for depression and p = 0.007 for anxiety) and 10-month (p = 0.004 and p < 0.001 for depression and anxiety, respectively) timepoints (Table 3).

Table 3

Independent (Welch's) T-Test of Mental Health Scores Across Vulnerability Perceptions (Based on CVS Cutoff Score)

Variable	*N*	*M*	*SD*	Range	*t*	*p*	Cohen's *d*
Composite Parental Mental Health at 3 Months	220 103	2.127 3.228	2.434 3.481	.00 – 19.00	-2.896	.004**	-.392
PHQ-9 Scores at 3 Months		1.964 2.981	2.643 3.678	.00 – 26.00	-2.518	.013*	-.338
GAD-7 Scores at 3 Months		2.291 3.476	2.768 3.960	.00 – 21.00	-2.739	.007**	-.371
Composite Parental Mental Health at 10 Months	211 106	2.031 3.543	2.144 3.758	.00 – 23.00	-3.839	<.001***	-.542
PHQ-9 Scores at 10 Months		2.071 3.359	2.342 4.161	.00 – 25.00	-2.958	.004**	-.419
GAD-7 Scores at 10 Months		1.991 3.726	2.488 3.753	.00 – 21.00	-4.310	<.001***	-.584

Note. For N, M, and SD, the first value represents parents whose CVS scores are below the CVS cutoff whereas the second value represents parents whose CVS scores are at/above the CVS cutoff value. The same analytic sample of parents is analyzed within each timepoint. * = < 0.05 ** = < 0.01 *** = < 0.001.

When comparing the perceptions of vulnerability between parents who were at risk for depression and/or anxiety and parents who were not (based on each scale's respective cutoff scores), parents at risk for anxiety perceived their infants to be significantly more vulnerable than parents who were not at risk for anxiety at the 3-month (p = 0.001) timepoint. Furthermore, parents at risk for depression perceived their infants to be significantly more vulnerable than parents who were not at risk for depression at the 10-month timepoint ($p = 0.011$). However, there were no significant differences in perceived vulnerability scores between parents who were versus were not at risk for depression at the 3-month timepoint and between parents who were versus were not at risk for anxiety at the 10-month timepoint (Table 4).

When comparing infants' objective vulnerability between parents who were at risk for depression and/or anxiety and parents who were not (based on each scale's respective cutoff scores), the results showed that parents who were at risk for depression were associated with infants who had greater objective vulnerability at the 10-month timepoint ($p = 0.045$) while parental risk for anxiety did not have a significant association with infants' objective vulnerability at the 3-month or 10-month timepoints (Table 4). Furthermore, parental risk for depression was not associated with infants' objective vulnerability at the 3-month timepoint.

Match/Mismatch scores were compared between parents who were at risk for depression and/or anxiety and parents who were not. The results indicated that parents who were at risk for anxiety at the 3-month timepoint and parents who were at risk for depression at the 10-month timepoint had greater mismatch in vulnerability perceptions due to their greater likelihood of overperceiving their children's vulnerability compared to parents who were not at risk for anxiety or depression, respectively ($p = 0.041$ for anxiety and $p = 0.001$ for depression; Table 4). Negative Match/Mismatch scores indicate a likelihood for overperceiving children's vulnerability since Match/Mismatch = *z-score of objective vulnerability sum – z-score of perceived vulnerability sum*. There were no significant differences in

Match/Mismatch scores between parents who were versus were not at risk for depression at the 3-month timepoint or between parents who were versus were not at risk for anxiety at the 10-month timepoint.

Table 4

Independent (Welch's) T-Tests Across Parental Mental Health Risk

Variable	*N*	*M*	*SD*	Range	*t*	*p*	Cohen's *d*
Objective Vulnerability at 3 Months Across Parental Risk for Depression (Based on PHQ-9 Cutoff)	274 10	.003 .241	.965 1.121	-1.23 – 5.33	-.663	.523	-.246
Perceived Vulnerability at 3 Months Across Parental Risk for Depression (Based on PHQ-9 Cutoff)		-.002 .410	.997 1.352	-1.58 – 3.71	-.955	.364	-.408
Match/Mismatch at 3 Months Across Parental Risk for Depression (Based on PHQ-9 Cutoff)		-.000 -.169	1.192 .537	-2.78 – 2.96	.912	.379	.143
Objective Vulnerability at 3 Months Across Parental Risk for Anxiety (Based on GAD-7 Cutoff)	274 12	-.018 .614	.927 1.498	-1.23 – 5.33	-1.452	.174	-.663
Perceived Vulnerability at 3 Months Across Parental Risk for Anxiety (Based on GAD-7 Cutoff)		-.047 1.488	.955 1.250	-1.58 – 3.71	-4.199	.001**	-1.586
Match/Mismatch at 3 Months Across Parental Risk for Anxiety (Based on GAD-7 Cutoff)		.023 -.873	1.151 1.331	-2.78 – 2.96	2.296	.041*	.774
Objective Vulnerability at 10 Months Across Parental Risk for Depression (Based on PHQ-9 Cutoff)	223 8	0.047 -.375	1.037 .478	-1.53 – 2.88	2.309	.045*	.412
Perceived Vulnerability at 10 Months Across Parental Risk for		-.068 .807	.933 .727	-1.61 – 2.22	-3.303	.011*	-.943

Depression (Based on PHQ-9 Cutoff)							
Match/Mismatch at 10 Months Across Parental Risk for Depression (Based on PHQ-9 Cutoff)		.115 -1.182	1.262 .724	-2.79 – 3.61	4.806	.001**	1.038
Objective Vulnerability at 10 Months Across Parental Risk for Anxiety (Based on GAD-7 Cutoff)		.011 .079	1.012 .779	-1.53 – 2.88	-.224	.829	-.067
Perceived Vulnerability at 10 Months Across Parental Risk for Anxiety (Based on GAD-7 Cutoff)	227 7	-.081 .058	.903 1.319	-1.61 – 2.22	-.277	.791	-.152
Match/Mismatch at 10 Months Across Parental Risk for Anxiety (Based on GAD-7 Cutoff)		.092 .020	1.236 1.206	-2.79 – 3.61	.154	.882	.058

Note. For N, M, and SD, the first value represents parents who are not at risk for depression or anxiety whereas the second value represents parents who are at risk for depression or anxiety based on each scale's cutoff value. Match/Mismatch = Objective Vulnerability – Perceived Vulnerability. * = < 0.05 ** = < 0.01 *** = < 0.001.

Addressing RQ3: Bivariate Linear Regressions

Parental mental health scores were significant predictors of Match/Mismatch scores, and vice versa, at both 3 months and 10 months. At the 3-month timepoint, as parental mental health worsened by 1 unit, Match/Mismatch scores decreased by 0.07 units (p = 0.003). Because Match/Mismatch = *objective vulnerability z-score – perceived vulnerability z-score*, a reduction in Match/Mismatch scores represents moving towards parental overperception of their infants' vulnerability, in comparison to their infants' objective vulnerability status. Furthermore, as Match/Mismatch scores increased by 1 unit, parental mental health severity significantly decreased by 0.44

units at the 3-month timepoint ($p = 0.003$). At the 10-month timepoint, as parental mental health worsened by 1 unit, Match/Mismatch scores decreased by 0.07 units ($p = 0.026$). As Match/Mismatch scores increased by 1 unit, parental mental health severity decreased by 0.31 units ($p = 0.026$). Composite mental health at the 3-month timepoint was not a significant predictor of Match/Mismatch at the 10-month timepoint ($p = 0.079$). So far, it appeared that current mental health status affected current Match/Mismatch status. Furthermore, Match/Mismatch scores at the 3-month timepoint were a significant predictor of parental mental health at the 10-month timepoint ($p = 0.003$). As the 3-month Match/Mismatch score increased by 1 unit, composite parental mental health severity at the 10-month timepoint reduced by 0.50 units. Here, there appeared to be a longitudinal relationship between the Match/Mismatch variable and parental mental health, at least when not controlling for demographic factors or mental health at 3 months.

