Maternal Mood and Anxiety Disorders and Child School Readiness: A Manitoba Population-Based Study

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Dedication

For my beloved Mother and Father, always.

Abstract

Objective: This study examined the relationship between several features of maternal Mood/Anxiety – timing, recurrence/persistence and severity – and child development on five key areas of school readiness at kindergarten, controlling for health, demographic and socio-economic factors.

Methods: Using administrative data to further understand these relationships at a population level and over time, 18,331 mother-child pairs were linked using a unique identifier. Maternal Mood/Anxiety was defined using the diagnoses a mother received during physician visits (depressive disorder, affective psychosis, adjustment reaction and anxiety), as well as by the drugs prescribed (antidepressants and sedatives/hypnotics) for depression or anxiety. The outcome measures were child scores on five domains of the Early Development Instrument (EDI), a population-level tool for determining readiness for school at an aggregate level. Structural equation modeling was used to examine the relationship between the timing, recurrence/persistence and severity of maternal Mood/Anxiety and child outcomes over time, and included infant health at birth, the family/socio-economic environment, child age and child gender as controls.

Results: Maternal Mood/Anxiety had a modest significant negative association with child outcomes, particularly social, emotional and physical development. Prenatal exposure was more strongly associated with the outcomes than any other time period over early childhood ($p<.001$). Both Mood/Anxiety recurrence and severity had a stronger negative association with the outcomes than any time period, with a slightly stronger association for recurrent/persistent. The influence of maternal Mood/Anxiety was mediated by the family environment, which had a strong, significant association with the outcomes, particularly child language and cognitive development ($p<.001$). Infant health at birth was significantly associated with child outcomes, particularly physical health, and this influence was also

mediated through Mood/Anxiety (p<.001). Socio-economic status (SES) was a moderator of the relationship between Mood/Anxiety and child outcomes; low-mid SES had a slightly greater negative association with EDI scores, particularly child social, emotional and physical development (p<.001). Male child had a strong negative association with the outcomes (p<.001) and child age at the time of the EDI assessment was positively associated with EDI scores (p<.001)

Conclusion: Using administrative data to define maternal mood and anxiety disorders is a sensitive measure to detect significant effects on five key areas of child development. Timing, recurrence/persistence and severity of maternal Mood/Anxiety all influence child outcomes, particularly for social, emotional and physical development. Findings from the study can be used to design, implement and evaluate high quality clinical, program and policy interventions to support mothers and families and the healthy development of their children.

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Chapter 1: Introduction

1.1 Background and Context for the Study

Experiences in the infancy and early childhood periods can have lasting effects over the life course. Due to the influence of the years prior to school entry, early child development has been identified as a determinant of health.[2, 3] Exposure to maternal mood and anxiety disorders[i] has been shown to have a negative influence on child development in infancy,[4] in early childhood,[5, 6] at school entry,[7, 8] and on later health and social outcomes. [5, 9] In addition, factors related to maternal mood and anxiety disorders and to child development broadly, such as the caregiving/family environment and socio-economic status (SES), influence the relationship between maternal mood and anxiety disorders and child school readiness. Specifically, the family environment has been found to account for – or mediate – some of the influence of maternal mood and anxiety disorders on child development outcomes.[10, 11] Further, SES has been identified as a moderator of this relationship. In other words, there are different outcomes for children exposed to maternal mood and anxiety disorders from different SES groups.[12] While these relationships between exposure to maternal mood and anxiety disorders and child outcomes have been established in the literature (see Chapter 2), the mechanisms, or pathways, through which maternal mood and anxiety disorders influence child development are less clear. Further, these mechanisms may differ depending on the particular nature of the maternal mood and anxiety disorder the child is exposed to – for example, the timing of exposure, recurrence or persistence or severity of illness.

While research has found a relationship between maternal mood and anxiety disorders and child outcomes – including factors that may mediate or moderate this relationship – there are limitations. The majority of these studies rely on maternal symptoms of depression or anxiety. Such studies must

[i] The phrase "mood and anxiety disorders" includes depression, anxiety and related conditions. This phrase will be used throughout the document except where specific names of conditions are used in referenced literature.

rely on respondent recall and are usually limited to specific points in time. In addition, these studies usually include smaller samples with fewer covariates to control for various factors that may influence this relationship. Further, few studies have examined aspects of maternal mood and anxiety disorders such as timing of exposure, recurrence/persistence and severity and how these features may influence child development. Research into the relationship between maternal mood and anxiety disorders has found sensitive periods of development for children in terms of when they were exposed.[13-15] Both chronic or recurring[16, 17] mood and anxiety disorders and more severe[17] illness have both been found to have a more negative effect on child development. Studies in the literature usually examine the influence of maternal mood and anxiety disorders on one or two areas of child development, typically social, emotional and behavioural development. School readiness has been identified as a multi-dimensional concept that includes a range of areas of child development such as social, emotional, physical, language and cognitive and communication skills.[18] This study examined the relationship between maternal Mood/Anxiety[ii] and five areas of child school readiness in a large, population-based sample using linked administrative data. Further, this study controlled for several health and social factors known to be related to maternal Mood/Anxiety and child development. Unique features of this study are a very large population-based sample, the use of administrative data to measure Mood/Anxiety, the examination of aspects such as timing, recurrence/persistence and severity of maternal Mood/Anxiety and their influence on child development, and the measurement of five key areas of child school readiness as measured by the Early Development Instrument (see Chapter 3 for details).

[ii] "Mood/Anxiety" is the latent construct created for the purposes of this study that indicates the presence of a treated mood or anxiety disorder (see Chapter 3 for details); any reference to the variable used in findings from this study uses the term "Mood/Anxiety."

1.2 Purpose of the Study

The purpose of this study was to examine the relationship between several features of maternal Mood/Anxiety – timing, recurrence/persistence and severity – and child development on five key areas of school readiness at kindergarten. Controlling for a number of factors such as health status at birth, family/socioeconomic environment and child age and gender, this relationship was explored using linked administrative data to further understand these relationships at a population level and over time. For this research, maternal Mood/Anxiety was defined using the diagnoses a mother received during physician visits (depressive disorder, affective psychosis, adjustment reaction and anxiety), as well as by the drugs prescribed (antidepressants and sedatives/hypnotics) for depression or anxiety. The outcome measure was child scores on five domains of the Early Development Instrument, a population-level tool for determining readiness for school at an aggregate level.

1.3 Data Sources

The Population Health Research Repository at the Manitoba Centre for Health Policy houses numerous health and social databases of information collected through government departments. Though initially collected for purposes other than research, administrative data present a valuable opportunity for the exploration of various research and policy questions at a population level. Data collected by different sectors including health care (e.g., physician visits, hospitalizations, dispensed prescriptions, immunizations), social services (e.g., children in care, receipt of income assistance) and education (e.g., standard assessments and test scores) can be linked together anonymously using individual identifiers. These "information-rich environments" can be used to study the broad determinants of health and health outcomes.[19] For this study, databases from the health (e.g., physician visits, filled prescriptions, birth outcomes, age of mother at first birth, marital status) and social (e.g., school readiness scores) sectors and the national census (e.g., average household income, area-level rates of unemployment,

high school completion and lone parenting) were linked together by unique identifiers. Information collected by the government departments is anonymized (e.g., no names or addresses are included and personal identifiers are scrambled) before it is sent to MCHP for research access. A series of access approvals must be granted before a researcher can utilize the data (see Section 1.8, Ethical Considerations, for more detail).

1.4 Study Sample

This study was conducted in the province of Manitoba, Canada. Approximately 15,000 children are born each year in Manitoba.[iii] The sample for this study includes two cohorts of children who received the Early Development Instrument assessment by kindergarten teachers in February/March of 2006 and 2007. These children were linked to their birth mothers using the Personal Health Identification Number (PHIN). Following exclusions (see Chapter 3 for details), a total of 18,331 mother-child pairs were available for the analyses.

[iii] For the 2009/10 fiscal year, there were 15,191 births in Manitoba; for 2001/02 (approximately when children in the study sample were born), there were 13,589 births.[57]

1.5 Theoretical Model

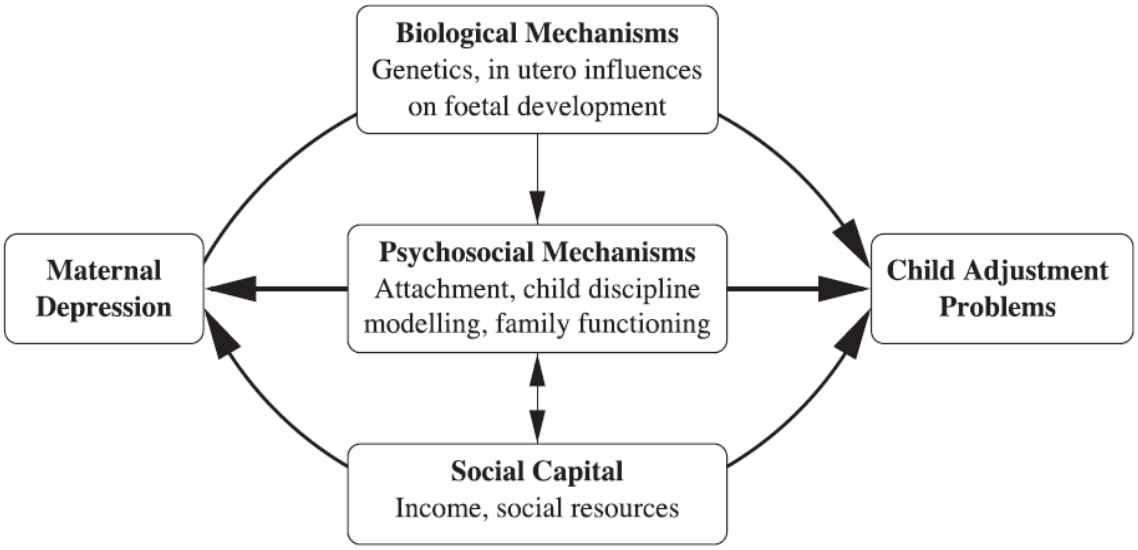

Figure 1.1. Theoretical model of mutual influences on maternal depression and child adjustment (Elgar et al., 2004)

As noted in Chapter 2 (Review of the Literature), the pathways between maternal depression and school readiness are not direct and are influenced by a variety of biological, familial and social contexts. Elgar et al.[20] developed a simplified version of the Goodman and Gotlib[21] integrative model of the transmission of risk from depressed mothers to children.[iv] The revised model also accounts for potential bi-directional or transactional relationships along the pathway. As shown in Figure 1.1, three sets of variables are situated along the causal pathway from maternal depression to child adjustment. Biological and Psychosocial mechanisms are hypothesized to mediate – or partially account for – the relationship. The third group, Social Capital, represents moderating influences (e.g., different outcomes for difference groups) such as SES and social resources. This model was used to guide the development

[iv] Copyright permission to reproduce the model in this thesis was obtained from the author.

of the proposed conceptual model for this study, which was modified to accommodate variables available in the administrative datasets (Figure 1.2, below).

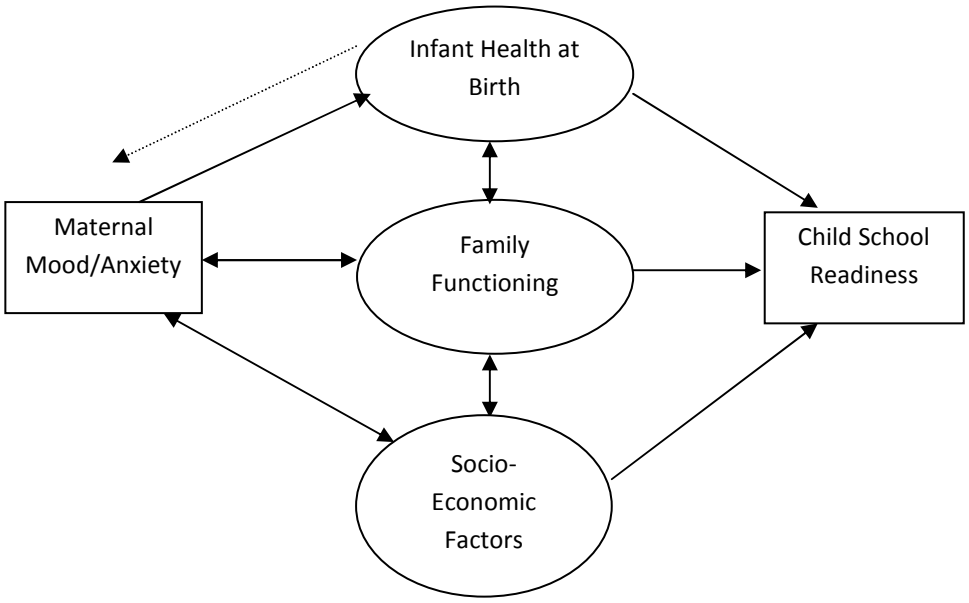

Figure 1.2 Proposed conceptual model

In this adapted model,[v] *Maternal Mood/Anxiety* replaced Maternal Depression, *Health at Birth* replaced Biological Mechanisms, *Family Functioning* replaced Psychosocial Mechanisms, *Socio-Economic Factors* replaced Social Capital and *Child School Readiness* replaced Child Adjustment Problems. Arrows indicating the theorized relationships between variables – and the direction of those relationships – were also included. Some relationships are a simple one-way relationship and others are bi-directional, as in the Elgar et al. model. In these cases, each variable may influence the other, and these relationships may be time-sensitive. For example, Maternal Mood/Anxiety during the prenatal period

[v] Variables in a rectangle are directly measured and those in ovals are latent constructs that represent phenomena that cannot be measured directly (see Chapter 3, Methods).

can influence Health at Birth. However, Health at Birth can only influence Maternal Mood/Anxiety in the postnatal period and beyond. The result was a fairly complex model that could only be tested (and revised) once the modeling began. It was in the early stages of modeling – the confirmatory factor analysis (see Chapter 3, Methods) – that it became clear the inclusion of some proposed variables, pathways and directions was no longer feasible. For example, bi-directional relationships added a level of complexity that was beyond the scope of this study so only uni-directional relationships were tested. In addition, the Family Functioning and Socio-Economic Factors constructs were combined into one, Family Context. Further, the direct path between Health at Birth and Family Context rendered the models unstable so it was removed. The conceptual model was revised to reflect the relationships tested in this study (Figure 1.3, below).

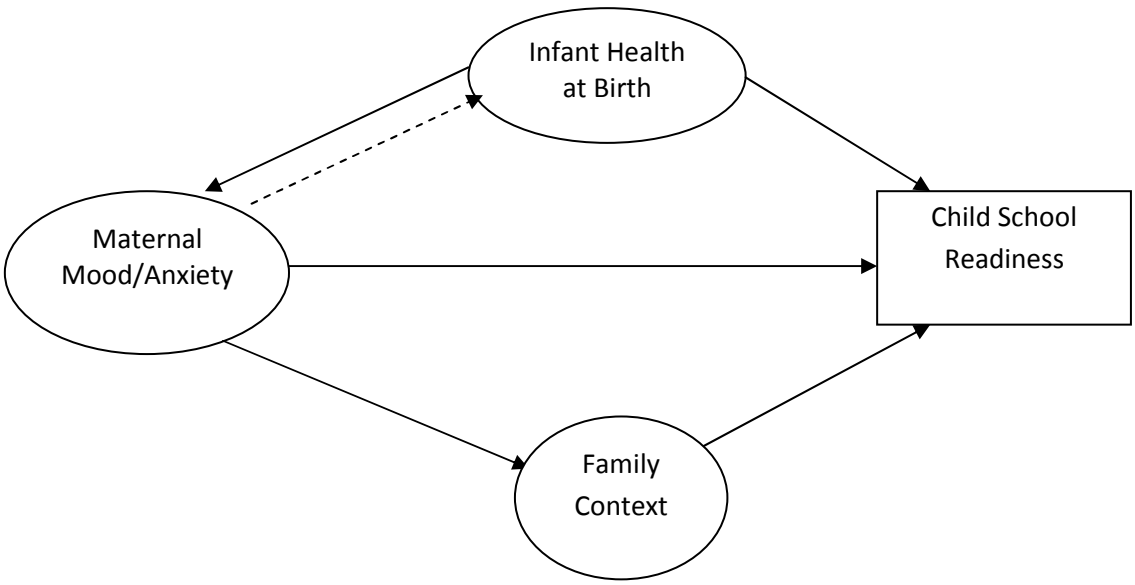

Figure 1.3 Revised conceptual model

In the revised conceptual model for this study, Maternal Mood/Anxiety,[vi] the primary predictor variable, is on the left and Child School Readiness, as measured by the EDI, is on the far right. Variables along the pathway between these two variables are Health at Birth and Family Context. As will be described further below (Chapter 3, Methods), there were four time periods in this study and maternal Mood/Anxiety, along with some of the intervening variables, was measured at more than one point in time. Arrows indicating the theorized relationships between variables – and the direction of those relationships – are also included.[vii] The specific variables and method of analysis used in this study are described in detail in Chapter 3.

1.6 Research Questions

1. Does maternal depression have an impact on school readiness, as measured by the EDI at age 5-6?

2. What aspect of maternal depression – timing, recurrence/persistence or severity – is most predictive of child performance on the EDI at 5-6 years of age?

3. What are the patterns of school readiness outcomes for children exposed to maternal Mood/Anxiety over the Prenatal and early childhood periods?

4. Do Health at Birth and Family Context mediate the relationship between maternal Mood/Anxiety and school readiness?

[vi] Maternal Mood/Anxiety was changed to a latent construct early in modeling, so this variable is designated by an oval in the revised model, as per structural equation modeling (SEM) standards (see Chapter 3, Methods).

[vii] Bi-directional relationships (e.g., between Mood/Anxiety and Family Context) added a level of complexity beyond the scope of this study, so only uni-directional relationships are reflected. The dotted arrow between Mood/Anxiety and Health at Birth reflects the pathway between these two variables for the Prenatal period only.

5. Does socio-economic status moderate the relationship between maternal Mood/Anxiety and school readiness?

1.7 Limitations and Delimitations of the Study

The use of administrative data for research is limited by the fact that the information is not originally collected to answer research questions. As a result, the large volume of data requires a high degree of validation and decision-making regarding definition and scope of variables to be used. Use of administrative data to measure maternal Mood/Anxiety is further limited in that maternal symptoms, functioning and the status of illness cannot be gleaned from the data. In addition, while the number of physician visits and filled prescriptions for depression and/or anxiety is an indicator of "treatment prevalence," it may not be a true measure of the prevalence of mood and anxiety disorders in the population. Further, it is difficult to determine whether large numbers of physician visits and/or filled prescriptions for depression and/or anxiety are reflective of well-treated illness or greater illness severity; it is likely that the administrative data capture both of these groups.

The study population was delimited to children who: had a valid EDI completed in the 2006 and 2007 school years (approximately February/March); who were linked to their birth mothers in the data; and where both mother and child resided in Manitoba with continuous health care coverage for the duration of the study period – one year prior to the child's birth up to the EDI assessment date(n=18,331). The requirement for continuous coverage for both mother and child is important as this study examines the relationship between exposure to maternal Mood/Anxiety and child outcomes in kindergarten over time, including the following time periods: Prenatal, Postnatal, Toddler and Year before EDI.

1.8 Ethical Considerations

Since anonymized secondary data were used (e.g., no direct research with human subjects), no significant ethical issues were identified. The Manitoba Centre for Health Policy (MCHP) acts as a steward for the data provided by various government departments. Confidentiality and anonymity of individuals' information is carefully protected by MCHP through a series of protocols and security measures (see MCHP Pledge of Privacy, Appendix 1). Approvals were obtained from the MCHP Research Review Committee, the University of Manitoba Health Research Ethics Board (HREB), the provincial Health Information Privacy Committee (HIPC) and other government departments providing data used in this study – Healthy Child Manitoba and Family Services. In addition, a Researcher Agreement between the University of Manitoba (specifically, MCHP, where the Repository is held), the government of Manitoba (to access to Manitoba Health, Healthy Living and Seniors (MHHLS) data) and the study author was signed. Annual renewals are required by the HREB and annual accreditation through MCHP is also required to ensure the researcher is up to date on issues related to ethics, privacy and confidentiality of the data.

1.9 Significance of the Study

The influence of maternal mood and anxiety disorders on child outcomes has been well-documented in the literature. However, most studies rely on maternal symptom reports and measure these only at specific points in time. In addition, sample sizes are usually small and unable to report on the relationship between maternal mood and anxiety disorders and child development at a population level. Further, select child outcomes are often the focus in these studies. This study addressed a number of limitations in the literature. It examined the relationship between maternal mood and anxiety disorders and child school readiness using population-based administrative data. A unique definition of maternal

Mood/Anxiety combined the number of physician visits and filled prescriptions for each time period and for the overall study period. In addition, recurrence/persistence and severity of Mood/Anxiety were examined. This study controlled for the influence of the family environment and SES using a combination of individual and area-level indicators from the administrative databases. In addition, five key areas of child school readiness – Language and Cognitive Development, Social Competence, Emotional Maturity, Physical Health and Well-Being and Communication Skills and General Knowledge – were examined for each time period, the overall study period and for Mood/Anxiety recurrence/persistence and severity.

Findings from this study identify which periods of prenatal and early childhood development may be more sensitive to maternal Mood/Anxiety. This information can inform the timing of interventions for both children and mothers/families. In addition to the timing of exposure, the influence of recurrent/persistent and more severe Mood/Anxiety on child school readiness was examined. Identifying whether such patterns of Mood/Anxiety negatively influence child development outcomes can inform the type of intervention that may be most beneficial. A unique contribution of this study is how these features of Mood/Anxiety, controlling for a variety of health and social factors, influence five areas of child school readiness at kindergarten in a large, population-based sample. Findings from the study can be used to design, implement and evaluate high quality clinical, program and policy interventions to support mothers with mood and anxiety disorders and the health and development of their children.

Chapter 2: Review of the Literature

2.1 Introduction

Early childhood has been identified as a critical stage of human development.[22] Early life experiences can "get under the skin" and influence the developing brain, stress response systems and later health outcomes, particularly during sensitive periods.[23-25] In particular, exposure to maternal depression and anxiety has effects across the early years up to school entry and beyond. In children, exposure to maternal depression and anxiety is associated with poor birth outcomes,[4, 26] elevated stress response,[4, 27, 28] negative temperament,[29] social, emotional and behavioural problems, [9, 30] impaired cognitive performance[13, 31] and compromised physical health[5] across early childhood and at school entry. The timing of exposure to these stressors, and whether exposure is recurrent/persistent or severe, has been found to influence child outcomes in some studies, but not in others. The range of findings is dependent on factors such as study design, sample size and timing and method of assessment of maternal mood and anxiety disorders and child outcomes. In the literature, a number of different mechanisms or pathways through which maternal mood and anxiety disorders may influence child development have been identified. Factors that are associated with maternal depression and anxiety, such as maternal-child interaction, family functioning, household demographics and socioeconomic status (SES) also contribute to children's development and later performance in school. These mediators (i.e., influences along the causal pathway) and moderators (i.e., different outcomes for different groups) also influence the range and strength of outcomes found in the studies reviewed. Further, school readiness has been found to be predictive of later school achievement and health, social and educational outcomes. This chapter provides a review of the literature on the effects of maternal depression and anxiety on child outcomes, in particular, domains of child development as measured by the Early Development

Instrument (EDI)[viii] – Language and Cognitive Development, Social Competence, Emotional Maturity and Physical Health and Well-Being. As discussed below, several studies have identified the importance of examining aspects of maternal depression and anxiety such as timing of exposure, recurrence/persistence and severity, and these were explored in this study (see Methods chapter). In addition, literature that examines the potential mechanisms or pathways that may explain how depression and anxiety affect child development, and the importance of school readiness for later development, are included.

2.2 Maternal Depression and Anxiety

For this review of the literature, articles were selected from electronic databases (e.g., MEDLINE, SCOPUS, Web of Science) as well as from reference lists of published material. Search terms included: *maternal depression, maternal anxiety, maternal mood, child outcomes, child development, school readiness, cognitive development, timing, severity and chronicity/recurrence/persistence of depression, mediators, moderators.* Emphasis was on maternal mood and anxiety disorders but some studies that included co-morbidities such as schizophrenia and personality disorder, particularly where independent depression or anxiety effects were found, were also reviewed. Studies that examined child exposure to depression and/or anxiety in mothers were the focus, though some that also assessed paternal depression were included. A range of child outcomes from birth was considered, with a particular focus on outcomes in the domains listed above up to approximately school entry. Some child outcomes were measured earlier than school entry but showed a relationship to school readiness domains, so were

[viii] A fifth domain, Communication Skills and General Knowledge, was not explicitly examined in the studies reviewed. However, it is possible that communication skills are closely related to social, emotional and language development.

included. Others assessed child outcomes into middle childhood or adolescence but were selected due to other relevant factors, such as in-depth assessment of various aspects of maternal depression or longer term effects of early childhood exposure. In order to more fully understand the implications of timing, recurrence/persistence and severity of depression on child development, longitudinal designs were prioritized. Table A2.1[ix] in Appendix 2 summarizes key studies reviewed in terms of which periods of exposure and aspects (e.g., timing, recurrence/persistence, severity) of maternal depression and anxiety impact on the various domains of child development at around school entry.

2.2.1 Prevalence of Maternal Mood and Anxiety Disorders

The *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV) defines major depression as experiencing five or more severe and persistent symptoms for at least two weeks. Symptoms include: sadness, changes in sleep pattern, change in appetite, loss of energy, feelings of worthlessness, difficulty concentrating, lack of interest in activities and suicidal thoughts.[32] While formal diagnosis with depression is based on such features, individuals can experience sub-clinical symptoms that result in impaired functioning.[30, 33] Depression has been defined as heterogeneous and episodic[34, 35] and is now understood to be a chronic lifelong illness.[36]

The lifetime prevalence of major depression in Canada is 10.8%[37] and the rate for women is nearly two times that for men.[37] Using medical records from a large US health management organization (n=4398), Deave et al.[38] found that for 15.4% of women, depression was identified for at least one period around pregnancy; 8.7% before pregnancy 6.9% during and 10.4% after. The Canadian Maternity Experiences

[ix] This table includes studies where child outcomes at school entry (age 4 and older) were linked to specific exposure periods and where timing, severity and chronicity were explored. Not all studies in the table are described in detail in the paper. Due to overlap in exposures and the potential confounding of timing, chronicity and severity, attempts were made to locate studies where they best fit.

Survey assessed depression symptoms in women between 5 and 10 months postpartum and found that 7.5% scored above the established threshold (≥13 on the Edinburgh scale).[39] In a study[40] of data (n=10,033) from the first six cycles (1994-5 to 2004-5) of the National Longitudinal Survey of Children and Youth (NLSCY), 6% of Canadian children were born to mothers who experienced depression in the postnatal year. Depression is more common in low-income women,[41] single parents[42] as well as women in visible minority groups.[43] In a sample of 2427 mothers from the US Fragile Families and Child Well-Being study,[44] 34% of children had a mother who reported symptoms of depression at least once in the five-year study period. A study of Aboriginal women participating in prenatal outreach programs in Saskatoon (n=402) found that the prevalence of depressive symptoms was 29.5%.[45] Further, maternal depression has been found to persist through pregnancy[46] and through early childhood.[47, 47-49] In a US cross-sectional study of low-income mothers (n=5820) whose children had attended Head Start prior to kindergarten, the strongest associations with maternal depression were maternal chronic health condition, homelessness and lowest income level. The presence of each of these associations elevated the odds of maternal depression by at least two-fold. Further, an inverse dose-response relationship was found between low income and maternal depressive symptoms, even after controlling for several biological and demographic factors.[41]

Anxiety is highly comorbid with depression[50-55] and it can be difficult to distinguish between the two.[26] Further, there is evidence that the two conditions may have an additive effect in terms of maternal and child morbidity.[51, 54, 55] Similar risk factors are found for anxiety as for depression. Rubertsson et al.[56] assessed first trimester anxiety in a Swedish population-based community sample of 916 women. The study found that 15.6% of the women experienced anxiety in early pregnancy. Factors associated with a greater risk of anxiety were: under 25 years of age (OR 2.6, CI 1.7-4.0); non-native (Swedish) language (OR 4.2, CI 2.7-7.0); high school education only (OR 1.6, CI 1.1-2.3); unemployed (OR 3.5, CI 2.1-5.8); nicotine use before pregnancy (OR 1.7, CI 1.1-2.5); and self-reported history of depression (OR 3.8, CI

2.6-5.6) or anxiety (OR 5.2, CI 3.5-7.9) before the current pregnancy. A study[53] of 2,891 women and their children from the Avon Longitudinal Study of Parents and Children (ALSPAC) found that 15% of the women reported anxiety symptoms at some point during the pregnancy. Farr et al.,[52] in a community sample of 4451 postpartum women, found that 18% reported anxiety symptoms in the postnatal year; of those, 35% reported depressive symptoms.

A study of perinatal health of Manitoba [57] women found, in 2008/09, that 7.5% of women were treated[x] for prenatal psychological distress (anxiety or depression) in the 8-month period prior to giving birth and 13.8% were treated for psychological distress in the 12 months after birth. Rates were higher for both time periods for disadvantaged women, including those who were low income, low education, lone parents, socially isolated and those with physical comorbidities (hypertension, diabetes or antepartum hemorrhage).

The Manitoba Centre for Health Policy uses an algorithm that includes various combinations of physician visits, filled prescriptions and hospitalizations for depression and anxiety (see Methods chapter for details) to identify mood and anxiety disorders in the population, typically over a five-year period. Rates using this or a related definition range from about one-fifth (21.0% for mothers of children 0-19 and 21.7% for mothers of children 0-5)[58] to 23.3% for Manitobans 10 years of age and older[59] and as high as 37.2% in a social housing cohort.[60]

Most studies of the impact of maternal depression on early childhood rely on mothers' self-reported symptoms and many include mothers' reporting of child outcomes. Field[61] found that depressed mothers tended to evaluate their behaviour toward their children as more positive than it was. Conversely, Goodman et al.[30], in a meta-analysis, found that mothers' ratings of child outcomes did not

[x] "Treatment prevalence" is reported as these definitions are based on contact with the health care system; true prevalence may be underestimated. See Chapter3 for further discussion of this concept.

differ between depressed and non-depressed mothers. However, despite concerns regarding the validity of depressed mothers' perceptions of their child's development, several authors have concluded that reports by depressed mothers are valid. Richters,[62] in a review of studies comparing reports of child behaviour by informants and mothers, found that in 83% of the studies the mothers agreed with other informants about their children's behaviour as well or better than did the non-depressed mothers. Similarly, Billings and Moos[63] did not find that depressed parents were negatively biased in their reports of their child's or family functioning.

The following section will describe findings from the literature on exposure to maternal mood and anxiety disorders over the early childhood years and the effects on child development.

2.2.2 Exposure to Maternal Mood and Anxiety Disorders During Early Childhood

2.2.2.1 Exposure in Prenatal Period

Newborns are vulnerable to the effects of maternal mood and anxiety disorders during pregnancy. Exposure to prenatal maternal distress is associated with early pregnancy loss,[64]increased infant cortisol levels,[55, 65, 66] decreased infant dopamine and serotonin,[55, 66] preterm birth,[67, 68] low birth weight,[4] decreased breastfeeding initiation,[69] and poor sleep patterns and infant responsiveness.[4] Outcomes have been found to vary depending on the type of maternal distress experienced. Tegethoff et al.,[68] in a large population-based cohort study (n=78,017 pregnancies), found that maternal anxiety and life stress both were associated with preterm birth but life stress was associated with increased offspring size. Field et al.[55] assessed neonatal outcomes for infants exposed to prenatal comorbid depression and anxiety and depression and anxiety alone. The study found that infants of comorbid and anxious mothers had lower birth weight than those of non-depressed or depressed mothers. Conversely, infants

of comorbid and depressed mothers had higher cortisol and norepinephrine and lower serotonin and dopamine levels when compared to the anxious and non-depressed groups.

A number of studies have examined the influence of prenatal depression and anxiety on later child outcomes. In a review of studies that examined the relationship between prenatal stress and adverse neurobiological outcomes in children, Talge et al.[70] found a consistent relationship between prenatal depression exposure and socio-emotional and cognitive outcomes in childhood, despite the fact that different methods were used to assess prenatal stress and child outcomes. Studies have confirmed impacts of prenatal exposure at school entry. Maternal prenatal depressive symptoms are highly predictive of children's externalizing behaviour (OR=3.1, CI 1.1-8.9) and total problems – internalizing, externalizing[xi] and social competence (OR=8.5, CI 2.7-26.5) – based on parent and teacher reporting.[71] In a review of studies that examined the influence of maternal depression, anxiety and stress on child outcomes, Glover[26] states that prenatal anxiety or depression may contribute 10-15% of the attributable load for child behavioural and emotional outcomes. Laplante et al.[8] assessed the impact of the 1998 Quebec ice storm on 89 five-and-a -half year olds whose mothers were pregnant during the ice storm. Objective and subjective stress in mothers and IQ and language in children were assessed. The study found that children exposed prenatally to high levels of objective stress had lower full IQs, verbal IQs and language abilities when compared to children exposed to low or moderate objective maternal stress in utero. Loomans et al.[72] examined 922 mother-child dyads and concluded that prenatal anxiety was modestly associated with child reaction time (cognitive) on a simple task.

In addition to early childhood and school entry outcomes, studies have found that the effects of prenatal depression or anxiety impact children during the school years. In a study of 3298 mother-child dyads, Barker et al.[54] found that prenatal depression had a more "general" effect on child development

[xi] Internalizing behaviours include anxiety, depression and phobias; externalizing behaviours include hyperactivity and delinquency.[135]

than did prenatal anxiety and that depression and anxiety each impacted different domains of child development. Based on assessments when the children were 7 and 8 years old, the study found increased child externalizing problems and decreased verbal IQ for children exposed to prenatal depression. In contrast, prenatal anxiety was associated with a slight increase in child internalizing problems. Leis et al.[53] assessed 2891 mothers and their children from the Avon Longitudinal Study of Parents and Children (ALSPAC) and found that prenatal exposure to depression was associated with emotional and behavioural problems at child ages 10-11, independent of later maternal mental health. Similar associations were found for exposure to prenatal anxiety. Guevremont et al.[73] examined the influence of maternal depression on child ADHD from prenatal to age 7 and found, of the specific time periods, the prenatal exposure to be the most significant.

Some studies found effects of prenatal exposure independent of postnatal depression. Deave et al.[38] assessed depression symptoms during pregnancy and child cognitive and behavioural development at 18 months. The study found that depression at 18 and 32 weeks of pregnancy was associated with developmental delay in young children, after controlling for postnatal depression as well as smoking, maternal age and life events. In contrast, O'Connor et al.[51] found that prenatal anxiety in late pregnancy, and not prenatal depression, predicts children's behavioural/emotional problems at 4 years of age. Further, the authors concluded that prenatal anxiety and postnatal depression represent separate risks for behavioural/emotional problems in children at age 4, and act in an additive manner. Huot et al.[29] found that maternal depression during pregnancy, but not postnatally, predicted negative temperament in children ages 6 months to 5 years, controlling for age and sex of the child and maternal depression at the time of assessment. The study also found that infant cortisol levels at 6 months also predicted later emotional disturbance, suggesting that the effects of maternal depression on behavioural and emotional problems may be mediated by altered temperament and increased stress

responsiveness. The authors suggest elevated maternal biochemistry may also be a mediator but this was not evaluated (See Section 2.4 below for further discussion).

While most studies focus on the influence of maternal mood and anxiety disorders on child social, emotional, behavioural or cognitive development, Raposa et al.[5] found that maternal depression during pregnancy is associated with later child physical health. Using structural equation modeling, the authors found a *direct* association between prenatal maternal depression and child physical health at age five. Further, they found that age five physical health in children was influenced by maternal prenatal depression *indirectly* through recurrent depression (measured at 3-4 days post birth, 6 months and child age five years).

The effects of prenatal exposure have been found to persist beyond childhood. A 14-year prospective study[9] based on the Avon Longitudinal Study of Parents and Children (ALSPAC) cohort found that maternal prenatal anxiety was predictive of behavioural and emotional problems over childhood, and these effects persisted into adolescence. Similar results were found for the effects of prenatal depression. Raposa et al.[5] found that prenatal maternal depression directly influences child physical health at age five and, subsequently, is associated with poor health and social functioning at age 20.

These studies illustrate the range of child outcomes affected by exposure to prenatal maternal depression and anxiety. While several studies have looked at birth and early infancy outcomes of prenatal exposure, assessments at school entry are typically for social, emotional and behavioural outcomes. Further, while there is substantial evidence that increased maternal stress and depression levels during pregnancy can negatively affect infants and children, mechanisms or pathways through which these effects occur are less clear (see Section 2.4 below for further discussion).

2.2.2.2 Exposure in Infancy

Prenatal depression is the strongest predictor of postnatal depression[4] and ongoing maternal depression and anxiety are predictors of postnatal parenting distress.[74] While it has been suggested that about half of postnatal depression starts during pregnancy,[75] depression in the postnatal period has been identified as a distinct entity.[76, 77] In addition, prenatal and postnatal anxiety have been found to represent separate risks for emotional and behavioural problems in children.[51, 54] Infants of chronically depressed mothers may experience learning difficulties in part because: (a) negative maternal affect interferes with infants' early learning efforts by raising their arousal level; (b) they are less exposed to the facilitative components of infant-directed speech; (c) mothers' pattern of physical touch may affect infants' neural development and/or readiness for learning; (d) the non-contingent interactional style may impede infants' development of symbolic thought; and (e) the lack of coordinated, synchronized mother-child interactions results in a number of missed opportunities for mothers to shape and promote child learning.[13] In addition, depression in parents has been found to be associated with involvement with child protection services,[78] increased emergency department visits and decreased preventive health services[79-81] and not initiating age-appropriate parenting safety behaviours. [82]

The postnatal year has been identified as a particularly sensitive period in terms of the influence of maternal mood and anxiety disorders on child development.[14, 83] Murray[15] followed a sample of depressed, previously depressed and non-depressed women up to 18 months postpartum, when their infants were assessed on cognitive, social and behavioural development. Infants of depressed mothers were more insecurely attached, had more problems with object concept tasks and more behavioural difficulties, but no effect was found for general mental development or language development. The author suggests that these findings are consistent with the existence of a sensitive period that influences child outcomes later on. The duration of mothers' depression was not related to any measure, nor was the presence of depression at 18 months (though the number of women was low).

Murray and colleagues[84] later found that exposure to maternal depression in the early postnatal period, and associated disturbances in the mother-infant relationship, are associated with longer term behavioural and social development of the child at age 5. Sinclair and Murray[85] assessed the impact of postnatal depression on children at school entry as assessed by teachers and found that prosocial behaviour, temperament and behavioural disturbance were all significantly affected by postnatal exposure, particularly for boys and children of lower SES. No effect was found for children's readiness for school. O'Connor et al.[51] found that 8-week postnatal depression was significantly predictive of child behavioural/emotional problems at age 4, after prenatal maternal mood was controlled for. Essex et al.[83] found that exposure to maternal major depression during infancy was associated with high internalizing symptoms at kindergarten, particularly when co-occurring with high externalizing symptoms. As the authors note, this study did not have a non-depressed control group for comparison, so it is difficult to argue for specificity of effect.

Murray et al.[86] found no evidence of a direct adverse effect of postnatal depression on child cognitive functioning at age 5, even among sub-groups of children suggested to be vulnerable (boys and children from low SES families). However, effects of maternal-infant interaction at 2 months of age affected child cognitive development at 18 months and mother-infant interactions at 18 months were predictive of cognitive development at 5 years, suggesting that the effects of postnatal depression may have been mediated through mother-infant interactions. The authors suggest that the findings point to early infancy as a particularly sensitive period of development. A limitation of this study is the use of the Bayley Mental Development Index (MDI). Talge et al.[70] state that, though widely used for the assessment of cognitive development of infants and young children, it is limited in its predictive value of functioning at later stages. Kurstjens and Wolke[12] also found no difference in cognitive scores between children of postnatally depressed and non-depressed women past the age of 20 months. In a longitudinal study using linked administrative data, Guevremont et al.[73] examined the association

between treatment for maternal depression over numerous time periods – prenatal, postnatal, child ages 1 to 3, 4 to 6 and 7 to 9 – and ADHD at child ages 7-9 years. The study found that each time period was associated with later ADHD in children with the exception of the postnatal year.

Cogill et al.[87] followed children exposed to maternal depression postnatally to age 4 and found that children's cognitive performance at age 4 was significantly reduced in association with maternal depression only in the first year of their lives. In conducting a re-analysis of Cogill et al.,[87] Hay and Kumar[88] found, as in the original analysis, that postnatal depression did impair cognitive abilities in children at age 4. However, multivariate analysis found that sensorimotor development in the first year of life – those components of intelligence developing rapidly at the time – was most affected by maternal depression. Further, the effects of maternal depression on cognitive development were limited to children with less educated mothers. The authors concluded that the first year of life is particularly sensitive to maternal depression. Sharp et al.[89] also found that the postnatal period is a sensitive period: Exposure to postnatal depression predicted poorer cognitive scores at age 4, but only for boys. The study controlled for a wide range of potential confounders (e.g., birth weight, parents' IQ scores, the home environment, number of siblings, degree of marital conflict, quality of mother-child interaction, SES) but none had a significant effect.

Postnatal exposure has been linked to negative outcomes in older children also. Fihrer et al.[7] found that maternal postnatal depression was significantly correlated with mothers' reports of child internalizing and externalizing problems and teachers' rating of externalizing problems at ages 6-8. Further, later internalizing problems were fully mediated by concurrent (at child age 6-8 years) depression in mothers; in other words, postnatal maternal depression influences child behaviour in early school years through the effect of concurrent depression. The same mediation effect was not found for child internalizing problems. In a study of 175 mothers with a lifetime history of major depressive disorder (MDD) and

their first-born children, Bagner et al.[14] found that maternal MDD during the postnatal year predicted child internalizing and total behaviour problems up to child age 12, after controlling for a range of covariates (child age, child gender, parent age, history of maternal MDD and MDD following postnatal year, grandparent MDD and maternal MDD duration). Further, the study found that approximately 10% more children of mothers with MDD in the postnatal year were in the clinical range on the Child Behaviour Checklist (CBCL) than children whose mothers experienced MDD at other time points. A strength of this study was the assessment of the timing of maternal depressive episodes, rather than symptom assessment. In a prospective 20-year study, Bureau et al. [90] found that maternal postnatal depressive symptoms were associated with child depressive symptoms at age 8 after controlling for gender, clinical risk status of the child and concurrent maternal depression symptoms. This association was also independent of maternal depression recurrence over childhood. Further, the unique influence of the postnatal year was also found for depression at age 19.

These studies illustrate the range of effects of postnatal depression and anxiety on child outcomes. Some studies found independent effects of the postnatal period – particularly for emotional and behavioural outcomes (the most frequently assessed outcomes), whereas others did not find the first year of life to be sensitive. For others, the influence of maternal depression and/or anxiety during the postnatal year is mediated through mother-infant interactions, a possible pathway through which postnatal exposure may influence child outcomes (see Mechanisms below). While findings are mixed, there appears to be evidence that exposure during the child's first year of life can be a particularly sensitive for early development. As Glover[91] states, more research is needed to determine the specific effects of the maternal prenatal and postnatal mood and anxiety disorders on child development, and these time periods are assessed as part of this study (see Chapter 3).

2.2.2.3 Exposure in Toddlerhood

Fewer studies appear to examine exposure specifically during the toddler period (child ages 1 to approximately 4 years) – most begin assessments earlier, in the postnatal phase, and/or continue through the school entry exposure and beyond. Studies have examined exposure to maternal depression or anxiety in the toddler period and assessed child outcomes in the toddler/preschool years. Bigatti et al.[92] examined whether maternal depression was associated with mother-child interactions in a group of low-income mothers and their children attending a literacy program. Mothers in the study were recruited from a Head Start program when their children were between 1 and 3 years of age. The study found that mothers who were depressed engaged in fewer literacy behaviours, were less likely to read to their children and did so for shorter periods, sang less to their children, asked fewer questions and reported feeling less comfortable with their children. No differences were found in cognitive development between children of depressed and non-depressed mothers. However, the authors note this is not surprising given the small sample sizes (e.g., the sample for the assessment tool for under 3 years was 76 children) and young ages of the children (mean=26.5 months). Attachment processes can be impaired also. Cicchetti et al. [11] found that toddlers with depressed mothers were at greater risk for insecure attachment than toddlers of non-disordered mothers. In predicting the growth of toddler vocabulary production, Pan et al.[49] found a curvilinear relationship between maternal depression at child age of 14 months and vocabulary up to 36 months. This effect was stronger during the latter part of the two-year study period, suggesting that the effects of maternal depression persist, or even increase, over time.

A few studies have assessed the relationship between toddler period exposure and child outcomes at school entry. Lyons-Ruth et al.[93] studied the influence of maternal psychosocial problems (e.g., depression symptoms, child maltreatment or history of psychiatric hospitalization) and disorganized attachment on teacher-rated child behaviour problems in kindergarten in a small low-income sample of

families (n=62). Assessments were done at 18 months and 5 years. Maternal psychosocial problems were associated with child hostile behaviour. As the authors state, disorganized attachment is likely to represent an early precursor of behaviour problems. In the study, children with disorganized attachment histories accounted for 71% of the cases of serious hostile behaviour at kindergarten. An additive effect was found for the presence of maternal psychosocial problems and disorganized infant attachment, where over one-half (56%) of exposed children displayed deviant levels of hostile behaviour in preschool. A limitation of this study was that the effects of depression were not separated from child maltreatment or hospitalizations and that the timing of exposure was not always clear. However, as the authors note, only three of the mothers with psychosocial problems had psychiatric hospitalizations alone; therefore, most of these mothers had problems that were present during early infancy of the child, either through depressive symptoms or involvement with child protection. Further, and perhaps most importantly, 52 of the 62 women had serious depressive symptoms. The sample size for the study was modest, but the longitudinal design and multiple measures represent strengths.

In contrast, other research has examined the impact of exposure to maternal depression through the toddler period, but did not find an effect. Essex et al.[83] concluded that, for girls only, first exposure to maternal depression in the toddler/preschool period may pose a unique risk for externalizing symptoms upon entering kindergarten. However, toddler exposure was not associated with internalizing problems. Sharp et al.[89] assessed a cohort of children (n=172) born to mothers in North London to determine if timing of exposure was predictive of cognitive performance at 4 years of age. While the study found strong effects for boys who were exposed in the postnatal year, no effect was found for exposure over the three years following the child's first year of life. Leckman-Westin and colleagues[94] did not find a lasting effect of toddler exposure to depression on behavior at age 12 if mediated by positive parenting.

Child outcomes in the early school years have been examined also. Jensen et al.[10] examined several paths that included the relationships between maternal depression, contextual risk (SES) and interpersonal stress and their influence on child social and cognitive outcomes at age 8. The study found two significant pathways, both of which included exposure to maternal depression at child age 2-4 years. Specifically, in the first path, maternal depression in pregnancy was associated with interpersonal stress at child age 0-2, which was associated with maternal depression at age 2-4. In the second path, contextual risk in the prenatal period was associated with interpersonal stress at ages 0-2 which was then associated with maternal depression at age 2-4. For both paths, maternal depression at age 2-4 was significantly associated with social and cognitive outcomes at age 8. These findings suggest that exposure during the toddler years plays an important role – along with contextual risk and interpersonal stress – in child outcomes. Further, the inter-relations among risk factors underscore the idea that risk factors may maintain and reinforce each other.[10] Barker et al.[54] assessed exposure to maternal depression and anxiety at child age 21 months and found exposure at this time was associated with internalizing difficulties at age 7-8 and that depression was modestly associated with internalizing and externalizing difficulties and a decrease in verbal IQ at age 7-8. Using linked administrative data to examine the relationship between maternal depression and ADHD, Guevremont et al.[73] found a significant association between exposure to treated depression at ages 1-3 and ADHD at ages 7-9. Letourneau et al.[40]found that exposure to maternal depression at ages 2-3 was associated with child anxiety at age 10, after controlling for the timing of exposure. Leckman-Westin et al.[94] found that maternal depression symptoms at age two were associated with more behavior problems where problem parenting behavior also existed. Negative effects of maternal depression on toddlers' behaviour persisted until 10 years later.

As shown, exposure to maternal depression and/or anxiety during the toddler years has been found to influence child outcomes at school entry and beyond, however, findings are equivocal. Where

associations were found, they are typically for emotional or behavioural outcomes (as noted, these are also the most frequently assessed child outcomes). In addition, the influence of disorganized attachment and positive or negative parenting were identified as potential mediators (see Section 2.4 below for further discussion).

2.2.2.4 Exposure at School Entry

Child exposure to maternal depression or anxiety around the time of school entry has been found to be associated with negative child outcomes. Sinclair and Murray[85] examined teachers' reports of child adjustment to school for five-year old children exposed to maternal depression over early childhood. In addition to finding an influence of postnatal depression, the authors found that recent exposure was significantly associated with greater levels of disturbance, particularly for boys from low SES families. Murray et al.[95] found increased negative cognitions (e.g., hopelessness, pessimism and low self-worth) in children who were exposed to maternal depression in the 12 months prior to assessment at age 5. Turney,[44] in a study of 2427 unmarried and low-income mothers from the Fragile Families and Child Well-Being survey, found that exposure to maternal depression at age 5 was associated with behaviour problems in children, but not cognitive outcomes, independent of chronic exposure over the course of early childhood. Luoma et al.[71] found that proportions of low-functioning or problematic children were generally larger among children of mothers with concurrent (child age 5) depressive symptoms, except for Internalizing Problems (Teacher's Report Form). Kim-Cohen[96] and colleagues concluded that children exposed to their mother's depression between ages 5 and 7 years showed a subsequent increase in anti-social behaviour by age 7 years. Alpern and Lyons-Ruth[97] found an increase in child hyperactivity and demanding behaviour in children exposed to recent depression at school entry and Guevremont et al.[73] found an association between treated maternal depression at child ages 4-6 and development of ADHD

at ages 7-9. In their study of the impact of maternal depression on child behaviour in the early school years (child ages 6-8), Fihrer et al.[7] found that concurrent maternal depression – experienced at child ages 6-8 – was associated with mother-reported internalizing and externalizing problems and teacher-rated externalizing problems. Further, the study found that concurrent maternal depression mediated the relationship between postnatal depression and child behaviour problems in the early school years. In other words, part of the influence of postnatal depression on child behaviour at age 6-8 years of age was due to the occurrence of depression in mothers at the time of the early school assessments.

In contrast to behavioural and emotional outcomes, studies that have examined exposure to maternal depression and/or anxiety at school entry and child cognitive outcomes have not found a relationship. Cogill et al.,[87] and Hay and Kumar[88] in a re-analysis, examined the relationship between concurrent maternal depression and child cognitive development at age 4 and found no association. Cogill et al.[87] suggest that the impact of maternal depression may be long term rather than transitory, however, the sample size was small and depression was not assessed in the period between one year postnatal and child age 4. In a study by Murray et al.[95], the association between recent maternal depression (previous 12 months, for 5 year-old children) and child negative cognitions ceased to be significant when maternal hostile and critical behaviour was taken into account.

Fewer studies have examined the influence of exposure to maternal depression and/or anxiety at school entry on child outcomes at that time, however, effects have been found for exposure close to, or in the period preceding entry to school. As discussed, studies examined emotional/behavioural outcomes as well as cognitive performance at school entry. Where cognitive outcomes were assessed, a conclusive influence of maternal mood and anxiety disorders is less clear.

2.2.2.5 Summary

As described in the literature, exposure to maternal mood and anxiety disorders in different time periods over early childhood has effects on outcomes at school entry. Exposure in the prenatal period has been shown to have a range of physiological effects on birth outcomes and infant biochemistry. These effects have been shown to impact stress and coping responses over the long-term, including at school entry and beyond. Several studies found an effect of postnatal depression on later child development, and identified this as a particularly sensitive period, where others did not. Effects have also been found in later childhood and up to around entry to school; however, results are equivocal. The range of findings for studies reviewed is dependent on factors such as study design, sample size, timing and methods of assessment and whether control, mediating or moderating influences were included. There is evidence that these intervening and moderating factors – such as genetics, the caregiving environment and SES – influence child outcomes following exposure to maternal mood and anxiety disorders. Mechanisms of how these and other factors influence the relationship between maternal mood and anxiety disorders and child development are discussed in more detail below (Section 2.4).

The next section examines the three aspects of maternal depression and anxiety disorders of interest for this study: timing, recurrence/persistence and severity.

2.3 Aspects of Maternal Mood and Anxiety Disorders

2.3.1 Timing

Evidence suggests that exposure to maternal depression at particular periods of child development do make a difference in terms of child functioning. Beyond studies that have assessed exposure at one

point in time, others have compared the exposure to maternal depression at more than one point in time to determine if "timing" is significant.

As described above, infancy has been identified as a particularly sensitive period.[13, 15, 84, 86, 88] However, there are contradictory findings in the literature. Essex et al.[83] examined the timing (two periods: postnatal to one year and toddler ages 2 to 4½) of initial exposure to maternal depression and found exposure during infancy to be associated with high internalizing problems, particularly when co-occurring with high externalizing problems, and exposure during toddlerhood was associated with an increased risk of externalizing symptoms in girls. Luoma et al.[71] examined the relationship between maternal depression symptoms prenatally, postnatally (1 week and 2 and 6 months) and at child 8-9 years (a subsample was also assessed at child ages 4-5 but the results were not included in this study) and later child behaviour outcomes at age 8-9. The study found the presence of prenatal and recurrent maternal depressive symptoms to yield the least favourable child psychosocial outcomes. In contrast, Kim-Cohen[96]and colleagues found that prenatal-only exposure to depression was not associated with child anti-social behaviour (ASB) at age 7; children of mothers who were exposed postnatally only or prenatally and postnatally were more likely to exibit ASB. Contrary to other studies that have found the postnatal period to be sensitive, Luoma and colleagues found the impact of depression in this period on later child behaviour problems to be slight. As they suggest, this may imply that consequences of postnatal depression for a child can be compensated along with maternal recovery over time. Turney[44] found a stronger association between both chronic depression and depression at age 5 than for the exposure to earlier depression (ages 1 and 3).

Brennan et al.[17] examined timing, severity and chronicity of maternal depression and their influences on child outcomes. Timing was defined within a strict range of severity and chronicity, to control for these, and was assessed by comparing children whose mothers reported a severe level of depressive

symptoms on only a single administration of the assessment inventory with one another, as well as with children whose mothers reported a moderate level of depressive symptoms on only a single administration. The study found that timing was modestly related to behaviour problems, particularly at age 5, but not for vocabulary and that timing of exposure to maternal depression at age 5 was more significantly related to child behaviour than symptoms at earlier points in time. A limitation of the study was that the assessment of timing was limited to a single episode of elevated symptoms and, as the authors suggest, the larger issue of timing may concern broad periods such as preschool, school age or adolescence. Hammen and Brennan[98] examined the timing, severity and chronicity of maternal depression over the first 10 years of life and the impact on the development of psychiatric disorders in 15-year old children (n=816). Timing was assessed as the presence of maternal depression between birth to 2 years, 3-5 years, or 6-10 years of age. The study found that women who were depressed at one point over the 10 years were likely to have depressive episodes at other times; therefore, as the authors state, timing of depression and total exposure (chronicity) are confounded with each other. To control for this, unique groups where women were depressed at one point in time but not another were identified. Compared to children whose mothers were never depressed, those whose mothers were depressed at only one point in time had higher rates of depression. Further, no association was found between timing of exposure and outcomes when chronicity and severity of symptoms were controlled.

In contrast to studies that measured maternal depression symptoms, Guevremont et al.[73] examined the impact of timing of a diagnosis of maternal depression (in the year before birth and at child ages 1-3, 4-6 and 7-9) on development of ADHD at ages 7-9 using a population-based registry linked to administrative health data. The study found that a diagnosis during any time period, except for when the child was less than one year old, predicted ADHD diagnosis at age 7-9. However, regardless of the timing, the chronicity of depression (presence at two more time points) was the most important predictor of ADHD. A limitation of the study is that the true rate of maternal depression may have been underestimated as

not all depressed women may have sought treatment and there are limitations to measuring depression using administrative data (see Introduction and Methods chapters). Further, as only the presence or absence of a depression diagnosis was assessed, severity of depression was not included, including comorbidity of other psychiatric conditions that may be related to child ADHD.

Alpern and Lyons-Ruth[97] assessed previous, recent and chronic exposure to maternal depression and teacher- and mother-rated child behaviour outcomes for mothers and their 4 to 6 year old children (n=64). The study found that 69% of women depressed at the preschool assessment also had depressive symptoms during the child's infancy. Children whose mothers were depressed both in infancy and at preschool had significantly higher rates of hostile behaviour at school and home, compared to children whose mothers were never depressed. Exposure to maternal depression in only the postnatal period was associated with more anxious and withdrawn behaviour in children, whereas exposure only at school entry was associated with more hyperactive and demanding behaviour. Child cognitive scores and father's absence were examined but did not mediate the independent effects of timing and chronicity.

In their study of the effects of postnatal and concurrent (at child age 6-8 years) maternal depression on child behaviour problems in the early school years, Fihrer et al.[7] sought to clarify the impact of timing, chronicity and severity of maternal symptoms on child outcomes. With respect to timing, the authors concluded that both early and later depression appear to be important. The study found that postnatal depression was associated with mother-reported child internalizing and externalizing at child age 6-8 and that maternal depression in those early school years was also associated with mother-reported child internalizing and externalizing and teacher-reported externalizing problems. In a longitudinal study of several cycles of the National Longitudinal Study of Children and Youth (NLSCY) (n=10,033), Letourneau et al.[40] reported that later onset of maternal depression (child ages 2-3 or older) had a stronger

association with poor child cognitive and behavioural outcomes at age 10 than exposure to earlier depression. Timing had no effect on math achievement.

Kurstjens and Wolke[12] studied the effects of several aspects of depression (timing, severity, duration, chronicity, frequency and recency) on child cognitive development. A sub-sample (n=1329) of singleton children enrolled in the Bavarian Longitudinal Study were evaluated at 20 months, 4.8 years and 6.3 years and their mothers were assessed by psychiatric interview at child age 6.3 years. Timing was measured by exposure to maternal depression in the first year of life ("postnatal depression") and beyond one year ("later depression"). The study did not find any main effect of timing – or any of the other aspects evaluated – on later cognitive development. A major limitation of the study was the use of retrospective reporting of maternal depression over a 7-year period. Further, the large number of comparisons of aspects of depression resulted in small cell sizes; however, the findings were statistically significant.

These studies illustrate the range of findings regarding timing of exposure to maternal mood and anxiety disorders. Several authors found a significant timing effect, whereas others did not, particularly where an effect of a single time period was assessed. The inconsistent and outcome-specific findings of the studies reviewed highlight the difficulty in isolating exposure at particular time periods compared to others. Further, the confounding of timing with chronicity or persistence, and severity, of maternal mood and anxiety disorders (see below) may also account for the lack of a "timing effect" for some studies. In addition, variations in study design, sample, methods and timing of assessment and covariates included can account for the range of findings. Despite the lack of unequivocal findings in the literature, there is evidence of "sensitive" periods for children exposed to maternal mood and anxiety disorders. In a large meta-analytic review (n=193 studies), Goodman et al.[30] suggest that their findings are consistent with the notion of sensitive periods of exposure to depression in that: a) children exposed

younger may be developmentally vulnerable than children exposed later; b) children exposed later may have more years of healthy development prior to exposure; c) later in development, other influences such as fathers, teachers and peers reduce the dependence on mothers and may attenuate the effects of exposure to maternal depression; and d) older children, with increased cognitive maturity, may better understand their mothers' symptoms and have more developed emotional and information processing. As the authors note, studies rarely select samples based on first exposure or statistically control for timing or prior exposure, so further longitudinal research is needed to sort out the effects of timing. As discussed in detail in the Methods chapter, this study examines the influence of different time periods over the early childhood years on outcomes at school entry.

2.3.2 Recurrence/Persistence

Persistent or recurring exposure to maternal depression or anxiety over the early childhood years has been found to have robust associations with negative child outcomes. As Essex et al.[83] and others[99-101] have suggested, the persistence or recurrence of maternal depression may mean that it is the length of exposure, rather than timing, that is most critical. As Sohr-Preston and Scaramella[13] note, chronicity of maternal depression may be more problematic for children than other aspects, possibly because depression interferes with mothers' ability to respond sensitively and consistently over time. Campbell, Cohn and Meyers[102] examined the impact of prolonged maternal depression in the postnatal period (at 2, 4 and 6 months) in a sample of married, middle-class women (n=67; controls = 63). The study found that mothers whose depression persisted to the 6-month point were less positive with their infants over the three time points and their infants were less positive in face-to-face interactions, compared to women whose depression was short-lived. Luoma et al.[71] found that a recurrence of maternal depression symptoms (at two or more time points) was associated with a greater proportion of poor

psychosocial functioning and behavioural problems. A study by the National Institute of Child Health and Human Development (NICHD)[101] found that mothers with chronic depression were least sensitive and responsive in their interactions with their children. Children of chronically depressed mothers (symptoms assessed at 1, 6, 15, 24 and 36 months) had poorer performance on school readiness, verbal comprehension and expressive language scores and more behaviour problems. In line with a mediation model, poor maternal sensitivity partially accounted for some of the negative effects of depressive symptoms on children. Further, higher levels of maternal sensitivity in depressed mothers appeared to partially buffer some of the effects of depression. Petterson and Albers[103] assessed the impact of maternal depression on child development (cognitive and motor skills) at 28 and 50 months of age. Large effects were found for both boys and girls, particularly in cognitive development outcomes.

Timko et al.[104] examined developmental outcomes for children of stably remitted, partially remitted and non-remitted parents with unipolar depression. Follow-up was conducted at child ages 1, 4 and 10 years. At the four-year follow-up, children of non-remitted parents were more likely to have feelings of being sad or blue, and have emotional, behavioural, discipline and academic[xii] problems than children of control parents. In addition, children of non-remitted parents exhibited more distress, physical health problems and behavioural problems and were more likely to be considered disturbed than children of stably remitted and partially remitted parents. Partially remitted and especially non-remitted families experienced poorer functioning than stably remitted families. These findings highlight somewhat of a dose-response relationship in terms of exposure to chronic/recurring parental depression. At baseline, controls were evenly divided between mothers and fathers, whereas the proportion of mothers in the depressed groups ranged from 58.6% (stably remitted and non-remitted) to 72.3% (partially remitted). A limitation of the study was that parents reported on all children living in the home, so individual data

[xii] Unspecified, and grouped under "behavioural" outcomes.

on each child was not collected. However, considering all children in the home allowed the investigators to explore the full range of outcomes on children of depressed parents. Kim-Cohen et al.[96] found a dose-response relationship between number of periods of maternal depression and degree of child anti-social behaviour (ASB). This study relied on twin data and, as the authors note, rates of depression may be higher in mothers of multiples than singletons. Further, the findings may not be generalizable to mothers and their singletons; however, effect sizes for this study (0.25 to 0.37) were similar to studies of singletons (0.25 to 0.46).

In an Australian study that examined the longitudinal relationships between maternal depression, child physical health and child depression, Raposa et al.[5] found that maternal depression during pregnancy was directly associated with child physical health problems before age 5. In turn, depression in pregnancy was indirectly associated with child physical health via persistent depression across the early childhood years. Poor physical health in children at age 5 was associated with later health stress and social adjustment problems at age 20. In a longitudinal study using linked administrative data in Manitoba, Kozyrskyj et al.[105] found that recurrent exposure to maternal distress following birth was associated with child asthma at age 7.

In a large sample (n=10,033) from several cycles of Canada's National Longitudinal Survey of Children and Youth (NLSCY), Letourneau et al.[40] found markedly higher odds of cognitive and behavioural problems in children aged 4-5 exposed to recurrent maternal depression from birth, compared to children of mothers with postnatal only depression or later depression only (past postnatal year). In their study of postnatal and concurrent maternal depression on child behavior problems at child age 6-8, Fihrer et al.[7] examined chronicity and defined this as the total number of depressive episodes reported by the mother between the postnatal year and child ages 6-8. They found significant correlations between the number of depressive episodes and symptom severity at 4 months postnatal

(r=0.46), mean symptom severity score (r=0.52) and concurrent symptoms at child age 6-8, confirming that severity, chronicity and concurrent symptoms are confounded.

Turney[44] examined the relationship between depression in unmarried, low-income mothers (n=2427) from the Fragile Families and Child Well-Being survey and child behavioural and cognitive outcomes at age five. Assessments were done at child age 1, 3 and 5 and chronicity or recurrence of depression was defined as the presence of depression at all three time periods. The study found that children of chronic-depressed (all three waves) mothers had more internalizing and externalizing behavior problems compared to children of never-depressed mothers, controlling for economic resources, family structure and maternal health. When a binary variable of greater than the 90th percentile for each of child internalizing and externalizing behavior was substituted for the continuous measures, children of chronic-depressed mothers exhibited more internalizing problems than children of never-depressed mothers. For externalizing problems, children of chronic-depressed mothers had more problems than children of mothers with depression at two points, one point or no points over the study period. Other studies have found that persistence or recurrence of maternal depression or anxiety has a stronger association with child outcomes than any particular time period.[17, 63, 97, 98, 103, 106, 107]

In contrast to the studies above, Kurstjens and Wolke[12] did not find any main effects of aspects of chronicity, duration or severity of maternal depression on child cognitive outcomes at 6.3 years of age. However, significant interactions were found for gender and severe-chronic depression: Low SES boys and boys hospitalized for neonatal risk whose mothers had severe-chronic depression had poorer cognitive performance than other subgroups. As the authors state, a limitation of these findings is that interactions in small samples are prone to outliers.

As shown in the studies cited, recurrence or persistence of maternal depression and/or anxiety has been found to have an influence on child outcomes at school entry. The majority of studies that examined

chronicity, persistence or recurrence of exposure did find a significant association and, for those that also examined particular time periods, persistence/recurrence was found to have a stronger influence. A few studies also found a dose-response relationship between number of periods of exposure and child outcomes; others found that the effects of chronic/recurrent exposure persisted even after maternal symptoms subsided. Again, the range of findings is dependent on study design, sample, covariates measured and methods and timing of assessment; however, a finding of note is that studies that examined recurrence/persistence at two or more specific points in time and those that examined longer periods of duration both found significant effects, suggesting a strong influence of recurrent or persistent exposure. Further, as discussed below, other factors – such as the caregiving environment, family context and SES – may maintain a compromised environment for the child and mediate or moderate the relationship between longer/more periods of exposure and development at school entry.

2.3.3 Severity

Another aspect of maternal mood and anxiety disorders that has been explored in the literature is severity. Greater severity is likely to result in more impairment of functioning.[17] In a large (n=4953) longitudinal study, Brennan et al.[17] assessed maternal depression symptoms during pregnancy, immediately postpartum, and when the child was 6 months old and 5 years old. Child behaviour and receptive vocabulary were assessed at age 5 follow-up. Severity (measured by a continuous variable reflecting the number of symptoms at each assessment and a categorical distinction between "moderate" and "severe") and chronicity (assessed with a continuous measure of the number of assessment periods where moderate or severe depression was present) were highly correlated (r=0.81). To tease out the differences between the impact of severity and chronicity, four distinct groupings were created: (a) neither severe nor chronic; (b) chronic but not severe; (c) severe but not chronic; and (d)

both chronic and severe. The study found that both severity and chronicity of symptoms were related to increased behaviour problems and lower vocabulary scores. Further, the interaction of severity and chronicity was significantly related to more child behaviour problems, but not to vocabulary scores. Analyses of the four distinct groups showed that children whose mothers had symptoms that were both chronic and severe had significantly more behavioural problems. The study included a number of controls and covariates (e.g., maternal age, child birth order and gender, maternal education, family income and changes to marital status) and concluded that demographic factors were more strongly related to child cognitive functioning than maternal depression symptoms. A limitation of the study was that attrition of more severe cases may have contributed to small to medium effect sizes for behavioural outcomes. Other limitations include: the depression assessment (Delusions-Symptoms-States Inventory) is not well known which limits comparison; mothers classified as "not depressed" at a given time period may have experienced depression in between assessments since true "chronicity" was not assessed; and symptoms of depression may not reflect a specific depression diagnosis but, rather, may be associated with other psychiatric or medical conditions. Another study by Brennan and colleagues[98] explored timing, severity and chronicity of maternal depression up to child age 10 on outcomes in adolescence, and found that the contribution of the mothers' most severe depressive level to later adolescent depression was significant, after controlling for demographic variables. However, neither chronicity nor the interaction between chronicity and severity were significant contributors. Despite no significant effect of chronicity, effects of mild depression differed from controls only if the duration was at least 12 months. In contrast, youth exposed to severe or moderate depression of only one or two months were as likely to develop depression as those exposed for longer periods. The authors note that a limitation of the study was the inability to detect whether the effects were due to genetics or psychosocial factors present even when depression has subsided. Further limitations include a small sample and reliance on retrospective maternal reports.

Petterson and Albers[103] tested the severity of maternal depressive symptoms (moderate = 16-30 on the CES-D and severe >30) on child cognitive and motor skills development and found that both levels had significant effects on development for both boys and girls; for boys only, severe depression had a larger effect than moderate on all three developmental measures. Fihrer et al.[7] examined the relationship between symptom severity of maternal depression at child age 4 months and found a moderate association with internalizing and externalizing scores at child ages 6-8. Keller et al.[106] examined the impact of severity and chronicity of parental affective illness on the adaptive functioning and psychopathology of children. Children aged 6-19 (n=71) and their mothers from 37 families were interviewed by structural clinical interview. At least one of the biological parents had a depressive disorder but neither had a history of mania, schizophrenia or schizoaffective disorder. Seven indices of severity and chronicity (for both parents) were evaluated in the study: duration of major depressive disorder (MDD); weighted duration of depression; number of episodes of major depression; times treated for MDD; times hospitalized for MDD; suicide attempts; sex of parent with MDD; and maximum severity of depression (for all episodes of MDD in both parents). Outcomes for children included current level of adaptive functioning, lifetime incidence of any psychiatric disorder (*DSM-III* criteria) and lifetime incidence of major depression (*DSM-III* criteria). The study found that for each of the indices (severity and chronicity), more severe or chronic parental illness was associated with more impaired child adaptive functioning and increased rate of child psychopathology. The one index that was not significantly associated with the child outcomes was "number of times hospitalized." For minor depression and dysthymia, the authors empirically tested several estimated relative weights of duration of major and minor depression and found that the association with child adaptive functioning was greatest when two years of dysthymia was scored as equivalent with one month of MDD. Maternal depression was significantly associated with poor adaptive functioning in the child, while the impact of fathers' depression was negligible. To test for systematic bias of absent fathers possibly being

depressed, data were imputed to assume all absent fathers were depressed. Even after these analyses, maternal depression remained highly significant and largely accounted for the impact of parental illness. Limitations of the study include a modest sample, analyses limited to the unit of the child (e.g., number of children and other unmeasured within-family effects excluded), mothers were typically the only informant and sampling may have been biased against families with severely ill fathers. Further, the children were older than the early childhood period so early influences in those sensitive periods were not assessed. As the authors note, in addition to unmeasured familial factors, genetics may play a role in both child and parental adjustment and psychopathology.[106]

Harder et al.[108] investigated the influence of severity as measured by a global parent functioning measure (Spitzer-Gibbon-Endicott Global Assessment) and history of parental psychiatric hospitalization on child functioning.[xiii] In the sample (n=101), diagnoses included schizophrenia (11%), affective disorders (9%) and non-psychotic disorders (60%), mostly neurotic depression. About one-half of the hospitalizations (49%) were for schizophrenia and the other half for affective (16%) and non-psychotic illnesses (34%). A variety of child cognitive and social competencies were assessed by teacher and peer ratings. The index parent's global assessment was significantly associated with primarily child cognitive functioning, as opposed to social or normative functioning. Results for the DSM-III diagnoses showed a more equivocal pattern: friendliness, cognitive competence and academic problem solving were significantly related to diagnosis. Interestingly, the study found that boys in families with affectively disordered parents scored high on all three of these elements. Effects were found to be independent of SES (measured by Hollingshead two-factor index). Similar to Keller et al.,[106] this study did not find an association between the number of psychiatric hospitalizations and any of the child measures. Diagnosis at the time of the study was not always indicative of a parent's impairment level, indicating

[xiii] The age of children at the time of the assessment was not specified, though in the University of Rochester Child and Family Study (URCFAS), from which the sample was derived, children were under10 years of age when their families were recruited.

that levels of impairment outside acute episodes may be more influential on child development and supporting the notion that parent functioning is an important covariate in the study of maternal depression on child outcomes. Overall, as the authors suggest, these findings suggest that the severity of chronic parental problems has significant implications for child competence in school. Campbell et al.[109] investigated the impact of trajectories of maternal depression from child age 1 month to 7 years. Group differences in teacher-rated outcomes (cognitive, social and behavioural) at first grade were fully explained by co-occurring differences in demographic characteristics that varied with trajectories of maternal depressive symptoms, with children whose mothers were in the moderate-increasing group showing the most problems.

The effects of maternal depression have been found to be more adverse than for exposure to other psychiatric illnesses. Sameroff et al.[107] found that both mothers with neurotic depression, and their offspring, showed poorer outcomes when compared to mother-infant dyads with schizophrenia and controls with no mental illness. Maternal mental illness was assessed by structured psychiatric interviews with mothers while pregnant and when the child was 30 months, and from a psychiatric registry. Infants were assessed at birth and at 4, 12, 30 and 48 months. Children of schizophrenic mothers performed more poorly than controls; however, as the authors concluded, children of mothers with depression were at the greatest risk for poor cognitive, psychomotor, social and emotional development. Further, the authors found that the impact of maternal depression persisted throughout the early years. A limitation of the study is that it is not clear whether exposure in the prenatal period and/or at 30 months, or both, was related to child outcomes. The study did find that children of chronically or severely ill mothers had poorer obstetric and newborn status, more difficult temperaments at 4 months, were less spontaneous and mobile at 12 months and at 30 to 48 months, had lower developmental test scores and were reported to have more behavioural problems in the home.

Depression is often present with other psychiatric disorders, contributing to illness severity. In particular, depression and anxiety often co-occur[16, 47, 50, 51, 110] A US survey of psychiatric comorbidity (n=9090) found that most lifetime (72.1%) and 12-month (78.5%) cases of MDD had comorbid disorders as defined by the DSM-IV. For the lifetime group, the majority (59.2%) had comorbid anxiety, followed by 24% with substance abuse disorder and 30% with impulse control disorder. For the 12-month group, comorbid anxiety disorders (57.5%) were more common than substance abuse disorders (8.5%) and impulse control disorders (16.6%). The study found that symptom severity is strongly associated with both role impairment and comorbidity.[111] Downey and Coyne[34] state that personality disorders that co-occur with major depression likely have a complex effect on children. Rutter and Quinton[112] found that both parental psychiatric disorder and marital discord were persistent over a four-year study period, however, the persistence was even greater when the parent had a personality disorder. Kim-Cohen et al.,[96] in a population-based, prospective, longitudinal twin study (n=1116 families) of the relationship between maternal depression and children's anti-social behaviour (ASB), found that maternal depression was significantly associated with anti-social personality disorder (ASPD) symptoms, as measured by diagnostic interview. Maternal depression was also associated with child ASB, and this association held after controlling for ASPD symptoms (a statistical control for passive gene-environment correlation). Maternal comorbidity accounted for 29% of the effect of maternal depression on child ASB by mother/teacher report and 18% of the effect as measured by teacher report only. The study concluded that comorbidity of maternal depression and ASPD posed the greatest risk for children's anti-social behaviour.

As these studies illustrate, severity of maternal mood and anxiety disorders has been found to be significantly associated with a range of poor child outcomes at school entry – emotional, behavioural and cognitive. However, the confounding of chronicity, severity and timing, as well as comorbidity, pose challenges for researchers when attempting to identify their influence. The findings for severity are less

clear than for recurrence/persistence and this may be due to confounding as well as the range of study design, sample size, timing and methods of assessment and the consideration of mediating, moderating and control variables.

2.3.4 Summary

While research has attempted to sort out the influences of timing, severity and chronicity, this effort has been challenged by the fact that they are typically confounded[7, 17, 98] Study findings varied depending on design, sample population, measures and analyses. In particular, how timing, chronicity and severity are measured is quite variable. Further, most studies rely on measures at specific points in time, sometimes with years in between assessments, so there may be significant gaps in terms of a pattern of chronicity or severity. In these cases, "recurrent" may be a more accurate term.[17, 71] Other confounding variables may account for some of the differences shown and, as the next section (Section 2.4) describes, various pathways or mechanisms of how maternal depression relates to child development have been put forth.

A significant finding that speaks to the importance of maternal mood and anxiety disorders as a factor in child development is that effects of maternal mood and anxiety disorders have been found to persist, even when symptoms subside. Lee and Gotlib[33] found that even when the severity of mothers' depressive symptoms abated, poor child outcomes persisted, suggesting there may be a substantial lag between alleviation of symptoms and improvement in child outcomes. Further, evidence suggests that even when depressive symptoms reduce or are no longer present, the home or family environment in which the child continues to be exposed may have a negative impact.[104] Billings and Moos[63] found that, despite remittance of depressive symptoms in parents, their children continued to have higher rates of dysfunction. As they suggest, changes in the "family milieu" (e.g., cohesion, expressiveness and conflict) may occur at different rates and more slowly for some, resulting in delayed improvements in child

adjustment. In a study of the impact of postnatal and concurrent (at child ages 6-8) maternal depression on child behavior problems, Fihrer et al.[7] found that severity of maternal symptoms at 4 months postnatal was significantly associated with child behavior problems 6 to 8 years later, supporting the notion that more severe illness has persisting or lasting effects (and, as noted above, is highly confounded by chronicity). Harder et al.[108] found that it was not the degree of impairment during an episode of parental mental illness that required hospitalization, nor the number or recency of such episodes that had the most impact on child competence; rather, it was the degree of recovery to a usual level of health following hospitalization. In other words, as the authors note, the parent-child interaction over the longer periods outside acute episodes of psychiatric illness were more predictive of child outcomes and may suggest "a route of risk transmission." Further, it is possible, due to an interaction between genes and the environment, that parents who pass on a genetic risk to their children may also create and sustain risky environments.[20] Regardless, the prolonged impact when depressive symptoms have subsided suggests that some other mechanisms may be operating which continue to pose a risk for child outcomes.

The next section examines literature that describes potential mechanisms or pathways that link exposure to maternal mood and anxiety disorders and child outcomes.

2.4 Mechanisms of Transmission: How Maternal Mood and Anxiety Disorders Affect Children

As several authors have suggested, difficulties faced by mothers with depression are not unique to the depression itself, or to the mother. Rather, there are other factors of contextual risk that may be associated with the depression that can influence the pathways to poor child development, including genetic/biological, psychosocial/parenting/family and the broader social context.[11, 13, 20, 34]

2.4.1 Genetics/Biological

The developmental or fetal programming approach suggests that influences in utero alter or 'program' the physiology of the infant which can lead to later illness, including mental illnesses, [9, 113] poorer health and immune function[4] and physical conditions such as cardiovascular disease, hypertension and type 2 diabetes. [114] It is believed that these changes in the development of the fetus are due to epigenetic processes – the interaction between genes or biology and the environment.[25, 113] Shonkoff et al.[25] suggest that there are two ways that these early experiences impact on later health: cumulative damage over time or through "biological embedding" (a phrase coined by Clyde Hertzman[115]) of negative influences during sensitive periods of development. However, the precise mechanisms – and causal directions – for these effects are unclear.[116]

As Hay and Kumar[88] suggest, intellectual development and depression are both heritable characteristics so any link between them could be mediated by genes, rather than early experiences.[88] Further, shared genetic factors contribute to the co-occurrence of lower SES and depressive symptoms.[117] However, Downey and Coyne[34] state that, based on twin and adoption studies, genetic factors can only partially account for the problems of children of depressed parents. It is more likely that genetic and other factors (biological, contextual) interact to influence child adjustment.[20, 34] Kim-Cohen et al.,[96] in a population-based prospective study of twins, found that familial liability for anti-social behaviour (ASB) accounted for approximately one-third of the observed association between maternal depression and child ASB. However, as the authors note, environmental mechanisms had a significant influence on the development of child conduct problems. As Elgar et al.[20] state, two key aspects of in utero influences on fetal development are that: (a) they function independent of genetics, as evidenced by animal studies showing transmission of physiological stress responses independent of genetic influence; and (b) unlike genetic mediation, the long-term effects of maternal depression on development show "multifinality,"

or a range of adverse emotional and behavioural outcomes evolving from common influences of problematic emotional regulation and temperament.

One possible direct biological pathway between maternal mood and anxiety disorders and child outcomes widely discussed in the literature is through the hypothalamic-pituitary-adrenal (HPA) axis. The HPA system is the interface between three endocrine systems in the body: the hypothalmus, the pituitary gland and the adrenal glands. The system eventually outputs glucocorticoid hormone (cortisol), the primary stress hormone. Under normal circumstances, cortisol is secreted and a negative-feedback loop regulates the system back to a normal state. However, this system is thought to be dysregulated in the depressed or stressed brain. Specifically, under these conditions, the glucocorticoid receptor function (which assists in the negative-feedback loop) decreases, resulting in hyperactivity of the HPA axis and increased inflammation.[27] Interestingly, normal pregnancy is associated with glucocorticoid resistance[118] due to elevated cortisol produced by the placenta; however, this resistance – and compromised glucocortisoid receptor function – is more pronounced in women who experience stress or depression during pregnancy.[27]

Decades of animal research has shown that prenatal maternal distress influences the HPA axis of mothers and infants and has varied and lasting impact on offspring.[70, 119, 120] However, as Weinstock [119, 120] notes, there is considerable variation in study features such as timing and nature of stress exposure, genetic strain of rat or mouse, sex of the offspring, timing of assessing the offspring HPA and type of cortisol measured (e.g., basal or stress-induced). As several reviews and studies have noted, studies in humans have also found that elevated maternal cortisol affects the hypothalamic-pituitary-adrenal (HPA) axis of infants[20, 24, 27, 121, 122] which results in higher stress hormone levels in infants,[28, 66, 122, 123] fetal growth restriction,[124] shorter gestation and low birth weight,[65] slower growth of the left and right hippocampus [125] and greater right frontal EEG asymmetry,[122] thereby disrupting the programming of the

fetal stress response systems.[113] Cortisol is thought to be a potential mediator[4] between HPA system dysregulation and negative outcomes for infants. In contrast, Kramer and colleagues[67, 126] examined possible pathways to preterm birth and did not find an association between hormonal measures (estradiol and progesterone) or cortisol and spontaneous preterm birth or maternal anxiety and stress.

O'Donnell et al.[127] suggest that changes to the placenta may be a pathway through which maternal depression or anxiety influences the developing fetus, rather than HPA axis, due to its role in regulating fetal exposure to the maternal environment. Pariante[27] suggests that hyperactivity of the HPA due to prenatal depression affects maternal caregiving through changes in the expression of several hormone-related genes (e.g., cortisol, oxytocin and estrogen-target). Riem et al.[128] found that better functioning of the oxytocin receptor gene was associated with greater physiological reactivity to infant crying and that depressive symptoms may suppress this response, thereby reducing maternal response to infant distress (See "Maternal/Family Context" below for further discussion on maternal care as a mediator). As with the animal studies, there is considerable variation in human studies. Glover et al.,[24] in a review of studies that have examined the relationship between prenatal mood and anxiety disorders or stress and effects on the HPA axis in children, state that while associations have been found, there are considerable variations in the nature of the association and types of stress or anxiety assessed.

Field et al.[66] found that infants' biochemistry (hormonal and neurotransmitter) mimicked that of their depressed mothers. The authors assessed urine samples of depressed (n= 45) and non-depressed (n=47) mothers and their infants and found that the depressed mothers had higher cortisol and norepinephrine and lower dopamine levels than non-depressed mothers prenatally and in the early postnatal period. These elevated levels were significantly associated with low birth weight and preterm birth. In addition, the study found that the newborn infants of depressed mothers had higher cortisol and lower dopamine and serotonin levels than their mothers. They suggest this is not surprising given

that heart rate and respiration in newborns is higher than in adults but that this finding further supports the notion that the biochemistry of neonates is reflective of their mothers. Field and colleagues[4] have also found that physiological profiles in infants are the same as their depressed mothers. These findings suggest that programming in infants and mothers due to stress is concurrent.[129]

In a full (n=832) and sibling (n=74 pairs) sample, Lewinn et al. [31] found that exposure to high levels of maternal cortisol during pregnancy was negatively related to offspring cognitive skills, independent of family attributes that characterize the postnatal environment, such as demographic characteristics and SES and genetics shared by siblings.[xiv] De Bruijn et al. [121] examined cortisol levels in toddler and preschool girls and boys exposed prenatally to maternal depression and anxiety. The study found that prenatally exposed girls had higher cortisol levels than non-exposed girls, but no difference was found for boys. Further, prenatally exposed girls had higher levels than prenatally exposed boys. These findings suggest that either biological mechanisms or the genetic-environment interaction operate differently for boys and girls. A limitation of this study is that it did not control for child exposure to maternal depression and anxiety after birth, which may have contributed to elevated cortisol levels.

Oberlander and colleagues[28] identified that the DNA methylation (a process that may alter gene expression) status of the glucocorticoid receptor (GR) gene may explain the epigenetic process that links prenatal maternal mood and stress reactivity in infants (due to altered HPA). Comparisons between the 3-month cortisol levels of infants born to depressed women treated with an antidepressant, depressed women/not treated and non-depressed/non-treated mothers found that exposure to maternal depressed/anxious mood (but not serotonin reuptake inhibitor exposure) in the third trimester was associated with an increase in methylation of the GR gene in newborns, suggestive of a "programming" process.

[xiv] it is interesting to note that this study did not control for maternal depression, a confounder associated with maternal cortisol levels and child cognitive development.

In contrast to mother's cortisol levels being a direct pathway toward compromised birth outcomes in infants, antidepressant medications consumed during pregnancy have been found to have a physiological impact on infants. Such medications are intended to act on the HPA system when consumed. Oberlander et al.[123] examined a large population-based dataset (n=119,547) in British Columbia that linked birth outcomes to maternal health records and prescriptions for selective serotonin reuptake inhibitor (SSRI) antidepressants. The authors controlled for severity of maternal mental illness and found that SSRI exposure prenatally was associated with a greater risk of low birth weight and respiratory distress. Pawluski et al.[130] examined whether these medications influenced the HPA system in newborns. The authors found that prenatal exposure to (SSRI) antidepressants resulted in increased corticosteroid-binding globulin (CGB) – the binding protein for cortisol – and salivary cortisol levels in infants, even when controlling for maternal depression. Another study by Ross et al.[131] found the effects of antidepressants in pregnancy to be small. In a systematic review and meta-analysis of 23 studies, the authors found that antidepressant exposure during pregnancy was significantly associated with low birth weight, gestational age and preterm delivery; however, the authors note the between-group differences (depressed/antidepressant, depressed/no antidepressant and no depression/no antidepression) were small and suggest that clinical significance be considered in the context of treatment decisions. Research has also found an influence of prenatal antidepressant exposure and later infant development. Hanley et al.[132] found that prenatal exposure to serotonin reuptake inhibitors (SRIs) was associated with lower scores on the gross motor, socio-emotional and adaptive subscales of the Bayley Scales of Infant Development measure, controlling for prenatal and postnatal depression, smoking and alcohol use during pregnancy. In addition, prenatal exposure to antidepressants has been found to induce "postnatal adaptation syndrome" (PNAS) where the infant's neurobehavioural adaptation has been impaired following withdrawal. Symptoms of PNAS include some combination of respiratory distress, difficulties feeding, jitters or tremors, shivering, temperature

instability, sleep problems, restlessness, jaundice, convulsions, rigidity and hypoglycemia with a greater risk from late-pregnancy exposure; however symptoms are usually mild and self-limited[133]

In addition to the indirect influence of maternal depression, anxiety and stress on the HPA system, an indirect pathway may operate through adverse health behaviours,[122] such as smoking, alcohol and substance abuse and lack of prenatal care.[75] While psychological stress may have a stronger impact on preterm delivery, health behaviours have been found to have a stronger effect on intrauterine growth.[75]

As noted above (see "Exposure in the Prenatal Period"), long term effects have been found following prenatal exposure to maternal depression and anxiety, supporting a programming hypothesis. While much of the effects of HPA dysregulation appears to occur from prenatal exposure, influences after birth can continue to alter the functioning of the HPA axis. Repeated exposure to depression or stressors after birth can continue to negatively affect the developing child's HPA system, resulting in allostatic load, or excess wear and tear on the biological stress response.[113] Such long term exposure can lead to a less flexible HPA response and increased risk of physical and mental illnesses,[113] also supporting the programming hypothesis.