Parental mental health scores were significant predictors of vulnerability perception scores, and vice versa, at both 3 months and 10 months. At the 3-month timepoint, when parental mental health worsened by 1 unit, parental perceptions of vulnerability z-scores increased by 0.12 units ($p < 0.001$). When parental perceptions of vulnerability increased by 1 unit, parental mental health severity worsened by 0.99 units ($p < 0.001$). Similarly, at the 10-month timepoint, when parental mental health worsened by 1 unit, parental perceptions of vulnerability scores increased by 0.12 units ($p < 0.001$), and when parental perceptions of vulnerability increased by 1 unit, then parental mental health severity worsened by 1.05 units ($p < 0.001$).

At the 3-month timepoint, parental mental health scores were significant predictors of objective vulnerability scores, and vice versa. When parental mental health worsened by 1 unit, objective vulnerability z-scores increased by 0.04 units (p = 0.028), and when objective vulnerability z-scores worsened by 1 unit, parental mental health worsened by 0.39 units (p = 0.028). Although parental mental health scores did not significantly differ between NICU and non-NICU parents, parental mental health severity significantly differed across infant objective vulnerability status at 3 months. At 10 months, parental mental health scores were not significant predictors of objective vulnerability scores, and objective vulnerability scores were not significant predictors of parental mental health.

Addressing RQ3: Hierarchical Linear Regressions

Stepwise multiple regressions were conducted to determine predictors of Match/Mismatch and composite parental mental health scores at 10 months.

Table 5

Stepwise Multiple Regression Predicting Match/Mismatch at 10 Months

Predictor Variables	*B*	β	*t*	R^2	ΔR^2	Sig. *F* Change
Model 1				.116	.116	.248
Race	-.430	-.144	-1.457			
Ethnicity	-.898	-.179	-1.834			
Biological Relation	.310	.034	.357			
Patient Gender	.300	.127	1.316			
Parent Gender	.131	.054	.555			
First Child	-.100	-.042	-.384			
Experimental vs. Control Group Status	-.209	-.086	-.919			
Parent Education	.119	.104	1.038			
Parent Income	-.082	-.107	-1.032			
Patient Age at Enrollment	-.031	-.153	-1.467			
Parent Age at Enrollment	.008	.029	.258			

Predictor Variables	*B*	*β*	*t*	R^2	ΔR^2	Sig. *F* Change
Model 2				.361	.244	< .001***
Race	-.031	-.010	-.119			
Ethnicity	-.779	-.155	-1.859			
Biological Relation	.858	.093	1.148			
Patient Gender	.079	.033	.399			
Parent Gender	.035	.014	.172			
First Child	-.043	-.018	-.191			
Experimental vs. Control Group Status	-.229	-.095	-1.179			
Parent Education	.038	.033	.383			
Parent Income	-.012	-.016	-.175			
Patient Age at Enrollment	-.024	-.119	-1.331			
Parent Age at Enrollment	-.012	-.044	-.466			
Match/Mismatch at 3 Months***	.567	.532	6.366			

Predictor Variables	*B*	*β*	*t*	R^2	ΔR^2	Sig. *F* Change
Model 3				.364	.004	.441
Race	-.034	-.011	-.129			
Ethnicity	-.798	-.159	-1.897			
Biological Relation	.851	.093	1.136			
Patient Gender	.075	.031	.376			
Parent Gender	.028	.011	.137			
First Child	-.033	-.014	-.149			
Experimental vs. Control Group Status	-.238	-.099	-1.223			
Parent Education	.040	.035	.400			
Parent Income	-.015	-.020	-.218			
Patient Age at Enrollment	-.023	-.115	-1.278			
Parent Age at Enrollment	-.011	-.040	-.415			
Match/Mismatch at 3 Months***	.556	.522	6.148			
Mental Health at 3 Months	-.028	-.062	-.774			

Note. * = < 0.05 ** = < 0.01 *** = < 0.001

Table 6

Stepwise Multiple Regression Predicting Mental Health at 10 Months

Predictor Variables	*B*	*β*	*t*	R^2	ΔR^2	Sig. *F* Change
Model 1				.122	.122	.050*
Race*	1.297	.188	2.365			
Ethnicity	-.047	-.004	-.048			
Biological Relation	1.289	.068	.866			
Patient Gender	.184	.036	.436			
Parent Gender**	-1.253	-.237	-2.891			
First Child	.073	.014	.157			
Experimental vs. Control Group Status	.412	.078	.992			
Parent Education	-.181	-.071	-.855			
Parent Income	.004	.002	.026			
Patient Age at Enrollment	.018	.060	.738			
Parent Age at Enrollment	.110	.172	1.848			

Predictor Variables	*B*	*β*	*t*	R^2	ΔR^2	Sig. *F* Change
Model 2				.529	.408	< .001***
Race*	.836	.121	2.062			
Ethnicity	.476	.040	.663			
Biological Relation	1.231	.065	1.125			
Patient Gender	.374	.072	1.201			
Parent Gender*	-.688	-.130	-2.134			
First Child	-.118	-.022	-.346			
Experimental vs. Control Group Status	.529	.101	1.735			
Parent Education	-.141	-.056	-.905			
Parent Income	.025	.014	.226			
Patient Age at Enrollment	.018	.060	.995			
Parent Age at Enrollment*	.094	.147	2.142			
Mental Health at 3 Months***	.645	.653	11.242			

Predictor Variables	*B*	*β*	*t*	R^2	ΔR^2	Sig. *F* Change
Model 3				.532	.003	.377
Race	.742	.108	1.771			
Ethnicity	.468	.040	.652			
Biological Relation	1.212	.064	1.107			
Patient Gender	.408	.079	1.300			
Parent Gender*	-.681	-.129	-2.109			
First Child	-.104	-.020	-.304			
Experimental vs. Control Group Status	.532	.101	1.743			
Parent Education	-.136	-.054	-.871			
Parent Income	.013	.008	.122			
Patient Age at Enrollment	.018	.060	1.005			
Parent Age at Enrollment*	.096	.150	2.181			
Mental Health at 3 Months***	.636	.644	10.913			
Match/Mismatch at 3 Months	-.117	-.054	-.887			

Note. * = < 0.05 ** = < 0.01 *** = < 0.001

To predict Match/Mismatch at 10 months (Table 5), step 1 (Model 1) included the following demographic variables as covariates: race, ethnicity, biological relationship, patient gender, parent gender, first child or not, control versus experimental group, parent education, household income, patient age at enrollment, and parent age at enrollment (R^2 = 0.116; p = 0.248). Next, step 2 (Model 2) included the aforementioned demographic variables along with Match/Mismatch at 3 months, and the introduction of Match/Mismatch at 3 months resulted in a statistically significant model (R^2 = 0.361; $p < 0.001$). Match/Mismatch at 3 months was a significant predictor of Match/Mismatch at 10 months, while controlling for all other demographic variables. In the final model (step 3 and Model 3), the demographic variables, Match/Mismatch at 3 months, and composite parental mental health at 3 months were included. Now, the model was no longer statistically significant and had a slightly higher R^2 value (R^2 = 0.364; p = 0.441).

Among the covariates, only Match/Mismatch at 3 months was a significant predictor of Match/Mismatch at 10 months. Because Model 3 has a slightly greater R^2 value than Model 2 (although not statistically significant), mental health at 3 months may have predictive value of Match/Mismatch at 10 months. However, only Match/Mismatch at 3 months was a *significant* predictor of Match/Mismatch at 10 months.

Similarly, to predict composite parental mental health at 10 months (Table 6), step 1 (Model 1) included the same demographic variables from the previous stepwise multiple regression as covariates (race, ethnicity, biological relationship, patient gender, parent gender, first child or not, control vs. experimental group, parent education, household income, patient age at enrollment, and parent age at enrollment; $R^2 = 0.122$; $p = 0.050$). Unlike Model 1 of the previous stepwise multiple regression, Model 1 of this regression was statistically significant. In this model, race and parent gender were significant predictors of composite parental mental health at 10 months. Next, step 2 (Model 2) included the aforementioned demographic variables along with composite parental mental health at 3 months, and the introduction of composite parental mental health at 3 months also resulted in a statistically significant model with greater model fit ($R^2 = 0.529$; $p < 0.001$). Race, parent gender, parent age, and composite parental mental health at 3 months were significant predictors of composite parental mental health at 10 months, while controlling for all other demographic variables. In the final model (step 3 and Model 3), the demographic variables, composite parental mental health at 3 months, and Match/Mismatch at 3 months were included, and the model was no longer statistically significant and there was a minute increase in model fit ($R^2 = 0.532$; $p = 0.377$). Among the covariates, parent gender, parent age, and composite parental mental health at 3 months were significant predictors of composite parental mental health at 10 months in Model 3. Because Model 3 has a greater R^2 value than Model 2 (but not statistically significant), Match/Mismatch at 3 months may have predictive value of composite parental mental health at 10 months, but only composite parental mental health at 3 months is a *significant* predictor of composite parental mental health at 10 months.

Post-Hoc Exploratory Analyses

Probing Significant Predictors

At the 3-month timepoint, infant objective vulnerability significantly differed across racial groups ($p = 0.045$) such that objective vulnerability scores were significantly greater among White infants than non-White infants. Race was an unexpected predictor of parental mental health at 10 months and was not an included variable in the overarching research questions. Because race was a significant predictor of mental health at 10 months (Models 1-2; Table 6), I probed the variable of parents' race further.

A one-way ANOVA revealed that mental health at 10 months did not significantly differ across race ($p = 0.139$). Match/Mismatch at 10 months also did not significantly differ across race ($p = 0.063$). In a Welch's independent samples *t*-test, perceptions of vulnerability, objective vulnerability, and Match/Mismatch scores were not significantly different between White and non-White caregivers at the 10-month timepoint. Furthermore, based on a Welch's independent samples *t*-test and one-way ANOVA, composite parental mental health at 10 months was not significantly different across race and parent gender.

Based on a one-way ANOVA, composite parental mental health at 10 months significantly differed across parent age at enrollment ($p < 0.001$) such that younger parents were more likely to experience greater mental health severity. However, there was no significant difference in parental mental health severity across age based on a bivariate linear regression at the 10-month timepoint. This may be due to the absence of sufficient statistical power since there were only nine parents who were at/above the cutoff score for risk for mental health severity compared to 312 parents who were below the cutoff score.

Match/Mismatch Differences Across Gender

Differences in Match/Mismatch scores and perceptions of vulnerability were assessed across parent gender via a Welch's independent samples *t*-test. There was a non-significant trend for Match/Mismatch scores across gender. Based on Match/Mismatch scores, female caregivers were somewhat more likely to overperceive their children's vulnerability while male caregivers were somewhat more likely to underperceive their children's vulnerability at 10 months ($p = 0.052$). In fact, female caregivers reported significantly greater perceived vulnerability scores than male caregivers ($p = 0.013$) at 10 months. Although male caregivers were likely to underperceive vulnerability, the average Match/Mismatch scores between female and male caregivers showed that male caregivers had a marginally significantly greater magnitude of mismatch between perceived and objective vulnerability values than female caregivers.

Further Exploring the Differences in Match/Mismatch Within Non-NICU Status

I conducted a paired-samples *t*-test between the 3-month and 10-month Match/Mismatch scores among non-NICU parents, which indicated that there was a significant difference between the 3-month and 10-month Match/Mismatch scores ($p < 0.001$). Non-NICU parents were likely to overperceive their infants' vulnerability level at the 3-month timepoint compared to being likely to underperceive their infants' vulnerability level at the 10-month timepoint. Non-NICU parents' mean level of overperception (the level of perception mismatch compared to objective vulnerability) at the 3-month timepoint was less than the mean level of underperception (magnitude of mismatch) at the 10-month timepoint. Hence, mismatch magnitude increased at the

10-month timepoint compared to the 3-month timepoint. Valid pairs among NICU parents could not be formed to compare the 3-month and 10-month Match/Mismatch scores in a paired-samples *t*-test due to the low number of NICU parents who filled out the Match/Mismatch-related survey items at the 10-month timepoint (n = 4).

Multivariable Model Regarding Socioeconomic Status

I ran a multivariable model with education, race, and ethnicity as predictors of Match/Mismatch. At the 3-month timepoint, the overall model fit was best and significant when race and ethnicity were predictors of Match/Mismatch ($R^2 = 0.034$; $p = 0.015$), but only race was a *significant* predictor of Match/Mismatch. At the 10-month timepoint, the overall model fit was best and significant when race, ethnicity, and education were predictors of Match/Mismatch ($R^2 = 0.048$; $p = 0.035$ at 10 months), but none of these variables were individually significant predictors of Match/Mismatch despite the overall model having a significant *p*-value.

Match/Mismatch Differences Across Demographic Factors

I used a one-way ANOVA to compare Match/Mismatch scores across each of the following demographic variables: education, income, ethnicity, race, patient gender, parent gender, biological relation or not, first child or not, and control versus experimental group. Match/Mismatch scores were compared across patient age and parent age using linear regressions. Among these demographic variables, Match/Mismatch scores at the 3-month timepoint significantly differed across income ($p = 0.015$). Furthermore, a regression showed a marginally significant relationship between patient age at enrollment and Match/Mismatch scores at 3 months ($p = 0.053$) such that as patient age at enrollment increased by 1 unit, the 3-month

Match/Mismatch score increased by 0.016 units. At the 10-month timepoint, Match/Mismatch scores also only significantly differed only across income (p = 0.011). As annual household income increased, Match/Mismatch scores tended to decrease. Parents of higher household incomes tended to overperceive (i.e., negative Match/Mismatch values) their infants' vulnerability while parents of lower annual household incomes tended to underperceive (i.e., positive Match/Mismatch values) their infants' vulnerability at the 10-month timepoint. Table 7 shows the descriptive values of this relationship across income.

Table 7

Descriptive Table of Match/Mismatch Scores at 10 Months Across Annual Household Income

Annual Household Income	*N*	Mean Match/Mismatch Score
Less than $10,000 to $49,999	5	-.9315
$50,000 to $74,999	7	.8296
$75,000 to $99,999	25	.7501
$100,000 to $149,999	46	-.1255
$150,000 to $199,999	43	.5219
$200,000 to $499,999	71	-.0087
$500,000 or above	11	-.1846

Note. N refers to the number of parents in each annual household income category.

Chapter 4

Discussion

The overarching aim of this study was to determine how perceived infant vulnerability compared with objective infant vulnerability status. To achieve this aim, this study's goals included the following: creating a comprehensive measure of infant objective vulnerability and Match/Mismatch status, comparing vulnerability measures across infant health status, identifying how parental mental health affected parental Match/Mismatch between infant vulnerability perceptions and objective infant vulnerability, and, lastly, identifying the direction of the relationships between parental mental health, perceived infant vulnerability, and Match/Mismatch between objective and perceived vulnerability.

Hypothesis Testing

Identifying Stability in the Measures of Match/Mismatch and Parental Mental Health

Based on the bivariate correlations, there was moderate correlation among the Match/Mismatch variables at the 3-month and 10-month timepoints, which displayed stability in the variable over time. While studies have previously displayed stability in CVS scores over time (e.g., 5 years; Vrijmoet-Wiersma et al., 2010), the findings of this current study regarding longitudinal stability in *Match/Mismatch scores* are novel. Similarly, there was moderate correlation among the GAD-7 scores at both timepoints, which, again, showed stability in the anxiety measure over time. Furthermore, there was a strong correlation among the PHQ-9 scores at both timepoints, which indicated stability in the depression variable over time. Because the GAD-7 and PHQ-9 scores were both highly correlated together ($r > 0.6$) at both timepoints and since highly correlated variables can be organized into a composite variable (Song et al., 2013), I created a composite mental health variable using the following formula: *(GAD-7 Total Score + PHQ-9 Total Score) / 2*. The high correlation between GAD-7 and PHQ-9 scores supports published literature regarding the high correlation between symptoms of anxiety and depression (Barlow & Campbell, 2000).