There are a range of potential genetic or biological mechanisms through which maternal depression, anxiety or stress can influence child development. As Talge et al.[70] suggest, mechanisms or pathways may involve interactions among these various biological systems, however, further research is needed to sort out these influences (as described in the Discussion chapter, a limitation of the current study is the inability to assess biological or genetic influences). The next section describes how infant health status at birth may be a potential influence on later child outcomes.

2.4.2 Health at Birth

As noted above, exposure to maternal depression can have a negative effect on birth outcomes. In addition, discordance or incompatibility between adaptation in prenatal environment and postnatal context[25, 91] has been found to have negative consequences. Due to developmental plasticity, the effects of prenatal exposure can be altered through reprogramming. However, if the reprogramming is incompatible with the postnatal environment, it can result in a "maladaptive physiology" that can contribute to later illness.[113]

Health status at birth can, in turn, influence child development in the early years and at school entry and beyond. The Longitudinal Study of Australian Children[134] examined the relationship between birth outcomes and school readiness in 8060 children aged 4-5 years. The authors found that low birth weight, preterm birth or small for gestational age resulted in significantly lower cognitive school readiness, but these factors were not associated with behavioural school readiness. These relationships held after controlling for social factors and prenatal risks. Bhutta et al.,[135] in a review of studies that examined the relationship between preterm birth and cognitive and behavioural outcomes of school-aged children (measured after their 5th birthday), found reduced scores for both cognitive and behavioural development for children who were born preterm. Another review by de Jong et al.[136] found greater problems with school, cognitive functioning, behavior and incidence of psychiatric disorders in moderate and late preterm (32 to 36 weeks) infants, children and adults, when compared to full-term peers.

The relationship between health at birth and child development can be indirect, or mediated through other factors. Using linked administrative data held at the Manitoba Centre for Health Policy, Fransoo et al.[137] found that health status at birth (a latent construct on which the Health at Birth construct for this study is based) *indirectly* affected child school performance in Grade 3. Specifically, major illness and

health status through early childhood fully mediated, or explained the relationship between health status at birth and child performance in school. The structural equation models used for the Fransoo et al. study were replicated a few years later by Santos et al.[138] and examined the influence of health at birth and related factors on Early Development Instrument outcomes for children in kindergarten (see below for a description of this instrument). The authors found, once again, that health status at birth indirectly influenced child outcomes and was fully mediated through child health status across early childhood. The effects of low birth weight can also influence child development differentially for different groups. An analysis[139] of the combined effects of low birth weight and SES on educational outcomes (age 7 to adult age 33) from the 1958 British cohort study found that SES explained a much greater proportion of the variation in cognition scores than did low birth weight. Jutte et al.[140] found that social risk factors such as mother's age, parent marital status and socio-economic status were more common than and at least as detrimental to child health and educational outcomes as biologic predictors such as birth weight, gestational age and Apgar score.

In addition to the mechanisms discussed, the environment in which the infant/child is raised can be an important factor in child outcomes. The next section discusses influences of the maternal and family context as a potential pathway through which depression and anxiety in mothers affects child development.

2.4.3 Maternal/Family Context

Prenatal stress has also been found to have a programming effect on future maternal caregiving.[64] Studies have found that maternal caregiving can be influenced by changes to the HPA system due to depression or anxiety. Specifically, oxytocin has been found to play a role in maternal sensitivity. Pariante[27] suggests that there may be biological pathway where maternal prenatal depression – and its

resulting HPA hyperactivity – impacts maternal care practices through changes in cortisol-, oxytocin- and estrogen-target gene expression. Riem et al.[128] found that the oxytocin receptor gene is associated with maternal responsiveness to infant crying and that symptoms of depression may weaken maternal responsiveness.

Studies show that the impact of maternal depression on infant cognitive performance is mediated by maternal sensitivity,[13, 86, 94, 101] possibly by impacting the HPA-axis functioning in children.[20, 121] In the US National Institute of Child Health and Human Development (NICHD) study (n=1215 women and their infants),[101] maternal sensitivity appeared to modestly mediate the effects of maternal depression on school readiness, expressive language and verbal comprehension measures. While the study had a large sample and longitudinal design, the authors suggest that similar relationships should be explored with a large sample of women with clinically diagnosed depression. Relatedly, attachment processes are impacted in mother-child interactions.[11, 93, 141, 142] Further, impaired parenting behaviour[20, 34, 35, 143-145] has been identified as a mechanism through which depression impacts on children and, specifically, maternal cognitions have been suggested as a potential mediator.[146] Dix and Yan[6] found that the more depressed mothers were over a two year period from infancy to child age two, the more negative their parenting. As Luoma et al.[71] suggest, it is difficult to determine whether negative mother-child interactions persist in a context only outside the school setting. Similarly, Pan et al. (2005), in finding that maternal depression negatively impacts toddler vocabulary development, caution that vocabulary was measured in mother-child interaction and, in a different context, vocabulary may be more diverse.

In a low-risk, middle class sample (n=67) with matched controls (n=63), Campbell et al.[102] found that mother-infant interactions (at 2, 4 and 6 months) where mothers were chronically depressed were characterized by less positive engagement rather than by the more negative, intrusive reactions found in higher risk samples (e.g., low income, lone parent) samples. The authors suggest that, for lower-risk

populations, more subtle aspects of parenting may mediate longer term effects on the mother-child relationship or child outcomes. The authors also note that there are individual differences in how depression manifests in mother-infant interactions and some depressed mothers are more able to engage in positive interactions than others. Further, this may account for who will and will not exhibit a more chronic course of depression. Campbell et al.[102] also note that parity should be a consideration in studies of the relationship between maternal depression and child outcomes; depressed mothers with just one child may be better able to focus on interacting positively with their infant than mothers with more than one child. A prospective, longitudinal Montreal study[147] found an inter-generational transmission of risk with respect to language development. Mothers' childhood social withdrawal was found to be predictive of their child-directed language as adults. In turn, mothers' language complexity predicted preschoolers' expressive language and mediated the relationship between maternal social withdrawal and child language development. Further, children's language-related school performance was predicted by their preschool expressive language.

The broader caregiving context in which depressed mothers raise their children may place them at increased risk. The presence of stressors such as increased stress levels and daily hassles, lack of social support, decreased marital satisfaction and increased family conflict can contribute to a weakened parenting environment.[11, 34, 42] Cicchetti et al.[11] found that contextual risk did not mediate the relationship between maternal depression and insecure attachment, but did mediate the relationship between maternal depression and child behaviour problems. Jensen et al.[10] examined the relationships between maternal depression (prenatal up to 33 months), interpersonal stress and contextual risks (e.g., inadequate housing, low income, single caregiver, early parenthood and low education). The study found that child executive functioning and social cognitive skills were influenced by both maternal depression and contextual risk and that these two operated through interpersonal stress to influence child outcomes. Petterson and Albers[103] found significantly lower cognitive but higher motor

development scores for girls whose parents were separated or divorced at 28 and 50 months, compared to girls with married parents.

Moderators[xv] of the relationship between maternal depression and child outcomes include father involvement[13, 21] and characteristics of the child, such as gender,[13, 35, 89, 121, 148] age[30, 35] and temperament.[6, 20, 35, 149] Regarding gender, studies have typically found maternal depression more negatively affects boys.[12, 30, 89, 103, 121] However, negative effects have been found for girls also. Petterson and Albers[103] found maternal depression impacted more negatively on girls' cognitive development than motor development. Possible explanations for why boys appear to be more affected by maternal depression in the early years include: a non-representative (more disadvantaged) sample in the study; the maturational advantage of girls; or depressed mothers may treat boys and girls differently.[89] With respect to temperament, Cote et al.[150] found that the strongest predictors of a high-rising trajectory of depression and anxiety symptoms in children up to 5 years of age were difficult child temperament at 5 months and lifetime maternal depression. As Glover[91] notes, it is not known to what extent cognitive impairment following exposure to prenatal maternal stress is due to easily distracted attention or to other behavioural changes.

As Glover[91] notes in a review of literature, the influence of maternal stresses on child development depends on the specific genetic make-up of the child and the mother; some may be more vulnerable, others more resilient and some children may be more vulnerable to specific outcomes. In a sample of 1364 families, Dix and Yan[6] tested the hypothesis that child vulnerability (e.g., high negative emotionality) mediates the relationship between maternal depression and child outcomes. The study found that higher negative emotionality at child age 6 months was predictive of low social competence, poor responsiveness to the mother and insecure attachment at age 3, independent of maternal

[xv] Where different outcomes may be expected for different groups; see Chapter 3 for further discussion.

depressive symptoms. However, when maternal depression was considered, negative outcomes at age three were greater for children with high negative emotionality. Where maternal depressive symptoms were low, differences in adjustment between children with low and high negative emotionality were essentially removed. For the meditation analyses, child vulnerability was found to mediate the greater impact of maternal depression only for separation distress. Bithoney et al.[151] found, at one year follow-up, that increased parental competence and child adaptability were found to be strongly associated with improved growth outcome, and parental stress and social isolation were negatively associated with growth.

In addition to maternal depression influencing children, child characteristics and behaviour may impact on mothers' mental state[20, 35, 48, 152] A bi-directional relationship has been found between maternal depression and child adjustment, even after controlling for earlier depressive symptoms[153] and characteristics such as quality of interactions with the mother, self-concept and age.[152] As Downey and Coyne[34] note, difficulty disentangling the causal direction of mother-child interaction is evident in infancy. Eisenhower et al.[154] found that child behaviour problems, particularly for delayed children, impacted negatively on mothers' physical health at child ages 3, 4 and 5. Maternal depressive symptoms at child age 3 were found to mediate this relationship. The study tested for a transactional relationship between child behaviour problems and maternal physical health but did not find evidence of one as maternal health did not predict later child behaviour problems. However, in this study, maternal physical health was the primary measure, rather than maternal depression. Dix and Yan[6] found that child characteristics can contribute to problematic parenting and that understanding the interplay between these two is important in understanding differential child outcomes, including where maternal depression is present.

The maternal and family/demographic contexts have been found to mediate or moderate the relationship between maternal depression and anxiety and child outcomes. Further, these environments may work together to influence outcomes.[10, 40] While compromised parenting or familial contexts may persist where mothers are depressed or anxious, positive maternal caregiving can attenuate negative effects of exposure to depression[14, 155, 156] (see Methods chapter for how this study accounts for family context; however, a limitation is the inability to examine maternal caregiving using administrative data). The next section examines the role of socioeconomic status in the relationship between maternal depression and anxiety and child development.

2.4.4 Socioeconomic Status (SES)

SES is associated with maternal depression. [10, 42, 157-159] In a meta-analysis of 51 studies, Lorant et al.[157] compared odds ratios of the lowest SES group to the highest, and concluded that low-SES individuals had greater odds of being depressed (OR=1.81, $p<0.0001$[xvi]), but odds were lower for new episodes (OR=1.24, $p<0.004$) than for persistent depression (OR=2.06, $p<0.001$). Further, a dose-response relationship was found for SES measures of education and income. The authors found that findings across studies varied according to several features of measurement and analysis: symptom inventories; clinical categories; and reference period. As a result of these features, gradients may be larger for symptom inventories compared to diagnostic schedules, for broader categories (e.g., including neurotic disorder) rather than limiting to affective disorders and where prevalence may be more influenced by duration in shorter reference periods. In addition, how SES was measured contributed to differences. The review included studies that used continuous individual measures of income, education, social class,

[xvi] The majority of the studies in the literature review did not provide confidence intervals for odds ratios; only p values.

occupation and wealth. Neighbourhood or regional levels of deprivation were excluded. Most studies used education and income; where several variables were used, education was retained because it was continuous and present for all, regardless of occupation status, and where education was not available, income was used, followed by occupation.

SES has been found to moderate the effect of maternal depression on caregiving[155] and child development;[13, 107] lower SES is associated with more compromised caregiving and poorer child outcomes. Children in families of lower SES do more poorly on cognitive tests and have poorer health and more behavioural problems than children of higher SES, and a gradient persists at each level of SES[2, 160-164] A study [165] of the duration and timing of poverty on child development to grade 3 found that chronically poor families provided lower quality childrearing environments, and children in these families had poorer cognitive performance and more behaviour problems than other children. The study found that the relationship between poverty and child outcomes was, in part, mediated through less positive parenting. As Beeber et al. [166] suggest, depressive symptoms interfere with maternal support required to confront poverty, thereby placing infants and toddlers at greater risk of delayed social, language and cognitive development. Kurstjens and Wolke[12] found highly significant effects of SES on child cognitive scores from 20 months to 6.3 years of age, independent of maternal depression. Family functioning variables associated with low SES, such as stress and maternal depression, can have a negative impact on child cognitive development, which can influence outcomes at school entry.[22, 167] However, family income and poverty status are powerful correlates of the cognitive development and behaviour of children, even after accounting for other differences – especially family structure and maternal schooling – between low- and high-income families.[159]

For a group of mothers chronically depressed between pregnancy and 33 months postpartum (10% of the sample of 12,152 in the Avon Longitudinal Study of Parents and Children (ALSPAC)[168]), contextual

risk – inadequate housing, poverty, lone caregiver, low education, early parenthood – had a greater effect on child outcomes at pregnancy only, and not at child ages 2 and 4. Beyond pregnancy, contextual risk functioned as a broader risk factor for child dysregulation in both groups of children alike – those with chronic-depressed and non-depressed mothers – supporting the pervasive influence of SES.

In turn, maternal depression has been found to moderate the relationship between poverty and early child development. Petterson and Albers[103] examined 7677 mother-child dyads from the US National Maternal and Infant Health Survey (NMIHS) and maternal depression negatively impacted the development of very young girls and boys and, to some degree, affluence buffered these effects. In this study, both poverty and maternal depression had a greater effect on cognitive than motor development. The home environment mediated about one-half of the effect of family income on cognitive ability.[159]

What is unclear are the mechanisms by which SES is linked to children's cognitive, health and behavioural outcomes. In particular, it is difficult to determine what SES conditions provide for children in terms of school readiness and what aspect of SES is most influential.[169] Assessment of SES varies in terms of how and when it is measured. Further, estimates of the role of SES in accounting for differences in school readiness test scores are complicated by the fact that SES is a proxy for many factors underlying school readiness.[169] It is theorized that both strain theory (e.g., the impact of community features such as values, social welfare and public policy) and stress theory (e.g., personal resources such as coping and self-esteem buffer the impact of stress on depression and higher SES individuals have more of these resources) account for the relationship between SES and depression.[157] Jensen et al.[10] found that the inter-relations between maternal depression, contextual risk and interpersonal stress have a negative effect on child outcomes. Further, they note that these inter-relations suggest that risks more removed from the child's social context, such as contextual risk, may work to maintain risks more proximal to the child's environment, such as maternal depression and

interpersonal stress. Adler et al. identified three possible pathways for the relationship between SES and health: a) a spurious association that arises from relationships of both SES and health outcomes to genetic factors; b) drift hypothesis – that health status influences SES, rather than the reverse; and c) that SES impacts on biological functions which, in turn, affect health status.[164] The authors suggest that understanding how SES influences biological functions is limited and that this may be due to how SES is conceptualized. Rather than existing as an independent effect on health, the components of SES are intertwined with the physical and social environment, socialization and psychological development and health behaviours[164] – essentially, the broad determinants of health.

As has been shown, a range of mechanisms – genetic/biological, maternal/familial and SES – have been found to play a role in the relationship between maternal depression and anxiety and child development. There is also evidence that these mechanisms can be attenuated by reprogramming and positive influences in the postnatal period and early childhood years. The following section describes the importance of school readiness and an overview of the Early Development Instrument.

2.5 The Importance of School Readiness

As Lemelin et al.[170] state, school readiness prior to school entry is one of the most important developmental tasks facing young children. While no single definition of school readiness exists, experts tend to agree that it is a multi-dimensional concept that extends beyond academic and cognitive skills to include physical, social and emotional development as well as approaches to learning.[171] School readiness is contrasted with "readiness to learn" which refers to a child's neurosystem being ready to adapt to new skills and neural pathways; school readiness is a more specific concept, referring to a child's ability to meet the task demands of school, and considers the context of the classroom and the school.[172] Based on research on early childhood development, Janus and Offord[18] identified five key

domains of school readiness: physical health and well-being; social competence; emotional maturity; language and cognitive development; communication skills and general knowledge. Successful development in each of these areas is indicative of a child's adequate readiness for school learning. In turn, school readiness is important for later school success and for health, social and economic outcomes over the life course.

2.5.1 Influences on School Readiness

As shown above, a wide range of influences impact child development in the early years. While exposure to maternal depression and anxiety can negatively affect several areas of child development, as described above, school readiness can be negatively affected by a host of other factors. For example, exposures during the prenatal period including poor fetal nutrition, infection and toxins such as smoking and alcohol can all negatively impact on a child's later cognitive development.[173] Studies have found that low birth weight[139, 174-176] and preterm birth[135, 174] impact negatively on later cognitive outcomes. Breastfeeding has been found to enhance children's cognitive development.[13] However, Ip et al.,[177] in a review of the effects of breastfeeding on child cognitive development, concluded that there is little or no evidence of an association once maternal intelligence and other confounders were considered.

While biological factors impact on school readiness, psychosocial factors have been found to exert a greater influence as children grow through early childhood. Lemelin et al.,[170] using data from the Quebec Newborn Twin Registry (n=840), found that the shared environment is significantly associated with general and specific cognitive school readiness. While genetic effects were found to be important for core school readiness skills, the shared environment remained a more important factor. The importance of psychosocial factors has been found to influence outcomes into late adolescence. In a large, population-based sample in Winnipeg, Manitoba (n=4667) Jutte et al.[140] found that social factors

such as maternal age, marital status and SES were at least as potentially detrimental – and more common than – biological indicators such as birth weight, gestational age and Apgar score on childhood hospitalization and a required high school examination. Studies have found gender to be a determinant of school readiness.[178, 179] Research suggests that differences for boys and girls may be biological in terms of the developing brain (e.g., the maturational advantage for girls regarding language development)[180] and also influenced by adult behaviour (mothers conversing more with their infant daughters than sons).[181] To et al.[179] found that having a mother who has symptoms of depression, has low education, or is an immigrant, and living in a low-income household increased the risk of poor development in children aged 1 to 5 years. Further, parenting influences,[173, 182, 183] reading practices,[184] mother-child interactions,[185] lone parenting[186] and young maternal age[187] have been found to negatively influence child functioning.

SES has a powerful influence on child development and school readiness. Low SES is associated with weaker measures of language development,[155] cognitive function,[188] school readiness[138, 184] and school performance.[58, 137, 189, 190] Brownell,[191] in a review of literature, found that SES is one of the most frequently studied and consistently cited predictors of child cognitive and behavioural development and child health outcomes. Children in families of lower SES do more poorly on cognitive tests and have poorer health and more behavioural problems than children of higher SES, and a gradient persists at each level of SES,[2, 160, 161, 192] and widens over time.[193] In fact, when controlled for, SES has been found to be more influential than other factors.[139, 159, 176] In particular, low income has been found to be more strongly associated with children's school outcomes, regardless of parental education.[184] Family functioning variables associated with low SES, such as stress and maternal depression, can have a negative impact on the child cognitive development, which can influence outcomes at school entry.[22, 167] Further, low SES early in life has been found to leave a "biological residue" that results in increased

susceptibility to chronic conditions in the fifth and sixth decades of life, independently of current SES, lifestyle and perceived stress.[194]

While each of these factors may impact on child development, it is often a combination of influences that determines a child's readiness for school. Janus and Duku[184] reported on data from the Understanding the Early Years (UEY) study in six communities across Canada (n=2196) and found that a combination of health, demographic and SES factors (suboptimal health status, being a boy and family income below LICO) more than doubled a child's likelihood of being at bottom side of school readiness gap more than other factors.

2.5.2 The Importance of School Readiness for Longer Term Outcomes

Early childhood development impacts health, well-being and competence throughout the lifespan.[195] Children who are not ready for learning at school entry are more likely to repeat grades and receive remedial and special education services.[58, 171, 173] Communication and social skills of children are important for taking on the tasks of school. Children with good verbal, social and attention skills are more likely to perform better in school than children without these skills, who may go on to develop health, behavioural and social problems[22, 169] There is substantial evidence that school readiness gaps are present at kindergarten[138, 173, 184, 196] and that these gaps tend to widen over time.[171]

Research has shown performance at school entry to be predictive of outcomes well into adulthood. As part of the longitudinal UK Birth Cohort Study (n=11,200), Feinstein and Byner[197] examined trajectories of cognitive performance between child ages 5 and 10 and their influence on later outcomes at age 30, including: low income, low education, unemployment, criminality, teen motherhood, smoking and depression. Patterns of continuity or discontinuity over the five years and the influence of SES

(occupational status) were assessed. The study found a high level of persistence in relative scores – 54% of those in the lowest score quartile at age 5 were still there at age 10 and another 27% moved up to the third quartile. Further, age 5 cognitive performance was found to be predictive of cognitive performance at age 10. However, nearly one in five children (19%) moved from the lowest score quartile at age 5 to above the median score at age 10, suggesting considerable change. Gender differences were found with respect to SES – low score persistence was more common in low SES females than for low SES males. The study found that cognitive scores at age 5 were more important than age 10 scores for adult criminality in males and teen pregnancy. For children remaining in the lowest score quartile from age 5 to age 10, odd ratios for most of the adults were two to three times that of the reference group (middle two quartiles). Even for children who moved out of the lowest score quartile ("escapers"), odds ratios for age 30 outcomes were still greater than 1.0. Findings from the study support the substantial predictive power of age 5 cognitive scores, confirming the importance of early development up to school entry. As the authors state, "age 5 scores matter." However, the study found that abilities at age five are not set in stone and changes through middle childhood can have effects well into adulthood. This suggests that the benefits of investing in school readiness should be continued well beyond school entry. If educational outcomes improve, longer lasting societal benefits include: higher lifetime incomes; higher tax revenues from more labour market participation; reduced social welfare expenses and reduced involvement in the criminal justice system.[171]

2.5.3 The Early Development Instrument (EDI)

The EDI is a 104-item teacher-administered assessment of children part-way through the kindergarten year. The tool covers the following five established domains of early child development: Language and Cognitive Development; Social Competence; Emotional Maturity; Physical Health and Well-being; and

Communication Skills and General Knowledge. The Early Development Instrument (EDI) was developed to measure children's readiness for school prior to Grade 1 and was designed to provide a feasible, affordable and psychometrically sound assessment of school readiness and report at the community level, monitor groups over time and predict later school performance.[198] The EDI is intended to measure school readiness for groups of children within a geographical community and results are reported at an aggregate level. Individual data can be used to link to other data sources – e.g., for research such as this study – but only if the results of the analyses are reported at a group level. Results can be used for program evaluation or research and should be interpreted according to the study design.[198] Typically, EDI results are reported as the proportion of children in an aggregrate area (e.g., school, neighbourhood, community, province) who are deemed "not ready" (i.e., score in the bottom 10 percent on one or more domains) for school.[198] Since data are collected for administrative purposes, strengths and limitations discussed above (see Introduction chapter) would apply. Specifically for the EDI, data available for addressing research questions are dependent on teacher reporting; however, bias has not been found to be a threat to the validity and reliability of the tool.[172, 198]

Domains were selected based on factor analysis of data conducted by the tool developers on over 16,000 kindergarten children.[198] Confirmatory factor analysis (CFA) was conducted to assess the factor structure of each domain. Analyses revealed 14 factors that were grouped into the five domains based on a conceptual framework. Seven items with loadings less than 0.3 on a factor were retained due to perceived importance by teachers (independent in washroom, well-coordinated, sucks a finger, knows how to handle a book, interested in books, interested in reading, remembers things easily) and the remaining seven loaded 0.3 or higher. The 14 factors accounted for 63.1% of the variance, with social competence accounting for nearly one-third (32.9%). Multi-level confirmatory factor analysis revealed that the factor structure within classrooms is similar to the structure between classrooms. Cronbach's alpha for the five domains ranged from 0.84 to 0.96, indicating satisfactory internal consistency.[18] Based

on factor analysis, four of the five domains (except Communication and General Knowledge) on the EDI were further subdivided into sub-domains for greater precision. Internal consistency of domains and sub-domains was tested by the developers using Cronbach's alpha and it was found that all, except the Physical Independence sub-domain, had high alphas which indicated uni-dimensionality and good internal consistency.[199] Further testing showed consistent agreements in parent-teacher ratings, inter-rater reliabilities, concurrent validity and convergent validity.[18] Further research[200] has found that the EDI demonstrates similar psychometric properties in several countries.

As part of Quebec's Longitudinal Study of Child Development, Forget-Dubois et al.[201] examined the predictive value of the EDI as a measure of school readiness and compared the results to a direct school readiness measure and a battery of cognitive assessments at grade 1. The study found that the EDI alone explained 36% of the variance in school achievement; the complete battery of measures explained 50%. Two domains – Physical Health and Well-Being and Language and Cognitive Development – made unique contributions above the other assessments. In contrast, the Social Competence and Emotional Maturity domains were limited in their prediction of early school achievement. Despite this limitation, the authors concluded that the EDI is a very promising instrument for quickly and easily assessing school readiness. Brinkman et al.[202] examined the EDI in relation to several similar measures of child development, including parent reports, teacher reports and two direct measures of receptive vocabulary in children – the Peabody Picture Vocabulary (PPVT) and tasks of copying and writing. The authors found that that the EDI correlated with these direct measures (0.10 to 0.69), particularly with other reports by teachers for similar activities. An Ontario study[203] linked Early Development Instrument (EDI) scores in kindergarten to school performance on the Education Quality and Accountability Office (EQAO) standards tests in grades 3 and 6. The study found that children who were "not ready" (scored in the bottom 10%) on one or more domains of the EDI performed more poorly on the EQAO tests in grades 3

and 6. Similarly, research in British Columbia has found EDI results to be predictive of performance in grade 4[204] and better competencies at high school graduation.[205]

In assessing measurement bias of the EDI, Guhn et al.[206] conducted ordinal logistic regression analyses to examine differential item functioning (DIF). The presence of DIF indicates that either item impact (different probabilities of responding correctly due to true differences) or item bias (different probabilities of responding correctly due to some function of the test or testing situation) is operating. The distinction cannot be determined by statistical analysis alone. As the EDI is completed by teachers, rather than children themselves, any DIF on the EDI must be understood in the context that differences will be based on perceptions and ratings of the teacher. Further, as the EDI has been used in a variety of diverse communities, testing for DIF is important.[206] Based on data collected on 43,900 kindergarten children in British Columbia over five years from 1999/2000 to 2003/04, Guhn and colleagues found that DIF of substantial effect size was present on several items. However, this was not found to be due to bias in teacher ratings but due to true group differences in the sample. There was no systemic measurement differences on the EDI regarding Aboriginal status[xvii] and gender, except one item where boys more likely to be rated as physically aggressive. English as a Second Language (ESL) students systematically received lower ratings on the EDI on language and communication domains, as would be expected, but not on physical, social and emotional domains.

[xvii] As the authors note, a limitation of this EDI sample is that it may not be representative of the diversity of Aboriginal children and their communities due to a large number of on-reserve communities opting out of the EDI.[206]

2.5.3.1 EDI Domains[199]

The Language and Cognitive Development domain has four sub-domains: Basic literacy skills (e.g., can turn a page, awareness of text flow, can write own name in English); interest literacy/numeracy and memory (e.g., interest in books, reading, math); advanced literacy skills (e.g., reading and writing); and basic numeracy skills (e.g., can count to 20, recognize larger of two numbers). This domain has been found to be most predictive of later school achievement.[201] The Social Competence domain has four sub-domains: Overall social competence (e.g., social skills, self-confidence, ability to get along with children); responsibility and respect (e.g., self-control, follows rules, takes care of materials); approaches and learning (e.g., listens attentively, follows directions, ability to problem-solve); and readiness to explore new things (e.g., curiosity about the world, eager to play with a new toy or book). The four sub-domains of the Emotional Maturity domain are: Pro-social and helping behaviour (e.g., helps someone who is hurt, volunteers to clean up mess, invites others to play); hyperactivity and inattention (e.g., restlessness, acts impulsively, distractable); anxious and fearful behaviour (e.g., appears unhappy/sad, fearful or anxious, incapable of making decisions); and aggressive behaviour (e.g., gets into physical fights, bullies others, takes others' things). As noted above, in validity studies, the Social Competence and Emotional Maturity domains of the EDI were found to be least predictive of later school achievement. Given the high correlation between these two domains, further testing assessed the predictive value of each domain separately; they were each significantly predictive of school achievement, though only marginally.[201] The Physical Health and Well-Being domain includes three sub-domains: Gross and fine motor skills (e.g., holding a pen, climbing stairs, low energy); physical readiness for the school day (e.g., dressed appropriately, arriving at school on time, not hungry or tired); and physical independence (e.g., self-hygiene, handedness, coordination). This domain was found to be the second most predictive of later school achievement, behind Language and Cognitive Development.[201]

The Communication Skills and General Knowledge domain assesses the ability to communicate needs and ideas clearly and understand others' communication. No sub-domains were created.

2.6 Conclusion

As reviewed in the literature, maternal depression exposure in the early years appears to have a negative impact on domains of school readiness – particularly socio-emotional and cognitive development. The impact of mood and anxiety disorders in mothers on behavioural outcomes seems less equivocal than for cognitive outcomes. This could be due to the fact that cognitive development may be less affected than emotional and behavioural domains under less than optimal caregiving contexts.[12] Inconsistencies persist regarding the most "sensitive" periods of child development and when the timing of maternal mood and anxiety is most influential, but the prenatal and postnatal periods appear to be of significant importance. While findings of negative effects for specific time periods have been found, increased severity and especially recurrence/persistence of mood and anxiety disorders appear to have a stronger influence on child outcomes. As discussed in the forthcoming chapters, exposure during several periods over the early childhood years – as well as recurrence/persistence and severity of maternal mood and anxiety disorders – are key features of this study.

The impact of maternal moos and anxiety disorders on child development – and school readiness – is far-reaching and, given the importance of school readiness as a predictor of later functioning, these effects can be lifelong. Further, while timing, chronicity and severity of maternal mood and anxiety are potentially confounded, chronicity and severity appear to have significant influences on child development, perhaps more so than timing. However, the influences of each aspect vary according to child outcomes and further research is needed to examine relations between these aspects of maternal

depression and child outcomes at school entry. In addition to the possibility that genes interact with child exposure to maternal depression, studies show that the environment that a child lives in can play a significant role in the development of later adverse outcomes and, in some cases, may be more predictive than depression itself. It has been suggested that biological factors become less important through childhood as psychosocial ones increase in influence.[140, 179] Further, there is evidence of a reciprocal, or bi-directional relationship between maternal depression and child development; child behaviour and adjustment can negatively impact on a mother's mental state, therefore continuing the cycle.

It is important to note that not all children have negative outcomes following exposure to maternal depression or anxiety. As Downey and Coyne[34] observe, despite the elevated risk of poor developmental outcomes for children, depressed mothers' continued ability to provide for their children may be a protective factor against other adversities. Also, the effects of depression may be mitigated by a positive family milieu[63] and difficulties in parenting are not specific to depressed mothers.[34] Cummings and Davies[35] caution that outcomes associated with maternal depression are not necessarily pathological and that there may be positive developmental outcomes, such as increased sensitivity to others' feelings, that may be found in children of depressed mothers.

Maternal mood and anxiety – and the biological/epigenetic, maternal, familial and SES environments – all operate to influence child school readiness at kindergarten. As the following chapters illustrate, the purpose of this study was to examine the association between maternal mood and anxiety disorders from the prenatal year through to and including the year before school entry – and the aspects of timing, recurrence/persistence and severity of mood and anxiety disorders – on five domains of school readiness as assessed in kindergarten in a population-based sample using linked administrative data. The following chapter outlines the methodology for this study in detail.

Chapter 3: Methods

3.1 Introduction

This research examined the relationship between Mood/Anxiety[xviii] in mothers and their child's school readiness as measured by the EDI in the kindergarten year. Related health and social factors – and their influence on this relationship – were also examined also. As several authors have described,[11, 13, 20, 34] the pathways between maternal mood and anxiety disorders and school readiness are not linear and are influenced by biological, familial and social contexts. The simultaneous analysis of a variety of health and social indicators illustrates how the social determinants of health, health at birth and demographic factors influence the relationship between maternal Mood/Anxiety and several domains of early childhood development at school entry.

A key unique feature of this research is the detailed examination of the influence of several aspects of maternal Mood/Anxiety on child outcomes at school entry. The features examined include: the *timing* of when maternal Mood/Anxiety was present (e.g., prenatal year, postnatal year, toddler years and year before the EDI); *recurrence/persistence* of maternal Mood/Anxiety (e.g., was Mood/Anxiety present for just one time period or recurrent for two or more periods over early childhood); and *severity* (e.g., is there a stronger impact of more severe maternal Mood/Anxiety on child outcomes). Further, mediating (an indirect influence along the causal pathway) and moderating (different effects for mothers with low

[xviii] "Mood/Anxiety" is used in place of "depression" and "anxiety" for the data analysis for this study. This broader definition is based on the current Mood and Anxiety Disorders definition [212] developed by the Manitoba Centre for Health Policy (MCHP). The former MCHP "Depression" and "Anxiety" definitions were combined into "Mood/Anxiety" as depression is difficult to isolate in administrative data due to the limitations of physician visit data (no decimals in International Classification of Diseases (ICD) codes to distinguish sub-categories) and a large number of medications (e.g., SSRIs, SNRIs, atypical antipsychotics) that are prescribed for either depression or anxiety. The Mood/Anxiety definition for this study includes depression medication and physician visits plus those for anxiety and related disorders. Sensitivity analyses confirmed that there is no difference in model results when using Mood/Anxiety or Depression-only definitions, so the Mood/Anxiety definition was retained.

SES compared to those with high SES, or interaction effect) influences were also examined. This chapter outlines the methods undertaken in this study.

3.2 Hypotheses

Several hypotheses were tested in this study:

1. Maternal Mood/Anxiety will be negatively associated with child EDI scores at age 5/6.

2. The timing of maternal Mood/Anxiety (e.g., whether Mood/Anxiety occurs in the prenatal, postnatal, toddler or year before EDI periods) will differentially affect child EDI scores at age 5/6.

3. Recurrence/persistence – specifically, the number of time periods – of maternal Mood/Anxiety will be negatively associated with poor child EDI scores at age 5/6.

4. The greater the severity of maternal Mood/Anxiety the more negatively it will be associated with child EDI scores at age 5/6.

5. The EDI domains of Social Competence and Emotional Maturity will be more greatly impacted by maternal Mood/Anxiety than the Language and Cognitive Development, Physical Health and Well-Being or Communications and General Knowledge domains.

6. The influence of maternal Mood/Anxiety on child EDI outcomes will be mediated through Health at Birth (for the Prenatal year) and Family Context.

7. Socio-economic status (SES) will moderate the relationship between maternal Mood/Anxiety and child EDI scores at age 5/6. For example, the lower the socio-economic status (SES), the stronger the negative impact of maternal Mood/Anxiety on child EDI outcomes.

3.3 Study Design

This study examined the relationship between maternal depression and child school readiness utilizing administrative data from the Population Health Research Data Repository housed at the Manitoba Centre for Health Policy. This longitudinal, population-based study used a retrospective cohort design where linked mother-child pairs were followed over time from one year prior to birth to the year in which the EDI assessment was completed for the child. Analysis of administrative data from several sources (see below) was undertaken. Children born in 2000 and 2001 were linked to their birth mother using an anonymous identifier. Mothers' contacts with the health care system for mood and anxiety disorders (prescriptions filled, physician visits and hospitalizations) were tracked for a five to six year period from one year prior to the child's birth to approximately six months into the kindergarten year (February/March 2006 and 2007). All identifying information for individuals in these data sources (e.g., name, address, personal health identification numbers) were removed by Manitoba Health, Healthy Living and Seniors before the data were sent to MCHP. Researchers are given access to these de-identified data once a series of approvals has been granted.

3.4 Study Participants

This study includes the cohort of children born in Manitoba[xix] between January 1, 2000 and December 31, 2001. Children were linked to their birth mothers using an anonymous identifier. This resulted in mother-child pairs, some of which included multiple children (n=1547) from the same mother, including singleton births (n=1051), twins (n=228 pairs) and triplets (n=4 sets). As a result of using unique mother-

[xix] Few First Nations communities in Manitoba participated in the EDI for the assessment years used in this study, therefore, data on children and mothers from these communities are limited.

child pairs (i.e., each child linked to their mother through a unique identifier), siblings, twins and triplets and were not excluded from the study.

A total of 23,236 mother-child dyads were included in the 2006 and 2007 EDI cohorts. Exclusions for this study include:

- Mother or child missing personal health information number (PHIN) (n=637)
- Mother or child without continuous Manitoba health coverage for the study period (n=3909)
- Children who were younger than 5 years or older than 6 years and 11 months at the time of the EDI (n=22)
- Duplicate EDI records (n=70)
- Children not born in hospital (n=267)

The final sample was 18,331 mother-child pairs that met all the inclusion criteria.

3.5 Time Periods

For this study, four discrete time periods were examined:

- The Prenatal year includes the 365 days prior to the birth of the child, not including the date of birth.

- The Postnatal year includes the date of birth plus 364 days, ending the day before the child's first birthday.

- The Toddler period begins the day of the child's first birthday and extends up to one day before the beginning of the last 12-month period - the year before the EDI assessment. As a result of the fourth period being counted back from the date of the EDI, the Toddler period is variable in length, an average of 3.7 years, or 45 months.

- The Year Before EDI (YBE) period begins the day after the end of the Toddler period (366 days prior to the EDI assessment) and runs 365 days up to the day before the EDI.

- In addition, a larger overall (Prenatal to EDI) study period was used which includes all four time periods. Results for this overall period are included along with the specific time periods and, for some analyses (see Results chapter), the overall study period is the reference period with no further breakdown by time period.

3.6 Analysis Plan – Structural Equation Modeling

Structural equation modeling (SEM) is used for data analysis. Developed in the 1970s, structural equation modeling (SEM) can be described as a family of statistical techniques which share several common features: *a priori* specification based on the researcher's hypotheses; the ability to differentiate between observed and latent variables; includes covariance as a basic statistic; broadly applicable to non-experimental and experimental data; includes a wide range of statistical techniques, particularly those in the general linear model (GLM); is generally a large-sample technique; and due to a focus on the overall model and the emphasis on larger samples, testing of statistical significance plays a smaller role in SEM than in most other statistical techniques.[207] Examples of situations where SEM would be strongly recommended include: where an outcome at one point in time is a predictor of another outcome in the future; when an outcome is predicted not only by the direct influence of the predictor variable, but also by their unobserved (latent) common cause; and generally, when more than one regression equation is necessary for modelling the phenomena of interest.[208]

Given the complexity of examining the impact of maternal Mood/Anxiety on school readiness, SEM is a reasonable choice for several reasons. First, SEM is an appropriate choice for this study due to the availability of a very large sample. A key strength of this study is the large, population-based sample (n=18,331). Sophisticated statistical tools (SAS 9.3) and the availability of extensive, detailed administrative datasets housed at MCHP allow for the sensitive investigation of these complex health and social relationships. As has been suggested, larger samples are required for more complex

structural equation models.[207] Such a large population-based sample allows for greater complexity in the model and substantial statistical power.

Second, SEM can test the relationship between maternal Mood/Anxiety and school readiness at different time periods over a six-year study period. Population-based datasets are especially suited to longitudinal research. Health care contacts of mothers can be tracked from the prenatal year through to child's EDI assessment in kindergarten and aspects of Mood/Anxiety such as timing, recurrence/persistence and severity can be included. SEM presents an opportunity to incorporate more complex – and time-varying – elements in a model to test theoretical relationships.

Third, SEM allows for the use of latent variables – "unobserved"[209] constructs that cannot be measured directly or that any single measure cannot measure well. Two (preferably three) or more manifest, or observed, variables are combined to provide a "hypothetical" latent measure of the unobserved construct.[209] For example, in this study, a latent variable for Health at Birth – which cannot be measured directly – includes four manifest indicators: gestational age, birth weight, neonatal intensive care unit (NICU) stay and length of birth hospitalization.

Fourth, SEM is useful for testing the contribution of mediating and moderating variables in the hypothesized model. As Elgar et al.[20] state, "closer examination of key mediating mechanisms is needed to refine integrative models of mutual influences, making them more relevant to clinical practice as well as our understanding of maternal and child mental health." (p. 453) For example, some health and social variables were examined as potential mediators (the family environment and health at birth)[xx] and moderator (SES) along the causal pathway between maternal Mood/Anxiety and school readiness (see Chapter 4, Results).

[xx] Child characteristics such as temperament have been identified as mediators in the relationship between maternal depression and child outcomes;[20, 35] however, this information cannot be measured using administrative data.

Finally, while typically a continuous measures approach,[207] SEM methods for including categorical data are now available. For example, as described below (see Study Variables), in this study measures of maternal Mood/Anxiety and Family Context are a mix of continuous and binary variables.

This study used the two-step SEM approach recommended by Anderson and Gerbing.[210] The first step, confirmatory factor analysis (CFA), involves testing the relationship between related manifest variables and their underlying latent constructs. The second step entails testing of the structural model which specifies the causal relationships between all of the constructs (and other variables) to one another. These relationships are mapped out in advance of the analysis in a theoretical model, as described above.

3.7 Study Variables

As noted, variables for this study were developed from previously collected administrative data. A mix of continuous and binary (transformed) variables – from a variety of health, social and population datasets – were used. Transformation of a continuous variable into a binary variable was based on a threshold or cut-off in the distribution of the continuous variable, as noted in the literature, or simply to indicate the presence of one or more counts of a particular variable. As will be described further below, some variables are fixed or "time-invariant" and others are measured at two or more points in time ("time-varying").[207] In addition, time-varying variables are either defined at a fixed point at the start of each time period or are defined as counts over each time period. This section provides a detailed description of the datasets and variables that were used for this study. Table 3.1 illustrates the source dataset, variable name and how it was defined. (For detailed descriptions of variables available at the beginning of the study but later excluded, see Table A3.1 in Appendix 3.)

Table 3.1: Administrative Datasets and Variables Used in the Study

Data Source	Variable	Definition
Manitoba Health Services Insurance Plan (MHSIP) Registry	Mother's age at first birth	Binary variable indicating mother was < 20 years of age at the birth of her first child
	Mother's marital status	Binary variable indicating mother was *not* married or common-law[xxi] at the beginning of each time period
	Male child	Binary variable child is male
Drug Data Support Files	Antidepressants	Number of mothers' antidepressant Rx for each time period
	> 1.0 defined daily dose (ddd)	Binary variable indicating mother had > 1.0 ddd of antidepressants for each time period
	Sedatives/Hypnotics	Number of mothers' sedative/hypnotic Rx for each time period
Medical Services (Physician Billings)	Physician visits	Number of mothers' mood and/or anxiety physician visits for each time period
Hospital Separation Abstracts	Low birth weight	Binary variable indicating infant's birth weight was < 2500 grams
	Preterm	Binary variable indicating infant was born < 37 weeks gestation
	NICU stay	Binary variable indicating infant NICU stay following birth
	Long birth stay	Binary variable indicating if infant was hospitalized for 4+ days after birth
Healthy Child Manitoba – Early Development Instrument	Physical Health and Well-Being	Child score (out of 10)
	Social Competence	Child score (out of 10)
	Emotional Maturity	Child score (out of 10)
	Language and Cognitive Development	Child score (out of 10)
	Communication Skills and General Knowledge	Child score (out of 10)
Census	Socio-economic Factor Index (SEFI2)[xxii] Score	Average household score on index at start of each time period

[xxi] A crude proxy measure that may indicate a less stable relationship status and/or lone parenthood.

[xxii] Composite index created by MCHP that includes the following area-level measures: unemployment rate age 15+; average household income age 15+; proportion of single parent households; and proportion aged 15+ without high school graduation.[288]

3.7.1 Datasets Used in the Study

Study variables were created from a number of datasets available through MCHP. [1]

Manitoba Health Services Insurance Plan (MHSIP) Registry: A key database at MCHP, this registry includes information on all individuals who have been registered with Manitoba Health at any time since 1970. Information on individual demographics, family composition, residential postal codes, Plan registration, birth and migration in and out of Manitoba are included. Individuals registered with the Plan receive a unique Personal Health Identification Number (PHIN) which allows for linkage of mothers and their children, linkage across datasets and the ability to track individuals over time.

Drug Data Support Files: This dataset includes a Drug Identification Number (DIN) Master file that is a longitudinal version of Health Canada's regularly updated Drug Product Database (DPD). The DIN Master file is updated annually and allows for the creation of DIN lists over time for any given set of drugs. These lists can then be linked to individuals to determine patterns of prescription use. For this study, drug name, strength, Anatomical Therapeutic Classification (ATC)[xxiii] codes and defined daily dose (DDD) (see below) were used.

[xxiii] Anatomical Therapeutic Chemical Classification System – a system for classifying drugs into groups based on the organ or system they act on.

Medical Services (Physician Visits): This dataset is maintained by Manitoba Health and includes claims for visits to physicians in offices, including non-residents visiting Manitoba doctors and Manitoba residents visiting doctors in other provinces. Claims are submitted by providers to Manitoba Health for reimbursement. For this study, visits to physicians for mental health concerns, by PHIN, were used.

Medical Services (Hospital Separation Abstracts): Maintained by Manitoba Health, this dataset includes claims for visits to Manitoba hospitals (residents and non-residents). For this study, information from infant birth hospitalizations (birth weight, gestational age, NICU stay, length of hospitalization – see below), by PHIN, were used.

Early Development Instrument (EDI): Managed by Healthy Child Manitoba Office (HCMO), this dataset includes EDI data on all children for whom an assessment was completed. For this study, the 2006 and 2007 assessment years were used. Child PHINs are included in the dataset allowing for linkage to their mothers and other linked data.

Census: A Canadian census is conducted by Statistics Canada every five years and includes demographic information on all individuals and housing units with a dissemination area (DA).[xxiv] For this study, the Socio-Economic Factor Index (SEFI2) includes derived area-level measures based on the 2001 and 2006 census years (see below).

Variables created from these datasets and used in this study are described below.

[xxiv] A small geographic area of one or more neighbourhood blocks – the smallest area for which census data are generated.

3.7.2 Predictor Variables

3.7.2.1 Maternal Mood/Anxiety

Measuring maternal mood and anxiety disorders using administrative data collected over time presents both unique opportunities and challenges for exploring the relationship between maternal Mood/Anxiety and child school readiness. Administrative health data – diagnoses made during physician visits and dispensed prescriptions for medications known to primarily treat mood and anxiety disorders – represent an alternative approach to symptom-based assessments for measuring maternal mood and anxiety disorders. Over a given period of time, an individual's pattern of health care use can be discerned. The population-based scope of these data allows for the exploration of patterns in a very large sample that includes the majority of women with children born in Manitoba in 2000 and 2001. Further, the data are enriched by the fact that a large majority of these women have at least one contact with the health care system. Heaman et al.[57] found that nearly three-quarters (73.8%) of Manitoba women seek prenatal care by the 13th week of pregnancy.

To develop the definition of maternal Mood/Anxiety for this study, previous work by MCHP was consulted. Prior to October, 2012, MCHP used separate definitions for depression and anxiety. *Depression* included: one or more physician visits for depressive disorder (ICD-9 code 311); or one or more physician visits for anxiety (ICD-9 code 300) plus an antidepressant or mood stabilizer; or one or more hospitalizations for depression or anxiety plus a prescription for an antidepressant or mood stabilizer (typically for a five-year period). [211, 212] *Anxiety* included: one or more hospitalizations for anxiety and related disorders; or three or more physician visits for anxiety disorders (ICD-9 code 300) in a five-year period.[213] MCHP created a binary variable to identify cases satisfying the defined combination of these health care contacts.

The limitations of administrative data make it difficult to define depression as an exclusive category. For example, as described above, some three-digit ICD-9 diagnosis codes (as used at physician visits) do not distinguish between sub-groups of depression, anxiety and other mood disorders. Further, psychotropic medications are not always prescribed for their original purposes (e.g., antidepressant and anti-anxiety medications are prescribed for sleep disorders and pain management[214-216]). For these reasons, MCHP combined the former Depression and Anxiety definitions into the new Mood and Anxiety Disorders definition[58-60, 212] which expands on the original definitions, plus some related conditions (e.g,. requiring a prescription for an antidepressant or mood stabilizer for certain diagnoses). Recent studies using the MCHP Mood and Anxiety definition found the population prevalence in Manitoba to be anywhere from 21% (of children 0-19 with mothers who met the mood and anxiety disorders definition)[58] to 23.3% (of Manitobans 10 years or older who met the definition).[xxv] While this definition is suitable for reporting population rates of conditions, it is limited in the ability to describe *degree* of Mood/Anxiety. As one goal of this study was to examine the issues of timing, recurrence/persistence and severity of maternal Mood/Anxiety, it was felt that a full exploration of these would be limited by binary variables that cannot illustrate the degree and range of health care contacts. The rich database of mothers' health care contacts over the prenatal through early childhood period offers an opportunity to examine mothers' Mood/Anxiety over time and to construct a more complex, continuous variable which includes the full *range* of contacts and determine whether this is a sensitive measure of Mood/Anxiety.

[xxv] For this study, 39% of women met a related definition to that used by MCHP; however, there were differences in how the prescription drug and hospitalization codes were grouped as well as differences in inclusions and exclusions. Therefore these two populations cannot be compared. It should be noted that the combination of variables used for this study in a latent Mood/Anxiety construct is not intended to provide a population rate but, rather, to examine how the combination of number of Mood/Anxiety contacts relates to child outcomes. Therefore, the percentage of mothers in this study who are identified as having mood and anxiety disorders will be higher than rate-based definitions (e.g., algorithms) such as that used by MCHP.

Informed by the revised MCHP definition, this study used the following health care contacts[xxvi] to define Mood/Anxiety in mothers for the study population: number of antidepressant prescriptions (ATC code N06A); an indicator for dose intensity for antidepressants (greater than 1.0 defined daily dose – see below); number of sedative/hypnotic prescriptions (ATC codes N05B and N05C); and number of physician visits for each of depressive disorder (ICD-9 code 311), affective psychosis (ICD-9 code 296), adjustment reaction (ICD-9 code 309) and anxiety (ICD-9 code 300). (See Table 3.1 below) The importance of the combination of diagnoses and prescriptions filled has been noted by other studies. For example, a Medicaid study by Gilmer et al.[217] found that models that combine both prescriptions and diagnoses have superior performance in classifying a wide range of chronic illnesses (including depression) compared to models that used either approach alone. For the purposes of testing how the measures of prescriptions filled and physician visits performed in the latent modelling (see Confirmatory Factor Analysis, Results chapter), continuous and binary versions of each variable were created.

Table 3.2: Mood/Anxiety Definition Using Administrative Data

Prescriptions	Physician Visits
# antidepressants (ATC N06A) >1.0 ddd of antidepressants (0/1) # sedatives/hypnotics (ATC N05B, N05C)	# visits for depressive disorder (311) # visits for affective psychosis (296) # visits for adjustment reaction (309) # visits for anxiety (300)

To illustrate the range of contacts for variables included in this definition, Table 3.3 provides the number and percentage of mothers with at least one health care contact in each category – number of

[xxvi] Other psychotropic drug categories and number of Mood/Anxiety hospitalizations were also considered for the Mood/Anxiety definition but either did not load in the latent modeling or in the final structural model, so were later dropped. (See Table A3.1 in Appendix 3)

antidepressant prescriptions, greater than 1.0 defined daily dose of antidepressants, number of sedative/hypnotic prescriptions and number of Mood/Anxiety visits. These figures are provided for each of the individual time periods and the overall study period. As will be described in the Confirmatory Factor Analysis and Structural Equation Modelling sections (Results chapter), these variables were combined into a latent construct.

Table 3.3: Number and Percentage of Mothers with One or More Mood/Anxiety Contacts (n=18,331)

Variable	Prenatal # (%)	Postnatal # (%)	Toddler # (%)	Year Before EDI # (%)	Overall* # (%)
Mood/Anxiety					
Numberof mothers with 1+ antidepressants	880 (4.80)	1536 (8.38)	4482 (24.45)	2736 (14.93)	5629 (30.71)
Number of mothers with > 1.0 ddd antidep	353 (1.93)	536 (2.92)	1651 (9.01)	1166 (6.36)	2586 (14.12)
Number of mothers with 1+ sedatives/hypnotics	700 (3.82)	926 (5.05)	3203 (17.47)	1653 (9.02)	4427 (24.15)
Number of mothers with 1+ Mood/Anxiety visits	2836 (15.47)	2799 (15.27)	7192 (39.23)	3528 (19.25)	9538 (52.03)

*Prenatal to EDI period

The specific variables used to define Mood/Anxiety in this study, and their source databases, are described below.

a) Medications

The Drug Program Information Program (DPIN) is an electronic database maintained by Manitoba Health, Healthy Living and Seniors which links all community-based pharmacies and includes prescription drug claims – insured and privately paid – from all pharmacies in Manitoba (excluding hospitals, nursing stations and CancerCare Manitoba). Drug profiles on each client, including when prescriptions are filled at point-of-sale, are included.[218]

This study grouped psychotropic prescriptions (N=1,738,786) filled by mothers in the study into four categories: antidepressants (ATC N06A), sedatives/hypnotics (ATCs N05B, N05C), antipsychotics (ATC N05A) and mood stabilizers (ATCs N03AF01 and N05AN01). Variables that indicated the number of prescriptions filled by each mother-child dyad in each category were created for each time period and for the overall Prenatal to EDI period. Number of mood stabilizers and number of antipsychotics were initially considered for inclusion but later dropped (see Appendix 3).

In addition to the number of prescriptions filled by category, a measure of dose intensity was included in the study. One measure of intensity of pharmaceutical use is defined daily dose (DDD). Defined by the World Health Organization,[219] DDD is an approximation of drug consumption and is an assumed average dose per day for particular solid-form drugs when used for their primary indication.[220] For this study, DDD was calculated as follows: metric quantity (e.g., mg, ml) of the drug prescribed divided by days' supply (e.g., 30 days). In the DPIN dataset, the DDD was calculated for all solid form psychotropic drugs. Since DDD information is only available for solid forms of drugs in the MCHP data, liquid and combination drugs have missing values for DDD. There are a larger number of injectible (i.e., liquid) and combination drugs (no single DDD value) in the sedative/hypnotic, antipsychotic and mood stabilizer categories. As a result, only DDDs for antidepressants – the largest category – were calculated. For one particular agent, l-tryptophan, DDD had missing values and could not be calculated. Based on typical clinical utilization of the drug as an antidepressant adjunct, a DDD value of 1.0 was imputed for this drug. A binary variable was created to indicate an antidepressant intensity of greater than 1.0 DDD – an indicator of higher than average use – per mother, in each of the four time periods. For the overall study period, a continuous variable of the number of periods that a mother had greater than 1.0 DDD was used.

b) Physician Visits

The Manitoba Health Medical Services database includes records of visits to physicians. Visits by residents and non-residents to Manitoba doctors as well as visits by Manitoba residents to physicians outside the province are also included in this database.[221]

Continuous variables for the number of visits for depression (ICD-9 code 311), anxiety (ICD-9 code 300), affective psychosis (ICD-9 code 296) and adjustment reaction (ICD-9 code 309) were calculated for each mother in each of the four time periods and for the overall study period. For the latent modelling (see Measurement Model below), visits for depression, adjustment reaction and affective psychosis were combined into a group called "depression" and all four diagnoses are included in the "Mood/Anxiety" latent construct. Given the strong relationship between substance abuse and mental health conditions,[211, 222] variables for number of substance abuse visits (ICD9 codes 291, 292, 303, 304, 305) were also examined but did not fit in the final model, so were dropped.

c) Timing

A key strength of this dataset is the ability to examine relationships over time. Timing is of particular importance because maternal depression at one period is predictive of depression at subsequent periods.[47, 158] Further, as described in Chapter 2, particular time periods in early childhood have been identified as sensitive periods where the influence of maternal Mood/Anxiety may be more pronounced. Examining specific time periods assisted in determining whether the presence of maternal mood and anxiety disorders at a particular time period makes a contribution to child school readiness outcomes. The four time periods used in this study were: Prenatal year, Postnatal year, Toddler years and Year Before the EDI (YBE). In addition, these four periods are combined into an overall study period. These are described in detail below.

The Prenatal period is the 12-month period prior to the child's birth, not including the date of birth. This 365-day period ensured that longer gestations would be included and is consistent in length with the other two one-year time periods. The Postnatal period, also 365 days long, is defined as the day of the child's birth up to the day before the first birthday. The Toddler period is a variable period that extends from the date of the child's first birthday to the day before one year prior to the EDI date. The period is variable because, although EDI assessments are usually done in February and March of the assessment year, children's birth dates range across the given calendar year. The range of length for the toddler time period was, therefore, 36 to 59 months, with an average of 45 months (3.7 years).[xxvii] The fourth time period – year before EDI – is the 12-month period prior to the EDI assessment.

d) Recurrence/Persistence

As discussed in Chapter 2, chronic, recurrent or persistent depression or Mood/Anxiety in mothers can negatively affect child development. Further, chronicity or persistence of mood and anxiety disorders is confounded with severity;[17, 98] chronic disorders are more likely to be of greater severity and more severe illness tends to persist over time. In order to assess whether recurrent or persistent mood and anxiety in mothers has a negative impact on outcomes at school entry, analyses were conducted with a predictor variable that identified the number of time periods a mother had one or more contacts (prescriptions or physician visits) for Mood/Anxiety: none, one, two, three or all four time periods.

[xxvii] Initially, for consistency, the Toddler period was defined as a three-year period from the child's first birthday to the day before the fourth birthday. While this removed the variability in the length of the time period, a "gap" period between the child's fourth birthday and one day before 12 months prior the EDI remained. This "gap" period ranged in length from 0 to 23 months (mean=7.89 months). Rather than leave out this significant period of time from the study, it was added back to the Toddler period.

e) Severity

As shown in Chapter 2, more severe Mood/Anxiety in mothers can be associated with more compromised child outcomes. As noted above, chronicity is often confounded with severity so recurrent or persistent Mood/Anxiety may be an indicator of measuring severity. Further, the continuous indicators of Mood/Anxiety used in this study – number of prescriptions and number of physician visits (and number of time periods with greater than 1.0 DDD of antidepressants for the overall Prenatal to EDI period) – capture the *degree* of Mood/Anxiety in terms of total number of contacts and this, to some degree, reflects severity. For this model, a non-latent variable was created that includes five categories of Mood/Anxiety severity, based on the distribution of these total counts of prescriptions and physician visits: none; low; low-mid; mid-high; and high. Another proxy measure for severity is whether someone is hospitalized for a mood disorder. However, as noted in Appendix 3, this variable was excluded from the Mood/Anxiety latent construct.

3.7.2.2 Health at Birth

While any one indicator will provide some information on health outcomes at birth, overall health status cannot be measured directly. As noted earlier, latent constructs can provide a proxy measure of a concept that is not easily measured. Previous work at MCHP by Fransoo et al.[137] used birth outcome variables in a latent construct for *health status at birth.* The four binary variables used in this study are based on those used by Fransoo et al.: preterm; low birth weight; NICU stay; and long birth hospitalization.[xxviii] Preterm indicates a premature birth at earlier than 37 weeks gestation. Premature

[xxviii] In confirmatory factor analysis, the variables of birth weight, gestational age, NICU stay and long birth hospitalizations all loaded significantly. Apgar score (5-minute) and delivery by Caesarean were also entered into the model but did not load significantly so were dropped.

birth is associated with poor child outcomes.[136] Low birth weight is defined as weighing less than 2500 grams at birth, also a known risk factor for child development.[174] NICU stay is defined as whether an infant was admitted to a neonatal intensive care unit (NICU)[xxix] following birth. Infants requiring this level of care are physically compromised in some way, including preterm birth, small-for-gestational age and requiring respiratory support.[57] The fourth indicator is long birth hospitalization which is defined as greater than the 90th percentile of birth hospital stays, or four or more days for this sample. These variables were measured at the child's birth and the same Health at Birth construct was used in models for each time period and the overall study period.

3.7.1.3 Family Context

A combination of socio-economic (SES) and family variables, including SEFI2 score, mother's marital status and young mother at first birth, were used to create the latent construct of Family Context. Several variables available in the administrative data were entered into the Family Context latent construct but were later excluded as they did not load in the latent modeling (see Confirmatory Factor Analysis, Results chapter) or were unstable in the final model as controls. These variables were: items from the Healthy Child Manitoba BabyFirst Screen[xxx] – relationship distress, postpartum separation and lack of bonding at birth; the number of siblings in the child's family; whether the family lived in an urban area; and receipt of income assistance. See Appendix 3 for more details.

[xxix] In Manitoba, NICUs are available in Winnipeg and Brandon and infants are transported to these facilities from around Manitoba, as deemed necessary.

[xxx] Inclusion of items from the BabyFirst Screen would have meant a 20% reduction in sample size, as approximately 80% of Manitoba mothers have a completed screen; one variable – relationship distress – did load in latent models but was dropped as its inclusion did not warrant such a significant reduction in sample size (see Appendix 3).

In the final analysis, the variables described below all loaded significantly in the latent construct and performed well in the models. In addition, each represents important elements that may pose challenges for families and their children – low SES, possible unstable relationship status and/or lack of social support, and young motherhood.

a) Socio-Economic Factor Index (SEFI2)

One measure for SES is the Socio-Economic Factor Index II (SEFI2) developed by MCHP. The SEFI2 is a composite measure derived from several census measures (at the dissemination area, or DA level) using factor analysis: unemployment rate, the proportion of adults without high school education, proportion of single-parent families and average household income, which adds improved face validity over an earlier version of the index. [223] These indicators are important predictors of health and social outcomes.[224] Scores linked to the mother are derived from the SEFI2 index and each score was defined at the start of each of the four time periods. For the overall study period, the average SEFI2 score across all four time periods was used.

b) Marital Status

Marital status is an indicator available in the Manitoba Health Registry that identifies whether an individual is married/common-law, single or widowed. In this study, marital status is a crude proxy measure that *may* indicate a less stable (or non-existent) relationship status and/or lack of social support – lone parenthood and lack of social support have been identified as important family risk factors.[225] Availability of this information depends on those with provincial health coverage identifying their status as married or common-law, and for both members of the couple to fall under the personal health information number (PHIN) of the "head of household." Since this is dependent on self-report,

not all married or common-law relationships will be noted in the Registry. Further, changes to marital status are also dependent on self-report so this information may be missing. However, despite these limitations, this is an important predictor of child health and social outcomes.[140] For this study, a binary variable was created to identify those mothers who were *not* married[xxxi] at the beginning of each time period. This variable was scaled to "not married" because, in latent variables, it is recommended that all manifest indicators be scaled in the same direction[226] and the other binary variables are scaled to negatively influence the outcome variables (e.g., mother less than 20 years at child's first birth). Marital status of mothers was defined at the beginning of each of the four time periods. For the overall Prenatal to EDI period, marital status at the Year Before EDI was used.

c) Mother's Age at First Birth

Mother's age at first birth is a strong predictor of health and social outcomes.[58, 78] Specifically, being a child of a teen mother is associated with an increased risk of: hospitalization, death before age 18, failure to complete high school, foster care, receipt of welfare as adults and becoming teen parents themselves.[227] For this study, a binary variable was created which indicates if a mother was under the age of 20 at the time of her first child's birth.

3.7.3 Outcome Variables

3.7.3.1 Early Development Instrument (EDI)

The specific variables pertaining to the EDI used in this study are described in detail below.

[xxxi] It should be noted that mothers who did not report their married/common-law status to Manitoba Health, Healthy Living and Seniors may, in fact, be married or common-law. In addition, changes to marital status are not always reported; therefore, the number of "not married" mothers may be over- or under-reported.

a) EDI Assessment Dates

In Manitoba, the EDI is completed every two years[xxxii] by kindergarten teachers in all 37 public school divisions and some First Nations and private schools on a voluntary basis. EDI assessments are typically done in February and March of the school year. Some assessments are done in January, when teachers receive the forms, and some are as late as June. In the EDI dataset, there were assessment dates from July to December for both of 2006 (n=21) and 2007 (n=28) years. These are erroneous dates either from when the form was completed by the teacher or when scanned into the Teleform database at Healthy Child Manitoba.[228, 229] There were also missing assessment dates in both 2006 (n=601) and 2007 (n=506). An accurate assessment date that falls within the normal assessment period is important as child age in months at EDI (an important predictor) is calculated using the assessment date. For this reason, both the missing and erroneous (past the end of the school year, June 30) assessment dates were imputed as March 15th for the applicable test year. This date was chosen as it falls in the middle of the month when most of the EDI assessments are completed.

b) Continuous Domain and Total Scores

EDI scores are calculated out of 10 for each of the five domains, for a total score out of 50. EDI results are not intended as individual assessments and are, therefore, typically reported on an aggregate level, for example, the proportion of children in a given jurisdiction (school, division, neighborhood, community, province, etc.) who are vulnerable or "not ready" (scored below the 10th percentile[xxxiii] on one or more domains). While this is typical reporting of EDI results, some studies have used continuous domain and total scores[206, 230] and, as noted above, individual scores can be used in research as long as

[xxxii] The first two cycles of the EDI in Manitoba, 2006 and 2007, were administered in consecutive years. Subsequent cycles are every two years.

[xxxiii] This threshold was chosen following development of a national normative sample (n=116,860).[232]

the results of the analysis are reported on an aggregate level. For this study, continuous domain scores were used.

In some cases, scores on one of the five EDI domains were missing in the EDI dataset. Each of the five domains had some missing values: Communication and General Knowledge (n=5); Emotional Maturity (n=176); Language and Cognitive Development (n=176); Physical Health and Well-Being (n=30); and Social Competence (n=6). A validity check confirmed that values were only ever missing on one of the five domains for any individual child. A closer look at the total scores (available for all children in the study) confirmed they were totals out of 50 (the maximum score); this made imputation of the missing domain value straightforward as all it required was subtracting the sum of the four domains with scores from the total score.

3.7.4 Control Variables

The richness of the administrative data makes it possible to include several key variables as control variables. Variables that did not load in the latent variables or, if loaded, reduced the fit of the final structural model, were entered as controls in earlier models. These included: one or more substance abuse visits or hospitalizations; a binary variable for urban residence; and a binary variable indicating receipt of income assistance. In addition, variables that were created as potential controls (i.e., were not tested in latent models) such as poor child health status, poor maternal health status and breastfed at birth were entered as controls; however, their inclusion reduced the overall fit of the final structural model so they were excluded. For this study, the binary variable of male child and the continuous variable indicating child age (in months) at the time of the EDI assessment were included as control variables in the final structural models.

3.8 Measurement Model

In the first part of Anderson and Gerbing's[210] two-step process, confirmatory factor analysis (CFA) was undertaken to determine how select manifest variables are related to an underlying latent construct, which cannot be directly measured. A series of models were run for each latent construct at applicable time periods and included both continuous and binary variables – exclusively or in combination. Results of the CFA are described in Chapter 4.

3.9 Structural Modelling

The final structural models included the latent constructs as described above and tested the theoretical relationships between these latent variables, control variables and the outcomes. First, univariate regressions were run for each of the predictor variables (manifest and latent) and the outcome domains. Next, crude structural equation models were run for the latent Mood/Anxiety construct and each of the outcome domains to determine the strength of these relationships without any other variables in the model. Models were then run, by outcome domain, for each time period and for the overall study period. In addition, models were run which examined Mood/Anxiety recurrence/persistence, Mood/Anxiety severity, and mothers with low and high SES. The next chapter describes the results of the measurement model and final structural models in detail.

Chapter 4: Results

4.1 Introduction

The purpose of this study was to examine the relationship between maternal Mood/Anxiety and child school readiness as measured by the EDI in kindergarten, while also examining several health, family and socio-economic variables. The relationships between these variables (see Figure 1.2, Chapter 1) were tested using Structural Equation Modeling (SEM).

Three key aspects of maternal Mood/Anxiety were explored in these analyses: timing, recurrence/persistence and severity. Children born in 2000 and 2001 were linked to their birth mothers. Mothers' Mood/Anxiety status was tracked over four time periods from one year prior to birth through to the child's EDI assessment in the kindergarten year. These time periods were: Prenatal year; Postnatal year; Toddler years; and the Year Before the EDI. Maternal Mood/Anxiety which occurred during the overall study period – the Prenatal year up to the EDI – was also examined. Several health, demographic and family variables were also measured at these various time periods. Models were run for each of the individual and overall time periods for each of the five EDI outcome areas: Language and Cognitive Development; Social Competence; Emotional Maturity; Physical Health and Well-Being; and Communication Skills and General Knowledge. Analyses to determine whether recurrent or persistent Mood/Anxiety negatively affected child outcomes included a non-latent predictor variable that identified the number of time periods a mother had one or more Mood/Anxiety prescriptions or physician visits. As noted in the literature review and the study hypotheses, children of mothers who had persistent or chronic Mood/Anxiety may have poorer developmental outcomes than children whose mothers were not chronically depressed or anxious. Severity of maternal Mood/Anxiety and whether there was a stronger influence on child outcomes was examined by including a non-latent predictor variable in the model that identified level of severity based on total number of Mood/Anxiety contacts

for the overall study period. Mediation analyses were included in each of the time period, recurrent/persistent and severity models. Supplementary analyses of whether SES moderates the relationship between Mood/Anxiety and child EDI outcomes was also undertaken.

This chapter includes an overview of descriptive statistics for the study population, results of the confirmatory factor analysis (measurement model of latent constructs), a summary of how each study variable – including latent constructs – relate to the outcome variables and results for the final structural model (testing relationship between latent constructs and the outcome variables) by time period and EDI outcome area.

4.2 Descriptive Statistics

The full sample for this study was 18,331 children who had an EDI assessment in 2006 or 2007 (born in 2000 and 2001), linked to their birth mothers. Summary statistics are provided for all time periods where feasible. In other cases (see Correlations, Section 4.2.2.1 below), just results for the overall study period are presented, as the reference model. As described in Chapter 3 (Section 3.7), some variable definitions vary by time period and sub-group.

4.2.1 Sample Means and Percentages

Table 4.1 provides a summary of means and percentages for variables measured at each of the four time periods and for the overall study period.[xxxiv] Due to the large proportion of zero values for each of the Mood/Anxiety variables, which skewed the standard deviation, means are presented for values of one

[xxxiv] With the exception of young mother (< 20 yrs at first birth), which is included in this table along with the other Family Context variables for consistency.

or more only. Mean values (for continuous variables) and percentages (for binary or categorical variables) for the Family Context indicators are for the full study sample (n=18,331).

Table 4.1: Means and Percentages for Model Variables, by Time Period

Variable	Constant	Prenatal	Postnatal	Toddler	Year Before EDI	Overall
	Mean	Mean	Mean	Mean	Mean	Mean
Mood/Anxiety						
Mean number of antidepressants for mothers with 1+	.	3.37	3.95	10.25	6.05	12.71
Percentage of mothers with > 1.0 ddd*of antidepressants	.	1.90%	2.90%	9.00%	6.40%	20.20%
Mean number of sedatives/hypnotics for mothers with 1+	.	2.26	2.95	5.47	4.07	6.45
Mean number of mood/anxiety visits for mothers with 1+	.	2.08	2.68	4.88	2.96	6.18
Family Context Variables (n=18,331)						
Mother not married†	.	50.80%	47.20%	45.70%	45.10%	45.10%
Average SEFI2 score	.	0.16	0.15	0.13	0.05	0.12
Low SES (SEFI2 >= 0)	.	55.00%	54.00%	53.00%	46.00%	47.00%
High SES (SEFI2 < 0)	.	45.00%	46.00%	47.00%	54.00%	53.00%
Mom < 20 yrs at 1st birth	8.00%	.	.	.	.	.

*Defined Daily Dose – a measure of dose intensity (See "Study Variables" in Methods chapter)
†Includes common-law; this variable is a crude proxy for stable relationship status and/or lone parenthood

4.2.1.1 Means and Percentages by Time Period

For the number of antidepressants, number of sedatives/hypnotics and number of Mood/Anxiety visits, mean values are the average number of prescriptions filled by mothers who had at least one of each type of contact, by time period. Mean values are higher for the number of antidepressant prescriptions (3.37 to 12.71) and for the number of sedative/hypnotic prescriptions (2.26 to 6.45) than for the mean number of Mood/Anxiety visits (2.08 to 6.18), for all time periods. The values for the dose intensity measure – greater than 1.0 defined daily dose of antidepressants indicator (> 1.0 DDD) – are the

percentage of mothers who had greater than 1.0 DDD for each time period and for the overall study period.

For all Mood/Anxiety indicators, means are lower for the Prenatal and Postnatal periods when compared to the other periods. This is partly due to a shorter time frame for these periods (12 months) than the Toddler period (3+ years) and overall study period (5+ years). However, when compared to the 12-month Year Before EDI period, these lower Prenatal and Postnatal means also suggest lower incidence of treatment (prescriptions and physician visits) for Mood/Anxiety before and after the child's birth. A Medicaid study[231] of women who received depression treatment – antidepressant prescription or depression physician visit – found that, compared to a control group, pregnancy is associated with a decrease in treatment for depression and such treatment remained lower in the postpartum period. Means are highest for the Toddler and Prenatal to EDI periods, given the longer time frames.

Family Context indicator means and percentages are a combination of constant and time-varying measures. Mother's age at first birth is the percentage of mothers who were under 20 years of age when they gave birth to their first child (8.0%). The Socio-Economic Factor Index (SEFI2) score[xxxv] was obtained for each mother at the start of each time period. These scores were divided into two groups, low-mid SES (top[xxxvi] 50% of SEFI2 scores) and mid-high SES (bottom 50% of SEFI2 scores). The average SEFI2 score and the percentage of mothers in each group are given for each time period. For mothers' marital status (not married), the percentage of mothers who were not registered as married/common-law at the start of each time period (or at the start of the year before the EDI for the overall study period) is given. For the individual time periods, this percentage ranges from a high of 50.8% at the start of the Prenatal period to a low of 45.1% at the beginning of the year before the EDI assessment,

[xxxv] SEFI2 scores ranged from -4.89 to 3.55 for the Prenatal, Postnatal and Toddler periods, based on the 2001 census and from -3.73 to 4.57 for the Year Before EDI period, based on the 2006 census. Changes to defined dissemination areas (DAs) at the 2006 census resulted in a different distribution of scores.
[xxxvi] A higher SEFI2 score reflects a lower socio-economic status.

decreasing slightly across the time periods. Marital status data are collected by Manitoba Health, Healthy Living and Seniors, as described in Chapter 3; the form is voluntary and, in order for a mother to be identified as married or common-law, she must declare a "head of household" on the form. Due to decreased reporting of married/common-law status, this has gradually become a less reliable data source over time.

4.2.1.2 Means and Percentages for Time Invariant Measures

In addition to the variables measured at each time period, several indicators were only measured at one point in time. Depending on the nature of the variable, Table 4.2 includes a combination of mean values (for continuous variables) and percentages (for binary and categorical variables) for the full study sample (n=18,331).

Table 4.2: Means and Percentages for Model Variables Measured Only at One Time (n=18,331)

Variable	Mean
Health at Birth	
Preterm (<37 weeks)	7.70%
Low birth weight (<2500g)	5.20%
NICU stay	4.70%
Long birth stay (4+ days)	8.90%
Control Variables	
Male child	50.90%
Child age (in months)	67.91
Outcome Variables (Score out of 10)	
Communication Skills and General Knowledge	7.64
Emotional Maturity	7.91
Language and Cog Dev	8.12
Physical Health	8.71
Social Competence	8.27

The Health at Birth values reflect the percentage of infants that met the criteria for each indicator. The highest percentage is a birth hospital stay of four or more days (8.9%) and the lowest is for a neonatal intensive care unit (NICU) stay following birth (4.7%). The control variable values are the percentage of children in the cohort who are male (50.9%) and the average child age in months (67.9 months, or five years and eight months), with a range of 60 to 83 months (five years to six years and 11 months). The EDI outcome values are average domain scores out of a total of 10. Mean scores are highest for the Physical Health[xxxvii] domain (8.71) and lowest for the Communications Skills domain (7.64), though all means are greater than seven out of 10. Mean scores for this study sample are very similar to the national EDI normative sample.[232] Further, domain scores are typically skewed toward the upper end as the vast majority of children have high scores.[232]

4.2.2 Relationships Between Study Variables

4.2.2.1 Correlations Between All Model Predictors

Correlations between the variables used over the six-year study period (one year prior to birth up to the EDI assessment) are shown in Table 4.3. As described above, there are three latent constructs in this study – Mood/Anxiety, Health at Birth and Family Context – and male child and child age in months at the time of the EDI are included as controls. Table 4.3 groups the variables by latent construct. Pearson correlation coefficients[xxxviii] and p values are given for each pair of variables and coefficients with p values significant at <.001 are highlighted in bold. As would be expected, correlations are higher among

[xxxvii] Where results are reported throughout the remainder of the document, abbreviated names of the outcome domains are used (e.g, Physical, Social, Emotional, Communication Skills, Language).

[xxxviii] For pairs of binary variables, the PHI coefficient is reported – it is interpreted the same as the Pearson correlation coefficient. Binary variables are denoted in the table with "(0/1)."

pairs of variables within the same latent construct as, when grouped together, these indicators are presumed to measure the same hypothetical construct.

Table 4.3: Correlations Between Model Variables – Overall Study Period

Variables	Mood/Anxiety				Health at Birth				Family Context		
	Antidep_ total	Sedhyp_ total	Over_ddd_ total	Visits_ total	Preterm (0/1)	Lowbwt (0/1)	NICUstay (0/1)	Longstay (0/1)	SEFI2_avg	Mom <20 (0/1)	Notmarry_ ybe (0/1)
Antidep_total	.										
Sedhyp_total	**0.375** <.0001	.									
Over_ddd_total	**0.596** <.0001	**0.332** <.0001	.								
Visits_total	**0.566** <.0001	**0.320** <.0001	**0.453** <.0001	.							
Preterm (0/1)	0.014 .058	0.021 .004	0.021 .005	0.019 .012	.						
Lowbwt (0/1)	-0.014 .063	-0.001 .945	-0.001 .856	-0.013 .082	**0.597** <.0001	.					
NICUstay (0/1)	0.009 .223	0.009 .240	0.020 .008	0.016 .027	**0.434** <.0001	**0.376** <.0001	.				
Longstay (0/1)	**0.026** .0004	**0.027** .0003	**0.026** .0004	0.024 .001	**0.470** <.0001	**0.410** <.0001	**0.527** <.0001	.			
SEFI2_avg	0.004 .613	**0.107** <.0001	**0.051** <.0001	0.003 .679	0.025 .001	0.029 .0001	-0.010 .180	0.020 .006	.		
Mom <20 (0/1)	**-0.028** .0001	-0.005 .477	-0.001 .893	0.0001 .995	-0.002 .809	0.007 .321	-0.001 .927	-0.008 .283	**0.189** <.0001	.	
Notmarry_ybe (0/1)	**0.030** <.0001	**0.084** <.0001	**0.070** <.0001	**0.062** <.0001	-0.018 .015	-0.022 .003	-0.019 .010	-0.005 .524	**0.239** <.0001	**0.252** <.0001	.

<.001

4.2.2.2 Relationships Between Mood/Anxiety at Each Time Period

As research has shown,[7] mood and anxiety disorders at one time is moderately to highly correlated with mood and anxiety disorders at other times. For this study, models were run (using the PROC CALIS statement in SAS 9.3) to determine standardized estimates of the relationship between Mood/Anxiety at each of the four time periods. As shown in Table 4.3, there is a strong relationship between Mood/Anxiety at different time periods; however, the strength of this relationship decreases with time. Specifically, there is a stronger relationship between periods closer together in time (e.g., Prenatal and Postnatal and Toddler and YBE) than those that are farther apart.

Table 4.4: Relationships (Standardized Estimates) Between Mood/Anxiety at Each Time Period

Variable	Prenatal	Postnatal	Toddler	YBE
Mood/Anxiety				
Prenatal	.	**0.71**	**0.57**	**0.46**
Postnatal		.	**0.74**	**0.52**
Toddler			.	**0.92**
YBE				.

<.001

4.2.2.3 Correlations Between Outcome Variables

Table 4.5 shows the correlations among the outcome variables for this study – the five EDI domains: Language and Cognitive Development, Social Competence, Emotional Maturity, Physical Health and Well-Being and Communication Skills and General Knowledge. As would be expected, these variables show fairly high correlations and are very similar to the EDI national normative full sample (n=125,282).[232] Of particular interest, as noted in the study hypotheses, are the outcomes of Social Competence and Emotional Maturity. As described in the literature review, these areas of child

development are particularly vulnerable to mood disorders in mothers. The strongest correlation is between the outcomes of Social Competence and Emotional Maturity (0.805).

Table 4.5: Correlations Between Outcome Variables

EDI Domain	Language	Social	Emotional	Physical	Communication
Language	.				
Social	**0.614** <.0001	.			
Emotional	**0.490** <.0001	**0.805** <.0001	.		
Physical	**0.558** <.0001	**0.581** <.0001	**0.474** <.0001	.	
Communication	**0.655** <.0001	**0.616** <.0001	**0.485** <.0001	**0.609** <.0001	.

<.001

4.3 Confirmatory Factor Analysis Results

The first part of Anderson and Gerbing's[210] two-step SEM process entails testing the relationship between the manifest variables and the underlying latent construct they are intended to measure. Latent models were created for the constructs of Mood/Anxiety, Health at Birth and Family Context, depicted in Figure 1.2 (Chapter 1) for each of the four time periods and the overall study period. Variables thought to be related to the same underlying construct were entered into models to determine their factor loadings – statistical estimates of the presumed causal effects of the latent variable, or factor, on observed (manifest) scores.[207] Models initially included a larger number of variables to determine which ones loaded significantly at or above the threshold of 0.30.[210] Those that loaded below the threshold were removed from the latent construct.[xxxix] In some time periods, one or more factor loadings were below the 0.30 threshold but were retained as a group for the full structural

[xxxix] A number of these variables were added as controls to the final structural model, but reduced model fit so were later dropped. See Appendix 3 for details.

models for consistency. Table 4.6 includes the factor load values for each indicator in the three latent constructs, across time periods.

Factor loadings of 0.60 or greater indicate a strong relationship between the latent construct and the underlying manifest variable. All factor loadings for the Health at Birth construct are at least 0.60. There is more variability in factor loadings for the Mood/Anxiety and Family Context constructs, and these vary across time periods. For example, in the Mood/Anxiety construct, number of antidepressant prescriptions consistently has the strongest factor loading (over 0.70), followed by greater than 1.0 DDD of antidepressants and number of Mood/Anxiety visits (both over 0.50). Number of sedatives/hypnotics has the lowest load value for this construct, but is consistently significant across all time periods. It should be noted that factor loadings for all four Mood/Anxiety indicators are highest for the overall study period. For the Family Context construct, the factor loadings are lower overall, with less range, and there is considerably more variation in factor loadings across time periods. This may indicate that how the variables relate to family context varies with time. The SEFI2 score is consistently the highest load value in this construct (over 0.39). However, for the other two variables – mother not married and young mother at first birth – factor loadings are not significant across all time periods. Specifically, these two variables do not meet the threshold for the Prenatal period. Of note is the fact that the factor load values for all three Family Context variables is at least 0.30 for the overall study period.

Table 4.6: Factor Loads for Latent Variables, by Time Period (n=18,331)

	Prenatal	Postnatal	Toddler	YBE	Overall
Latent Construct					
Mood and Anxiety					
# antidepressants	**0.74**	**0.77**	**0.83**	**0.80**	**0.85**
> 1.0 ddd antidepressants	**0.54**	**0.60**	**0.53**	**0.61**	**0.70**
# sedatives/hypnotics	**0.35**	**0.39**	**0.44**	**0.43**	**0.46**
# mood visits	**0.51**	**0.56**	**0.67**	**0.55**	**0.67**
Health at Birth					
preterm (< 37 weeks)	**0.77**	**.**	**.**	**.**	**.**
low birthweight (< 2500g)	**0.70**	**.**	**.**	**.**	**.**
NICU stay	**0.61**	**.**	**.**	**.**	**.**
long birth hosp	**0.64**	**.**	**.**	**.**	**.**
Family Context					
SEFI2	**0.76**	**0.42**	**0.39**	**0.43**	**0.42**
Mother not married	0.22	**0.44**	**0.53**	**0.55**	**0.57**
Young mother	0.20	**0.38**	**0.44**	**0.46**	**0.45**

<.001, NS

4.3.1 Mood/Anxiety

As described in Chapter 3, a broader definition of Mood/Anxiety disorders was included for this study as it is difficult to isolate depression in administrative data and the current revised MCHP definition has broadened diagnosis codes to account for this.[212] To determine whether the definition used would differentially impact the structural model results, latent models were run to determine the set of variables that best measured the separate concepts of Depression and Mood/Anxiety in the dataset. The four manifest variables are the same for both constructs, with the exception of physician visits – the Depression definition includes diagnoses for depressive disorder, affective psychosis and adjustment reaction and the Mood/Anxiety definition includes these, plus visits for anxiety. There was little difference in terms of factor loadings between Depression and Mood/Anxiety definitions. The most

notable contrast is the larger load value for Mood/Anxiety visits in the Mood/Anxiety construct compared to the depression visits factor load in the Depression latent construct. As a result, the broader Mood/Anxiety construct was retained. Table 4.7 provides the results of this comparison.