The Fisher's *r*-to-*Z* transformation involved a comparison of the correlation between mental health variables and vulnerability variables at 3 months and 10 months. There were no statistically significant differences in both the mental health and vulnerability correlations at both timepoints, thus showing stability in the high correlation between anxiety and depression over time as well as consistency in the low correlation between objective and perceived vulnerability over time. The consistent low correlation between objective and perceived vulnerability measures implies a consistent presence of vulnerability mismatch at both timepoints. Furthermore, the moderate correlation between Match/Mismatch at 3 months and 10 months suggests that parents' degree and direction of vulnerability mismatch is relatively consistent across time.

The Relationship Between Infant Health Status, Parental Mental Health, and Vulnerability Measures

At the 3-month timepoint, there was a significant relationship between parental mental health and infant objective vulnerability such that parental mental health severity increased as infant objective vulnerability increased, and vice versa. The infant's hospital status (either NICU or well-baby nursery) was also a form of objective vulnerability measurement. Hence, it was interesting to note that composite parental mental health did not significantly differ between NICU and non-NICU parents at the 3-month timepoint. This implies that the NICU status label may not be sufficient to capture the medical vulnerability level of infants, especially since the objective vulnerability measure is a combination of *nine* different longitudinal indicators of infant health. Furthermore, NICU status was determined at the newborn stage whereas the nine objective vulnerability indicators were longitudinal measures (cumulative scores from either post-disclosure to the 3-month timepoint or post-disclosure to the 10-month timepoint). The longitudinal nature of the objective vulnerability indicators provides greater insight into the infant's *current* medical risk status while the NICU or well-baby status assigned at birth may no longer hold true at the 3-month or 10-month timepoints, thus further elucidating why composite parental mental health significantly differed across infant objective vulnerability levels but not across NICU and well-baby status.

The relationship between objective vulnerability and parental mental health was corroborated by the association between infants' greater objective vulnerability and parents' risk for depression at the 10-month timepoint as well as the association between parents perceiving their infants to be vulnerable and parents' greater composite mental health severity at both timepoints. This data supports recent literature, which shows that NICU mothers are at high risk for depression and anxiety (Mendelson et al., 2017; Segre et al., 2014). Among a published sample of mothers of NICU infants, 25.5% experienced clinical depression, 27.7% experienced moderate to severe anxiety, and 51% experienced both clinical depression and moderate to severe anxiety (Segre et al., 2014). While it is understood that an infant's fragile medical status would impact a parent, the data collected from this current study confirmed this empirically and underscores the need for future hospital-based interventions to support the mental health of NICU parents so that they can, in turn, be mentally present to care for an ill newborn.

The objective vulnerability score at 3 months was significantly greater for NICU than non-NICU infants, which is expected because of NICU infants' medically fragile disposition. Furthermore, the objective vulnerability scores became more similar between NICU and non-NICU infants at 10 months, as evidenced by the lack of statistically significant differences in objective vulnerability at the 10-month timepoint, thus displaying NICU infants' signs of recovery between the 3-month and 10-month timepoints. In other words, the objective vulnerability score was statistically significantly greater for NICU infants compared to non-NICU infants at the 3-month timepoint but not at the 10-month timepoint. This may be due to the fact that as infants in the NICU spent time in the hospital, received treatment and care, and were discharged, it is reasonable that they became less medically vulnerable over that period of time. Hence, there may have been less of a difference between the well-baby infants and NICU infants at 10 months in terms of medical fragility and vulnerability, which is a positive finding. However, it is salient to note that only four parents represented the NICU sample at the 10-month timepoint, which is a wide difference compared to the 54 parents who represented the NICU sample at the 3-month timepoint.

The lengthy nature of the objective vulnerability survey questions may have contributed to the missing data among NICU parents at the 10-month timepoint. Although not significant, NICU parents' perceived vulnerability and magnitude of mismatch is greater than that of non-NICU parents at 10 months. The NICU parents who dropped out between the 3-month and 10-month timepoints *could* have potentially reported significantly greater perceived infant vulnerability and Match/Mismatch compared to parents of well-baby infants, which may have contributed to greater mental health severity and NICU parents' lack of survey completion at 10 months.

For perceptions of vulnerability, parental perceptions were significantly higher among NICU infants compared to non-NICU infants at 3 months, which is understandable based on parents' reactions to NICU infants' higher objective vulnerability status. At the 10-month timepoint, NICU parents did not perceive their infants to be significantly more vulnerable than non-NICU infants, which makes sense given the lack of statistically significant differences in objective vulnerability at the 10-month timepoint. This may elucidate why there was no statistically significant differences in Match/Mismatch scores (objective vulnerability score – perceived vulnerability score) between NICU and non-NICU parents at the 10-month timepoint. However, because NICU parents are at greater risk for developing mental health symptomatology (Mendelson et al., 2017; Segre et al., 2014) and because they continue to experience high stress after infant discharge due to extensive medical expenses (Purdy et al., 2015), health care professionals should continue to monitor and assist NICU parents with reducing elevated perceptions of infant vulnerability after a reduction in objective infant vulnerability status.

Notably, Match/Mismatch scores at 3 months were significantly greater for NICU parents than non-NICU parents. This underscores that parents of infants in the NICU were more likely to misperceive their infants' level of vulnerability compared to the infants' objective vulnerability status. The stress of having a child in the NICU, both in the hospital and after infant discharge (Purdy et al., 2015), may contribute to the increased likelihood of vulnerability misperception. Interestingly, parents of well-baby infants were more likely to overestimate their infant's vulnerability level while NICU parents were more likely to underestimate their infants' vulnerability level. The Match/Mismatch scores at 10 months did not significantly differ between NICU and non-NICU parents; however, it is essential to note that only 4 NICU parents reported all data related to the Match/Mismatch variable at 10 months. Hence, the absence of statistical power may have contributed to the lack of significant findings in the *t*-test.

The direction of vulnerability misperception among NICU and non-NICU parents at 3 months is the opposite of what I would have expected. I initially hypothesized that NICU parents would have overperceived their infants' vulnerability due to their infants' medically fragile status. Possible reasons for the unexpected fact that parents of NICU infants were likely to underperceive their infants' vulnerability could be that infants who were assigned NICU status at birth may have recovered and may thus no longer be at NICU status at the 3-month timepoint. Not all infants who were assigned well-baby status at birth remained at that status, and not all NICU babies remained in a highly medically vulnerable status at the 3-month timepoint. It is important for researchers to thus be cognizant of the effects of medical cohort labels, such as "well-baby" and "NICU" since such labels are not always permanent. Also, parents of NICU infants may have been reporting their perceptions of their infant's current status in comparison with "worst-case" scenarios for infants needing NICU care whereas non-NICU parents may have been reporting how they viewed their infant's current status in comparison with the general, same-age infant population. In future studies, researchers should keep in mind how the definition of certain words may be interpreted differently by various participants, thus affecting their responses. It was also evident that NICU parents had significantly greater mismatch at the 3-month timepoint compared to non-NICU parents, which may have been due to the stress associated with infants being or having been in the NICU (Purdy et al., 2015).

The 10-month data was quite unexpected as well. Here, although not statistically significant due to the low power of NICU parents (Table 1), NICU parents overperceived their infants' vulnerability to a much greater extent than the degree of underperception by non-NICU parents. Compared to the 3-month timepoint, the average mismatch magnitude increased at the 10-month timepoint for NICU parents; however, this finding needs to be interpreted with caution because the number of NICU parents reporting Match/Mismatch scores dropped from 54 parents at 3 months to 4 parents at 10 months. Non-NICU parents' mismatch decreased between the 3-month and 10-month timepoints, which may have been occurring as time passed and as parents became more acquainted with their infants at home.