Table 4.7: Depression and Mood/Anxiety Latent Construct Factor Loads, by Time Period (n=18,331)

	Prenatal	Postnatal	Toddler	YBE	Overall
Latent Construct					
Depression					
# antidepressants	**0.77**	**0.79**	**0.88**	**0.81**	**0.87**
> 1.0 ddd antidepressants	**0.53**	**0.61**	**0.51**	**0.61**	**0.69**
# sedatives/hypnotics	**0.31**	**0.35**	**0.40**	**0.42**	**0.43**
# depression visits	**0.48**	**0.50**	**0.59**	**0.46**	**0.60**
Mood/Anxiety					
# antidepressants	**0.74**	**0.77**	**0.83**	**0.80**	**0.85**
> 1.0 ddd antidepressants	**0.54**	**0.60**	**0.53**	**0.61**	**0.70**
# sedatives/hypnotics	**0.35**	**0.39**	**0.44**	**0.43**	**0.46**
# Mood/Anxiety visits	**0.51**	**0.56**	**0.67**	**0.55**	**0.67**

<.001

This project focused on a detailed examination of indicators of mood and anxiety disorders in mothers in the study sample over four key time periods – Prenatal, Postnatal, Toddler and Year Before EDI (YBE). For each of the time periods, counts of the number of prescriptions filled (by category) and counts of the number of Mood/Anxiety physician visits were entered in the latent models.[xl] Use of these data allowed for discerning the *degree* of Mood/Anxiety in mothers rather than using a binary variable in each time period. For each mother, the following was defined: Number of drugs prescribed in each psychotropic category (antidepressants, sedatives/hypnotics); a binary indicator of whether a mother had greater

[xl] Number of Mood/Anxiety hospitalizations was also entered into the latent model, and did load above 0.30 in some time periods. However, when number of hospitalizations was included in the final structural model, fit was reduced so this indicator was excluded.

than 1.0 defined daily dose (DDD) of antidepressants; and the number of physician visits for Mood/Anxiety (depressive disorder, affective psychosis, adjustment reaction and anxiety). (Table 3.1 in Chapter 3 lists the categories of psychotropic prescriptions and Anatomical Therapeutic Classification (ATC) codes and type of physician visit and International Classification of Diseases (ICD) 9 codes). In addition, given the high incidence of comorbidity between psychiatric diagnoses and substance abuse,[211] continuous variables for the number of physician visits for substance abuse and the number of hospitalizations for substance abuse were created. However, neither of these loaded significantly with the other manifest variables so they were dropped from the construct. All four of the Mood/Anxiety manifest indicators loaded above 0.30 in all time periods.

As noted in Chapter 3, both continuous and binary variables were considered. For example, manifest variables in the binary Mood/Anxiety latent constructs included: One or more prescriptions (e.g., antidepressants or sedative/hypnotics) filled in a given time period; one or more Mood/Anxiety visits in a time period; and greater than 1.0 defined daily dose (DDD) of antidepressants. These drug and visit binary variables were tested in the latent models and did load significantly. However, the transformation of the continuous variables of health care contacts into binary variables removes the range of contacts for mothers in the study and the *degree* of depression or Mood/Anxiety. Therefore, latent constructs with continuous health care contacts were selected as the best for this study. The binary variable of greater than 1.0 DDD did significantly load in the latent models and was retained along with the continuous prescription and physician visit variables.

4.3.2 Health at Birth

Similar to the work of Fransoo et al.,[137] the variables of birth weight, gestational age, NICU stay, length of birth hospitalization and 5-minute Apgar score were entered into the latent model for Health at Birth.

As expected, all of the variables loaded significantly except for 5-minute Apgar score. As noted by Fransoo et al.,[137] this may be due to the fact that most children are born quite healthy and high Apgar scores do not fit as well in a latent construct with variables that have a much broader distribution. Both continuous and binary versions of the variables were included in latent models. As was the case in Fransoo et al.,[137] the binary versions of the variables performed better in the latent model: Preterm (<37 weeks), low birth weight (<2500 grams), NICU stay and at or above the 90th percentile for length of birth hospital stay (four or more days). All had consistently high loads (>0.60) suggesting all were related to one another and measuring the underlying construct.

In previous iterations of this construct,[58, 137, 138] a binary variable of whether an infant was in the NICU for three or more days was used. This variable was initially tested in creation of the measurement model for this study and loaded significantly (0.65), as expected. However, further discussions suggested that, conceptually, *any* NICU stay for an infant indicates a more compromised status than using a percentile-based cut-off for length of NICU stay (e.g., 90%). Therefore, a binary variable indicating whether or not an infant was admitted to the NICU was included, and also had a strong factor load (0.61).

4.3.3 Family Context

In the final model, SEFI2 score, mother's marital status and young mother at first birth were the strongest combination for the Family Context construct. Even though not all variables loaded above 0.30 for all time periods, this group was retained for consistency and model fit. Further, this combination of family context variables resulted in the best model fit for all time periods (see Section 4.6). Other potential family context variables, such as income assistance and substance abuse, did load in the earlier latent variables but they were unstable in the final model (i.e., reduced model fit or reversed direction of the relationship between Mood/Anxiety and the outcome) so were dropped. The

revised model (Figure 4.1) with the SES latent construct removed and replaced by Family Context (including SEFI2 score for SES) is below.

4.4 Revised Conceptual Model

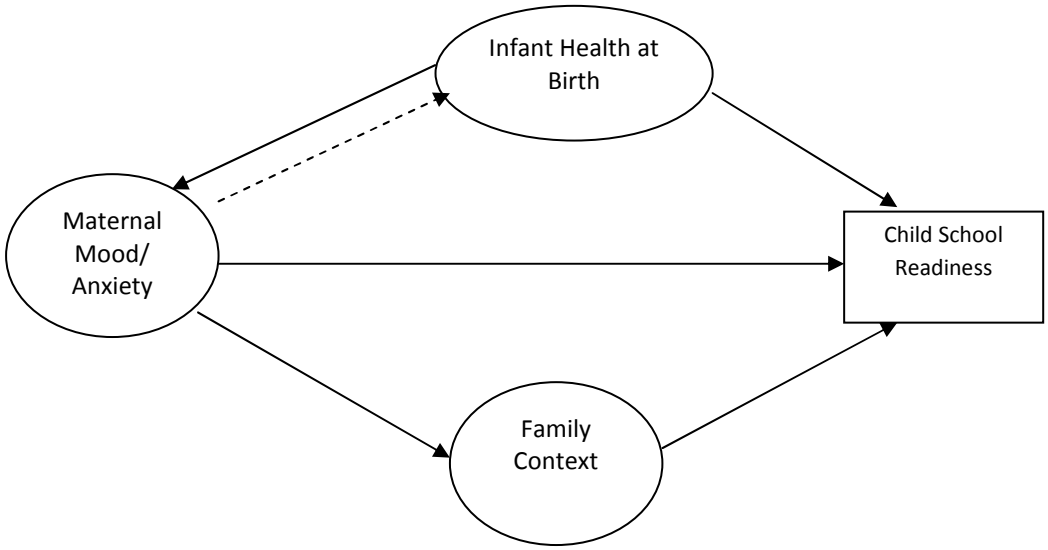

Figure 1.3 Revised conceptual model

As mentioned in the Introduction (Chapter 1), the conceptual model for the study was revised to reflect the confirmatory factor analysis. In the revised conceptual model, the direction of the arrow between maternal Mood/Anxiety and Health at Birth has been reversed to reflect the fact that infant health status at the time of birth precedes measurement of Mood/Anxiety in mothers for the Postnatal, Toddler and Year Before EDI periods. The arrow with dashes from maternal Mood/Anxiety to Health at Birth is applicable for the Prenatal period only. The Mood/Anxiety latent construct includes: Number of antidepressant prescriptions; greater than 1.0 DDD of antidepressants; number of sedatives/hypnotic prescriptions; and number of Mood/Anxiety physician visits. Health at Birth includes: Preterm; low birth

weight; NICU stay; and long birth hospital stay. Family Context includes: SEFI2 score; mother's marital status; and young mom (< 20 years) at first birth. Table 4.8 provides detail on how each of these variables was defined for each of the time periods.

Table 4.8: Variables Used in Final Structural Models, By Time Period

Variable	Prenatal	Postnatal	Toddler	YBE	Overall
Mood/Anxiety					
# Antidepressants	# Rx	# Rx	# Rx	# Rx	# Rx
Greater than 1.0 DDD	0/1	0/1	0/1	0/1	# periods
# Sedatives/hypnotics	# Rx	# Rx	# Rx	# Rx	# Rx
# Mood/Anxiety visits	# visits	# visits	# visits	# visits	# visits
Health at Birth					
Preterm (< 37 weeks)	0/1	0/1	0/1	0/1	0/1
Low birth weight (< 2500 g)	0/1	0/1	0/1	0/1	0/1
NICU stay	0/1	0/1	0/1	0/1	0/1
Long birth hospitalization	0/1	0/1	0/1	0/1	0/1
Family Context					
SEFI2 score**	Score	Score	Score	Score	Avg score
Mother not married**	0/1	0/1	0/1	0/1	0/1 YBE
Young mother at first birth	0/1	0/1	0/1	0/1	0/1
Controls					
Male child	0/1	0/1	0/1	0/1	0/1
Child age in months at EDI	Age	Age	Age	Age	Age

**Measured at start of time period

4.5 Univariate Regressions for Model Variables

Table 4.9 shows the univariate regressions (R^2 value) of each model variable – manifest and latent – on each of the EDI outcome domains. For this table, the overall study period was used. With the exception of the relationships between the number of antidepressants and the Language and Cognitive

Development domain and number of antidepressants and the Communication Skills domain, all values are statistically significant; the relationship between Mood/Anxiety visits and the Communication Skills domain at $p<.01$ and all others at $p<.001$. As illustrated by the low R^2 values, the relationship between each of the Mood/Anxiety indicators – and the Mood/Anxiety latent construct – and the outcomes is very small. This same pattern holds for the relationship between each of the Health at Birth variables and latent construct and the outcomes. In contrast, the Family Context variables and latent construct and control variables of male child and child age in months at EDI have the strongest univariate relationship to each of the outcomes. These findings demonstrate that Mood/Anxiety, as defined in this study, has little direct influence on each of the outcome domains. Family Context, on the other hand, has a much stronger effect on the outcome domains, and these relationships are found in the final structural model (see Section 4.6 below).

Table 4.9: Univariate Regressions of Each Predictor Variable on Outcome Domains – Overall Study Period

	R^2 Value				
Manifest Variables	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
# antidepressants	0.0003	**0.0009**	**0.0010**	**0.0027**	0.0022
> 1.0 ddd antidep	**0.0016**	**0.0029**	**0.0027**	**0.0046**	**0.0012**
# sedatives/hypnotics	**0.0029**	**0.0021**	**0.0010**	**0.0027**	**0.0022**
# mood and anxiety visits	**0.0007**	**0.0025**	**0.0016**	**0.0028**	*0.0006*
Preterm (<37 weeks)	**0.0025**	**0.0013**	**0.0011**	**0.0036**	**0.0020**
Low bweight (<2500g)	**0.0030**	**0.0015**	**0.0007**	**0.0039**	**0.0023**
NICU stay	**0.0023**	**0.0011**	**0.0010**	**0.0030**	**0.0018**
Long birth stay (> 90%)	**0.0021**	**0.0021**	**0.0024**	**0.0053**	**0.0030**
SEFI2 score	**0.0639**	**0.0256**	**0.0153**	**0.0365**	**0.0409**
Mother not married	**0.0250**	**0.0197**	**0.0143**	**0.0220**	**0.0075**
Mom < 20 yrs at 1st birth	**0.0108**	**0.0078**	**0.0057**	**0.0083**	**0.0033**
Male child	**0.0238**	**0.0409**	**0.0559**	**0.0178**	**0.0191**
Age_months	**0.0172**	**0.0065**	**0.0050**	**0.0089**	**0.0105**
Latent Variables					
Mood/Anxiety	**0.0013**	**0.0030**	**0.0025**	**0.0048**	**0.0009**
Health at Birth	**0.0051**	**0.0030**	**0.0025**	**0.0079**	**0.0046**
Family Context	**0.1420**	**0.0731**	**0.0488**	**0.0915**	**0.0626**

<.001 *<.01* NS

4.6 Final Structural Models

Whereas the confirmatory factor analysis stage of this research examined the relationship between the manifest indicators and the latent construct they are intended to reflect, the structural model tested the theory outlined in the Methods chapter: how the latent constructs – mother's Mood/Anxiety, Health at Birth and Family Context – and demographic control variables relate to one another and to the outcome

measures. The outcome variables are the five domains of the EDI: Language and Cognitive Development; Social Competence; Emotional Maturity; Physical Health and Well-Being; and Communication Skills and General Knowledge.

Models were run for the overall study period (one year prior to birth up to EDI) and for each of the four time periods. Further, these models were also run for each of the five EDI domains (outcome variables). Analyses were also conducted for Mood/Anxiety recurrence/persistence and Mood/Anxiety severity. Additional analyses were done to determine if EDI outcomes differed for children of mothers with different levels of SES. These results are described in Supplementary Analyses below (Section 4.6.8).

Table 4.10 shows the fit statistics used for this study and the recommended thresholds. In structural equation modeling, there is no one statistic, or set of statistics, to measure model fit. Bentler's Comparative Fit Index (CFI) and Bentler & Bonnet's Non-Normed Fit Index (NNFI) are incremental or comparative fit indices which assess model fit improvement when compared to a baseline, typically the null model.[207] For CFI and NNFI, values of .90 or better indicate adequate fit.[226] The Root Mean Square Error of Approximation (RMSEA) is an absolute index which compares a hypothesized model to the sample data and assesses whether the specified model reproduces patterns in the data.[226]

Table 4.10: Fit Statistics Thresholds for Final Structural Model

Fit Statistic	Value Should be Above/Below†
Bentler's Comparative Fit Index (CFI)	> 0.90
Bentler & Bonnet's Non-Normed Fit Index (NNFI)	> 0.90
Root Mean Square Error of Approximation (RMSEA)	< 0.06

†SAS Institute Inc.[226]

Table 4.11 includes the fit statistics values for each of the individual time periods and overall study period models, for the Social Competence domain.

Table 4.11: Fit Statistics for Final Model, by Time Period (Social Competence)

Fit Statistic	Overall	Prenatal	Postnatal	Toddler	YBE
Comparative Fit Index (CFI)	0.95	0.93	0.94	0.95	0.95
Non-Normed Fit Index (NNFI)	0.94	0.91	0.93	0.93	0.94
Root Mean Square Error of Approximation (RMSEA	0.0415	0.0413	0.0396	0.0400	0.0381

As shown in Table 4.11, the fit statistics for the models meet or exceed the threshold values as noted in Table 4.10, indicating very good model fit. These fit statistics values were virtually identical across each of the five EDI domain models within each time period, so only the Social Competence fit statistics are reported in the table. Fit statistics for each model are included in all of the tables of results below.

4.6.1 Crude Relationships Between Mood/Anxiety and Outcome Domains

In order to ascertain if there is a direct relationship between the Mood/Anxiety latent construct and the outcome variables, models were run with these variables only. As shown in Table 4.12, there was a significant ($p<.001$) negative association between Mood/Anxiety in mothers and EDI domain scores in children, across all outcome areas. Specifically, this association was strongest for the Physical Health and Well-Being domain (-0.07), followed by Social Competence (-0.06), Emotional Maturity (-0.05), Language and Cognitive Development (-0.04) and Communication Skills and General Knowledge (-0.03). For mediation analyses (described below in full model results), it was important to determine if a significant association was present when only these two variables were included.

Table 4.12: Crude Models of Mood/Anxiety and Outcome Domains

Variable	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Mood/Anxiety --> Outcome	**-0.04**	**-0.06**	**-0.05**	**-0.07**	**-0.03**

<.001; *<.01*; NS

The following sections describe the findings for the overall study period and for each individual time period. Tables provide a summary of the standardized path coefficients for each path in the model, by outcome domain. Direct, indirect and total effects of the Mood/Anxiety and Health at Birth constructs are also provided.[xli] Values in bold are significant at p<.001, italics indicate p<.01 and non-significant values are not highlighted. Also included is the R^2 value for the model – the proportion of the variation in the outcome variable explained by the model variables. Detailed descriptions of what the tables illustrate are provided in text below the table. The R^2 values are noted in the Results section for each model where the findings are of note; otherwise, a detailed summary of how these vary across models is provided in the chapter summary. Definitions of how each model variable was scaled for each time period are provided in Table 4.8 (above).

4.6.2 Overall Study Period Model

a) Variables

While examination of the influence of Mood/Anxiety in mothers during particular time periods was a key focus, this study also looked at the influence of maternal Mood/Anxiety disorder when defined over

[xli] Direct effects indicate the strength of the relationship between two variables, indirect effects indicate the strength of the relationship for two variables mediated through one or more other variables (the coefficients along the mediated path are multiplied by one another to calculate indirect effects) and the total effect is the sum of the direct and indirect effects.

the entire study period – one year prenatal up to and including the year before the EDI. For this model, the Mood/Anxiety latent construct included a manifest indicator for the total number of each health care contact (prescriptions and physician visits) as well as *the number of time periods* a mother had greater than 1.0 DDD of antidepressants (as opposed to whether or not a mother had greater than 1.0 DDD in each of the individual time periods). This modified definition of the dose intensity of antidepressants was used because of the combination of all separate time periods into one; it is a more sensitive measure than if only one time period was selected. These variables were calculated for the period from 365 days prior to the child's birth up to the day before the EDI assessment. As in all models, the Health at Birth latent construct was measured by the following binary indicators: preterm, low birth weight, admission to the NICU and long birth hospitalization.

Family Context variables for the Prenatal to EDI period were scaled as follows: As noted above, SEFI2 scores were available at the start of the each of the four time periods. For the overall study period, these four scores were summed and divided by four to obtain an average score. Mothers' marital status for the Year Before EDI period and the constant measure of young mother at first birth were also used. As in all models, male child and age of child in months at the time of the EDI were entered as control variables.[xlii]

[xlii] Control variables that did not load significantly when running the final models were: Urban, child health (2+ major ADGs), mother's health (90%+ all ADGs), breastfed and substance abuse. Former Mood/Anxiety manifest indicators for the number of antipsychotics and the number of hospitalizations did not load significantly either. Income assistance had a strong influence in the final models, but had the effect of either reducing the model fit (when entered as a manifest indicator in Family Context) or reversed the direction between Mood/Anxiety and the outcome (when entered as a control), so was subsequently dropped (see Appendix 3 for further details).

b) Results

Table 4.13 includes the standardized path estimates for the overall study period model – the most comprehensive model covering all four individual time periods. Estimates are provided for each of the five outcome areas.

Table 4.13: Standardized Estimates for the Overall Study Period, by Outcome Domain (n=18,331)

Variable	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Latent Constructs					
Mood/Anxiety --> Outcome	-0.01	**-0.04**	**-0.04**	**-0.05**	-0.01
Mood/Anxiety <-- Health at Birth	0.02	0.02	0.02	0.02	0.02
Health at Birth --> Outcome	**-0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**
Mood/Anxiety --> Family Context	**0.07**	**0.07**	**0.07**	**0.07**	**0.07**
Family Context --> Outcome	**-0.38**	**-0.27**	**-0.22**	**-0.30**	**-0.25**
Direct Effect of Mood/Anxiety†	-0.0108	**-0.0365**	**-0.0354**	**-0.0474**	-0.0127
Indirect Effect of Mood/Anxiety	**-0.0249**	**-0.0183**	**-0.0150**	**-0.0204**	**-0.0165**
Total Effect of Mood/Anxiety	**-0.0358**	**-0.0549**	**-0.0504**	**-0.0677**	**-0.0292**
Direct Effect of Health at Birth	**-0.0690**	**-0.0520**	**-0.0467**	**-0.0868**	**-0.0657**
Indirect Effect of Health at Birth	-0.0008	-0.0012	-0.0011	-0.0015	-0.0006
Total Effect of Health at Birth	**-0.0697**	**-0.0532**	**-0.0478**	**-0.0883**	**-0.0663**
Control Variables					
Male child --> Outcome	**-0.16**	**-0.20**	**-0.24**	**-0.14**	**-0.14**
Child age --> Outcome	**0.14**	**0.09**	**0.08**	**0.10**	**0.11**
CFI	0.95	0.95	0.95	0.95	0.95
NNFI	0.93	0.94	0.94	0.93	0.93
RMSEA	0.0434	0.0415	0.0411	0.0420	0.0437
R2	0.1893	0.1252	0.1139	0.1285	0.0976

<.001; *<.01*; NS

†Direct effect between Mood/Anxiety and outcome domain

As shown in Table 4.13 for the overall study period, the direct association between Mood/Anxiety and the Social Competence (-0.04, p<.001), Emotional Maturity (-0.04, p<.001) and Physical Health and Well-Being (-0.05, p<.001) domains is modest but statistically significant. These direct paths were not significant for the Language and Cognitive Development and Communication Skills domains.

The association between Health at Birth and Mood/Anxiety was consistently not significant and the relationship between Health at Birth and outcome areas was consistently negative and significant, with the strongest association for the latter on the Physical Health and Well-Being domain (-0.09, p<.001). This suggests that the greater the health challenges at birth, the poorer physical development upon entry to school, as would be expected.

There is a strong and significant positive relationship between Mood/Anxiety and Family Context for all outcome domains (0.07, p<.001). Further, Family Context has a very strong, negative association with each outcome area, suggesting that family environment factors have a much stronger influence on child development in kindergarten than maternal Mood/Anxiety. The relationship between Family Context and Language domain is the strongest by far (-0.38, p< .0001) when compared to the other domains.

While direct associations were found between Mood/Anxiety and the outcomes for three domains (above), Mood/Anxiety has a significant *indirect* association with each of the outcome domains through Family Context. In other words, the influence of maternal mood and anxiety disorders on child EDI scores is *mediated* through family environment factors. This mediation is *partial* where the direct path from Mood/Anxiety to the outcome is significant – for the Social, Emotional and Physical domains – and *full* mediation for the other two domains, Language and Communication Skills, where no direct significant path was found. The total effect of Mood/Anxiety is the sum of the direct (Mood/Anxiety to outcome path) and indirect (Mood/Anxiety effect mediated through Family Context) effects. The strongest total effect of Mood/Anxiety is found in the Physical outcome domain (-0.0677, p<.001), a

consistent pattern across all time periods. This suggests that the combination of variables in the model has a stronger influence on the Physical domain than for the others.

For the Health at Birth construct, the arrows in the overall study period model run directly from this construct to Mood/Anxiety and then directly from Mood/Anxiety to the outcome and indirectly from Mood/Anxiety to the outcome through Family Context (see Figure 1.4, below). The total effect of Health at Birth is the sum of these direct and indirect effects and is significant for all outcome areas, with the largest effect found for the Physical Health domain (-0.0884, p<.001). Further, the direct effect of Health at Birth on the outcomes is significant for all domains, indicating partial mediation of Health at Birth on the outcomes through Mood/Anxiety and Family Context.

The relationships between the control variables and the outcome domains remain strong and in a consistent direction, however, the strength of these relationships varied across domains. Being a male child had the strongest negative association with the Social Competence and Emotional Maturity domains and child age in months had the highest positive association with Language and Cognitive Development and the lowest with the Emotional Maturity domain.

The R^2 value indicates the proportion of the variance in the outcomes explained by the model variables. As shown in Table 4.13, the largest proportion explained was for the Language and Cognitive Development domain (18.9%). This finding is consistent across all models tested in the study and the much stronger association between Family Context and the Language domain would contribute to this larger R^2 value.

Figure 1.4 [xliii] illustrates the paths between variables and the path coefficients as above in Table 4.13; significant coefficient values are denoted in bold (<.001) or italics (<.01). The three variables denoted

[xliii] See the Appendix 4 for diagrams of the individual time periods, recurrent/persistent model and SES models for the Social Competence outcome.

with an oval are the latent constructs; arrows to the manifest indicators and their factor loads are also depicted (see Confirmatory Factor Analysis, section 4.3, Chapter 3).

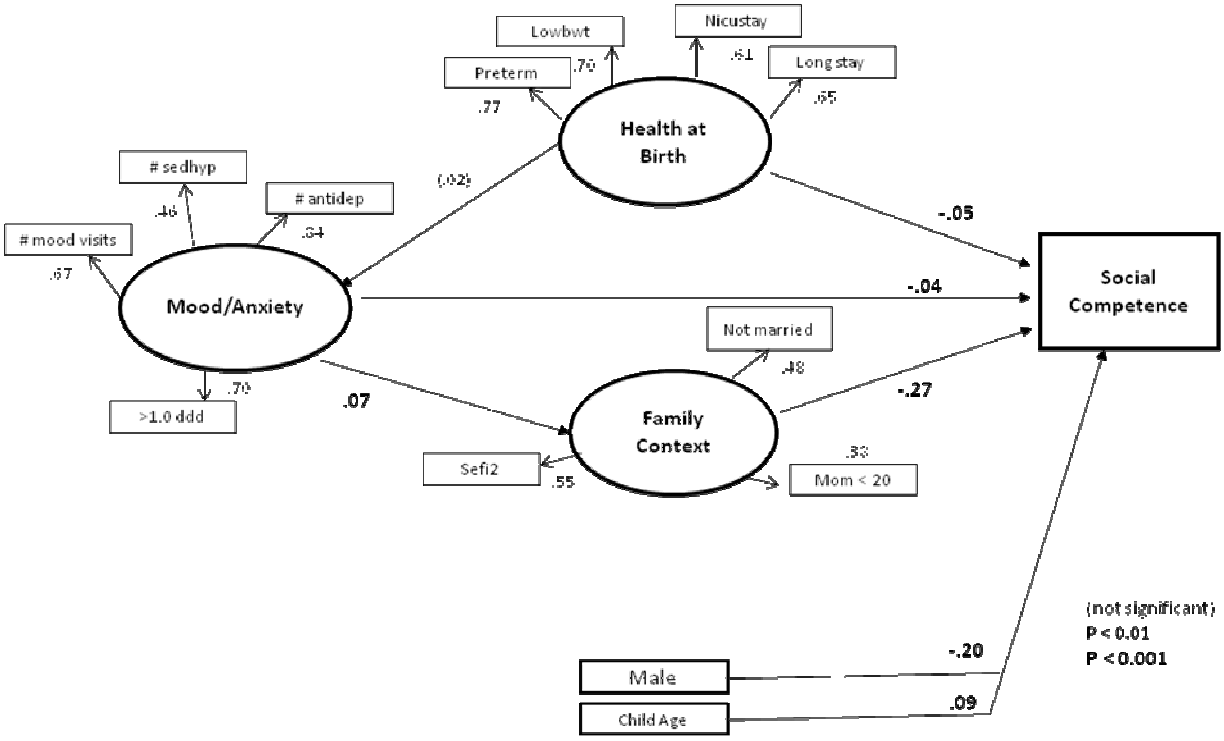

Figure 1.4 Path diagram for overall study period (Social Competence)

Having examined the relationship between Mood/Anxiety and EDI outcomes for the entire study period, a key focus of this study was to determine if exposure to maternal Mood/Anxiety in any particular time period from before the child's birth to the EDI assessment is related to child outcomes. Detailed descriptions of models for each of the four time periods are provided below.

4.6.3 Prenatal Model

a) Variables

For this study, the Prenatal period is the twelve-month period before the birth of the child. The Mood/Anxiety latent construct included manifest indicators for each of the following: number of antidepressants, number of sedatives/hypnotics, a binary variable for dose intensity (greater than 1.0 DDD of antidepressants) and number of Mood/Anxiety visits. Each of these was calculated for the period from 365 days prior to and including the day before the child's birth. Health at Birth includes variables only from birth so this construct did not change.

The Family Context latent construct included most of the same variables as the overall study period but scaled in a slightly different manner. Variables measured at the start of the Prenatal period included household SEFI2 score and mother's marital status. The young mother (< 20 years old) at first birth variable is a constant so remained the same. Male child and child age in months were entered as controls.

b) Results

Table 4.14: Standardized Estimates for the Prenatal Period, by Outcome Domain (n=18,331)

Variable	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Latent Constructs					
Mood/Anxiety --> Outcome	*-0.03*	**-0.04**	**-0.04**	**-0.04**	*-0.03*
Mood/Anxiety --> Health at Birth	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**
Health at Birth --> Outcome	**-0.07**	**-0.05**	**-0.04**	**-0.08**	**-0.06**
Mood/Anxiety --> Family Context	**0.07**	**0.07**	**0.07**	**0.07**	**0.05**
Family Context --> Outcome	**-0.38**	**-0.27**	**-0.21**	**-0.31**	**-0.26**
Direct Effect of Mood/Anxiety†	*-0.0246*	**-0.0351**	**-0.0369**	**-0.0381**	*-0.0257*
Indirect Effect of Mood/Anxiety	**-0.0281**	**-0.0211**	**-0.0166**	**-0.0249**	**-0.0164**
Total Effect of Mood/Anxiety	**-0.0528**	**-0.0563**	**-0.0535**	**-0.0631**	**-0.0421**
Control Variables					
Male child --> Outcome	**-0.16**	**-0.20**	**-0.24**	**-0.14**	**-0.14**
Child age --> Outcome	**0.14**	**0.09**	**0.08**	**0.10**	**0.11**
CFI	0.93	0.93	0.93	0.93	0.93
NNFI	0.91	0.91	0.91	0.91	0.91
RMSEA	0.0410	0.0413	0.0412	0.0412	0.0408
R2	0.1942	0.1273	0.1122	0.1332	0.1009

<.001; *<.01*; NS

†Direct effect between Mood/Anxiety and outcome domain

As shown in Table 4.14, a statistically significant direct negative relationship was found between Prenatal Mood/Anxiety and all of the outcome domains (-0.03 to -0.04). The relationship was somewhat stronger for the Social Competence, Emotional Maturity and Physical Health and Well-Being domains (p<.001).

The relationship between Mood/Anxiety and Health at Birth was positive and significant (0.04, <.001) across all outcome domains in the Prenatal year, the only time period where this was the case. This may be due to the fact that mother's Mood/Anxiety *preceded* the health at birth indicators in time, thus

having a possible influence on birth outcomes. It may also suggest a different mechanism of transmission of risk[xliv] during the prenatal period than for other time periods. Similar to the overall study period model, a consistently significant negative association was found for the relationship between Health at Birth and each outcome domain, with the strongest effect (-0.08, p<.0001) on the Physical Health domain.

The relationship between Mood/Anxiety and Family Context is positive and similar across all time periods (.05 to .07, p<.001), suggesting that even though the time-specific measures of the family context variables may change over time, the overall strength of the relationship is consistent. The path from Family Context to the outcome domains is very strong and significant, suggesting a powerful effect of the prenatal family environment on child development at school entry. The strongest association was found for the Language domain (-0.38, p<.0001) and the lowest for the Emotional Maturity domain (-0.21, p<.0001).

As noted above, the significant direct associations between Mood/Anxiety and each of the outcome domains confirm *partial* mediation models for these outcomes. Specifically, the influence of Prenatal Mood/Anxiety in mothers on the five outcome domains is mediated through Health at Birth[xlv] and Family Context. Similar to the overall study period model, the largest total effect of Mood/Anxiety was found for the Physical Health domain (-0.0631), p<.0001).

[xliv] As outlined in the literature review (Chapter 2), maternal mood and anxiety disorders influence child development in utero through various biological and epigenetic processes.

[xlv] For the Prenatal period only, Mood/Anxiety precedes Health at Birth; therefore, the influence of Mood/Anxiety can be mediated through Health at Birth.

4.6.4 Postnatal Model

a) Variables

For the Postnatal model, the same Mood/Anxiety variables were used: number of antidepressants; greater than 1.0 DDD; number of sedatives/hypnotics; and number of Mood/Anxiety physician visits. These were calculated for the period from the day of the child's birth up to the day before the child's first birthday. The Health at Birth construct remains the same; however, the direction of the path runs from Health at Birth to Mood/Anxiety for this and subsequent models due to the indicators being measured earlier in time than the Mood/Anxiety contacts. The Family Context variables are measured at the start of the Postnatal period. Controls were male child and child age in months at EDI.

b) Results

Table 4.15: Standardized Estimates for Postnatal Period, by Outcome Domain (n=18,331)

Variable	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Latent Constructs					
Mood/Anxiety --> Outcome	-0.02	**-0.03**	*-0.03*	**-0.04**	-0.01
Mood/Anxiety <-- Health at Birth	0.02	0.02	0.02	0.02	0.02
Health at Birth --> Outcome	**-0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**
Mood/Anxiety --> Family Context	**0.06**	**0.06**	**0.06**	**0.06**	**0.06**
Family Context --> Outcome	**-0.39**	**-0.29**	**-0.23**	**-0.32**	**-0.28**
Direct Effect of Mood/Anxiety†	-0.0194	**-0.0325**	*-0.0274*	**-0.0383**	-0.0092
Indirect Effect of Mood/Anxiety	**-0.0245**	**-0.0180**	**-0.0146**	**-0.0201**	**-0.0173**
Total Effect of Mood/Anxiety	**-0.0440**	**-0.0505**	**-0.0421**	**-0.0585**	*-0.0264*
Direct Effect of Health at Birth	**-0.0690**	**-0.0521**	**-0.0468**	**-0.0870**	**-0.0652**
Indirect Effect of Health at Birth	**-0.0010**	-0.0011	-0.0009	-0.0013	-0.0006
Total Effect of Health at Birth	**-0.0699**	**-0.0532**	**-0.0477**	**-0.0883**	**-0.0658**
Control Variables					
Male child --> Outcome	**-0.16**	**-0.20**	**-0.24**	**-0.13**	**-0.14**
Child age --> Outcome	**0.14**	**0.09**	**0.08**	**0.10**	**0.11**
CFI	0.94	0.94	0.94	0.94	0.94
NNFI	0.92	0.93	0.93	0.92	0.92
RMSEA	0.0401	0.0396	0.0394	0.0397	0.0406
R2	0.1999	0.1346	0.1201	0.1389	0.1118

<.001; *<.01*; NS

†Direct effect between Mood/Anxiety and outcome domain

As shown in Table 4.15, a statistically significant direct negative association was found for the relationship between Postnatal Mood/Anxiety and the Physical Health (-0.04, p<.001), Social Competence (-0.03, p<.001) and Emotional Maturity (-0.03, p<.01) domains. No direct association was found for the Language or Communication Skills domains.

Mood/Anxiety did not have a significant association with Health at Birth for the Postnatal year. However, poor Health at Birth had a significant negative relationship with all outcome areas with the strongest association for the Physical domain (-0.09, p<.0001).

Mood/Anxiety had the same significant relationship with Family Context across all domains (0.06, p<.001). The relationship between Family Context and the outcome domains mirrors the other time periods where the strongest negative association was found with the Language outcome (-0.39, p<.001) and the lowest, but still substantial association, was for the Emotional domain (-0.23, p<.001).

The outcome domains with a significant direct path from Mood/Anxiety are partial mediation models and those with no significant direct path – the Language domain and the Communication Skills domain – are fully mediated by the influence of the Family Context construct. The strongest total effect of Mood/Anxiety on the outcome, as with the other time periods, was for the Physical domain (-0.0585, p<.0001). As above, the path For Health at Birth, most of the influence on the outcome domains is direct, as noted above. The only domain where a significant indirect influence is present – in others words, where the influence of Health at Birth is mediated through Mood/Anxiety or Family Context – is for the Language domain (-0.0010, p<.001); a very modest association. The largest R^2 for any models tested was found for the Language and Cognitive domain outcome for the Postnatal period (20.0%).

4.6.5 Toddler Model

a) Variables

As described earlier, the Toddler period begins at the child's first birthday and ends one day prior to the beginning of the year before the EDI assessment. The variable distribution of a child's birthday (January to December of a given year) and the more finite period of the EDI assessment (February to March of

the kindergarten year) result in the Toddler period being variable in length – from 36 months (first birthday to fourth birthday) for children who had just turned five at the time of the EDI to 59 months for children who were six (nearly seven) years old at the assessment. The average length of the Toddler period was 45 months (3.7 years). The same manifest indicators were included for the Toddler Mood/Anxiety latent construct as for the Prenatal and Postnatal years but over the longer time period. Family Context variables were defined similarly to the Postnatal year: Young mother at first birth and SEFI2 score and mother's marital status were measured at the start of the time period. Male child and child age in months at the time of the EDI were entered as controls.

b) Results

Table 4.16: Standardized Estimates for Toddler Period, by Outcome Domain (n=18,331)

Variable	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Latent Constructs					
Mood/Anxiety --> Outcome	-0.01	**-0.04**	**-0.04**	**-0.05**	-0.02
Mood/Anxiety <-- Health at Birth	0.02	0.02	0.02	0.02	0.02
Health at Birth --> Outcome	**-0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**
Mood/Anxiety --> Family Context	*0.04*	**0.04**	**0.04**	**0.04**	**0.04**
Family Context --> Outcome	**-0.37**	**-0.27**	**-0.22**	**-0.29**	**-0.24**
Direct Effect of Mood/Anxiety†	-0.0124	**-0.0382**	**-0.0378**	**-0.0468**	-0.0147
Indirect Effect of Mood/Anxiety	**-0.0157**	*-0.0108*	*-0.0087*	*-0.0121*	*-0.0099*
Total Effect of Mood/Anxiety	**-0.0281**	**-0.0490**	**-0.0465**	**-0.0589**	*-0.0246*
Direct Effect of Health at Birth	**-0.0691**	**-0.0521**	**-0.0468**	**-0.0871**	**-0.0657**
Indirect Effect of Health at Birth	-0.0004	-0.0007	-0.0007	-0.0009	-0.0004
Total Effect of Health at Birth	**-0.0695**	**-0.0529**	**-0.0474**	**-0.0879**	**-0.0661**
Control Variables					
Male child --> Outcome	**-0.16**	**-0.20**	**-0.24**	**-0.14**	**-0.14**
Child age --> Outcome	**0.14**	**0.09**	**0.08**	**0.10**	**0.11**
CFI	0.94	0.95	0.95	0.95	0.94
NNFI	0.93	0.93	0.93	0.93	0.92
RMSEA	0.0415	0.0400	0.0397	0.0403	0.0418
R2	0.1850	0.1236	0.1126	0.1238	0.0940

<.001; *<.01*; NS

†Direct effect between Mood/Anxiety and outcome domain

Table 4.16 shows that the pattern of direct pathways from Toddler Mood/Anxiety to the outcome domains is very similar to the overall study period and Postnatal models – small but significant negative associations with the Social Competence (-0.04, p<.001) and Emotional Maturity (-0.04, p<.001) domains and a slightly stronger association with the Physical domain (-0.05, p<.001). No significant associations were found between Mood/Anxiety and the Language domain or the Communication Skills domain.

For the Toddler period, no direct significant association was found between Health at Birth and Toddler Mood/Anxiety. The pattern of the relationship between Health at Birth and the outcome domains was negative and significant, with the strongest association with the Physical outcome domain (-0.09, p<.001), as in the other time periods.

The path from Mood/Anxiety to Family Context in the Toddler period was consistently positive and significant across all outcome domains (0.04, p<.001; <.01 for Language domain) and the pattern of association from Family Context to the outcome domains was very similar to other models, with the strongest association for the Language outcome (-0.37, p<.001).

The significant direct associations between Mood/Anxiety and the Social, Emotional and Physical domains reflect partially mediated models, through Family Context. No direct association was found for the Language domain or Communication Skills domain, indicating full mediation models. Consistent with other time periods, the strongest total effect of Mood/Anxiety was found for the Physical domain (-0.0589, p<.0001). As shown by the lack of significant indirect effect of Health at Birth, the influence of this construct on the outcomes is direct, for all domains in this period. In other words, Health at Birth does not significantly influence the EDI outcomes indirectly through Mood/Anxiety or Family Context. The largest total effect of Health at Birth was for the Physical Health domain (-0.0879, p<.001).

4.6.6 Year Before EDI (YBE) Model

a) Variables

The year before the EDI is the closest in proximity to the child's EDI assessment and includes the 365 days prior to the date of the EDI for each child. The three latent constructs of Mood/Anxiety, Health at

Birth and Family Context are defined the same as previous time periods, scaled to the Year Before the EDI. Male child and child age in months at the time of the EDI were entered as controls.

b) Results

Table 4.17: Standardized Estimates for YBE Period, by Outcome Domain (n=18,331)

Variable	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Latent Constructs					
Mood/Anxiety --> Outcome	-0.01	**-0.03**	*-0.03*	**-0.05**	-0.02
Mood/Anxiety <-- Health at Birth	0.02	0.02	0.02	0.02	0.02
Health at Birth --> Outcome	**-0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**
Mood/Anxiety --> Family Context	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*
Family Context --> Outcome	**-0.36**	**-0.26**	**-0.21**	**-0.30**	**-0.23**
Direct Effect of Mood/Anxiety†	-0.0129	**-0.0327**	**-0.0283**	**-0.0502**	-0.0150
Indirect Effect of Mood/Anxiety	*-0.0140*	**-0.0108**	**-0.0088**	*-0.0120*	*-0.0089*
Total Effect of Mood/Anxiety	*-0.0269*	**-0.0434**	**-0.0371**	**-0.0622**	*-0.0239*
Direct Effect of Health at Birth	**-0.0699**	**-0.0526**	**-0.0472**	**-0.0874**	**-0.0662**
Indirect Effect of Health at Birth	-0.0004	-0.0007	-0.0006	-0.0010	-0.0004
Total Effect of Health at Birth	**-0.0704**	**-0.0533**	**-0.0478**	**-0.0884**	**-0.0666**
Control Variables					
Male child --> Outcome	**-0.16**	**-0.20**	**-0.24**	**-0.14**	**-0.14**
Child age --> Outcome	**0.14**	**0.09**	**0.08**	**0.10**	**0.11**
CFI	0.95	0.95	-0.95	0.95	0.94
NNFI	0.93	0.94	-0.94	0.93	0.93
RMSEA	0.0399	0.0381	0.0379	0.0388	0.0400
R2	0.1761	0.1209	0.1111	0.1262	0.0884

<.001; *<.01*; NS

†Direct effect between Mood/Anxiety and outcome domain

As Table 4.17 illustrates, similar patterns were found for the Year Before EDI period and the other time periods. A slight but significant direct negative association was found for the relationship between Mood/Anxiety and the Social Competence (-0.03, p<.001) and Emotional Maturity (-0.03, p<.01)

domains and a stronger association was found for the Physical Health domain (-0.05, p<.001). No significant association was found between Mood/Anxiety in this period and the Language domain or Communication Skills domain.

No significant association was found for the relationship between Health at Birth and Mood/Anxiety in the Year Before the EDI. However, consistent with other time period models, there was a significant negative relationship between Health at Birth and each of the outcomes, particularly for the Physical domain (-0.09, p<.0001).

When compared to the other time periods, the relationship between mothers' Mood/Anxiety in the Year Before the EDI and Family Context is slightly lower, but still statistically significant (-0.04, p<.01). A very similar pattern of association between Family Context and each of the outcome domains was found for this time period, with the strongest association being found for the Language outcome domain (-0.36, p<.001).

The direct significant associations between Mood/Anxiety and the Social Competence, Emotional Maturity and Physical Health domains indicate partial mediation by Family Context and the lack of direct association for the Language domain and Communication Skills domain indicates full mediation of Family Context. As was the case for the other time periods, the strongest total effect of Mood/Anxiety was found for the Physical domain (-0.0622, p<.0001). Again, Health at Birth directly influences all five of the outcome domains; no indirect influence, or mediation, occurs through Mood/Anxiety or Family Context. The largest total effect of Health at Birth was for the Physical Health domain (-0.0884, p<.001). Compared to all other full models tested, the R^2 value for the Language domain in the Year Before EDI period was the lowest (17.6%).

4.6.6.1 Summary

These findings for the overall study period and time period models illustrate that the Prenatal year may be a more sensitive period in terms of the influence of mother's mood and anxiety disorders on child outcomes at school entry. The Prenatal year was the only time period where a significant influence of Mood/Anxiety was found for all five domains. This influence in the Prenatal year was strongest on the Social Competence, Emotional Maturity and Physical Health domains. Health at Birth was also significantly influenced by Prenatal Mood/Anxiety across all five domains. Another trend that suggests a unique influence of the Prenatal period was the association between Mood/Anxiety and Family Context. The strength of this positive association was largest for the Prenatal year across all five domains, when compared to the Postnatal, Toddler and YBE periods. The association between these two constructs in the Prenatal period was about the same as for the overall study period (0.07, $p<.001$ for all domains), with a slightly smaller association with the Communication Skills domain in the Prenatal year. From the Prenatal year forward, the association between Mood/Anxiety and Family Context steadily decreases from 0.07 ($p<.001$) to 0.04 ($p<.01$), suggesting a weaker relationship between these two over time. While the relationship between Mood/Anxiety and Family Context was only tested in one direction in this study, it is important to note that there may be a bi-directional relationship where Family Context influences Mood/Anxiety.[xlvi]

Another finding was that the Social, Emotional and Physical domains are more negatively associated with maternal Mood/Anxiety than the Language or Communication Skills domains. In particular, the total effect of maternal Mood/Anxiety is highest for the Physical Health and Well-Being domain across all time period models. In other words, the combination of effects (direct and indirect) of the paths between the latent constructs in the models is strongest for the Physical Health and Well-Being domain.