Although parents at risk for anxiety perceived their infants to be significantly more vulnerable than parents who were not at risk for anxiety at the 3-month timepoint, the caveat to note is that these parents may be displaying signs of anxiety and the associated high perception of vulnerability *because* their infants were objectively more vulnerable. In essence, there is a bidirectional relationship between parental mental health and parental perceptions of infant vulnerability, as revealed by the bivariate linear regressions. Hence, both directions of the relationship need to be taken into account when interpreting the results regarding parental mental health and perceptions of infant vulnerability. These findings regarding parent anxiety and perceived infant vulnerability were not significant at the 10-month timepoint. There are developmental variations among parents and infants between the 3-month and 10-month timepoints. For instance, younger infants have a more immature, developing immune system compared to older infants (Niers et al., 2007). Younger infants' resultingly increased susceptibility to infection and disease can contribute to parents' increased risk for anxiety. Furthermore, parents are in the delayed postpartum period at the 3-month timepoint in contrast to the 10-month timepoint, and the delayed postpartum period may increase risk for mental health symptomatology. A study of postpartum women about eight weeks postpartum showed that 8.2% experienced syndromal generalized anxiety disorder and 19.7% experienced sub-syndromal generalized anxiety disorder (Wenzel et al., 2005).

Based on the comparison of parents' composite mental health scores between those who perceived their infants to be vulnerable (at/above the CVS cutoff score of 10) and those who did not (below the cutoff score), the results showed that parents who perceived their infants to be vulnerable were at significantly greater risk for major depression and anxiety at both the 3-month and 10-month timepoints. Similarly, at the 3-month timepoint, parents who were at risk for anxiety had significantly greater perceptions of infant vulnerability. This implies that the relationship between parental mental health and their perceptions of their infant's vulnerability was bidirectional, especially at the 3-month timepoint, which supports our initial hypothesis and confirms that both a) and b) of Figure 2 hold true.

Identifying the Directionality in the Relationship Between Parental Mental Health and Vulnerability Measures

The independent samples *t*-test utilized categorical versions of parental mental health while the bivariate linear regressions utilized the continuous form of the variables. The results of the Welch's independent samples *t*-test showed that Match/Mismatch scores significantly differed across parental mental health risk at both timepoints (across risk for anxiety at 3 months and across risk for depression at 10 months). Similarly, the bivariate linear regressions showed that parental mental health predicted Match/Mismatch scores at both timepoints and that Match/Mismatch scores predicted parental mental health. The categorical variable of mental health is binary and only indicates either "0" = not at risk for anxiety and/or depression or "1" = at risk for anxiety and/or depression. However, the continuous form of mental health is not binary and is instead a range from 0 – 21 for GAD-7 and 0-27 for PHQ-9. Yet, the categorical and continuous measures indicated similar results.

At both timepoints, increases in parental mental health severity predicted greater parental perceptions of vulnerability, especially overperception (a form of misperception) in infant vulnerability. This underscores the importance of increasing mental health screenings for parents of infants and increasing parental accessibility to mental health care, especially in light of the 2022 U.S. Preventive Services Task Force guidelines that recommend anxiety screening for adults of ages 65 and younger (Baumgaertner, 2022). This will help to reduce the risk for infant vulnerability misperceptions, thus protecting parent-child interactions and infant health outcomes.

Increases in misperception, especially greater perceptions of vulnerability, predicted greater parental mental health severity. This highlights the need for future studies to identify factors, such as increased communication between health care providers and parents, that can promote alignment between parents' perceived vulnerability and infants' objective medical risk status in order to protect parental mental health and parent-child relationships. More specifically, this also unveils the need for future studies to find optimal methods for health care providers to communicate with parents about children's health in ways that help parents enhance care for their children but do not cause or exacerbate parental psychological harm.

The correlations and Fisher's *r*-to-*Z* transformation indicated that the Match/Mismatch variables between the 3-month and 10-month timepoint and the parental mental health scores between both timepoints were highly and consistently correlated. Similarly, the hierarchical linear regressions also showed that, when controlling for demographic variables, the 3-month Match/Mismatch score predicted the 10-month Match/Mismatch score and that the 3-month parental mental health score predicted the 10-month parental mental health score. This underscores that there was a stable, longitudinal relationship within each measure.

The bivariate linear regressions showed a bidirectional relationship between parental mental health scores and objective vulnerability scores at the 3-month timepoint but not the 10-month timepoint. This 3-month timepoint data underscores that having a young infant with high medical vulnerability is stressful and anxiety-provoking for parents. Also, in contrast to the 10-month timepoint, the 3-month timepoint represents the delayed postpartum period, which may contribute to increased risk for mental health symptomatology, especially since postpartum depression impacts 10-15% of women within a year of childbirth (CDC, 2008).

The bivariate linear regressions indicated that current parental mental health predicted parent Match/Mismatch scores within each timepoint and that the 3-month Match/Mismatch scores predicted the 10-month parental mental health severity scores. This latter finding was contrasted by the fact that the hierarchical linear regressions showed that, when controlling for demographic variables (race, ethnicity, biological relationship, patient gender, parent gender, first child or not, control vs. experimental group, parent education, household income, patient age at enrollment, and parent age at enrollment), Match/Mismatch scores at 3 months did not predict future parental mental health at the 10-month timepoint (Table 6).

When predicting parental mental health at 10 months, race and parent gender were significant predictors in Models 1-2 while parent gender and parent age were significant predictors in Models 2-3. These covariates are further explored in the Demographic Influences section. The goal of the hierarchical linear regressions is to determine the main effect of parental mental health on Match/Mismatch and vice versa. To achieve this, we want to account for the effects of potential confounding demographic variables (i.e., covariates) on the outcome variable to have greater precision when interpreting the effects of interest. Hence, controlling for covariates, meaning comparing the outcome variable between subjects who have the same covariate value (e.g., same race or same income), yields different and more rigorously interpretable results regarding the effect of the independent variable on the dependent variable (Lee, 2005).

In light of Thomasgard (1998)'s findings of greater psychological symptoms among parents who perceived their children to be highly vulnerable and Teti et al. (2005)'s findings that mothers' depressive symptoms predicted future perceptions of infant vulnerability, it is not safe to fully discredit the role of parental mental health at 3 months in predicting Match/Mismatch at 10 months or to discredit the role of Match/Mismatch at 3 months in predicting parental mental health at 10 months. In this study, the fit (R^2) of Model 3 of both hierarchical linear regressions were slightly higher, although not statistically significant, compared to Model 2 (Tables 5-6).

Limitations

The BabySeq Project study team made sure that parents, who reported clinical levels of depression or anxiety or expressed thoughts related to suicidal ideation, were contacted and helped by a clinical psychologist (Holm et al., 2018). This was necessary to ensure that both the parents and infants were safe and had access to necessary resources for mental health support; however, it is important for researchers to keep in mind that this practice may have unknowingly created a ceiling effect in the reporting of depression and/or anxiety levels.

Other limitations of this study include the use of parental mental health data from only two timepoints as well as the restriction of the sample size due to missing data and the use of listwise deletion, as previously discussed in the Missing Value Analysis section. This is especially true for the data from NICU parents since the dataset included complete Match/Mismatch data from only four NICU parents at the 10-month timepoint.

Another limitation of this study is that the majority of the sample had a bachelor's degree or higher (88.2%), were earning at least $100,000 (80.6%), and were non-Hispanic (93.4%) and White (74.3%). Hence, the study results may not be fully generalizable to parents and infants of other, diverse backgrounds. Furthermore, race was dichotomized to represent either White or non-White parents because the sample was overwhelmingly White, and the other race groups were statistically unbalanced in comparison to the number of White parents. Future replications of this study should aim to recruit and enroll a more diverse sample in order for the results to be more generalizable across populations.

Strengths

A major strength of the BabySeq Project data is that it had a narrow, specified age range that was specific to infants while the Green & Solnit (1964) study’s age range was too broad and thus not generalizable to infants. In other words, Green & Solnit (1964) did not account for how variations in child age affected parents’ perceptions of child vulnerability while this study uniquely and specifically focused on parents’ perceptions of one understudied population, infants.