[xlvi] This limitation applies for all models where Mood/Anxiety and Family Context were significantly associated.

Despite the significant associations between maternal Mood/Anxiety and at least three outcome domains across all time periods, the influence of family environment factors is much stronger on child EDI outcomes than maternal Mood/Anxiety. This association between Family Context and the outcome varies across domains, but is consistently very strong. In particular, the Language domain is most strongly impacted by the Family Context variables, by a large margin. This accounts for the larger R^2 values for the Language and Cognitive Development domains; nearly 20% of the variation in the Language outcome is explained by the model latent and control variables.

Mood/Anxiety influences child EDI outcomes indirectly through Family Context for all time periods, as indicated by the statistically significant indirect effect for Mood/Anxiety. However, similar to the direct association between Mood/Anxiety and Family Context (above), the strength of this mediation effect through Family Context weakens over time for all domains. This finding suggests that the relationship between maternal mood and anxiety disorders and the family environment is stronger in the Prenatal period and decreases as the child ages up to the EDI assessment in kindergarten. As above, it is important to note that the indirect effect of Mood/Anxiety on EDI outcomes through Family Context could be the reverse: Family Context may influence child outcomes through Mood/Anxiety. This path was not tested in this study, due to the complexity of the models, but the indirect (and total) effects found in this study may be overestimated due to this possibility.[xlvii]

In the Prenatal year, the direct association between Mood/Anxiety and Health at Birth is consistently negative and significant (no indirect associations apply for this period as the arrow from Health at Birth only runs to the outcome variables). The pattern of direct and indirect (mediated through Mood/Anxiety and Family Context) associations between Health at Birth and the outcomes is fairly consistent across domains and for the Postnatal to YBE time periods. For these periods – with the

[xlvii] This limitation applies to all models where Mood/Anxiety influences child outcomes through Family Context.

exception of the Language domain in the Postnatal year – the effects of Health at Birth are significantly direct, with no mediation through Mood/Anxiety or Family Context. The strongest association for Health at Birth is for the Physical Health domain across all time periods, as would be expected. Consistently, the lowest association between Health at Birth and the outcomes is for the Social Competence and Emotional Maturity domains.

4.6.7 Recurrent/Persistent Model

a) Variables

To examine whether recurrent or persistent Mood/Anxiety in mothers is negatively associated with EDI domain scores in children, a variable was created which identifies the number of time periods a mother had one or more Mood/Anxiety contacts (prescriptions or physician visits) over the study period: no periods of Mood/Anxiety (0); one time period (1); two time periods (2); three time periods (3); or all four periods (4). Table 4.19 shows the percentage of mothers in each category. This variable was used in place of the Mood/Anxiety latent variable, as described for the time period models above. The Health at Birth construct remained the same and the Family Context construct was the same as that used for the Overall study period model; measures taken at the start of the time period – SEFI2 score and mother's marital status – were taken at the start of the Year Before the EDI.

Table 4.18: Percentage of Mothers with Mood/Anxiety by Number of Time Periods (n=18,331)

Number of time periods	None	1	2	3	4
# (%) of mothers	7146 (38.98)	5059 (27.60)	3473 (18.95)	1811 (9.88)	841 (4.59)

b) Results

Table 4.19: Standardized Estimates for the Recurrent/Persistent Model, by Outcome Domain (n=18,331)

Variable	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Predictors					
Mood Recurrence --> Outcome	*-0.03*	**-0.06**	**-0.05**	**-0.05**	*-0.02*
Mood Recurrence <-- Health at Birth	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**
Health at Birth --> Outcome	**0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**
Mood Recurrence --> Family Context	**0.14**	**0.14**	**0.14**	**0.14**	**0.14**
Family Context --> Outcome	**-0.37**	**-0.26**	**-0.21**	**-0.29**	**-0.25**
Direct Effect of Mood Recurrence†	**-0.0276**	**-0.0553**	**0.0490**	**-0.0517**	*-0.0214*
Indirect Effect of Mood Recurrence	**-0.0515**	**-0.0369**	**-0.0300**	**-0.0414**	**-0.0341**
Total Effect of Mood Recurrence	**-0.0791**	**-0.0922**	**-0.0791**	**-0.0931**	**-0.0555**
Direct Effect of Health at Birth	**-0.0677**	**-0.0505**	**-0.0454**	**-0.0856**	**-0.0649**
Indirect Effect of Health at Birth	**-0.0028**	**-0.0032**	**-0.0028**	**-0.0032**	**-0.0019**
Total Effect of Health at Birth	**-0.0705**	**-0.0537**	**-0.0482**	**-0.0888**	**-0.0668**
Control Variables					
Male child --> Outcome	**-0.16**	**-0.20**	**-0.24**	**-0.14**	**-0.14**
Child age --> Outcome	**0.14**	**0.09**	**0.08**	**0.10**	**0.11**
CFI	0.92	0.93	0.93	0.93	0.92
NNFI	0.89	0.90	0.90	0.90	0.88
RMSEA	0.0535	0.0504	0.0499	0.0513	0.0539
R^2	0.1888	0.1266	0.1148	0.1284	0.0967

<.001; *<.01*; NS
†Direct effect between Mood/Anxiety and outcome domain

As Table 4.19 shows, the number of time periods a mother had one or more Mood/Anxiety prescriptions or physician visits is significantly and negatively associated with child EDI scores on all five outcome domains; most notably for the Social Competence domain (-0.06, p<.001), followed by the Emotional

Maturity and Physical Health and Well-Being domains (both -0.05, p<.001). These direct significant associations are higher than for any of the time period models, including the overall study period.

The association between Health at Birth and recurrent/persistent Mood/Anxiety was positive and significant 0.04 (p<.001) across all five domain areas. This is consistent with the only time period model where the same association was found – the Prenatal period.[xlviii] A significant negative association was found between Health at Birth and each of the five outcome domains and, consistent with the time period models, the strongest association was found for the Physical Health and Well-Being domain (-0.09, p<.001).

Similar to the time period models, the association between recurrent/persistent Mood/Anxiety and the Family Context latent construct was positive and significant; however, this association was considerably stronger for the recurrent/persistent model. For example, in the overall study period model, the association between Mood/Anxiety and the outcome domains was consistently 0.07 (p<.001); the association for all domains in the recurrent/persistent model was 0.14 (p<.001). This suggests that the number of periods a mother had a Mood/Anxiety prescription or physician visit is much more strongly associated with Family Context than is the total number of prescriptions and physician visits (as in the Mood/Anxiety latent construct). The association between Family Context and the outcome domains is consistent with the time period models; the strongest association was found for the Language and Cognitive Development outcome (-0.37, p<.001).

The direct significant associations between recurrent/persistent Mood/Anxiety and the outcome domains is indicative of partial mediation by Family Context; in other words, the effect of recurrent/persistent mood and anxiety in mothers is partially explained by the relationship between

[xlviii] As noted above, for the Prenatal model, the direction of the arrow between Mood/Anxiety and Health at Birth runs from Mood/Anxiety; for all other time periods and models tested, this arrow runs from Health at Birth to Mood/Anxiety.

Mood/Anxiety and Family Context and Family Context and the outcome domains. Given the stronger direct and indirect effects of Mood/Anxiety in this model, the total effect of recurrent/persistent Mood/Anxiety is considerably higher than for the overall study period model using the latent Mood/Anxiety construct. Specifically, the largest total effect of Mood/Anxiety in the overall study period model was for the Physical Health domain (-0.0677, p<.001) whereas, in the recurrent/persistent model, the largest total effect of Mood/Anxiety was -0.0931 (p<.001), again for the Physical Health domain. These larger total effects in the recurrent/persistent model are found across all five outcome domains. In contrast to the time period models, including the overall study period, there was a significant indirect association between Health at Birth and all five outcome domains, indicating that the effect of Health at Birth in the recurrent/persistent model is partially mediated through Mood/Anxiety and Family Context.

4.6.8 Severity Model

a) Variables

To explore the association between severity of maternal Mood/Anxiety and child EDI scores, a non-latent predictor variable which divided the total number of mood and anxiety contacts (prescriptions and physician visits) into five groups was created. Based on the distribution of these combined totals, the following five groupings were created: no Mood/Anxiety (0); low severity (1); low-mid severity (2); mid-high severity (3); and high severity (4). Table 4.21 shows the percentage of mothers in each category. This variable was used in place of the Mood/Anxiety latent variable, as described above. The Health at Birth and Family Context constructs were the same as for the overall study period and recurrence/persistent models above.

Table 4.20: Percentage of Mothers with Mood/Anxiety by Severity Category (n=18,331)

Mood Severity	No Mood/Anx	Low	Low-Mid	Mid-High	High
# (%) of mothers	7146 (38.98)	2713 (14.80)	3812 (20.80)	2785 (15.19)	1875 (10.23)

b) Results

Table 4.21: Standardized Estimates for the Severity Model, by Outcome Domain (n=18,331)

Variable	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Predictors					
Mood Severity --> Outcome	-0.02	**-0.05**	**-0.05**	**-0.05**	-0.01
Mood Severity <-- Health at Birth	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**
Health at Birth --> Outcome	**-0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**
Mood Severity --> Family Context	**0.14**	**0.15**	**0.15**	**0.15**	**0.14**
Family Context --> Outcome	**-0.37**	**-0.26**	**-0.21**	**-0.29**	**-0.25**
Direct Effect of Mood Severity†	-0.0186	**-0.0489**	**-0.0474**	**-0.0500**	-0.0143
Indirect Effect of Mood Severity	**-0.0530**	**-0.0381**	**-0.0310**	**-0.0426**	**-0.0351**
Total Effect of Mood Severity	**-0.0716**	**-0.0869**	**-0.0783**	**-0.0925**	**-0.0494**
Direct Effect of Health at Birth	**-0.0678**	**-0.0504**	**-0.0452**	**-0.0853**	**-0.0650**
Indirect Effect of Health at Birth	**-0.0028**	**-0.0034**	**-0.0031**	**-0.0037**	**-0.0020**
Total Effect of Health at Birth	**-0.0707**	**-0.0538**	**-0.0483**	**-0.0889**	**-0.0669**
Controls Variables					
Male child --> Outcome	**-0.16**	**-0.20**	**-0.24**	**-0.14**	**-0.14**
Child age --> Outcome	**0.14**	**0.09**	**0.08**	**0.10**	**0.11**
CFI	0.92	0.93	0.93	0.93	0.92
NNFI	0.89	0.90	0.90	0.90	0.88
RMSEA	0.0535	0.0505	0.0499	0.0514	0.0539
R^2	0.1882	0.1259	0.1147	0.1282	0.0962

<.001; *<.01*; NS

†Direct effect between Mood/Anxiety and outcome domain

As shown in Table 4.21, the association between severity of maternal Mood/Anxiety and the outcome areas was negative and significant for three of the five domains – Social Competence, Emotional Maturity and Physical Health (all -0.05, p<.001). This finding differs from the recurrent/persistent model where a significant association was found for all five domains. Again, these direct associations were slightly stronger than for the time period models and very slightly below values for the recurrent/persistent model.

As was the case in the recurrence/persistence model, a consistent positive association (0.04, p<.001) was found between Health at Birth and Mood/Anxiety. Further, the same pattern of association between Health at Birth and the outcome domains was found for this model, with the largest association for the Physical Health domain (-0.09, p<.001).

The associations between severity of Mood/Anxiety and Family Context were the same as for the recurrence/persistence model (-0.14, p<.001 for all domains), double that of the individual and overall study period models. The same pattern of association between Family Context and the outcome areas was found, with the strongest association being found for Language and Cognitive Development (-0.37, p<.001).

Direct significant effects of Mood/Anxiety on each outcome is indicative of partial mediation by Family Context. Another similarity with the recurrence/persistence model is the larger total effects of severity of Mood/Anxiety (compared to the time period models) across all domains, ranging from -0.0494 (p<.001) for Communication Skills to -0.0925 (p<.001) for the Physical Health domain. As was the case with the recurrence/persistence model, Health at Birth was significantly indirectly associated with all of the outcomes, indicating partial mediation through Mood/Anxiety and Family Context. These total effects of Health at Birth were also larger than for any of the time period models and lower than the total effect of Mood/Anxiety severity.

4.6.8.1 Summary

The analyses of recurrent/persistent Mood/Anxiety and severity of Mood/Anxiety demonstrates a stronger influence of these two aspects of Mood/Anxiety on child EDI outcomes than for Mood/Anxiety in the individual or overall time periods. In this study, Mood/Anxiety recurrence and severity were highly correlated with each other (0.90, $p<.001$), so the similarities between the two models is not unexpected. However, the slightly stronger associations between recurrent/persistent Mood/Anxiety and the outcomes suggests that the number of time periods that Mood/Anxiety persists may be more influential on child development than the level of Mood/Anxiety severity. Though direct significant effects of Mood/Anxiety were found, there is a much stronger influence of Family Context on child outcomes in both these models. Further, the associations between Mood/Anxiety and Family Context, in both the recurrence/persistent and severity models, are double what they were for any of the time periods or overall study period. This larger relationship between Mood/Anxiety and the family environment accounts for the larger total effects of both Mood/Anxiety and Health at Birth on the outcomes for these two models.

The final full models in this study explained from 8.8% to 20% of the variance in the outcome domains. The largest proportion of the variance explained was for the Language and Cognitive Development models, and this was consistent across all time periods, the overall study period and for the recurrence/persistence and severity models (17.6% to 20%). The second largest proportion of variation explained was for the Physical Health and Well-Being domain, with a range of 12.6% to 13.9% across all full models. The range for the proportion explained for the remaining three outcome domains was 12.1%-13.5% for the Social Competence domain, 11.1%-12.0% for the Emotional Competence domain and 8.8%-11.2% for the Communication Skills and General Knowledge domain. These findings indicate that, for the Language and Cognitive Development domain, the combination of variables included in the models explained a significant proportion of the variance in the outcome. Interestingly, the relationship

between maternal Mood/Anxiety and the Language domain was weak in the models; however, a much larger association was found between Family Context and the Language domain than for any other outcome domain. In other words, child language and cognitive development at school entry is most influenced by the family environment factors included in this study, and to a much greater degree than any of the other domains of child development assessed. The model that explained the greatest amount of variance in the Language outcome was the Postnatal period. This time period did not stand out as particularly sensitive to maternal mood and anxiety disorders but language development may be more sensitive to the family environment in the year following birth. More modest proportions of variance were explained for the other outcome domains. What this suggests is, for these models, the combination of variables used in the models explains less variation in the outcome domains and a larger proportion of the variance is left unexplained by variables that were not included in the analysis.

The proportion of the variance explained for the recurrence/persistence and severity models was very similar and in the middle of the range for models provided above – from 9.6% for the Communication Skills domain to 18.8% for the Language domain.

4.6.9 Supplementary Analyses: Socio-Economic Status (SES)

In addition to the time period, recurrence/persistence and severity models, analyses of whether EDI outcomes vary for children of mothers with different SES levels was undertaken. These models were run for the overall study period only and mothers were stratified into two groups based on their average SEFI2 score; low-mid SES mothers included those at and above the sample mean score of 0.12 and mid-high SES mothers included those below the sample mean.

Table 4.22: Standardized Estimates for the Low-Mid SES Model, by Outcome Domain (n=9179)

Variable	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Latent Constructs					
Mood/Anxiety --> Outcome	-0.02	*-0.04*	*-0.04*	**-0.05**	-0.02
Mood/Anxiety <-- Health at Birth	0.00	0.00	0.00	0.00	0.00
Health at Birth --> Outcome	**-0.06**	**-0.05**	**-0.04**	**-0.09**	**-0.06**
Mood/Anxiety --> Family Context	**0.07**	**0.07**	**0.08**	**0.07**	**0.07**
Family Context --> Outcome	**-0.34**	**-0.24**	**-0.20**	**-0.27**	**-0.20**
Direct Effect of Mood/Anxiety†	-0.0146	**-0.0382**	**-0.0389**	**-0.0501**	-0.0189
Indirect Effect of Mood/Anxiety	**-0.0224**	**-0.0175**	**-0.0146**	**-0.0190**	**-0.0139**
Total Effect of Mood/Anxiety	*-0.0370*	**-0.0557**	**-0.0535**	**-0.0691**	*-0.0329*
Direct Effect of Health at Birth	**-0.0615**	**-0.0474**	**-0.0417**	**-0.0859**	**-0.0611**
Indirect Effect of Health at Birth	-0.0001	-0.0002	-0.0002	-0.0003	-0.0001
Total Effect of Health at Birth	**-0.0616**	**-0.0476**	**-0.0419**	**-0.0862**	**-0.0612**
Controls Variables					
Male child --> Outcome	**-0.17**	**-0.19**	**-0.23**	**-0.14**	**-0.14**
Child age --> Outcome	**0.15**	**0.09**	**0.08**	**0.11**	**0.12**
CFI	0.94	0.94	0.94	0.94	0.94
NNFI	0.92	0.92	0.93	0.92	0.92
RMSEA	0.0469	0.0449	0.0446	0.0453	0.0468
R2	0.1678	0.1072	0.1009	0.1127	0.0782

<.001; *<.01*; NS

†Direct effect between Mood/Anxiety and outcome domain

As shown in Table 4.22, there was a negative significant association between Mood/Anxiety and the Social Competence (-0.04, p<.01), Emotional Maturity (-0.04, p<.01) and Physical Health domains (-0.05, p<.001) for mothers with low-mid SES. No significant association was found between Health at Birth and Mood/Anxiety for this group. However, a similar pattern of association to the models above was found between Health at Birth and the outcome domains; the strongest association for the Physical domain (-0.09, p<.001). A consistent pattern of association was found between Mood/Anxiety and

Family Context for all domains, with a slightly higher estimate for the Emotional Maturity domain (-0.08, p<.001). Further, a similar pattern of association was found between Family Context and the outcome domains and, consistent with other models, the largest association was found for the Language domain (-0.34, p<.001).

As noted above, significant negative direct effects of Mood/Anxiety were found for the Social, Emotional and Physical domains. Significant negative indirect effects were found for all five domains, indicating partial mediation of mothers' Mood/Anxiety through Family Context. The largest total effect of Mood/Anxiety was found for the Physical Health domain (-0.0691, p<.001). Consistent with other models described above, Health at Birth did not have a significant indirect effect on the outcome domains. In other words, Health at Birth directly impacted the outcome domains but was not mediated through Mood/Anxiety and Family Context. The largest total effect of Health at Birth was, again, for the Physical Health domain (-0.0862, p<.001). Similar to the time period, recurrent/persistent and severity models above, being a male child was most strongly associated with the Social Competence domain (-0.23, p<.001) and child age in months was most strongly associated with the Language domain (0.16, p<.001).

Table 4.23: Mid-High SES Model Standardized Estimates, by Outcome Domain (n=9152)

Variable	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Latent Constructs					
Mood/Anxiety --> Outcome	-0.01	*-0.03*	-0.03	**-0.05**	-0.02
Mood/Anxiety <-- Health at Birth	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*
Health at Birth --> Outcome	**-0.08**	**-0.06**	**-0.05**	**-0.09**	**-0.07**
Mood/Anxiety --> Family Context	**0.09**	**0.09**	**0.09**	**0.09**	**0.07**
Family Context --> Outcome	**-0.19**	**-0.20**	**-0.17**	**-0.18**	**-0.09**
Direct Effect of Mood/Anxiety†	**-0.0170**	*-0.0328*	-0.0286	**-0.0464**	-0.0147
Indirect Effect of Mood/Anxiety	-0.0139	**-0.0180**	**-0.0151**	**-0.0158**	*-0.0069*
Total Effect of Mood/Anxiety	*-0.0309*	**-0.0508**	**-0.0437**	**-0.0622**	-0.0216
Direct Effect of Health at Birth	**-0.0776**	**-0.0561**	**-0.0493**	**-0.0857**	**-0.0667**
Indirect Effect of Health at Birth	-0.0011	-0.0018	-0.0015	-0.0022	-0.0008
Total Effect of Health at Birth	**-0.0787**	**-0.0579**	**-0.0509**	**-0.0878**	**-0.0675**
Controls Variables					
Male child --> Outcome	**-0.15**	**-0.22**	**-0.25**	**-0.14**	**-0.14**
Child age --> Outcome	**0.13**	**0.08**	**0.08**	**0.08**	**0.09**
CFI	0.97	0.97	0.97	0.97	0.97
NNFI	0.96	0.96	0.96	0.96	0.96
RMSEA	0.0323	0.0318	0.0315	0.0316	0.0322
R2	0.0827	0.0995	0.0922	0.0692	0.0429

<.001; *<.01*; NS

†Direct effect between Mood/Anxiety and outcome domain

For mothers with mid-high SES (bottom 50% of average SEFI2 scores), a significant negative association was found between Mood/Anxiety and only two outcome domains -- Social Competence (-0.03, p<.01) and Physical Health (-0.05, p<.001) domains. The strength of these associations was smaller than for the mothers with low-mid SES for the Social domains and the same for the Physical domain. In contrast to the low SES model, a significant negative association was found between Health at Birth and mothers' Mood/Anxiety (-0.04, p<.01) across all domains. A very similar pattern of association was found

between Health at Birth and the outcome domains; the strongest association was found for the Physical domains (-0.09, p<.001).

Mood/Anxiety was positively associated with Family Context for mothers with mid-high SES – a slightly stronger association (0.09, p<.001) compared to the mothers with low-mid SES. However, a markedly lower association was found between Family Context and the outcome domains for the mid-high SES mothers. The largest association for this relationship was found for the Social Competence domain (-0.20, p<.001) whereas the largest association for the low SES mothers was -0.34 (p<.001), for the Language domain. The lowest association between Family Context and outcomes for mothers with mid-high SES was -0.09 (p<.001) for the Communication Skills domain, compared to the lowest associations for low-mid SES mothers (-0.20, p<.001) for the Emotional and Communication Skills domains).

In contrast to the mothers with low-mid SES, a significant indirect effect of Mood/Anxiety was found for four of the five domains. In other words, the effect of Mood/Anxiety on the outcomes was partially mediated by Family Context for the Social, Emotional, Physical and Communications domains and not significant for the Language domain. Similar to the mothers with low-mid SES, the largest total effect of Mood/Anxiety was found for the Physical Health domain (-0.0622, p<.001). A similar pattern was found for the indirect and total effects of Health at Birth and the outcomes; no significant indirect effect indicates that Health at Birth influenced the outcomes directly and was not mediated through Mood/Anxiety or Family Context. The largest effect of Health at Birth was found for the Physical Health domain (-0.0878, p<.001). Similar to the low-mid SES model and other models above, being a male child was most strongly associated with the Social Competence domain (-0.25, p<.001) and child age in months was most strongly associated with the Language domain (0.13, p<.001).

For these supplementary models, the range of the proportion of variance explained (R^2) was slightly lower for the low-mid SES model than for others (7.8% to 16.8%). In contrast, the range of the

proportion explained for the mid-high SES model was considerably lower than for other models tested (4.3% to 8.27%). What this indicates is that, for children of mothers with mid to high SES, there are even more factors unaccounted for that may explain the relationship between the variables and the outcome, and the combination of variables used in these models explains only a small proportion of variance in differences in EDI scores.

4.7 Summary of Findings from the Final Models

As outlined in the Methods chapter, three key aspects of maternal Mood/Anxiety were examined in this study – timing, recurrence/persistence and severity. Below is a summary of the model findings and what they say about these aspects.

4.7.1 Timing

One of the key purposes of this study was to determine if the timing of exposure to maternal Mood/Anxiety had an impact on child development as measured on the EDI in kindergarten. As results from the final structural models illustrate, family environment factors have a very strong influence on EDI results, for all domains, much stronger than any direct influence of Mood/Anxiety on the outcomes. However, the Prenatal period does stand out as a sensitive period. As would be expected, the relationship between Mood/Anxiety in the Prenatal year and Health at Birth is positive and significant across all outcome domains. This suggests that prenatal mood and anxiety disorders have a negative effect on birth outcomes and a possible lasting impact on child outcomes on the EDI. Further, a direct influence of Mood/Anxiety was found for all five outcome domains in the Prenatal year, the only period where this was the case. Even for the Language domain and the Communication Skills domain – which

were not significantly influenced by maternal Mood/Anxiety in any other time period – a significant negative effect of Prenatal Mood/Anxiety was found (-0.03, $p<.01$). In turn, the total effect of Mood/Anxiety is higher for the Prenatal period than for the other three individual time periods (the total effect of Mood/Anxiety is slightly higher for the overall study period).

The influence of Family Context on the EDI outcomes was highly significant across all time periods; however, this relationship is slightly stronger for the Postnatal year than for any other individual time period or the overall study period, across all domains.

No other time periods stood out as particularly unique. Surprisingly, there were lower associations between Mood/Anxiety and the outcomes in the Postnatal year, contrary to what other studies have found. The relationship between Health at Birth and the outcome domains is a fairly consistent pattern across all time periods with the largest association found for the Physical Health domain, as would be expected. Further, Health at Birth had a direct influence on the outcomes with no indirect (mediation) found through Mood/Anxiety or Family Context for any of the time periods (except for the Prenatal year where Health at Birth mediates the relationship between Mood/Anxiety and the outcomes) and a very small indirect association with the Language domain in the Postnatal period. The relationship between Family Context and the outcome domains is also consistent across time periods with the largest association found for the Language and Cognitive Development domain, by a notable margin. This suggests that while mothers' Mood/Anxiety did not influence child language and cognitive functioning directly, there is a significant indirect mediation through Family Context, for all time periods and the overall study period.

4.7.2 Recurrence/Persistence

As described above, another focus of this study was to determine if recurrent or persistent Mood/Anxiety in mothers had a stronger effect on child outcomes in kindergarten than non-recurrent Mood/Anxiety. As the recurrent/persistent model illustrates, the number of time periods a mother had a mood or anxiety contact (prescription or physician visit) was more negatively associated with poor EDI outcomes than any of the time periods or overall study period. Further, a positive significant relationship was found between Health at Birth and recurrent/persistent Mood/Anxiety; the only time period this was found for was the Prenatal year. A much stronger association – about double the effect – was found between recurrent/persistent Mood/Anxiety and Family Context than for any of the time periods or overall study period. The total effects of Mood/Anxiety and Health at Birth were considerably higher for the recurrent/persistent model than for the time period models.

4.7.3 Severity

The model using a scaled predictor that measured levels of Mood/Anxiety severity from none to high had very similar results to the recurrent/persistent model. It would be expected that they would be similar as research confirms a high association between chronicity and severity of mood and anxiety disorders. A notable difference between these two models is that recurrent/persistent Mood/Anxiety was significantly associated with all outcome domains whereas Mood/Anxiety severity was only associated with three domains. For the three domains that both aspects of Mood/Anxiety had a significant association – Social, Emotional and Physical – the direct effect of Mood/Anxiety on the outcome domains was very slightly lower for the severity model than for the recurrent/persistent model. This suggests that the number of time periods a mother had a Mood/Anxiety contact may have a stronger association with child EDI outcomes than the level of severity over the study period.

4.7.4 EDI Domains

Interesting findings emerged for the impact of Mood/Anxiety in mothers on child EDI scores across domains. Each of the five domains is intended to assess children on five different areas of development at school entry: Language and Cognitive Development; Social Competence; Emotional Maturity; Physical Health and Well-Being; and Communication Skills and General Knowledge. For each of the time periods, differences were found for the effect of Mood/Anxiety on these outcome areas. Mothers' Mood/Anxiety had no significant effect on the Language outcome domain, except for in the Prenatal year and in the recurrent/persistent model. This same pattern was found for the Communication Skills domain for the time period models. Statistically significant effects were found for the relationship between Mood/Anxiety and the Social, Emotional and Physical domains for all models. This effect was strongest in the Prenatal year for the time periods and even higher for the recurrent/persistent model, followed by the severity model. Interestingly, the strongest effect of Mood/Anxiety was found on the Physical domain, across all time periods and for the severity model. The largest association for this relationship was found in the Year Before the EDI and severity models. In contrast, the strongest negative association between Mood/Anxiety and the outcomes was found for the Social Competence domain in the recurrent/persistent model. This is the only model where this stronger association was found. For the time periods, the strongest total effect of both Mood/Anxiety and Health at Birth in the mediation testing was found for the Physical domain. The total effects of Mood/Anxiety on the outcomes was larger in the recurrent/persistent and severity models than for any of the time periods or overall study period; the total effect of Health at Birth was very similar in the recurrent/persistent and severity models when compared to the time periods.

Mood/Anxiety did not have a significant association with Health at Birth in any time period, except for the Prenatal period. A significant effect was found in this period across all outcome domains. While little association was found between Mood/Anxiety and Health at Birth, Health at Birth significantly

impacted all outcome domains across time periods, with the strongest impact on the Physical domain. The lowest impact was on the Social and Emotional domains. This pattern of highest and lowest impact of Health at Birth was consistent across all time periods and for the recurrent/persistent and severity models.

The relationship between the Mood/Anxiety and Family Context constructs was positive and significant across all domains and time periods. By far, the strongest associations were found in the recurrent/persistent and severity models. The strength of the relationship varied slightly across time periods with the largest effect in the overall study period and for the Prenatal year. The largest impact of Family Context on child development outcomes was on the Language domain, by a significant margin, and this association was slightly higher in the Postnatal period than for any other individual time periods or overall study period. The lowest effect, though still substantial, was on the Emotional domain, and this pattern persisted across time period models and for the recurrent/persistent and severity models.

The Social and Emotional domains were most negatively associated with being a male child; the lowest effects of this variable were on the Physical Health domain and the Communication Skills domain. Child age in months was more positively association with the Language domain, a slightly lower association with the Physical and Communication Skills domains and the lowest association with the Emotional domain. This pattern was consistent across all time period models and for the recurrent/persistent and severity models.

4.7.5 Socio-Economic Status (SES)

As shown in the models for mothers with low-mid SES and mid-high SES, there are differences in terms of the how the model variables are associated with child EDI outcomes. For mothers with low-mid SES, there were larger associations between Mood/Anxiety and the Social Competence and Emotional Maturity domains. The association was the same between Mood/Anxiety and the Physical domain for both low-mid SES and mid-high SES mothers (the association between Mood/Anxiety and the outcomes was not significant for the Language domain or Communication Skills domains, for either low-mid SES or mid-high SES mothers).

Interestingly, there was a stronger association between Health at Birth and Mood/Anxiety for mid-high SES mothers than those with low-mid SES. In turn, a slightly stronger association was found between Health at Birth and the outcome domains for the mid-high SES mothers. The association between Health at Birth and the Physical domain was the same for both low-mid SES and mid-high SES mothers. For Family Context, there was a stronger association between Mood/Anxiety and the Family Context construct for mid-high SES mothers. However, a much stronger association was found between Family Context and the outcome domains for the low-mid SES mothers.

The indirect effect of Mood/Anxiety for low-mid SES mothers was significant across all outcome domains, indicating partial mediation of mother's Mood/Anxiety and child EDI scores through Family Context. Mediation was only found for four of the five outcome domains for the mid-high SES mothers. For both models, Health at Birth had only a direct significant effect on the outcomes; no mediation was found through Mood/Anxiety or Family Context.

These results confirm that, for this study population, socio-economic status does moderate the relationship between Mood/Anxiety in mothers and child EDI outcomes in kindergarten. While some

associations were stronger for the mid-high SES mothers, the key associations – those between Mood/Anxiety and the outcomes and between Family Context and the outcomes – were stronger for the low-mid SES mothers, as would be expected. These findings suggest that SES is an important variable to consider when examining the factors that influence the relationship between mothers' Mood/Anxiety and child development.

4.8 Conclusion

This chapter has provided a detailed overview of the results from the confirmatory factor analysis, descriptive statistics on the study variables and relationships between them, and a description of each of the final structural models for this study. The next chapter – the Discussion – will discuss these findings further in relation to the relevant literature.

Chapter 5: Discussion

5.1 Introduction

While there is considerable research into the relationship between maternal depression and anxiety on child outcomes, few studies have examined this relationship using population-based data and, to date, none have examined this relationship using longitudinal administrative data to assess five developmental domains of the Early Development Instrument, an important population-based measure of child school readiness. Measurement of maternal mood and anxiety disorders in a population-based study poses a number of challenges, as outlined in earlier chapters. Most studies focus on symptom-based assessments that are not corroborated by formal diagnosis. Further, studies that have examined aspects of maternal Mood/Anxiety such as timing, recurrence/persistence and severity are usually limited by a smaller sample size and specific points of measurement and follow-up that are dependent on participant recall. Administrative data from various health and social datasets affords the researcher with the ability to study entire populations over time, and to not rely on self-report data. Using a latent construct of continuous counts of mothers' prescriptions filled and physician visits for Mood/Anxiety – rather than a specific algorithm – is a unique way of measuring maternal Mood/Anxiety using administrative data. While less specific than algorithms requiring particular combinations of prescriptions, visits and/or hospitalizations, the continuous counts provides some measure of the degree of Mood/Anxiety over the study period and this study was an opportunity to test whether this definition was specific enough to detect differences in child outcomes. In addition, inclusion of a range of individual and area-level socio-demographic variables at the population-level allows for testing of potential mediators and moderators of the relationship between maternal Mood/Anxiety and child outcomes at school entry.

This study addresses the gaps in the literature using a very large population-based sample of mother-child pairs (n=18,331) to assess the relationship between maternal Mood/Anxiety – and related variables – and child EDI outcomes. As an analytical technique, structural equation modeling is well-suited to test complex relationships between sets of variables, including those not measured directly with the use of latent constructs. Unique contributions of this study include the examination of several aspects of maternal Mood/Anxiety in detail using population-based administrative data and how maternal Mood/Anxiety, health at birth and family context inter-relate to influence child outcomes in five key areas of child school readiness.

5.2 Key Findings

For the each of the time periods and aspects of Mood/Anxiety, the proportion of variation in the outcome explained by the combination of variables in the model is indicated by the R^2 value. As described in the Results chapter, the R^2 values ranged from the lowest for the Communication Skills domain (8.8% to 11.2%) to the largest for the Language and Cognitive Development domain (17.6% to 20.0%), across all models tested. Variation in these values was found across time periods with the largest Language domain R^2 being found for the Postnatal year. Though the postnatal period did not stand out as particularly sensitive to maternal Mood/Anxiety, child cognitive and language development at school entry may be more sensitive to the family environment during the postnatal year than during other time periods. R^2 values were fairly similar across each of the time period, recurrence/persistence and severity models, with the same patterns for outcome domains as described above. What this indicates is that the combination of variables included in all of these models explained about the same amount of variation in each of the outcome domains. However, for the supplementary analyses where the sample was stratified by SES over the study period, marked differences in R^2 values were found. The

proportion of variance in the outcomes explained for the low-mid SES model was just slightly lower than for the other models tested that did not stratify by SES. In contrast, the proportion explained for the mid-high SES model was about one-half of that explained in the low-mid SES model. What this suggests is that factors unaccounted for (i.e., not included) in the models explain much more of the variation in the outcomes for children of mothers with mid-high SES than for models that include low-mid SES mothers. This is consistent with research by Turkheimer et al.[233] that found genetics plays a much larger role than shared environment in higher SES families compared to those living in lower SES.

The range of R^2 values found in this study is comparable to values found in other population-based studies that have used structural equation modeling to examine child outcomes. Fransoo et al.[137] examined the influence of health status at birth and major and minor illness through early childhood on Grade 3 performance. The study included a range of socio-demographic control variables, including a binary variable indicating the presence of maternal depression at any time over the study period. The R^2 value for the final study model was 21%. Santos et al.[138] replicated the study by Fransoo et al. and replaced the Grade 3 scores outcome variable with the five EDI domains. The range of R^2 values in the Santos et al. study was slightly narrower than for the current study but was similar in terms of the outcome domains (11.2% for the Communication Skills domain to 16.5% for the Language and Cognitive Development domain). The proportion of the variance explained in this study is higher than that found in other research by Barker et al.[54] that used SEM to examine the contribution of prenatal and postnatal maternal anxiety and depression to child functioning (n=3298). Covariates included SES, marital status, teen mother, substance abuse, cigarette smoking and crime/trouble with the police; R^2 values for the three outcomes were 2% for verbal IQ, 4% for externalizing behaviour and 8% for internalizing behaviour. Conversely, research by Stein et al.[155] that examined the influence of maternal postnatal depression over time on child language development at 36 months (n=1201) explained a considerably larger proportion of the variance. Covariates included: maternal caregiving (measured at two points in

time), SES class, parental education levels, family income, gender and bilingualism; the R^2 value for the model was 41%. Since maternal caregiving has been identified as a fairly strong mediator of the relationship between maternal mood and anxiety disorders and child outcomes [86, 94, 101], it is possible that inclusion of this measure accounts for the much higher R^2.

The following sections summarize the key findings for each set of relationships (e.g., paths) in the models and how these relate, or not, to the literature. Sections 5.2.1 to 5.2.4 summarize the overall findings for the relationships between predictor variables (latent constructs and controls) and the outcomes. Section 5.2.5 provides detail on these relationships across specific EDI domains. Where applicable, tables that summarize the findings across outcome domains are included. Sections 5.2.6 (Timing, Recurrence/Persistence and Severity) and 5.2.7 (Stratified Analysis) summarize key overall and domain-specific findings and how these relate to the findings in the literature.

5.2.1 Direct and Indirect Effects of Maternal Mood/Anxiety

As hypothesized (Hypothesis 1), this study found that maternal Mood/Anxiety has a modest but significant negative association (-0.03 to -0.06) with at least some of the child domain scores on the EDI (see Section 5.2.5 below for details), across each of the time periods, overall study period and aspects of Mood/Anxiety. In particular, a stronger association with the outcomes was found for the both Prenatal period and for recurrent/persistent Mood/Anxiety. These findings confirm the hypotheses regarding the impact on child outcomes for exposure during different time periods (Hypothesis 2) and the impact of recurring Mood/Anxiety on child outcomes (Hypothesis 3). In addition, a negative direct relationship was found between severity of Mood/Anxiety and child outcomes (Hypothesis 4), though not as strong a relationship as recurrent/persistent Mood/Anxiety. However, the direct associations between Mood/Anxiety and the outcomes in this study were fairly modest. As shown in the crude model tables

(Section 4.6.1, Chapter 4), significant direct associations (-0.03 to -0.07, p<.001) were found between maternal Mood/Anxiety and the outcome domains when only these variables (Mood/Anxiety and each outcome) were included in the model. The modest direct influence in this study may be partly due to the nature of how mood and anxiety was measured. Administrative data such as number of prescriptions filled and number of physician visits only tell us about "treatment prevalence" based on contacts with the health care system. Symptomology, maternal functional status, mother-child interactions and the "status" of one's illness (or not) cannot be gleaned from these data. As shown in the review of literature (Chapter 2), studies that have examined mothers' functioning and symptoms of depression and mood disorders have found direct influences on child development, though the strength of the associations depends on study design, how Mood/Anxiety is measured and other factors controlled for (e.g., family environment). The lack of strong direct effect in this study may also be due to the nature of the outcome measure – domain scores on the EDI are highly skewed to the upper end; in other words, most children have high scores. However, even with the skewed distribution of the domain scores, large and significant associations were found between Family Functioning and the outcome domains (see 5.2.2.3 below), so the distribution may have had a negligible influence on the small direct association between Mood/Anxiety and the outcomes.

The finding of a modest direct association between maternal Mood/Anxiety and child outcomes is consistent with several studies. Goodman et al.,[30] in a meta-analysis of 193 studies that examined the strength of association between maternal depression and child emotional or behavioural functioning, found significant associations with child internalizing, externalizing and negative affect behaviour and general psychopathology and that these effects were modest-sized.

For the Prenatal period only (due to the direction of the arrow from Mood/Anxiety to Health at Birth), a significant positive association (0.04, p<.001) was found between Mood/Anxiety and poor health status

at birth. As discussed in Chapter 2, this finding is consistent with a wide range of literature that found poor birth outcomes for infants exposed to maternal mood and anxiety disorders in utero.[4, 55, 124, 126]

The direct relationships between maternal Mood/Anxiety and Family Context were consistently positive and significant for each of the time periods. This speaks to the association between mood and anxiety disorders and related factors such as family environment and SES that may mediate or moderate the relationship between Mood/Anxiety and child outcomes.[11, 20, 40] An interesting pattern of association between Mood/Anxiety and Family Context emerged in the study. A modest but consistent association was found across domains for all of the time periods, with the largest association (0.07, $p<.001$) found for Prenatal period and overall study period. In contrast, a lower association was found for both the Toddler (0.04, $p<.001$) and Year before EDI (0.04, $p<.01$) periods, suggesting that the relationship between treated Mood/Anxiety and Family Context varies over time. A more striking finding is the strong association between two key aspects of Mood/Anxiety – recurrent/persistent and severe – and Family Context. For both aspects, the strength of the relationship between Mood/Anxiety and Family Context was 0.14-0.15 ($p<.001$), double that found for the highest association in any of the time periods. This finding is suggestive of a stronger influence of both Mood/Anxiety and Family Context where recurrence or severity is greater.

While a modest direct effect of maternal Mood/Anxiety was found for at least some of the outcome domains across all models (see Section 5.2.5 below), the effect of Mood/Anxiety was largely mediated through other constructs: Health at Birth (for the Prenatal period only) and – most substantially – through Family Context, confirming the study hypothesis 6. In other words, the negative relationship between maternal Mood/Anxiety and the EDI outcomes is partially accounted for by poor health status at birth and, even more so, by family environment factors such as low SES, young parenthood and unmarried mother. Partial mediation by Health at Birth and Family Context is indicated by a significant

indirect association between Mood/Anxiety and the outcomes. Specifically, significant indirect associations between Mood/Anxiety and the outcomes were found across all time periods, with somewhat weaker indirect associations for the Toddler and YBE periods. Stronger indirect associations between Mood/Anxiety and the outcome domains were found for both recurrent/persistent and severe Mood/Anxiety; this would be expected, given the stronger direct associations between Mood/Anxiety and Family Context. What these findings suggest is that poor health at birth and a more compromised family environment have an even greater contribution to the effect of Mood/Anxiety on the outcomes for some time periods (e.g., Prenatal and Postnatal, as well as the overall study period) than others and, especially, for the relationships between recurrent/persistent Mood/Anxiety and the outcomes and severe Mood/Anxiety and the outcomes. These findings are consistent with the literature. Other studies have found family environment or contextual risk factors to mediate the relationship between maternal Mood/Anxiety and child development. [10, 11, 40] A unique contribution of this study is the ability to identify specific time periods and aspects of Mood/Anxiety where Health at Birth and Family Context partially account for the relationship between Mood/Anxiety and the outcomes.

5.2.2 Direct and Indirect Effects of Health at Birth

The latent construct of Health at Birth had a significant *direct* negative association (-0.04 to -0.09) with all five of the outcome domains. In other words, the health status of an infant at birth has a significant relationship with all five areas of school readiness at kindergarten. Health at Birth was not significantly directly associated with Mood/Anxiety for any of the time periods beyond the Prenatal year (see above) or for the overall study period.[xlix] With respect to aspects of Mood/Anxiety, Health at Birth was

[xlix] As noted above, Prenatal Mood/Anxiety precedes Health at Birth in time and the arrow in this model runs from Mood/Anxiety to Health at Birth.

significantly associated only with recurrent/persistent and severe Mood/Anxiety. A possible explanation for this is the categories created for recurrent/persistent and severe Mood/Anxiety may be more effective at identifying non-linear relationships that are not present when the continuous combination of Mood/Anxiety prescriptions and visits is used (as in the time periods and overall study period).

No significant *indirect* (mediated through Mood/Anxiety and Family Context) relationship was found between Health at Birth and the outcomes for any of the time periods or aspects of Mood/Anxiety, with the exception of a very small significant indirect association between Health at Birth and Language and Cognitive Development in the Postnatal year (see Section 5.2.5 for detail on the domains) and small indirect associations between Health at Birth and all outcome domains for the recurrent/persistent and severity models. For these latter models, Health at Birth had a small association with child outcomes on the EDI, mediated through Mood/Anxiety and Family Context.

5.2.3 Direct Effects of Family Context on the Outcomes

As Goodman et al.[30] found, few studies address mediational or transactional processes in the relationship between maternal mood and anxiety disorders and child outcomes. This study included a latent construct of variables related to the family environment – an index of area-level SES (SEFI2 score), mother's marital status and young mother (< 20 yrs) at birth of the first child. As shown in Chapter 4, the Family Context variable had, by far, the strongest association with the five outcome domains, for all time periods and aspects of Mood/Anxiety (-0.21 t o -0.39). As shown above, the modest significant associations between maternal Mood/Anxiety and the outcomes and significant indirect associations between Mood/Anxiety and the outcomes indicate that maternal Mood/Anxiety influences child development at school entry through Family Context. In other words, a more compromised family environment will strengthen the relationship between maternal Mood/Anxiety and child development

at school entry. Other research has found this relationship also. Goodman and Gotlib,[21] in their review of studies that examined the relationship between maternal depression and child psychopathology, concluded that socio-demographic variables – such as race/ethnicity, family income level, young age of mother and marital status – are important to consider and likely make a significant contribution to development of psychopathology in children exposed to maternal depression. Timko et al.[104] found family functioning (e.g., conflict, activities) accounted for more of child outcomes than parental depression. The strong influence of family/social factors has been found to persist past school entry through adolescence. Jutte et al.,[140] in examining biological (birth weight, gestational age and Apgar score) and social (mother's age, marital status and SES) risk factors in a population-based cohort (n= 4667) of children (followed from birth to 19 years of age), found that both sets of risk factors were associated with poor outcomes; however, the social risk factors had the same – and in some cases stronger – associations (and greater population attributable risk) with later health and educational outcomes. It may well be, as the literature on mechanisms suggests (Chapter 2), that maternal mood and anxiety disorders and contextual factors work to reinforce one another.

5.2.4 Direct Effects of Demographic (Control) Variables

In this study, child age in months at the time of EDI assessment and sex were included as controls. Child age in months was positively associated with EDI outcomes across all time periods and aspects of Mood/Anxiety and male gender was consistently negatively associated with EDI scores. Specifically, older children scored better on the EDI domains than younger children and male children tended to have lower scores, compared to girls. The size of these associations across models and specific outcome domains was substantial. For child age in months, the associations were between 0.13 and 0.24 and for sex, the associations ranged from -0.08 to -0.15. Values varied by outcome domain (see Section 5.2.5 below) and these patterns were fairly consistent for all time periods and aspects of Mood/Anxiety. For

the stratified analyses by level of SES, a slightly stronger association was found between child age and the outcomes for children of mothers with low-mid SES. In other words, younger age had a slightly stronger negative relationship with EDI scores for lower SES children. These findings are consistent with other studies that have found younger children[30, 232] and boys[180] to be more vulnerable on school readiness measures.

5.2.5 Model Effects on EDI Domains

As noted above, this section summarizes the key findings of the relationships between each of the latent constructs and the study outcomes, by specific EDI domain. In addition, the relationships between the control variables and the specific domains are included.

5.2.5.1 Mood/Anxiety

Table 5.1: Summary of Associations Between Mood/Anxiety and Outcomes (EDI Domains)

Model	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Mood/Anxiety --> Outcome					
Prenatal	*-0.03*	**-0.04**	**-0.04**	**-0.04**	*-0.03*
Postnatal	-0.02	**-0.03**	*-0.03*	**-0.04**	-0.01
Toddler	-0.01	**-0.04**	**-0.04**	**-0.05**	-0.02
Year Before EDI	-0.01	**-0.03**	*-0.03*	**-0.05**	-0.02
Overall study period	-0.01	**-0.04**	**-0.04**	**-0.05**	-0.01
Recurrence/Persistence	*-0.03*	**-0.06**	**-0.05**	**-0.05**	*-0.02*
Severity	-0.02	**-0.05**	**-0.05**	**-0.05**	-0.01
Low-Mid SES	-0.02	*-0.04*	*-0.04*	**-0.05**	-0.02
Mid-High SES	-0.01	*-0.03*	*-0.03*	**-0.05**	-0.02

<.001; *<.01*; NS

As shown in Table 5.1, for the Prenatal model, modest significant associations (-0.03 to -0.04) were found between Mood/Anxiety and the outcomes across all five domain areas; however, the strongest associations were found for the Social, Emotional and Physical domains (-0.04, p<.001). For all other time periods, including the overall study period, a modest direct association was found between maternal Mood/Anxiety and the Social Competence, Emotional Maturity and Physical Health domains (-0.03 to -0.05). (Significant associations were not found for the Language and Cognitive Development and the Communication Skills and General Knowledge[l] domains for any time period beyond the Prenatal year or the overall study period.) These findings confirm the study hypothesis (Hypothesis 5) that Social Competence and Emotional Maturity are most influenced by exposure to maternal Mood/Anxiety.

[l] Research reviewed did not assess outcomes explicitly that would fall under the EDI Communication Skills and General Knowledge domain. It is likely that the skills in this domain fall under the language, cognitive, social and emotional outcomes assessed in the literature.

Other Manitoba research that has examined the association between maternal depression and EDI outcomes also found significant associations for the Social, Emotional and Physical domains.[58] In contrast, Santos et al.[138] did not find any significant association between maternal depression as a control variable and any of the EDI domains. However, the study focused on health at birth and major and minor illness through early childhood and the mix of variables used may not correlate with the measure of maternal depression used or may have masked the relationship between maternal depression and EDI scores.

The lack of significant association between maternal Mood/Anxiety beyond the Prenatal year and the Language and Cognitive Development domain is consistent with other studies that did not find a significant association between maternal mood and anxiety disorders and language or cognitive development.[44, 86-89] The finding of a significant association between maternal Mood/Anxiety and the Social and Emotional domains is consistent with numerous other studies,[7, 71, 83, 84] as is the association with Physical Health. [87, 88, 103] As described in the review of the literature (Chapter2), potential mechanisms or pathways between exposure to maternal Mood/Anxiety and child outcomes may interfere with both the infant/child's stress response and mother-child interaction, which can negatively affect child social, emotional and physical development.

Similar to the Prenatal year, and in contrast to the other time periods, a significant modest association was found between recurrent/persistent maternal Mood/Anxiety and all five outcome domains (-0.02 to -0.06), suggesting that exposure to recurrent or persistent maternal depression or anxiety over early childhood has a stronger effect on school readiness at kindergarten than any particular time period following birth. The strongest associations were found, consistent with the time periods and overall study period, for the Social (-0.06), Emotional (-0.05) and Physical (-0.05) domains, and these coefficients were slightly stronger in the recurrent/persistent model than for any other model tested in

this study, suggesting that these three areas of child development are particularly susceptible to the effects of recurrent or persistent maternal mood and anxiety disorders. A significant association between recurrent/persistent Mood/Anxiety and child language and cognitive skills (-0.03) is consistent with what Sohr-Preston and Scaramella[13] found in their review of studies on the influence of maternal depression and child cognitive and language development. A similar finding in terms of recurrent/persistent Mood/Anxiety affecting multiple outcome areas was found in a study by Petterson and Albers[103] where children of mothers depressed at two points in time (28 and 50 months postnatal) had lower scores on social, cognitive and physical development compared to children whose mothers were not depressed at either period.

While significant associations were found between Mood/Anxiety and all five outcome domains for the recurrent/persistent model, the same pattern was not found for levels of Mood/Anxiety severity. The pattern of association between severity of maternal Mood/Anxiety and the outcome domains was similar to that found for the time periods and overall study period; relationships were found between severity of Mood/Anxiety and the Social, Emotional and Physical domains (-0.05) and no relationship was found between severity of Mood/Anxiety and the Language domain or the Communication Skills domain. This finding suggests that the number of time periods a mother is depressed/anxious (recurrent/persistent model) has a broader effect (i.e., impacts more outcome domains) on child development measures at kindergarten than the level of severity of mother's depression or anxiety.[li]

[li] It is also possible that the measure for recurrence/persistence (the number of time periods Mood/Anxiety was present) was more robust than the measure for severity (categories of the number of mental health contacts, from low to high), which may account for the differences found.

Table 5.2: Summary of Associations Between Mood/Anxiety and Family Context

Model	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Mood/Anxiety --> Family Context					
Prenatal	**0.07**	**0.07**	**0.07**	**0.07**	**0.05**
Postnatal	**0.06**	**0.06**	**0.06**	**0.06**	**0.06**
Toddler	*0.04*	**0.04**	**0.04**	**0.04**	**0.04**
Year Before EDI	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*
Overall study period	**0.07**	**0.07**	**0.07**	**0.07**	**0.07**
Recurrence/Persistence	**0.14**	**0.14**	**0.14**	**0.14**	**0.14**
Severity	**0.14**	**0.15**	**0.15**	**0.15**	**0.14**

<.001; *<.01*; NS

As shown in Table 5.2 above, Mood/Anxiety had a direct positive association with Family Context for all time periods and aspects of Mood/Anxiety (0.04 to 0.15). That is, mother's Mood/Anxiety was consistently related to a family environment facing challenges in each of the time periods, the overall study period and, most notably, where mother's Mood/Anxiety was recurrent/persistent or severe. As described in Chapter 2, the relationship between maternal mood and anxiety disorders and family environment is well-established, so these findings are consistent with the literature. A weaker relationship was found between Mood/Anxiety and Family Context in the Toddler and Year Before EDI periods (0.04) than for the other time periods. This suggests that the influence of maternal Mood/Anxiety varies over the early childhood period and tends to weaken over time. In addition, the strongest relationship between Mood/Anxiety and Family Context was found in the recurrent/persistent (0.14) and severity (0.14 to 0.15) models, about double the strength of the association found in the time periods and overall study period. This finding suggests that where maternal depression or anxiety is recurring or more severe, an even stronger relationship exists with a family environment that is faced with challenges.

Indirect effects of Mood/Anxiety were significant for all time periods and aspects of Mood/Anxiety and this indicates a partial mediation through Family Context, as discussed above. The strongest indirect effect was for the Language domain. The strongest indirect effects of Mood/Anxiety were found in the recurrent/persistent and severity models and, again, the largest effect was for the Language outcome.

5.2.5.2 Health at Birth

Table 5.3: Summary of Associations Between Health at Birth and Outcomes

Model	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Health at Birth --> Outcomes					
Prenatal	**-0.07**	**-0.05**	**-0.04**	**-0.08**	**-0.06**
Postnatal	**-0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**
Toddler	**-0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**
Year Before EDI	**-0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**
Overall study period	**-0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**
Recurrence/Persistence	**0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**
Severity	**-0.07**	**-0.05**	**-0.05**	**-0.09**	**-0.07**

<.001; <*.01*; NS

As shown in Table 5.3, Health at Birth had a significant direct association (0.04 to 0.09) with all outcome domains, particularly for the Physical Health domain, across all time periods and aspects of Mood/Anxiety. This finding is consistent with other research that has found health status at birth to influence health through early childhood[137, 138] and physical development at school entry.[58, 134-136, 138] The lowest direct association between Health at Birth and the outcome domains was for the Social (0.05) and Emotional (0.04 to 0.05) domains. This was also consistent for all time periods and aspects of Mood/Anxiety. In contrast, no pattern emerged for the indirect effect of Health at Birth on the outcome

domains. This indirect association was only significant for recurrent/persistent Mood/Anxiety and severity of Mood/Anxiety, and these effects were very slight.

5.2.5.3 Family Context

Table 5.4: Summary of Associations Between Family Context and Outcomes

Model	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Family Context --> Outcomes					
Prenatal	**-0.38**	**-0.27**	**-0.21**	**-0.31**	**-0.26**
Postnatal	**-0.39**	**-0.29**	**-0.23**	**-0.32**	**-0.28**
Toddler	**-0.37**	**-0.27**	**-0.22**	**-0.29**	**-0.24**
Year Before EDI	**-0.36**	**-0.26**	**-0.21**	**-0.30**	**-0.23**
Overall study period	**-0.38**	**-0.27**	**-0.22**	**-0.30**	**-0.25**
Recurrence/Persistence	**-0.37**	**-0.26**	**-0.21**	**-0.29**	**-0.25**
Severity	**-0.37**	**-0.26**	**-0.21**	**-0.29**	**-0.25**
Low-Mid SES	**-0.34**	**-0.24**	**-0.20**	**-0.27**	**-0.20**
Mid-High SES	**-0.19**	**-0.20**	**-0.17**	**-0.18**	**-0.09**

<.001; *<.01*; NS

As shown in Table 5.4, Family Context had a very strong relationship with each of the outcome domains, across all models tested. In other words, a family environment faced with socio-demographic challenges was very strongly associated with poor scores on each of the EDI domains, and this relationship persisted across all time periods and aspects of maternal Mood/Anxiety. Specifically, a challenged family environment was most strongly associated with the Language and Cognitive Development domain (-0.36 to -0.39) and the lowest association – though still substantial – was with the Emotional Maturity domain (-0.21 to -0.23). The finding that Language and Cognitive Development is most

strongly affected by the family environment is in contrast to the other direct associations found in this study; specifically, as described above, both maternal Mood/Anxiety and Health at Birth were more strongly associated with the Social, Emotional and Physical domains. However, a stronger association between a challenged family context/environment and lower child verbal/cognitive outcomes has been found in the literature. Jensen et al.[10] examined the influence of maternal depression, interpersonal stress and contextual risk (poor housing, low SES, lone caregiver, early parenthood and low parental education) on child outcomes and found that, compared to maternal depression, contextual risk was more strongly associated with decreased verbal IQ. They state their findings may support the notion that decreased verbal IQ (and related "crystallized measures of intelligence") may be more especially vulnerable to decreased cognitive stimulation due to limited education and resources of parents (e.g., high contextual risk). Brennan et al.[17] found that demographic factors such as maternal education and family income were more strongly related to child cognitive functioning at age 5 than maternal depression symptoms. Brownell et al.[58] used structural equation modeling to assess influences on child EDI scores and grade 3 achievement and found that material deprivation (less than high school education and area-level indicators of poor neighbourhood and low labour force participation) was significantly associated with the Language and Cognitive Development domain on the EDI at school entry. One possible pathway or mechanism for this association is the beliefs and practices of parents in lower functioning families. Davis-Kean[234] used structural equation modeling and found that low parental education and family income were negatively associated with children's academic achievement and this relationship was mediated through parental beliefs and behaviours. That is, in low-SES families, child school performance is negatively affected by low income and low parental education, and this effect is partially accounted for by parental beliefs about educational achievement and parenting behaviours (e.g., reading, parent-child play and parental warmth). As shown in Table 5.4 above, for the stratified models by mother's SES (see 5.2.7 below for more detail), a marked difference in the

association between Family Context and the outcome domains was found; the estimate for low-mid SES mothers was very similar to that of all other models tested in the study (-0.20 to -0.34). However, for the mid-high SES mothers, the association was considerably lower (-0.09 to -0.20), suggesting that the relationship between Mood/Anxiety and Family Context is less influential for families with more financial and social resources.

5.2.5.4 Control Variables

Child age in months had a stronger positive association with the Language and Cognitive Development domain (0.14) than any other domain (0.08 to 0.11) and this pattern was consistent across all time periods and aspects of Mood/Anxiety. Being a male child had the strongest negative association the Emotional Development (-0.24) and Social Competence (-0.20) domains and this pattern, too, was consistent across all time periods and aspects of Mood/Anxiety. These findings are very similar to that found in other studies that looked at EDI outcomes.[58, 138]

5.2.6 Timing, Recurrence/Persistence and Severity of Maternal Mood/Anxiety

As several studies have noted, [17, 98, 168] it is important to assess the impact of timing, duration and severity of maternal mood and anxiety disorders – and various co-occurring risk factors – on child development. These three key aspects of maternal Mood/Anxiety and their influence on child outcomes were examined in this study. Time periods from the Prenatal year to the year Before EDI assessment and the overall study period were examined separately, as were models using a scaled variable for recurrent/persistent Mood/Anxiety (number of time periods over study period) and for severity (four levels based on total number of prescriptions and physician visits for study period). Key findings for these are provided below.

5.2.6.1 Timing

In this study, the Prenatal period appears to be a sensitive period with respect to maternal Mood/Anxiety having a slightly stronger – and more pervasive (i.e., across all domains) – negative association (-0.03 to -0.04) with child outcomes at school entry, compared to any other time period. This significant influence of prenatal mood and anxiety disorders was found across all outcome domains, but was strongest for the Social Competence, Emotional Maturity and Physical Health and Well-Being domains (-0.04). This finding is consistent with studies that have found the prenatal period to be particularly sensitive to maternal depression and anxiety.[5, 71, 73] As described in Chapter 2, various mechanisms or pathways between prenatal exposure and child outcomes at school entry have been proposed. However, it is unclear in this study what particular feature(s) of the prenatal year may account for the stronger association with EDI outcomes. Biological programming due to maternal biochemistry and HPA axis function, epigenetic processes, adverse health behaviours during pregnancy and in utero exposure to psychotropic medications have been found to be negatively associated with child outcomes and may be possible mechanisms of transmission of the effects of Mood/Anxiety.[lii]

In contrast to a number of studies that have identified the postnatal period as a sensitive developmental period, this study did not find any unique association between maternal Mood/Anxiety in the year after birth and child outcomes at kindergarten. In fact, the direct estimates for the association between maternal Mood/Anxiety in the Postnatal year (-0.01, NS to -0.04, p<.001) are most similar to the Year Before EDI, with slightly lower estimates for the three significant domains – Social, Emotional and Physical – than estimates for the Prenatal, Toddler and overall study periods. The lack of a sensitive postnatal period in this study is consistent with some studies that did not find a unique effect.[12, 29, 71, 105]

[lii] Though this study was unable to measure biological and epigenetic processes, mothers' filled prescriptions over the duration of the study period was available; however, it is unknown how much medication was actually consumed. For health behaviours, some of this information was available in the administrative data (e.g., medical contacts for substance abuse) but was excluded from the models (see Table A3.1 in Appendix 3 for details).

The Toddler period did not stand out in this study as having any significantly larger influence on child development at school entry than the other time periods. Of note is the fact that this time period was three or more years long, allowing for a potentially longer exposure period which could influence outcomes.[liii] However, this was not the case in this study. Few studies examined exposure in the toddler years and findings were mixed, so aside from the potential longer duration of exposure during this time, the finding for this study is not surprising.

This study did not find that exposure to maternal Mood/Anxiety in the year before school had any unique association with child outcomes over any of the other time periods. While studies have found an effect of exposure recent or concurrent to school entry,[7, 71] others have not, suggesting that this time period is not particularly sensitive in terms of influencing child development at school entry.[44, 87, 88]

As this study did not expressly control for a timing effect (i.e., each time period model was run separately, without including other time periods in the model; this complexity was beyond the scope of this project), it is difficult to determine if there is a specific effect of timing above and beyond that of any one time period. However, results from this study do illustrate that the prenatal year appears to be more sensitive to maternal Mood/Anxiety than other individual time periods and, for models that examined the overall study period, recurrent or persistent Mood/Anxiety had a stronger association with the outcome domains. Again, for all time periods and aspects of Mood/Anxiety in this study, family environment variables had a much stronger association with child outcomes on the EDI, regardless of time period or aspect of Mood/Anxiety examined.

[liii] Conversely, the length of this time period may also provide more time for recovery from the effects of a remitted disorder.

5.2.6.2 Recurrence/Persistence

Consistent with the literature, as described in Chapter 2, this study found a slightly stronger association between recurrent/persistent Mood/Anxiety and child outcomes (-0.02 to -0.06) when compared to the time periods and severity of Mood/Anxiety. Along with the Prenatal period, recurrence/persistence of maternal Mood/Anxiety had a slight but significant association between maternal Mood/Anxiety and the Language and Cognitive (-0.03, p<.01) and Communication Skills (-0.03, p<.01) domains. In addition, there were stronger *indirect* associations between recurrent/persistent Mood/Anxiety and all of the outcome domains, which reflect the partial mediation of this relationship by Family Context. In other words, recurrent/persistent Mood/Anxiety has a strong association with Family Context (0.14), and this family environment plays an even larger mediating role (i.e., accounts for some of the effect) in the relationship between recurrent/persistent Mood/Anxiety and child outcomes.

Few studies that examined recurrence or "chronicity" of maternal mood and anxiety disorders failed to find a significant association with child outcomes. The importance of this aspect of maternal mood and anxiety disorders on child outcomes is highlighted by the fact that a wide range of studies found a significant effect of recurrence/persistence, despite variation in study design, sample size, timing and mode of measurement and covariates included. Two large-sample studies reviewed that used administrative claims data to define maternal mood also found recurrence or persistence to be most significant. Guevremont et al.[73]found that the number of years a child was exposed to maternal depression from the prenatal period to child ages 7-9 was more predictive of child ADHD than any individual time period. Kozyrskyj et al.[105] found a dose-response relationship between exposure to maternal distress and development of asthma at age 7 and more negative outcome for children exposed continuously from birth to age 7.

A possible mechanism that has been suggested for why recurrent or persistent maternal depression or anxiety is more detrimental to child outcomes at school entry than other aspects of depression (timing or severity) is that prolonged depression or anxiety may interfere with the mother's ability to respond to her child(ren) sensitively and consistently over time.[13] As described in Chapter 2, maternal sensitivity toward the child and mother-child interactions have been found to be negatively affected by maternal depression and anxiety. In addition, maternal sensitivity has been shown to influence child development. Where maternal depression or anxiety is recurring or persistent, opportunities for positive maternal sensitivity decrease and, consequently, may negatively affect child outcomes at school entry.

5.2.6.3 Severity

While this study found modest significant associations between severity of maternal Mood/Anxiety and the EDI domains of Social Competence, Emotional Maturity and Physical Health (0.05, $p<.001$), relationships were not found between severity of Mood/Anxiety and either the Language or Communication Skills domains. This finding of a relationship with only these three outcome areas is consistent with the influence of time periods beyond the Prenatal year and the overall study period. However, in contrast to the time periods and overall study period, the strength of the relationships between severity of Mood/Anxiety and child social, emotional and physical development were second only to the recurrent/persistent model. This is consistent with other studies where severity of symptoms has been found to have a significant association with child emotional/behavioural[17, 98, 106, 107] development.

Despite the modest direct association between severity of maternal Mood/Anxiety and the outcomes, the *indirect* association between Mood/Anxiety and the outcome domains – through Family Context –

was stronger than that found for any of the time periods. This is expected, given the stronger relationship between severity of Mood/Anxiety and Family Context. These findings also suggest that using a scaled variable of four categories of severity – based on total number of prescriptions and physician visits – is a more sensitive measure of severity, or *degree* of Mood/Anxiety, than the continuous latent measure of total prescriptions and physician visits (used for all time periods and the overall study period).

As noted in Chapter 2, sorting out the influence of timing, recurrence/persistence and severity is complicated by the fact that these three are typically confounded.

5.2.7 Supplementary Analyses: Socio-Economic Status (SES)

Table 5.5: Summary of Stratified Analysis, by Outcome Domain

Model	Language and Cognitive	Social Competence	Emotional Maturity	Physical Health and Well-Being	Communication Skills
Mothers with Low-Mid SES (n=9179)					
Mood/Anxiety --> Outcome	-0.02	*-0.04*	*-0.04*	**-0.05**	-0.02
Mood/Anxiety <-- Health at Birth	0.00	0.00	0.00	0.00	0.00
Health at Birth --> Outcome	**-0.06**	**-0.05**	**-0.04**	**-0.09**	**-0.06**
Mood/Anxiety --> Family Context	**0.07**	**0.07**	**0.08**	**0.07**	**0.07**
Family Context --> Outcome	**-0.34**	**-0.24**	**-0.20**	**-0.27**	**-0.20**
Mothers with Mid-High SES (n=9152)					
Mood/Anxiety --> Outcome	-0.01	*-0.03*	*-0.03*	**-0.05**	-0.02
Mood/Anxiety <-- Health at Birth	*0.04*	*0.04*	*0.04*	*0.04*	*0.04*
Health at Birth --> Outcome	**-0.08**	**-0.06**	**-0.05**	**-0.09**	**-0.07**
Mood/Anxiety --> Family Context	**0.09**	**0.09**	**0.09**	**0.09**	**0.07**
Family Context --> Outcome	**-0.19**	**-0.20**	**-0.17**	**-0.18**	**-0.09**

<.001; *<.01*; NS

SES has been identified as a moderator of the relationships between maternal mood and anxiety disorders and caregiving[155] and maternal mood and anxiety disorders and child development.[13, 107] In order to determine whether outcomes differed for children of mothers with varied SES status (in other words, whether SES moderated the relationship between maternal Mood/Anxiety and EDI scores), two separate models were run with the study sample stratified evenly into two groups:[liv] mothers with low-mid SES and those with mid-high SES. As summarized in Table 5.5, and consistent with Hypothesis 7, there were some different findings between the two groups. For mothers with low-mid SES, the direct association between Mood/Anxiety and the outcomes was significant for three of the five domains (Social Competence, Emotional Maturity and Physical Health), similar to mothers with mid-high SES; however, the strength of the relationships was slightly stronger. For both groups, the strongest

[liv] Based on mothers' average Socio-Economic Factor Index (SEFI) score for the overall study period (mean=0.12).

association was with the Physical Health outcome domain. Consistent with most of the time periods and aspects of Mood/Anxiety in this study, no significant association was found between Mood/Anxiety and the Language and Cognitive Development or Communication Skills domains. This finding of a slightly stronger negative association between exposure to maternal Mood/Anxiety and EDI outcomes for children whose mothers were in the low-mid SES group is consistent with findings in the literature.[12, 159, 160, 235] Specifically, as previous research has shown (Chapter 2), prevalence of maternal mood and anxiety disorders is higher in low SES groups and families with lower SES may lack the financial and educational resources to support early learning. In turn, the combination of these multiple stressors results in children being less ready for school. In addition, the finding in this study that outcomes differed for children whose mothers were in different SES groups indicates that SES moderates the relationship between maternal Mood/Anxiety and child development. This is consistent with other studies that have used socio-economic indicators similar to that used in this study[lv] to measure SES. Jensen et al.[10] and Barker[168] used several indicators in contextual risk that included: inadequate housing and facilities; poverty; single caregiver; young parenthood (19 years or younger); and low parental education. These studies found SES to moderate the relationship between maternal depression and child outcomes.

The relationship between Health at Birth and Mood/Anxiety was consistently positive and significant across all outcome domains for children whose mothers had mid-high SES and no relationship was found between Health at Birth and Mood/Anxiety for children whose mothers had low-mid SES. In other words, for children in higher SES families, negative health status at birth is related to (and may possibly influence) maternal Mood/Anxiety. Further, the association between Health at Birth and the outcome

[lv] The SEFI2 score used in this study includes: area-level unemployment, single parenthood, less than high school completion rates, and average household income.

domains was stronger in the high-mid SES group, with the exception of the Physical Health domain where the association was the same for both groups. A possible explanation for the stronger associations in the mid-high SES group could be that, for mothers with low-mid SES, other factors – such as family environment – play a much larger role in the influence on child outcomes than health status at birth.

An interesting finding of note is that the association between Mood/Anxiety and Family Context was slightly stronger for mid-high SES mothers. With the exception of the Communication Skills domain, this finding was consistent across the outcome domains. However, the association between Family Context and the outcome domains was much stronger for low-mid SES mothers.

Though differences were found between the low-mid SES and mid-high SES groups, these associations in this study were modest. This is consistent with the literature. In their meta-analysis of 193 studies, Goodman et al.[30] expected to find larger effects of SES as a moderator. Of importance also is the role of other factors that may mediate or moderate the relationship between SES and child outcomes. As Duncan et al.[159] found, about half of the effect of family income on cognitive ability is mediated by the home environment. In other words, the quality of the environment the child is raised in partially accounts for the negative effect of low family income level on child cognitive development.

5.2.8 Summary of the Key Findings

As the findings above illustrate, research using structural equation modeling and linked administrative data in a large population-based sample is a unique way of measuring the relationship between maternal Mood/Anxiety and child development at school entry. This study design – and the variables measured – allows for a level of power and sophistication to identify whether child exposure during

particular time periods and/or specific aspects of maternal Mood/Anxiety have an influence on scores of five domains of child school readiness. In particular, child exposure to maternal Mood/Anxiety in the Prenatal period appears to be more detrimental to child school readiness at kindergarten than exposure during time periods beyond birth (e.g., Postnatal year, Toddler year and the Year Before EDI). In addition, exposure to recurrent/persistent maternal Mood/Anxiety over early childhood has an even stronger negative relationship with child school readiness. With respect to the outcome domains, child social, emotional and physical development at age 5 are most likely to be negatively impacted by exposure to maternal Mood/Anxiety. As shown throughout the chapter, these findings are consistent with other research. The finding of a stronger relationship between prenatal exposure to Mood/Anxiety on child outcomes may lend support to the programming hypothesis, as described in Chapter 2. Specifically, changes to fetal development in utero where mothers experience depression or anxiety may alter child physical and emotional development in such a way that school readiness is compromised in these areas. Further, the stronger association between exposure to persistent/recurrent maternal Mood/Anxiety and child development reflects the notion that long-term exposure may further contribute to an impaired child stress response and this, in turn, may lead to later illness, further supporting the programming hypothesis. In addition, this study found that maternal/family SES does have a modest influence on child school readiness in kindergarten. In particular, for children in lower SES families, there is a much stronger relationship between the family environment and child outcomes and a slightly stronger relationship between maternal Mood/Anxiety and child outcomes. What this means is that the family environment plays an even stronger role in influencing child EDI scores for children whose mothers were in the lower SES group, compared to other children.

5.3 Strengths of the Study

Strengths of this study include those related to administrative data, measures included and the study methodology.

5.3.1 Strengths of Administrative Data

One of the key strengths of this study is the very large population-based dataset. Administrative data are collected for the entire population and can be aggregated at the individual, physician, hospital, region or population levels.[19] Given the very large sample, a more stringent threshold for significance ($p<.01$ or smaller) can be used, reducing the chance of Type I error (e.g., finding significant associations that do not exist). In addition, use of administrative data for this study allows for linkage with other databases to measure a variety of family and social context variables (e.g., socio-economic status (SES), marital status, mother's age at first birth) and determine their influence on the relationship between maternal Mood/Anxiety and child development at school entry. A significant advantage of relying on administrative data to measure maternal depression is the availability of population-level data which provides information on vulnerable groups who may be less likely to complete surveys[236] or may be lost to follow-up due to illness severity.[92] These groups can be included more easily.

Another strength of using administrative data for this research was the availability of health care contacts -- prescriptions and physician visits -- to define maternal Mood/Anxiety disorders. Much of the research on maternal depression and anxiety involves measurement of symptoms experienced – either by self-report or in a clinical interview. A limitation of self-reported data is that it is subject to recall bias, not corroborated by a clinical diagnosis and usually only available at one point in time. In some studies, clinical interviews have been used and at least offer a formal diagnosis based on established

guidelines in the DSM-IV.[16] However, there are limitations with respect to inconsistent diagnostic criteria and assessment instruments, [237] and criterion validity of instruments and physicians' ability to recognize depressive mental illness in a clinical setting.[238] This approach is nearly impossible to undertake at a population level given the resource-intensive nature of such interviews. While similar diagnostic limitations may be found with administrative data with respect to physicians recognizing mental illness and or coding discrepancies (as noted above), the availability of population-level data on filled prescriptions and physician diagnoses overcomes many of the limitations of self-report and interview data. Further, studies have examined rates of mental illness identified in administrative data and other sources and found congruence with diagnostic interviews[239] and survey data.[lvi] [240]

Use of both filled prescriptions and physician visits affords advantages over using one or the other. Data from a Medicaid prescription study found that models that combine both diagnoses and prescriptions dispensed have superior overall performance in correctly classifying a wide range of chronic diseases (including depression) compared with models that used either approach alone.[217]

Another strength of using administrative data in this study is related to the longitudinal nature of the data. Specifically, aspects of maternal mood and anxiety disorders such as timing, severity and recurrence/persistence can be measured using continuous measures over the entire study period, rather than limited to finite points in time.

[lvi] While the prevalence of those with mental illness was similar in a comparison between administrative data (e.g., algorithm) and the National Population Health Survey (NPHS), both measures were found to underestimate prevalence and each identified different groups of people.[240]

5.3.2 Strengths of Measures Included in the Study

In addition to measuring maternal Mood/Anxiety, this study was able to include a number of socio-demographic variables that may influence the relationship between maternal mood and child development at school entry. The broad range of measures available in administrative datasets allows for population-level information on numerous health and social factors, and their relationship to the outcomes, a key strength of this study. In particular, the Health at Birth measure includes a number of indicators of newborn health – preterm birth, low birth weight, NICU stay and long birth hospitalization – that have been shown to be influenced by exposures during the prenatal year and also predictive of later health and social outcomes. Surveys and other retrospective forms of data collection are limited by respondent recall and may not yield accurate information. Record-keeping in hospital separation abstracts provides reliable, detailed population-level data on these birth outcomes. The Family Context variables include a mix of individual and area-level measures found to be a significantly related to maternal Mood/Anxiety and child outcomes. For example, the Socio-Economic Factor Index (SEFI2) reflects the following, based on census dissemination area (DA): average household income; proportion of residents with high school education; proportion of single parent households; and proportion of residents who are unemployed. While not available at the individual level, these area-level measures – when combined together into the SEFI index – are an important predictor of health and social outcomes.[224] Other indicators in the Family Context construct are mother's marital status and mother younger than 20 years of age at the time of first birth. While there are some limitations to the marital status indicator (see above), both of these variables have been found to be a significant predictors of later outcomes.[241, 242] Other research has used these important family and SES indicators in related research. Though they did not use population-level administrative data, Jensen et al.[10] and Barker[168] used very similar indicators to measure what they call "contextual risk" and found this set of measures to be a significant influence in the relationship between maternal Mood/Anxiety and child development.

In addition to these measures, child age in months and child gender (male child), both significant moderators of the maternal mood-child outcomes relationship (as described in Chapter 2), were available for this study as controls.

5.3.3 Strengths of the Study Methodology

Another strength of this study was the use of structural equation modeling (SEM). Tomarken and Waller[243] describe SEM as "mathematically complex and constantly evolving" as well as increasing in popularity as it becomes more accessible and able to handle increasingly complex modeling. In fact, SEM has the ability to handle more complex modelling that other methods cannot.[208] Well-suited to large sample sizes, SEM allows for testing of hypothesized relationships. For this study, maternal Mood/Anxiety, infant health status at birth and a number of family environment variables could all be included in the same model assessing child EDI outcomes. In addition, SEM allows for the use of latent constructs to represent variables that cannot be measured directly. The three latent constructs in this study - Mood/Anxiety, Health at Birth and Family Context - included a range of related indicators representing several phenomena, rather than a single, limited variable.

SEM is particularly beneficial for its strength at handling mediation models.[244, 245] A strength of this study is that both direct and indirect, or mediating, effects were accounted for. While it is difficult to measure specific mechanisms of the transmission of maternal Mood/Anxiety to child outcomes, mediation or indirect effects suggest potential mechanisms. For example, in this study, maternal Mood/Anxiety influenced child EDI outcomes largely through family environment factors. In addition, infant health status at birth had an indirect effect on EDI results through Mood/Anxiety and family context.

5.4 Limitations of the Study

Limitations of this study include those related to administrative data, measures not included and the study methodology.

5.4.1 Limitations of Administrative Data

While administrative data provide the opportunity to examine a range of outcomes in a large population-based sample, reliance on medical contacts to define maternal Mood/Anxiety does have its limitations. As noted, data are dependent on individuals making contact with the health care system so what is really being measured is "treatment prevalence." As a result, groups of individuals who may be reluctant to seek medical care may be under-represented. Low-income women may be reluctant to seek treatment for depression due to perceiving that depression is part of the reality of their life situation, stigma and distrust of mental health and child welfare agencies.[246] In addition, barriers such as language, discrimination, limited time off work and lack of transportation and child care may also limit access for low income individuals.[247]

A limitation of relying on diagnosis codes is that not everyone with depressive symptoms will be captured in the administrative records. However, sub-clinical symptoms in themselves have been linked to social impairment and increased risk for major depressive disorder (MDD) and other mental diagnoses.[13] Tataryn et al.[239] estimated that, in 1991-1992 in Manitoba, cases in treatment represented 15-60% of true prevalence of mental illnesses.[239] There are several reasons why administrative data do not include all population cases of depression. Cases of depression may be omitted from coding due to lack of adequate screening,[248] code substitution by physicians out of concern for patient confidentiality[249] and limits on the number of codes that can be recorded at physician visits. Definitions

such as above use three-digit codes for physician visits which result in broad categories that may not distinguish between sub-codes (e.g., noted with decimal places).[240] While this may not under-represent cases of depression or anxiety, it places limits on specificity of illness. In addition, there is a lack of consistency in how diagnoses are made.[123] Conversely, administrative data definitions may include those who do not actually have a diagnosis of depression. Spettell et al.[250] found that two administrative data algorithms for depression had low positive predictive values (49% for diagnosis or prescription and 60% for diagnosis along with any prescription) and, as a result, frequently falsely classified patients as having depression. Further, greater intensity of treatment (e.g., a higher number of visits and/or prescriptions filled) may be indicative of either more severe illness (and, therefore, worse outcomes) or of well-treated mood and anxiety disorders (and more positive outcomes). It is likely that the administrative data are capturing both of these; however, it is difficult to determine which of these scenarios the greater intensity represents.

Another limitation of measuring maternal mood and anxiety disorders with administrative data is that specific symptoms, maternal functioning (including mother-child interaction) and illness status cannot be gleaned from these data. Depressive symptomology has been found to be more predictive of compromised mother-child interactions than affective diagnosis.[34] Harder et al.[108] examined the relationships of parent diagnostic classifications as measured by the DSM-III (schizophrenia, affective disorders, non-psychotic disorders and neurotic disorders) and parent psychopathology severity (using a continuous global measure) to child functioning in a sample of families with one parent previously hospitalized (n=101). Assessments were done at the time of most recent hospitalization, an average of 4.36 years prior to the study, and the study itself. The study found that the continuous measure of impairment at the time of the study was more strongly related to child outcomes than DSM-III diagnoses. These findings show that formal diagnosis is not always indicative of level of impairment.[108]

With respect to medication, a limitation is that it is not possible to determine actual patterns of pharmaceutical use since only "filled" prescriptions are tracked. It is unknown whether medications were actually consumed but it is known if subsequent prescriptions were filled. Further, several provider and patient factors influence rates of medications prescribed and prescriptions filled by women with infants and young children: Physicians may believe that postpartum depression is brief and self-correcting; some physicians may be reluctant to prescribe antidepressants or anxiolytics to lactating women out of concern for the infant; a woman's decision to fill a prescription for an antidepressant or anxiolytic may be affected by fear of the effects of medications on herself or her infant, or concern about stigma or dependence.[251] In addition, prescription rates have been found to be affected by regulatory warnings.[252]

Given the limitations of measuring depression and anxiety in administrative data discussed in Chapter 3, this study did not distinguish between anxiety and depression. While studies have found distinct effects, depression and anxiety are also highly comorbid and further research is needed to sort if biological changes and mechanisms differ for anxiety and depression.[26]

With respect to EDI domain scores, a potential limitation is the distribution of domain scores. As noted earlier, these are not normally distributed and are skewed to higher scores; most children score high on the assessment. As a result, it may be more difficult to detect differences between children on the EDI outcomes.

5.4.2 Limitations of Variables Not Measured

Although a number of variables from several databases were included, this study is limited by measures that could not be included. For example, biological or genetic factors in mothers and children could not

be accounted for. Such measures may account for unexplained differences in child outcomes and could assist in identifying specific mechanisms between exposure to maternal Mood/Anxiety and child outcomes; as Glover et al. [26] note, further research into mechanisms is needed. Maternal behaviours such as diet and substance use (e.g., alcohol, tobacco, drugs) – and how these may influence development in utero – were also not included. In addition, mother-child interactions were not measured for this study. As shown in Chapter 2, these interactions have been found to mediate the relationship between maternal mood and anxiety disorders and child outcomes. Another limitation of this study is that it did not include fathers as it is more difficult to link children to fathers in data. Fathers' parenting practices – and certainly paternal Mood/Anxiety – can influence child outcomes. However, despite this limitation, research has found maternal mood largely accounts for the impact of parental illness, even after fathers' depression was controlled for. [26, 106]

This study did not account for a mother having another child during the study period. This may have influenced a mother's pattern of care for Mood/Anxiety and possibly the nature of her interactions with the index child. As described in Chapter 3, prescriptions and physician visits for Mood/Anxiety are lower during the prenatal and postnatal periods; rates for these medical contacts across time periods could have been higher if additional pregnancies were accounted for. In addition, the study focused on mother-child pairs and did not account for the number of other children in the household.

5.4.3 Limitations of the Study Methodology

Structural equation modeling allows for the analysis of complex relationships. However, as with any statistical technique, there are limitations to what can be included. A risk with SEM is the temptation to put too many variables into the model. A limitation of this study is it did not control for exposure at each time period. As described in Chapter 2, several studies did examine “timing” as a specific variable

and while some found a specific effect of timing, others did not. As Glover et al.[26] state, there may be different outcomes according to region of brain that is most vulnerable (e.g., amygdala or hippocampus) at certain times. Deave et al.[38] suggest that postnatal depression may be a factor along the pathway from prenatal exposure to child outcomes, in which case controlling for postnatal exposure would not be appropriate. However, postnatal exposure may have an independent effect on child outcomes, and controlling for it in this case would be appropriate. One way to account for this is to include previous or subsequent time periods in each model. While this study examined the impact of exposure to maternal Mood/Anxiety during several time periods, the other time periods were not included (i.e., controlled for) in each time period model due to the complexity of the models. Another limitation of this study is it did not examine bi-directional influences. For example, two-way relationships have been found to exist between maternal depression and child adjustment; maternal mood and anxiety disorders influences child development and child development or characteristics can also influence maternal mood.[153] These relationships would be represented by two-way arrows in the structural equation models, however, this level of complexity was beyond the scope of this study.

5.5 Conclusion

This study makes a unique contribution to the literature by being the first to use linked administrative data to examine the relationship between several aspects of maternal Mood/Anxiety and child outcomes on the Early Development Instrument, over time. The examination of child exposure to maternal Mood/Anxiety over several time periods from the prenatal period up to kindergarten is a key strength of this study; it allows for the identification of possible "sensitive" periods where child development is more vulnerable. Further, the use of large population-level health and social datasets that include data on mother-child pairs from one year pre-birth up to the EDI assessment allows for the

study of a several key aspects of maternal Mood/Anxiety – timing, recurrence/persistence and severity. Despite very few studies using structural equation modeling to examine the influence of maternal mood on child development – and none to date that have looked at these relationships in an in-depth way using administrative data from a variety of population-based health and social datasets – the findings from this study are consistent with other research. In particular, exposure to prenatal and/or recurrent/persistent Mood/Anxiety seem to have a stronger negative association with child development on several domains of early development than other time periods or aspects of maternal Mood/Anxiety (e.g., severity). Further, child social, emotional and physical development, as measured on the EDI, are particularly vulnerable to exposure to maternal mood and anxiety disorders over early childhood, and especially for the prenatal period and recurrent Mood/Anxiety. However, the associations between maternal Mood/Anxiety and EDI outcomes in this study were modest. The strongest associations in the models were for the relationship between the family environment – socio-economic status, mother's marital status and age of mother at first birth – and child outcomes on the EDI. This finding suggests that the family context has a much stronger influence on child outcomes at school entry than treatment prevalence of maternal Mood/Anxiety, and a number of studies support this finding. The significant indirect effect of Mood/Anxiety in most of the models confirms that the family environment partially mediates – or accounts for – the relationship between maternal Mood/Anxiety and child EDI scores. A third latent variable in the models – Health at Birth – had a significant direct association with Mood/Anxiety in some of the models but not others. Further, the influence of health status at birth in this study on child outcomes was mediated through Mood/Anxiety and Family Context. As stated earlier, not all children exposed to maternal depression or anxiety will be negatively affected. Maternal caregiving, father involvement and the environment in which the child is raised can mitigate the negative effects of Mood/Anxiety on child development.