Other strengths of this study include the use of a large sample with representation across diverse infant health status (NICU versus well-baby status), comprehensive nature of the objective vulnerability measure, longitudinal study design, and inclusion of both mothers and fathers in the sample.

Future Directions

Based on the magnitude of missing data, especially among NICU parents, future researchers should consider probing medical records to identify objective vulnerability data rather than relying on parental self-report. An examination of medical records is feasible with the widespread usage of electronic medical record systems, and this may help identify more accurate data and exert less of a burden on parents who are completing the surveys. Also, because NICU parents have a high risk for developing anxiety and depression (Mendelson et al., 2017), it is important for researchers to keep in mind that such mental health severity may also be contributing to their likelihood of dropping out, leading to extensive missing data. Thus, shortening the survey by utilizing medical records for the objective vulnerability data will help maximize parental responses.

However, a recent review also expresses the difficulties associated with the use of medical records for research purposes (Edmondson & Reimer, 2020). The challenges associated with this method include maintaining privacy and confidentiality by ensuring that the utilized data cannot be reidentified. Another challenge is timeliness since data processing from medical records is often the most time-consuming portion of research projects (Edmondson & Reimer, 2020; Ehrenstein et al., 2019). The time-consuming nature is because many medical records contain unstructured data in the form of "notes" (Ehrenstein et al., 2019) and because medical charts contain data from a variety of sources (Edmondson & Reimer, 2020). Furthermore, children may have electronic medical records from numerous locations, thus making it difficult to feasibly identify consolidated medical data for each child.

Measurement

I ran Little's MCAR test for the individual nine components of the objective vulnerability measure, and the data were not missing completely at random. One reason could be that parents with the sickest infants, and therefore who were undergoing high levels of mental stress, may not have had the time or mental energy to fill out all of the objective vulnerability questions. Parents may have also been leaving questions blank if those questions did not pertain to them (such as the number of ER visits) rather than entering “0.” Meanwhile, other parents may have been actively answering “0” for such questions. The survey questions regarding objective vulnerability were quite lengthy, which may have contributed to the missing data. The high correlation of missingness among the components of the objective vulnerability measure implies that parents who were skipping one of the components were likely to skip a majority of the objective vulnerability components, potentially due to the lengthy nature of this section of the survey.

Future replications of this study should consider shortening the length of the survey to reduce the chances of high missing data. An option for reducing the number of survey questions would be to give parents the option, in the beginning of the study, to allow researchers to glean data from medical records. However, the complexity of this option is increased when families attend a variety of health care facilities that do not utilize a universal electronic medical record system.

My initial worry was that parents were so overwhelmed with having had an infant in the hospital that they were not filling out the survey questions and were not reporting data. This may be true since parents with higher perceptions of vulnerability were likely to leave certain questions blank, such as those regarding the number of times and days in the ICU. However, after probing this query of missing data, I see that, based on the high correlation of missingness among the objective vulnerability variables, perhaps parents were skipping over questions that did not apply to them, especially since the survey was quite long. Again, the length of the survey should be considered and taken into account in missing data analysis and survey development in future studies.

I also noted a dilemma regarding whether PCP visits should be included in the measure of objective vulnerability. The goal for creating the objective vulnerability measure is to account for an infant's measurable, empirical health status at a given point in time. However, the number of times that a child visits a PCP may not truly be representative of a child's medical fragility status. For instance, if a parent is highly concerned over potential minor issues, then he/she/they may take the child to the PCP frequently even though the child may be medically healthy, and this would yield a higher objective vulnerability score. After probing this question further, I determined that PCP visits can remain in the measure of objective vulnerability since the correlation between objective and perceived vulnerability did not significantly differ between when PCP visits were versus were not included in the objective vulnerability measure. This implies that future measures of children's objective health status can include PCP visits as an indicator of health status.

It is important for researchers to keep in mind that PCP visits will vary across socioeconomic groups. For instance, compared to other families, low-income African American families with children who have chronic illnesses have a lower likelihood of visiting or having a PCP (Dowell, 2015). Furthermore, a literature review shows that low-income families and children have numerous barriers to accessing primary health care, which includes low education levels, issues with health insurance, and lack of trust in health care professionals (Lazar & Davenport, 2018). Hence, the number of PCP visits does not specifically reveal objective health status but is instead dependent on a variety of external factors, such as socioeconomic status.

Demographic Influences

Race, Ethnicity, and Socioeconomic Status. Interestingly, at the 3-month timepoint, infant objective vulnerability significantly differed across racial groups such that objective vulnerability scores were significantly greater among White infants than non-White infants. This finding may stem from racial disparities in access to health care resources. A recent study involving the comparison of health care use between Black and White people from 1963 to 2019 showed that White people's health care use, based on dollars per capita of expenditure, remained greater than that of Black people every year (Dickman et al., 2022). Furthermore, among privately insured individuals between 2014 and 2019, White people had greater ambulatory care visits than Black people (Dickman et al., 2022). This is corroborated by another study, which showed that Black individuals are 30% less likely and Hispanic individuals are 40% less likely to see an outpatient neurologist compared to similar White individuals (Saadi et al., 2017). Additionally, a study of Philadelphia, Pennsylvania showed that Black individuals are 28 times more likely to be in a census tract that had low spatial access to PCPs (Brown et al., 2016).

All of these findings from prior literature indicate the evidence of racial disparities across health care accessibility. Because White families have greater access to health care resources, such as PCPs and outpatient visits, their infants may thus have naturally higher objective vulnerability scores that instead reflect greater *access* to health care resources compared to Black families. Objective vulnerability scores represent a sum of nine different components, which include PCP and specialist visits. Therefore, greater access to these health care resources would naturally reveal higher objective vulnerability scores.

When controlling for other demographic variables, it was intriguing to note that race was a significant predictor of parental mental health scores at the 10-month timepoint. This underscores a need for health care professionals to ensure that all parents, especially non-White parents, have access to mental health resources. A study of young adults reveals that Black individuals are less likely to utilize mental health services compared to White individuals (Broman, 2012). In addition, Black and Latina women are significantly less likely to seek mental health care in the postpartum period compared to their White counterparts (Kozhimannil et al., 2011). The lack of equitable access and reception of mental health resources across race, especially in the postpartum period, contributes to race being a significant predictor of parental mental health scores at the 10-month timepoint.

Parents' mental health symptomatology may stem from an unclear understanding of their infants' objective health status. In such cases, there is a need for physicians to ensure that non-White parents have an accurate understanding of their infants' health status and treatment plan by expressing information in a way that is accessible to all parents. Parents' accessibility to infants' health information will better assist them with aligning their perceptions of vulnerability to their infants' objective vulnerability, thus helping to reduce parental risk for mental health severity.

A research study involving the measurement of parents' survey responses about their experiences at a pediatric primary care setting showed that Asian and Latino parents expressed reception of lower quality care compared to African American and White parents (Seid et al., 2003). Furthermore, this study showed that experiences were primarily affected by language fluency and access (Seid et al., 2003). Additionally, parent self-report data showed that compared to White and African American parents, Hispanic parents felt less likely to receive enough time with their child's pediatrician (Flores et al., 2005). Such literature further corroborates the need for equal access to health care information across race and ethnicity. The absence of such equitable access may be contributing to differences in parental mental health scores across race. When comparing non-Hispanic Black and White children, non-Hispanic Black children were more likely to have more severe asthma symptoms, yet they were less likely to have been previously prescribed preventative medicine and were still only *just* as likely as White children to receive preventative medicine at a doctor's visit (Lewis et al., 2014). Racial disparities in health care elucidate a pressing need for increased equity in access to health care resources and information.

As annual household income increased, Match/Mismatch scores tended to decrease (Table 7). The reduction in the magnitude of mismatch may be because parents of greater income may have access to greater health care resources, such as private health insurance and increased visits with health care providers, which allow them to better understand their children's health status. However, it was interesting to note that parents of higher household incomes tended to overperceive their infants' vulnerability, but to a lesser degree, while parents of lower annual household incomes tended to underperceive their infants' vulnerability at the 10-month timepoint.

Parent Gender. It was interesting to note that perceptions of vulnerability were significantly greater among female caregivers than male caregivers at the 10-month timepoint. This finding was significant at the 10-month timepoint, but not the 3-month timepoint. At the 3-month timepoint, both female and male caregivers had similar perceptions of infant vulnerability, potentially due to the natural agreement that younger infants are highly vulnerable since they are still developing their immature immune systems (Niers et al., 2007). However, at the 10-month timepoint, infants were seven months older and more developed compared to the 3-month timepoint, thus contributing to male caregivers' lowered perceptions of infant vulnerability.

Female caregivers' higher perceptions of infant vulnerability at the 10-month timepoint may relate to the fact that compared to fathers, mothers spend more time providing basic care and directly interacting with infants (Laflamme et al., 2002). Furthermore, a study of NICU babies' mothers and fathers showed that mothers experienced greater anxiety and depression than fathers, although both parents faced elevated distress levels (Doering et al., 1999). The extra childcaring roles that mothers are involved in and the greater risk for anxiety and depression may contribute to mothers perceiving their infants to be significantly more vulnerable than fathers' perceptions.

Parent Age. Based on a one-way ANOVA, composite parental mental health at 10 months significantly differed across parent age at enrollment since younger parents were more likely to experience greater mental health severity. This may be explained by the fact that younger parents may be less experienced and/or less prepared to support a child in the hospital, which may contribute to greater stress and mental health severity. This finding is corroborated by other studies, which indicate that younger parents of NICU infants (Dudek-Shriber, 2004) and younger parents of children receiving pediatric oncology care (Streisand et al., 2001) experience greater stress than older parents.

Clinical Implications

There is a need for health care professionals, especially those involved in the care of infants and their parents, to identify parents who are at risk for mismatch in infant vulnerability perception. By recognizing such at-risk parents, physicians can then aim to provide resources that will assist parents in better understanding their infant's objective health status. This is similarly elucidated by Frankel et al. (2021), who express that health care professionals should identify maternal perceptions of difficult infant behaviors in order to identify mothers in need of greater support.

With increased access to health care information, including knowledge that crosses cultural, linguistic, and educational barriers, parents will have greater clarity regarding their children's medical conditions. Hence, it is salient for health care professionals to ensure that extra care is provided when disseminating infant health information to vulnerable groups of parents, which include NICU parents, parents of notably ill infants, parents with mental health symptomatology, parents with lower annual household income, younger parents, and non-White parents. Because such groups were noted to be at risk for greater mismatch in infant vulnerability perception, it is essential that they have a comfortable physician-parent relationship in order to seek as much information as necessary to comprehend infant vulnerability status.

Furthermore, this present study showed that parents with mismatch in infant vulnerability perceptions are at greater risk for mental health severity. Hence, an identification of parents at risk for mismatch in vulnerability perceptions will help elucidate parents who are at risk for mental health symptomatology so that health care providers can subsequently assist parents with accessing mental health resources. The Match/Mismatch score is thus multifaceted, meaning that it can be utilized to underscore parents' need for increased access to infant health information and to highlight parents' risk for mental health severity.

Previous research indicates several ways pediatricians can promote comfortable physician-parent relationships. For instance, such relationships are promoted with continued and recurring moments of contact between parents and physicians (Godoy & Carter, 2013). In addition, physicians should aim to incorporate open discussion with parents in times of disagreement (Lantos, 2015). Physicians' own knowledge and awareness of their attitudes towards race and ethnicity are essential to ensuring that they are sensitive to diverse groups of parents (Godoy & Carter, 2013). An example of this includes physicians learning about ways that different cultural and ethnic groups view parenting behaviors (Godoy & Carter, 2013). Finally, easy access to professional language translation services to cross linguistic barriers, including via translated forms and paperwork, are salient to promoting comfortable physician-parent relationships across diverse groups of parents (Godoy & Carter, 2013).

Prior research also elucidates ways for physicians to maximize communication in comfortable physician-parent relationships, especially when children are medically vulnerable. One of these strategies includes physicians contacting parents frequently to update them about new information regarding children's health (Meert et al., 2011). During conversations, physicians should aim to be mindful about their tone, body language, and attention towards parents when speaking (Meert et al., 2011). For example, despite understandable time limitations and discomfort, physicians should aim to not multitask when relaying important, including difficult, news to parents about children's health (Meert et al., 2011). Furthermore, another strategy includes physicians ensuring that language is accessible to parents by not utilizing complicated or niche jargon (Meert et al., 2011). Lastly, physicians should ensure to give parents the time, space, and encouragement to ask any questions that parents may have either at the moment or after processing the newly delivered information (Meert et al., 2011).

Research among physicians and parents at informed consent conferences for pediatric acute leukemia clinical trials shows that interventions directed at physician communication leads to better rapport development between physicians and parents (Cousino et al., 2011). Such results are noted only when physicians attend a full day of communication training with additional half-day sessions (Cousino et al., 2011). Furthermore, standardized communication trainings for physicians have displayed improvement in pediatric residents' ability to form relationships with parents, based on evaluation of clinical exam performances (Nikendei et al., 2011).

It is not beneficial for physicians to withhold information regarding children's prognoses, such as during a child's end-of-life stage, or to prevent parents from having greater clarity about their child's vulnerability status (Meert et al., 2011). One might hypothesize that withholding such information would protect parents from emotional distress or that physicians should wait until negative prognoses are fully confirmed before communicating them to parents (Meert et al., 2011). However, physicians not honestly revealing the gravity of a child's medical condition in an upfront manner will inadvertently lead to parents feeling betrayed, angry, and unprepared due to the prior development of false hopes (Meert et al., 2011).

The aforementioned suggestions center on physicians' behaviors in physician-parent relationships. However, this present thesis focuses on parents' perspectives and parent-reported data. Hence, a parent-centered suggestion for future research includes conducting focus groups with parents, including parents of infants in NICUs and well-baby nurseries, to identify the type of information that parents want from their children's physicians as well as parents' preferred manner of information delivery from physicians. Although the data from this study is based on parent knowledge of infant medical history rather than physician disclosure of news regarding infant health status, comfortable and open physician-parent relationships and a greater understanding of infant health status may help to reduce parent mismatch in infant vulnerability perceptions.

Conclusion

The unique takeaways from this thesis include that there is an evident bidirectional relationship between parental mental health and parental perceptions of infant vulnerability, including parental Match/Mismatch in infant vulnerability perceptions compared to infants' objective vulnerability. More specifically, parents who perceived their infants to be vulnerable had significantly greater anxious and depressive symptomatology at both timepoints compared to parents who did not perceive their infants to be vulnerable. Also, parents who were at risk for anxiety at 3 months and at risk for depression at 10 months had significantly greater perceptions of infant vulnerability and greater vulnerability mismatch compared to parents were not at risk for anxiety or depression, respectively.

Additionally, bivariate regressions showed that parental mental health scores were significant predictors of Match/Mismatch scores, and vice versa, at both 3 months and 10 months. Such relationships between parental mental health and vulnerability measures often take place concurrently but not longitudinally, which means that there is scope for early, protective interventions on parental mental health and on potential misperceptions about infant vulnerability. For instance, parental mental health and Match/Mismatch predict each other within a single timepoint. However, when controlling for covariates, Match/Mismatch at the 3-month timepoint, but not parental mental health at the 3-month timepoint, predict Match/Mismatch at the 10-month timepoint. Similarly, parental mental health at the 3-month timepoint, but not Match/Mismatch at the 3-month timepoint, predict parental mental health at the 10-month timepoint. Potentially, the consistency within the constructs of Match/Mismatch and parental mental health are so strong that there is insufficient variance left to be explained by the opposite variables (parental mental health and Match/Mismatch, respectively).

Infants' NICU status, which implies high objective vulnerability and may thus affect parental mental health, also affects parents' perceptions of their infants' vulnerability and parents' Match/Mismatch in vulnerability perceptions at 3 months. In essence, this is the first study to display these relationships over time, particularly among parents of infants with diverse health statuses (NICU and well-baby nursery infants) and particularly through the use of novel objective vulnerability and Match/Mismatch variables.

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Appendix A: Supplemental Analyses

Stepwise Multiple Regression Predicting Match/Mismatch (Absolute Value Scores) at 10 Months

Predictor Variables	*B*	β	*t*	R^2	ΔR^2	Sig. *F* Change
Model 1				.050	.050	.890
Race	-.013	-.007	-.068			
Ethnicity	.062	.020	.196			
Biological Relation	.671	.118	1.206			
Patient Gender	.121	.082	.828			
Parent Gender	-.135	-.090	-.891			
First Child	-.057	-.038	-.342			
Experimental vs. Control Group Status	.067	.045	.463			
Parent Education	-.006	-.008	-.076			
Parent Income	-.021	-.046	-.423			
Patient Age at Enrollment	-.016	-.128	-1.181			
Parent Age at Enrollment	-.005	-.029	-.255			

Predictor Variables	*B*	β	*t*	R^2	ΔR^2	Sig. *F* Change
Model 2				.122	.072	.004**
Race	-.059	-.032	-.322			
Ethnicity	-.097	-.031	-.314			
Biological Relation	.724	.128	1.346			
Patient Gender	.110	.075	.783			
Parent Gender	-.180	-.121	-1.224			
First Child	.054	.036	.325			
Experimental vs. Control Group Status	.106	.071	.752			
Parent Education	-.003	-.004	-.044			
Parent Income	-.022	-.046	-.440			
Patient Age at Enrollment	-.009	-.076	-.716			
Parent Age at Enrollment	-.013	-.077	-.686			
Match/Mismatch at 3 Months**	.311	.287	2.949			

Predictor Variables	*B*	β	*t*	R^2	ΔR^2	Sig. *F* Change
Model 3				.122	.000	.964
Race	-.059	-.032	-.319			
Ethnicity	-.097	-.031	-.315			
Biological Relation	.724	.128	1.340			
Patient Gender	.110	.075	.776			
Parent Gender	-.180	-.121	-1.218			
First Child	.054	.036	.326			
Experimental vs. Control Group Status	.106	.071	.744			
Parent Education	-.003	-.004	-.044			
Parent Income	-.022	-.046	-.439			
Patient Age at Enrollment	-.009	-.076	-.708			
Parent Age at Enrollment	-.013	-.077	-.680			
Match/Mismatch at 3 Months**	.311	.287	2.932			
Mental Health at 3 Months	-.001	-.004	-.046			

Note. * = < 0.05 ** = < 0.01 *** = < 0.001

Appendix B: Supplemental Analyses

Stepwise Multiple Regression Predicting Mental Health at 10 Months

Predictor Variables	*B*	*β*	*t*	R^2	ΔR^2	Sig. *F* Change
Model 1				.122	.122	.050*
Race*	1.297	.188	2.365			
Ethnicity	-.047	-.004	-.048			
Biological Relation	1.289	.068	.866			
Patient Gender	.184	.036	.436			
Parent Gender**	-1.253	-.237	-2.891			
First Child	.073	.014	.157			
Experimental vs. Control Group Status	.412	.078	.992			
Parent Education	-.181	-.071	-.855			
Parent Income	.004	.002	.026			
Patient Age at Enrollment	.018	.060	.738			
Parent Age at Enrollment	.110	.172	1.848			

Predictor Variables	*B*	*β*	*t*	R^2	ΔR^2	Sig. *F* Change
Model 2				.529	.408	< .001***
Race*	.836	.121	2.062			
Ethnicity	.476	.040	.663			
Biological Relation	1.231	.065	1.125			
Patient Gender	.374	.072	1.201			
Parent Gender*	-.688	-.130	-2.134			
First Child	-.118	-.022	-.346			
Experimental vs. Control Group Status	.529	.101	1.735			
Parent Education	-.141	-.056	-.905			
Parent Income	.025	.014	.226			
Patient Age at Enrollment	.018	.060	.995			
Parent Age at Enrollment*	.094	.147	2.142			
Mental Health at 3 Months***	.645	.653	11.242			

Predictor Variables	*B*	*β*	*t*	R^2	ΔR^2	Sig. *F* Change
Model 3				.530	.001	.600
Race*	.823	.119	2.023			
Ethnicity	.420	.035	.577			
Biological Relation	1.236	.065	1.127			
Patient Gender	.369	.071	1.182			
Parent Gender*	-.699	-.132	-2.158			
First Child	-.095	-.018	-.274			
Experimental vs. Control Group Status	.536	.102	1.750			
Parent Education	-.133	-.052	-.847			
Parent Income	.019	.011	.176			
Patient Age at Enrollment	.019	.061	1.009			
Parent Age at Enrollment*	.094	.147	2.135			
Mental Health at 3 Months***	.644	.652	11.190			
Match/Mismatch (Absolute Value) at 3 Months	.111	.031	.526			

Note. * = < 0.05 ** = < 0.01 *** = < 0.001

The absolute value of the Match/Mismatch scores elucidates information regarding the magnitude of the discrepancy between objective infant vulnerability and perceived infant vulnerability scores. It is essential to note that increasing Match/Mismatch scores may imply varying outcomes, so interpretation of the beta weights in relationships regarding Match/Mismatch needs to be conducted with caution. For instance, a positive beta weight, a positive correlation, or an increase in Match/Mismatch may represent moving towards a match between objective and perceived infant vulnerability, if the Match/Mismatch scores are increasing from a negative value towards zero. However, a positive beta weight, a positive correlation, or an increase in Match/Mismatch may *also* represent moving towards greater mismatch between objective and perceived infant vulnerability, if the Match/Mismatch scores are increasing from a low, positive value to a higher, positive value.

In order to further understand the longitudinal relationship between Match/Mismatch magnitude scores and parental mental health, I conducted two stepwise multiple regressions, similar to Tables 5-6, using the absolute values of Match/Mismatch scores. This way, the elucidated relationships from the stepwise multiple regressions would be based on the magnitude of the Match/Mismatch scores. The results of these stepwise multiple regressions, using the absolute values of Match/Mismatch scores, are displayed in Appendices A-B. Interestingly, the models that were significant ($p < 0.05$) in Tables 5-6 remained significant in Appendices A-B with the Match/Mismatch absolute value scores. This similarity shows that Match/Mismatch magnitude and directionality scores at 3 months predict

Match/Mismatch magnitude and directionality scores, respectively, at 10 months. The similar results also indicate that parental mental health at 3 months does not predict Match/Mismatch severity or directionality at 10 months, regardless of when using the magnitude or raw scores for Match/Mismatch. These aforementioned relationships are not highly dependent on whether the raw or absolute value scores are used for Match/Mismatch. In the stepwise multiple regressions, using the magnitude of mismatch (based on the absolute values of Match/Mismatch) and the directionality of mismatch (based on the raw Match/Mismatch scores) yielded similar results. This implies that positive beta weights, when using the raw Match/Mismatch scores, were potentially representing increasing Match/Mismatch values from low positive to high positive values, which would yield similar results when utilizing the absolute values of Match/Mismatch in the stepwise multiple regressions.

Based on bivariate linear regressions, parental mental health scores were not significant predictors of Match/Mismatch magnitude scores, and vice versa, at both 3 months and 10 months, unlike the findings with the raw Match/Mismatch scores. Furthermore, Match/Mismatch magnitude scores at the 3-month timepoint were not significant predictors of parental mental health at the 10-month timepoint ($p = 0.295$), in contrast with the finding from the analysis of raw Match/Mismatch scores. This shows that current mental health status does not predict current or future Match/Mismatch *severity*, although current mental health can predict directionality of Match/Mismatch. Composite mental health at the 3-month timepoint was not a significant predictor of Match/Mismatch magnitude at the 10-month timepoint ($p = 0.887$), which is similar to the findings with the raw Match/Mismatch scores. This confirms that parental mental health does not predict future Match/Mismatch directionality or severity.