As shown in Chapter 2, school readiness in children has important implications for later learning and health and social outcomes. The next chapter discusses the policy and program implications of this study and implications for further research.

Chapter 6: Implications

6.1 Introduction

This study examined the relationship between treated maternal mood and anxiety disorders and child outcomes as measured on the EDI, controlling for related socio-demographic variables. Prenatal and recurrent/persistent exposure to Mood/Anxiety stood out as more influential on EDI outcomes than exposure during other developmental periods or exposure that occurred during a single period. Further, Mood/Anxiety had a stronger influence on the Social, Emotional and Physical Health domains than on the Language and Cognitive domain or Communication Skills domain. Infant health status at birth directly influenced EDI outcomes but had only a modest indirect effect on the outcomes through Mood/Anxiety and Family Context for a few models. Family environment factors – such as SES, mother's marital status and young mother at first birth – had a very strong influence on the child EDI scores, particularly for Language and Cognitive Development, and these family factors mediated the influence of Mood/Anxiety on child development. In other words, the relationship between maternal Mood/Anxiety and EDI scores is even greater when a family faces challenges. These findings suggest the following areas for support and intervention for mothers and children to address maternal mood and anxiety disorders and increase child school readiness at kindergarten:

1. Address maternal depression and anxiety, especially during the prenatal year and early in child-rearing;

2. Address supports for pregnant women to positively influence birth outcomes;

3. Due to the negative influence of poverty, early motherhood and lone parenthood, address the broader family context to positively influence child school readiness.

This chapter outlines these areas of intervention and support and also implications for future research.

6.2 Address Maternal Mood/Anxiety in the Prenatal and Early Childhood Periods

This study found that prenatal Mood/Anxiety in mothers is associated with poor birth outcomes and lower EDI scores on all five domains. In addition, maternal Mood/Anxiety in each of the time periods from prenatal to school entry and for severity of mood (for the overall study period) is associated with lower EDI scores on child social, emotional and physical development. Recurrent/persistent maternal mood over the study period was associated with lower EDI scores on all five domains, though most notably for child social, emotional and physical development. There are several implications for these findings.

The Prenatal period appears to be a sensitive period in terms of the relationship between maternal Mood/Anxiety and child outcomes on the EDI. Given the potential for maternal mood and anxiety disorders in the prenatal period to influence the developing stress response of the fetus[4] as well as mother-infant bonding[102] and later child development,[9, 13] screening for depression and anxiety should be implemented as part of routine prenatal care. Unfortunately, this is often not the case as clinicians do not generally address maternal depression and anxiety at prenatal visits.[253] A review of studies by the American College of Obstetricians and Gynecologists found that only 20% of the ob-gyns routinely screened for anxiety. Barriers to screening were time constraints and perceived lack of training.[254] In addition, some providers have ethical concerns that mothers may find questions intrusive or stigmatizing.[255] Further, even where screening occurs, identification of mental illnesses is low. As few as one-quarter of screened cases of maternal mood disorders are detected by providers of prenatal care.[256] As shown in the literature review, the broader spectrum of maternal mood can also impact birth outcomes. As O'Connor et al.[116] suggest, much of the conversation around treatment of maternal prenatal mood is focused on depression. They contend that the influence of maternal prenatal mood extends beyond depression to include stress and distress and that attention on addressing prenatal mood should be broadened.

An ongoing debate in the literature is whether depression during pregnancy should be treated with antidepressants. Given the impact of prenatal depression on the developing fetus,[16, 66, 257] some argue that the risks of untreated depression may outweigh the benefits (i.e., reduced exposure to medication in utero).[28, 258] A review of the effects of antidepressant use during pregnancy concluded that while most antidepressants do not pose a major teratogenic risk, data are: varied by type of drug; limited for newer drugs; inconsistent with respect to the risk of cardiovascular malformations; controversial regarding the risks of prematurity and low birth weight; and information on the long-term effects is too limited to determine risk.[259] However, as the course of depression is quite varied,[36] others suggest that screening should be a routine part of prenatal care and treatment with antidepressants should be made on a case-by-case basis.[75]

In their review of interventions for depression, anxiety, stress and distress in pregnancy, O'Connor et al.[116] found a wealth of literature on non-medical interventions. They note that a limitation of reviews focused on treatment of prenatal mood is that they are heavily focused on medication and suggest that the neglect of behavioural interventions is detrimental as medication may be only suitable for particular groups. Non-medical interventions may either be more favoured by pregnant women or by those working with them in settings of primary and preventive care; however, more research is needed to determine this. Inter-personal psychotherapy[260] has been found to be effective in reducing depression in pregnant women and a randomized controlled trial (RCT) of cognitive behavioural therapy in pregnancy is underway.[261] An RCT that looked at applied relaxation in pregnancy found that levels of perceived stress were reduced and sense of control increased following relaxation techniques. Given that maternal stress, depression and anxiety can negatively influence fetal development, such interventions may be cost-effective, non-pharmaceutical options which can improve birth outcomes and later child development. Another RCT[262] that examined the role of prenatal yoga in reducing maternal

anxiety found that an 8-week course of yoga significantly reduced anxiety as well as depressive symptoms in pregnant women.

As shown in the literature review (Chapter 2), the effects of prenatal exposure to maternal mood disorders may be mitigated by the postnatal environment.[64] In turn, as prenatal mood is the strongest predictor of postnatal mood,[4] prenatal interventions may be one of the most effective means to prevent postpartum mood disorders.[116] Although postnatal Mood/Anxiety was moderately associated with child EDI outcomes in this study, the postnatal period has been identified as sensitive in other studies, particularly those that assessed maternal symptoms of depression or anxiety. In addition to prenatal screening for mental health and providing supports, which may prevent postnatal mood disorders, the early postnatal period is another optimum time to screen for depression and anxiety in the primary care setting. Pharmacological interventions have been utilized to prevent postnatal depression. Two randomized clinical trials investigated the use of prophylactic antidepressants in the postnatal period for women with a history of depression. While tricyclic medication was not effective,[263] a selective serotonin reuptake inhibitor (SSRI) started soon after delivery did reduce the risk of recurrence.[264]

Non-pharmacological interventions have also been found to be effective in the postnatal and early childhood periods. A Cochrane Collaboration systematic review of 10 trials (RCT and quasi-experimental) examining the effectiveness of psychological and psycho-social interventions for postnatal depression found that peer support, non-directive counselling, cognitive behavioural therapy, psychodynamic psychotherapy and interpersonal therapy are all effective treatments, though long-term effectiveness is unknown.[265] Another Cochrane review[266] examined 20 studies of parenting programs and found such interventions can make a significant impact on mothers' short-term psychosocial health. However, long-term effectiveness was also unclear. A pilot[267] of a short-term home-based depressive symptom intervention for mothers in Early Head Start programs (n=16) randomly assigned women to

either the intervention or to usual care/intervention wait list. For the intervention group, master's-prepared mental health nurses conducted eight home visits over an 8-10 week period. Strategies for managing depressive symptoms included addressing problematic life issues, increasing access to social support and parenting effectively while symptomatic. Symptom assessment using the CES-D and one-hour mother-child observations were conducted at baseline, 8 weeks and 16 weeks. The intervention group showed a significant reduction in depressive symptoms that was maintained over the four-month period. The authors reported that despite the small sample size, repeated measures allowed for the detection of statistically significant differences. Feedback from participants on the home visiting model by professional nurses, including the flexibility and sensitivity of the intervention, was positive. Nylen et al.[268] reviewed treatment-outcome studies for maternal depression and concluded that mother-infant psychotherapies and home-based interventions are effective approaches to reducing the impact of depression on children. The authors state that while more research is needed into the specific mechanisms of protective effects and whether benefits are maintained over time, treatment approaches that include both mothers and infants and their relationship are likely to be most efficacious. Programs targeting parenting practices of depressed mothers have been found to increase children's cognitive competence during early childhood.[13]

Psychotherapy for depressed mothers has been shown to benefit toddlers' cognitive development. In an evaluation of the efficacy of Toddler-Parent Psychotherapy (TPP), mothers with major depressive disorder (MDD) were assigned to the intervention (n=43), a non-intervention group (n=54) and compared to a non-depressed control group (n=61). While groups did not differ on child Bayley Mental Development Index scores at baseline (20 months), a relative decline in IQ was found for the children of the depressed non-intervention group at post-intervention follow-up (age 3 years). Child IQ scores for the depressed intervention and control groups remained equivalent. Non-intervention children whose mothers had subsequent depressive episodes experienced the poorest outcome.[269]

Evidence has shown that interventions need not focus on addressing maternal mood and anxiety disorders exclusively to achieve improved outcomes for children. Bigatti et al.[92] evaluated the Producing Infant/Mother Ethnic Readers (PRIMER) program – a community-based literacy program for low-income families – and results showed that, despite depressed mothers being less skilled in their behaviours to promote child literacy before the intervention, both depressed and non-depressed mothers showed equivalent gains in their literacy behaviours and their children's cognitive test scores. They suggest this is encouraging from a policy perspective as it implies that depression does not decrease the success of intervention programs designed to improve parent-child interactions.

Continued supports for mothers with severe or recurrent/persistent depression or anxiety have been shown to improve outcomes for children. In the Sequenced Treatment Alternatives to Relieve Depression (STAR*D) program, study participants were initially treated with an antidepressant (citalopram). Participants whose depression did not remit or who were intolerant of citalopram were offered other treatments, including antidepressants, cognitive behavioral therapy, or a combination of treatments.[270] An evaluation[270] of the program found that maternal depression severity and child psychiatric symptoms decreased over the one-year study period; decreases in child symptoms were associated with decreases in maternal symptom severity. The authors reported a statistically significant decrease in child psychiatric symptoms for children whose mothers' symptoms remitted earlier in the one-year intervention (less than three months into the intervention), but not for those children whose mothers did not remit. The study concluded that continued efforts to treat maternal depression until symptoms remit is associated with decreased symptoms in mothers and improved functioning in children (ages 7-17).

Given the evidence in the literature that maternal sensitivity may be a mechanism through which maternal depression and anxiety influence child outcomes, interventions to support maternal sensitivity

could be a gateway to reducing the influence of maternal depression and anxiety on child school readiness. A study by the NICHD Early Child Care Research Network[101] examined the impact of maternal depression on maternal sensitivity toward their infants, mother-child interaction and child outcomes at 36 months. The study concluded that maternal sensitivity mediated (or accounted for) differences in child school readiness and verbal comprehension and, for expressive language and cooperation, outcomes were better among children whose mothers were depressed. As the authors note, these findings suggest that interventions for depressed mothers with young children may benefit from focusing on maternal sensitivity and quality of mother-child interaction, rather than depression alone.

Benefits of an intervention may simply be delayed. While an initial evaluation of Early Head Start found positive outcomes for three-year old children and families, no impact was found on maternal depression.[271] However, a follow-up study when the children were entering kindergarten found that program outcomes at child age three mediated a later modest (effect size = 0.10) reduction in maternal depression two years later. Specifically, a combination of the most promising child factors (including children's vocabulary and cognitive abilities) accounted for 57% of the later impact and the most promising parent factors accounted for over 35%.[48]

As this study found, exposure to maternal Mood/Anxiety – most notably Prenatal and recurrent/persistent exposure – has a negative relationship with child development in kindergarten. The studies above have shown the range of interventions that can reduce maternal depression and anxiety and, as a result, improve outcomes for children. However, as noted above, pharmacological interventions may not be suitable for some women. In addition, access to more intensive services such as psychotherapy may be limited by lack of availability, finances and time due to the demands of motherhood. As Knitzer et al.[246] suggest, embedding interventions to prevent or reduce maternal depression and its effects on children into early childhood programs is a potentially powerful, but

underutilized strategy (see 6.4 below for examples). Further, and related to the finding in this study of a sensitive Prenatal period, community interventions that can have a positive impact on parental mental health and the home environment should be started prenatally rather than postnatally, and should provide support to families at least on a weekly basis.[41] This study also found a slightly more negative relationship between exposure to maternal Mood/Anxiety and child outcomes for children in low-mid SES homes. A potential implication of this is that investments should prioritize mothers and children in situations of socioeconomic disadvantage.[155]

6.3 Address Factors to Support Healthy Birth Outcomes

This study found that poor health status at birth – low birth weight, preterm birth, NICU stay and long birth hospitalization – was significantly associated with lower scores on all five EDI domains in kindergarten. Not surprisingly, child physical development was most strongly influenced by these birth measures. The implication of these findings is that measures to improve birth outcomes may improve school readiness and later health and social outcomes. For example, public health interventions such as encouraging prenatal flu vaccine may reduce miscarriage and being born preterm or small for gestational age. [116] In addition, early and consistent prenatal care has been linked to better birth outcomes.[272]

Programs that support vulnerable pregnant women are one method of supporting improved birth outcomes. In Manitoba, the Healthy Child Manitoba Office (HCMO) delivers and evaluates the Healthy Baby program. This two-part initiative was introduced in 2001 and includes the Manitoba Prenatal Benefit and Community Support Programs. The Prenatal Benefit provides monthly financial assistance (up to $81.41) for pregnant women with a family income below $32,000 per year. The Community Support Programs promote healthy pregnancy and improved birth and infant outcomes through social

support, encouraging early and consistent prenatal care, parenting education, promotion of healthy diet, lifestyle and breastfeeding and education on fetal and infant development.[273] An evaluation of the program found that receipt of the Prenatal Benefit was associated with reduced preterm and low birth weight births and participation in the Community Support Programs was associated with increased adequate prenatal care.[274, 275] The Canada Prenatal Nutrition Program (CPNP) provides long-term funding to community groups to support healthy pregnancy and birth outcomes for women facing conditions of risk (e.g., low income, teen pregnancy, social and geographic isolation, substance abuse and family violence). Services include support and education on nutrition, healthy lifestyle, infant development, breastfeeding and food preparation and the provision of prenatal vitamins, food and coupons.[276] An evaluation of the program found improved outcomes for vulnerable women and their infants in the areas of improved health practices, reduced low birth weight, increased breastfeeding initiation, increased social support and significant cost savings estimated at $1.6M annually.[277]

6.4 Address Family Context to Support Early Childhood Development and School Readiness

This study found that family environment factors such as SES, young maternal age and marital status were the largest predictors of child EDI scores on the five domains of school readiness, particularly for child language and cognitive abilities. Implications of this finding are that supports should be available to address these factors to better prepare children for school. SES-related conditions such as high school education, low income, unemployment, lone parenting and early parenting can be addressed through various program and policy initiatives. Further, such interventions may be especially beneficial for families where the mother has experienced depression or anxiety. Jensen et al.[10] found that the inter-relations of maternal depression, contextual risk and interpersonal stress negatively impact on child cognitive and social development and, therefore, assisting mothers faced with high-risk

environments to manage interpersonal stress may benefit the child by mitigating the effects of exposure to depression and contextual risks.

A study by Stroick and Jenson[278] for the Canadian Policy Research Networks (CPRN) identified three key "enabling" conditions needed for child well-being: (1) adequate income; (2) effective parenting; and (3) supportive community environments. Specifically, adequate income includes earned income, social assistance and maintenance payments from non-custodial parents as well as affordable accessible child care and tax incentives for families with dependent children. Effective parenting includes supports for family-friendly workplaces, flexible work hours, maternity and parental benefits and child care. In addition, programs that support parenting are part of this effort and are closely tied to the third condition, supportive community environments. These include available resources to support infant and child health and development and cultural and recreation opportunities with the policy support of communities, community groups, employers and governments.

Canada provides various forms of income assistance to its citizens including employment insurance and tax credits.[279] Social assistance is administered by provincial and territorial governments and provides a basic living allowance to individuals and families in financial need.[280] There are several benefits specific to families with children. Canada's National Child Benefit program is a partnership between the federal, provincial and territorial governments to assist low income families with children under 18 years. The Canada Child Tax Benefit (CCTB) provides a monthly income-tested amount to low- and middle-income families. The National Child Benefit Supplement (NCBS) is included in the monthly CCTB benefit as a top-up for low income families.[281] The Universal Child Care Benefit (UCCB) is a taxable benefit that provides a $100 monthly payment to eligible families with children under six years to assist with child care.[281]

Between 1974 and 1978, a guaranteed income experiment by the governments of Manitoba and Canada allocated a guaranteed minimum income, or "mincome" to residents of Dauphin, Manitoba and a sample of residents in Winnipeg. The goal of the project was to examine impacts on the labour market. Research conducted by Dr. Evelyn Forget[282] utilized administrative data in the MCHP Repository and a quasi-experimental design with a matched sample and propensity score matching to determine whether health and social outcomes differed for those who participated in the program in Dauphin (30% of the population). For participants, the study found that hospitalizations in Dauphin – particularly for accidents, injuries and mental health – decreased compared to controls and there was a significant reduction in physician visits, particularly for mental health diagnoses. No effects were found for birth outcomes, birth rates or divorce rates. However, children stayed in school longer, had their first child later and had fewer children over their lifetime compared to controls. The results suggest that a modest guaranteed income can improve population health, generating health care system savings.

There is evidence to suggest that income supports for low income families with young children may provide benefits in terms of a reduced stress response in children. A quasi-experimental study (n=1197) in Mexico[283] found that children from low-income families who participated in a conditional cash transfer program over a 3.5 year period had lower salivary cortisol than children whose families did not participate in the program. Further, maternal depression was a moderator of the relationship between program participation and salivary cortisol; specifically, a greater effect of the program was found where maternal depression symptoms were more severe. The authors suggest that the findings are strong evidence that socio-economic conditions can influence child stress response and this is a potential mechanism through which later physical and mental health problems may develop.

For early parenting, a range of support services in Manitoba are working toward prevention. Healthy Child Manitoba offers services to discourage teen parenting, including the Teen Talk Program and Teen

Clinics. Teen Talk offers education and support on reproductive health, mental health, sexuality, substance abuse and violence prevention to adolescents in Manitoba. Sixteen teen clinics offer primary care services for adolescents in the province from a community-based, youth-centred perspective.[284] Initiatives in schools such as the Baby Think it Over program delivered by Futures in Thompson, Manitoba may reduce early parenthood. Funded by the federal Community Action Program for Children (CAPC), programs such as this are delivered in communities across Canada with the goal of reducing unwanted pregnancy and sexually transmitted diseases.[285] The Towards Flourishing Mental Health Promotion Strategy, a partnership between Healthy Child Manitoba and the Winnipeg Regional Health Authority (WRHA) with funding from the Public Health Agency of Canada, provides mental health supports to families through the Families First Home Visiting Program.[lvii] Components of the Strategy include: Education for families; enhancing access and collaboration; mental health promotion facilitation; screening; training; and everyday strategies for mental health. In addition, the Strategy employs a cultural sensitivity lens and a rigorous evaluation of pilot sites is currently underway.[286]

Services such as those described above are examples of positive efforts to address key areas of the familial and social environment that influence child outcomes, as identified in this study. Further, as the literature above shows, there is supporting evidence that such interventions improve outcomes for children and families and are important areas of investment from a policy perspective.

[lvii] Data from the Families First evaluation found that 12-15% of Manitoba women screened using the Families First Screening Form showed signs of depression or anxiety; the Strategy evolved as a result of these data and the WRHA Perinatal Mental Health Project.[289]

6.5 Implications for Future Research

The findings of this study have implications for future research examining the relationship between maternal mood and anxiety disorders and child development outcomes at school entry. This study examined several time periods and aspects of maternal Mood/Anxiety in a large sample of diverse mothers in Manitoba. The use of a latent construct for maternal Mood/Anxiety that combined continuous counts of the number of physician visits and filled prescriptions is a unique way of measuring maternal mood and anxiety disorders. This measure was sensitive enough to detect differences in child EDI scores following exposure to maternal Mood/Anxiety at different time periods and for recurrence and severity. Future research using administrative data could explore other possible definitions of Mood/Anxiety using administrative data. In addition, future research could benefit from taking this analysis a step further and utilizing latent class analysis to determine if different groups, or classes of mothers – based on timing, severity or persistence/recurrence – are associated with differential outcomes for children. Large samples, such as those based on administrative datasets, are well-suited for such sophisticated analyses that could provide more detail on sub-groups, or classes, of women with Mood/Anxiety and how outcomes for their children may differ.

Given the importance of the timing of exposure to maternal mood and anxiety disorders and sensitive periods of child development, time-lag studies which control for a specific timing effect would further strengthen the evidence base by identifying sensitive periods of child development *independent of other time periods*.

Related to sensitive periods of child development, further research on the specific mechanisms through which maternal mood and anxiety disorders influences outcomes is important to identify which particular pathways may lead to outcomes on specific domains and to inform interventions. In particular, measurement of biological or epigenetic markers in the prenatal period may help identify

mechanisms at work in the prenatal period. Further, analysis that includes measurement of maternal sensitivity and mother-child interactions, over time, could possibly shed light on what mechanisms are operating between mood and anxiety disorders at different periods over early childhood and for the stronger influence of chronic mood and anxiety disorders. As Glover[26] notes, prospective research that includes as many control variables as possible may help isolate mechanisms of transmission.

In addition, including bi-directional relationships between maternal mood and child temperament and behaviour should also be considered in future research. These mutual influences have been found in other research[20] and, while complex, their inclusion in future studies would add more explanatory power to the relationship between maternal mood and anxiety disorders and child outcomes. This study was unable to measure child temperament as this information is not available in the administrative datasets. In addition, research that distinguishes between maternal depression, anxiety, stress and distress may help inform specific pathways as these conditions have been shown to differentially affect child development. In this study, maternal Mood/Anxiety was measured using a combination of diagnoses and filled prescriptions for depression, anxiety and related conditions. As described earlier, physician visit ICD-9 codes do not always distinguish between mental health conditions and medications for mood disorders are often prescribed for a variety of conditions. These limitations inhibit the ability to adequately distinguish between depression, anxiety and stress using administrative data.

Evaluation of interventions – including clinical, programs and policies – would inform further design and implementation of such initiatives and determine whether outcomes are achieved. Such evidence would contribute to higher quality initiatives to address maternal mood and anxiety disorders and child school readiness. Lastly, assessment of outcomes beyond the school entry period would demonstrate

long-term effects of early childhood exposure to maternal mood as well as potential mediating and moderating factors along the pathway over time.

6.6 Conclusion

The findings from this study have implications in the clinical, program and policy arenas, as described in this chapter. Interventions and supports for mothers with mood and anxiety disorders should begin in the prenatal period and continue into the postnatal period and beyond to strengthen the mother-child relationship and to provide program and policy supports for both low income families and others vulnerable at school entry. As this study found, five key domains of school readiness, as measured by the EDI, are influenced by maternal mood and anxiety disorders and, to a much larger degree, by the family/socio-economic environment. In particular, as this study found, interventions should support child social, emotional and physical development. Future research, as described, can further strengthen this evidence base.

Evidence has shown that the benefits of early intervention far outweigh the initial cost investment.[171] In addition, while higher quality, more intensive interventions are costly, so is the lifelong impact of not being ready to take on the challenges of school.[287] A combination of policies to support mothers and families and evidence-based quality early childhood interventions can contribute to improved school readiness and later health and social outcomes. The strong association found in this study (and in the literature) between maternal Mood/Anxiety and other familial and social factors suggests that intervening in those areas – most notably with more vulnerable families – will have a positive impact on school readiness.

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Appendix 1: MCHP Pledge of Privacy

MCHP Pledge of Privacy

The Manitoba Centre for Health policy strictly adheres to its Privacy Code and Principles. In fact, we've taken them further, with our own Pledge of Privacy. Our top priority is to respect the privacy of user and providers of the health care system, and furthermore, to protect data against loss, destruction or unauthorized use.

We promise to:

Respect Privacy: MCHP, through the University of Manitoba, is a public trustee of sensitive de-identified information. We are bound by legislation, professional ethical standards and moral responsibility to never share, sell or under any circumstance or use the data for purposes other than approved research. We ensure that all data under our management are anonymized and that their use adheres to strict procedures, practices and policies.

Safeguard Confidentiality: We respect the confidentiality of sensitive and private information. All staff and collaborating researchers must sign an oath of confidentiality; anyone who breeches this oath faces immediate loss of access to data and possible dismissal. All records are anonymized before we receive them. Before findings are released, all MCHP publications are reviewed by Manitoba Health, Healthy Living and Seniors and/or appropriate data providing agencies and our own management to further ensure individual privacy.

Provide Security: The environment in which research is conducted is tightly controlled. We restrict access to our workplace with additional levels of security for access to data spaces. The security of data is further protected through state-of-the-art technology including but not limited to firewalls, encryption, password access and monitoring of users. The databases are housed on computers that are isolated to prevent access by unauthorized persons.

Appendix 2: Literature Table

Table A2.1: Matrix of Findings in Literature – Impact of Aspects of Maternal Depression/Anxiety on Domains* of School Readiness†

Domain of School Readiness	Physical Health and Wellbeing	Social Competence‡	Emotional Maturity‡	Language and Cognitive Development
Aspect of Maternal Depression				
Prenatal Exposure	Raposa et al. (2014)	Guevremont et al. (2007) – ADHD; Luoma et al. (2001)[∞]; Barker et al. (2011); Leis et al. (2014); O'Connor et al. (2002); Jensen et al. (2013)[∞]; O'Donnell et al. (2014); Huot et al. (2004)	Guevremont et al. (2007) – ADHD; Luoma et al. (2001)[∞]; Barker et al. (2011); Leis et al. (2014); O'Connor et al. (2002); Jensen et al. (2013)[∞]; O'Donnell et al. (2014); Huot et al. (2004)	Lewinn et al. (2009)[∞]; Barker et al. (2011); Laplante et al. (2008); Jensen et al. (2013)[∞]
Postnatal Exposure	Cogill et al. (1986) and reanalysis by Hay & Kumar (1995) – sensorimotor	Sinclair & Murray (1998); Essex et al. (2001); O'Connor et al. (2002); Murray et al. (1999); Alpern & Lyons-Ruth (1993); Luoma et al. (2001)∞; Essex et al. (2001); Guevremont et al. (2007) - ADHD; Fihrer et al. (2009)[∞]; Bagner et al. (2010)[∞]; Jensen et al. (2013); Bureau et al. (2009)[∞]; O'Donnell et al. (2014)[∞]	Sinclair & Murray (1998); Essex et al. (2001); O'Connor et al. (2002); Murray et al. (1999); Alpern & Lyons-Ruth (1993); Luoma et al. (2001)[∞]; Essex et al. (2001); Guevremont et al. (2007) - ADHD; Fihrer et al. (2009)[∞]; Bagner et al. (2010)[∞] ; Jensen et al. (2013);Bureau et al. (2009)[∞]; O'Donnell et al. (2014)[∞]	Cogill et al. (1986) and re-analysis by Hay & Kumar (1995); Sharp et al. (1995) – boys; Stein et al. (2008); Jensen et al. (2013); Kurstens & Wolke (2001)
Exposure through Toddlerhood	Petterson & Albers (2001) – motor skills	Guevremont et al. (2007) – ADHD; Essex et al. (2001) – girls; Lyons-Ruth et al. (1993)[∞]; Leckman-Westin et al. (2009); Letourneau et al. (2013); Barker et al. (2011)[a]; Jensen et al. (2013)	Guevremont et al. (2007) – ADHD; Essex et al. (2001) – girls; Lyons-Ruth et al. (1993)[∞]; Leckman-Westin et al. (2009); Letourneau et al. (2013); Barker et al. (2011); Jensen et al. (2013)	Letourneau et al. (2013); Barker et al. (2011)
Exposure at School Entry		Sinclair & Murray (1998); Murray et al. (2001); Guevremont et al. (2007) – ADHD; Kim-Cohen et al. (2006) – ASB; Alpern & Lyons-Ruth (1993); Luoma et al. (2001)[∞]; Fihrer et al. (2009)[∞]; Turney et al. (2011)	Sinclair & Murray (1998); Murray et al. (2001); Guevremont et al. (2007) – ADHD; Kim-Cohen et al. (2006) – ASB; Alpern & Lyons-Ruth (1993); Luoma et al. (2001)[∞]; Fihrer et al. (2009)[∞]; Turney et al. (2011)	

* Studies did not explicitly study outcomes related to the Communication Skills and General Knowledge domain (EDI), so it is excluded from this table.

† For this table, only studies that examined outcomes for children ages 4 and older are included.

‡ Studies that examined "child behaviour" are included under both the Social Competence and Emotional Maturity domains.

[∞] Child outcomes for these studies were assessed at ages above school entry (e.g., 6-7 years and older).

[a] The authors assessed postnatal depression and anxiety at child age 1.5 years; for the purposes of this thesis research, this is defined as "toddler" exposure.

Table A2.1: Matrix of Findings in Literature – Impact of Aspects of Maternal Depression/Anxiety on Domains* of School Readiness†

Domain of School Readiness	Physical Health and Wellbeing	Social Competence‡	Emotional Maturity‡	Language and Cognitive Development
Timing[b]		Alpern & Lyons-Ruth (1993); Luoma et al. (2001)[∞] ; Brennan et al. (2000); Hammen & Brennan (2003); Essex et al. (2001); Fihrer et al. (2009)[∞]; Guevremont et al. (2007); Barker (2013); Kim-Cohen et al. (2006) – ASB; Letourneau et al. (2013); Turney et al. 2011);	Alpern & Lyons-Ruth (1993); Luoma et al. (2001)[∞]; Brennan et al. (2000); Hammen & Brennan (2003); Essex et al. (2001); Fihrer et al. (2009)[∞]; Guevremont et al. (2007); Barker (2013); Kim-Cohen et al. (2006) – ASB; Letourneau et al. (2013); Turney et al. (2011);	
Persistence/Recurrence	Timko et al. (2002); Billings & Moos (1986)[∞]; Raposa et al. (2009); Petterson & Albers (2001) – boys' motor; Kozyrskyj et al. (2008) - asthma	NICHD (1999); Keller et al. (1986)[∞]; Timko et al. (2002); Guevremont et al. (2007) – ADHD; Sameroff et al. (1987); Brennan et al. (2000); Hammen & Brennan (2003)[∞]; Billings & Moos (1986)[∞]; Alpern & Lyons-Ruth (1993); Kim-Cohen et al. (2006) – ASB; Turney (2011); Fihrer et al. (2009)[∞]; Luoma et al. (2001)[∞]; Letourneau et al. (2013)	NICHD (1999); Keller et al. (1986)[∞]; Timko et al. (2002); Guevremont et al. (2007) – ADHD; Sameroff et al. (1987); Brennan et al. (2000); Hammen & Brennan (2003)[∞]; Billings & Moos (1986)[∞]; Alpern & Lyons-Ruth (1993); Kim-Cohen et al. (2006) – ASB; Turney (2011); Fihrer et al. (2009)[∞]; Luoma et al. (2001)[∞]; Letourneau et al. (2013)	NICHD (1999); Sameroff et al. (1987); Brennan et al. (2000); Kurstjens & Wolke (2001) – for neonatal risk and low SES boys; Petterson & Albers (2001); Billings & Moos (1986)[∞]; Timko et al. (2002) – 'academic'; Turney (2011); Letourneau et al. (2013)
Severity	Billings & Moos (1986)[∞]; Petterson & Albers (2001) - boys	Billings & Moos (1986)[∞]; Harder et al. (1980)[∞]; Keller et al. (1986)[∞]; Sameroff et al. (1987); Brennan et al. (2000); Hammen & Brennan (2003)[∞]; Campbell et al. (2007); Fihrer et al. (2009)[∞]; Petterson & Albers (2001) - boys	Billings & Moos (1986)[∞]; Harder et al. (1980)[∞]; Keller et al. (1986)[∞]; Sameroff et al. (1987); Brennan et al. (2000); Hammen & Brennan (2003)[∞]; Campbell et al. (2007); Fihrer et al. (2009)[∞]; Petterson & Albers (2001) - boys	Harder et al. (1980)[∞]; Sameroff et al. (1987); Brennan et al. (2000); Campbell et al. (2007); Petterson & Albers (2001) - boys

[b] Exposure periods and "timing" usually overlap but these studies looked explicitly at "timing" as a variable of study.

Appendix 3: Background to Modeling and Excluded Variables

APPENDIX 3: Background to Modeling and Excluded Variables

Once latent construct modeling was complete, the relationships among the latent constructs, control variables and the outcome variables were tested using full structural models. Initially, models were run with just the Mood/Anxiety and Health at Birth constructs and other latent constructs were then added in. Early full models included four latent constructs: Mood/Anxiety; Health at Birth; Family Functioning; and Socio-Economic Status (SES). Mood/Anxiety included[lviii] the following manifest variables: number of antidepressant prescriptions; > 1.0 defined daily dose (DDD) of antidepressants; number of sedative/hypnotic prescriptions; number of antipsychotic prescriptions; number of mood/anxiety physician visits; and number of mood/anxiety hospitalizations. Health at Birth included[lix] the same variables as the final model: preterm; low birth weight; NICU stay; and long birth hospitalization. The Family Functioning construct included:[lx] receipt of child and family services (CFS); mother's marital status; and number of siblings. The SES latent construct included:[lxi] SEFI2 score; receipt of income assistance; and young mother (< 20 yrs) at first birth.

In the models that included both the Family Functioning and SES latent constructs, the fit statistics were not adequate (greater than 0.90 for CFI and NNFI and less than 0.06 for RMSEA). As described in Chapter 3 (Methods), fit statistics are an indicator of how well the model describes the relationships

[lviii] As described in Chapter 3 (Methods), the number of mood stabilizer prescriptions did not load above the threshold for any of the time periods so was excluded from the Mood/Anxiety construct. The number of substance abuse physician visits was also considered but did not have a factor load above 0.30 so was excluded.

[lix] Five-minute Apgar score was considered in the latent models but did not have a factor load above 0.30 so was excluded.

[lx] As noted in Chapter 3 (Methods), variables from the Healthy Child Manitoba BabyFirst screen -- relationship distress, postpartum separation and lack of bonding at birth -- were considered for inclusion in the Family Functioning construct. While relationship distress did have a factor load above 0.30, inclusion of this variable would have required a 20% reduction in the study sample as only 80% of the mothers had a BabyFirst Screen. For this reason, the relationship distress variable was dropped.

[lxi] Mother's education (completed Grade 12) was available from the BabyFirst screen; however, as noted above, inclusion of this variable would require a loss of 20% of the study sample, so this variable was excluded. While an important measure of SES, the SEFI2 variable includes an area-level measure of less than high school completion and young mother is also a potential proxy for lower education level.

between variables and accepted standards in SEM are for models to meet or exceed the thresholds for each statistic. In addition, when all four latent constructs were included, the coefficient for the path between Mood/Anxiety and the outcomes was positive, rather than the expected negative value. What these values suggested was that for greater levels of Mood/Anxiety, the higher the child EDI scores. While unanticipated results can occur in statistical models, it is important to note that this reverse path only occurred when a particular variable was included in the model (see below). Further, as shown in Chapter 4 (Results), the crude models that included only the Mood/Anxiety construct and outcome variables showed a negative association between Mood/Anxiety and the EDI outcomes. After extensive modelling and sensitivity testing where variables were added and removed to detect which one(s) might account for this reversed path, it was determined that the income assistance variable had a strong effect on the models and seemed be the cause of the reversed Mood/Anxiety to outcome path. This was unexpected because the income assistance binary variable was included in the SES construct and, like the other manifest indicators in that construct (SEFI2 and young mother), there was a negative relationship with the outcomes. In addition, these three manifest indicators all had factor loads above 0.30 in the SES construct; however, the income assistance variable had strongest factor load of all three variables. When the income assistance variable was excluded from the SES construct, the coefficient for the path between Mood/Anxiety and the outcomes reversed back to negative. These patterns were consistent across all models. As a result, income assistance was removed from the SES construct.

Once income assistance was removed from the SES construct, only young mother and SEFI2 score remained in SES. Rather than keep this as a two-variable construct, these variables were combined with the Family Functioning variables – mother's marital status, receipt of CFS and number of siblings – to determine how they loaded together as one latent construct - renamed Family Context. All variables, with the exception of number of siblings, had a factor load at or above 0.30. The variables included in this amalgamated construct were: SEFI2 score, young mother, mother's marital status and receipt of CFS

services. While the binary variable for whether a family received Child and Family Services did have a factor load above the significance threshold in both the Family Functioning and the new Family Context constructs, it was determined mid-way through the modeling that only children[lxii] who were "in care"[lxiii] were included in that variable. Children in care are those who are removed from their family of origin and placed in the care of another adult who is not a parent or guardian, due to concerns about the well-being of the child. Since this variable was an indicator of a child not being consistently exposed to their mothers' depression or anxiety over the study period, it was determined that this variable should not be included in the model. The revised Family Context construct included the SEFI2 score, young mother and mother's marital status. After removal of the CFS variable, the remaining three variables fit well together in the construct (e.g., all had factor loads at or above 0.30) and the overall fit statistics of the model remained significant. Further, the coefficient for the path between Mood/Anxiety and the outcome variables was negative. This pattern was consistent across all models. While the CFS variable was excluded, the children in the study sample (n=18,331) who were in care (n=681, or 3.72%) were not excluded from the study. These children were exposed to their mother's depression or anxiety for at least the critical prenatal period. Further, sensitivity testing determined that model estimates were only slightly different when those children were removed, so the decision was made to keep them in the full sample.

To determine whether the income assistance variable would have the same effect on the models as described above when it was included in the SES latent construct, it was added to the new Family

[lxii] CFS services in the Child and Family Services Information System (CFSIS) database are linked to child personal health information number (PHIN).

[lxiii] Other CFS services include protective (mandatory) and support (voluntary) services and, in both cases, these are provided to families while the children remain in the home. The administrative data on these types of services are more unreliable so are rarely used in practice at MCHP for research purposes.

Context construct. As was previously the case, the addition of the income assistance variable dropped the model fit statistics and reversed the direction of the coefficient for the path from Mood/Anxiety to the outcomes from negative to positive. This pattern emerged across all models. Therefore, the income assistance variable was not included as part of the Family Context construct.

Further refinement of the models involved improving model fit by: a) including those manifest variables that loaded well together in the latent constructs and contributed to model fit and; b) excluding those that did not load well or reduced model fit. For example, in the Mood/Anxiety construct, the inclusion of the manifest variables for the number of antipsychotics and the number of mood/anxiety hospitalizations reduced the fit of the models. As a result, number of antipsychotics and number of mood/anxiety hospitalizations were removed from the Mood/Anxiety construct. The number of mothers with one or more of each of these indicators was considerably lower than for the other indicators in the Mood/Anxiety construct (see Table 4.1 in Chapter 4) and it is quite likely that mothers who had been hospitalized had at least one mood/anxiety visit or prescription for an antidepressant or sedative/hypnotic, so would already be captured in the latent construct. For the number of antipsychotic prescriptions, these are not typical medications prescribed for depression or anxiety and can be considered a possible indicator of illness severity (see below), so the exclusion of this variable from the Mood/Anxiety construct was not deemed to negatively impact the construct.

Variables that were unstable in the latent constructs (e.g., income assistance, as described above, number of mood hospitalizations, number of antipsychotic prescriptions) and some of the others that did not load at or above the significance threshold of 0.30 in the final latent models, (e.g., number of siblings, substance abuse, breastfed, urban, mother overall health and child overall health) were included as possible control variables (see Table A5.1, below). The continuous variables of number of siblings, number of mood/anxiety hospitalizations and number of antipsychotic prescriptions were

entered into the models as controls first as continuous variables to see their effect on the model (size of coefficient and model fit). These variables were then transformed into binary variables and entered into the model as binary controls. For number of siblings, the binary variable indicated whether a family had four or more siblings in addition to the EDI child, an indicator of a large family which has been found to be associated with poorer health and social outcomes. Control variables for the number of mood/anxiety hospitalizations and number of antipsychotic prescriptions were only entered into the models as binary variables. These binary variables indicated whether a mother had one or more of these over the study period and were possible indicators of illness severity. In addition, child age in months (continuous) and male child (binary) were also included as controls. Inclusion of numerous combinations of these control variables -- including entered one at a time and in combinations with each of the other controls -- resulted in mixed results; for the most part, variables were either not statistically significant and added nothing to the model (e.g., urban, breastfed) or, for the others, they were significant but dropped the overall fit of the model. In the end, inclusion of just two control variables – child age in months at the EDI and male child – were the strongest in the final models. See Table A5.1 (below) for a description of each excluded variable and reasons for exclusion.

As described in Chapter 4 (Results), the final models included the revised Mood/Anxiety construct as described above (number of antidepressant prescriptions, number of sedative/hypnotic prescriptions, binary variable for greater than 1.0 DDD antidepressants and number of mood/anxiety physician visits), the original Health at Birth construct (binary variables for preterm birth, low birth weight, NICU stay and long birth hospitalization) and the revised Family Context construct (SEFI2 score, young mother and mother's marital status), with child age in months and male child included as controls.

Table A5.1: Administrative Data Available for Consideration and Reasons for Exclusion

Data Source	Variable	Definition	Reason(s) for Exclusion
Manitoba Health Services Insurance Plan	Number of siblings	Number of children linked to mother (other than study child) at the start of each time period[vii] Binary variable of 4+ children linked to mother (other than study child) at the start of each time period	Inclusion in family latent construct did not load above threshold; inclusion of continuous or binary measure as control variable on the outcome reduced model fit
	Urban/Rural	Binary variable of whether or not mother resided in urban community at start of each time period	Inclusion in family latent construct did not load above threshold; inclusion as control variable on the outcome reduced model fit
	Apgar scores	Infant 5-minute post-birth Apgar score	Inclusion in the Health at Birth latent did not load above threshold
	Breastfed at birth	Binary variable of whether an infant was breastfed at birth in hospital	Inclusion as control variable on the outcome reduced model fit
Drug Data Support Files	Antipsychotics	Number of mothers' antipsychotic prescriptions for each time period Binary variable of one or more antipsychotic prescriptions for each time period (indicator of severity)	Inclusion in Mood/Anxiety latent construct did not load above threshold in all time periods and reduced model fit; inclusion of binary measure as control variable on the outcome reduced model fit
	Mood Stabilizers	Number of mothers' mood stabilizer prescriptions for each time period	Inclusion in Mood/Anxiety latent construct did not load above threshold
Medical Services (Physician Visits)	Substance abuse visits	Number of mothers' substance abuse physician visits for each time period	Inclusion in Mood/Anxiety latent construct was not significant in all time periods and reduced model fit; inclusion of binary measure as control variable on the outcome reduced model fit
Medical Services (Hospital Separation Abstracts)	Mood/anxiety hospitalizations	Number of mothers' mood/anxiety hosps for each time period Binary variable of one or	Inclusion in Mood/Anxiety latent construct did not load above threshold in all time periods and reduced

[vii] Prenatal year, Postnatal year, Toddler years, Year Before EDI and overall study period.

		more mood/anxiety hosps for each time period (indicator of severity)	model fit; inclusion of binary measure as control variable on the outcome reduced model fit
Adjusted Diagnostic Groupings (ADGs)[viii]	Mother's overall health	Binary variable of whether mother had 90%+ major and minor ADGs over study period	Inclusion of binary measure as control variable on the outcome reduced model fit
	Child's overall health	Binary variable of whether child had 2+ major ADGs over study period	Inclusion of binary measure as control variable on the outcome reduced model fit
Social Allowances Management Information Network (SAMIN)	Family received income assistance	Binary variable of whether mother received income assistance in one or more months in each time period	Inclusion in Family Context latent construct reversed estimate for Mood/Anxiety --> outcome path to positive; inclusion as control variable on the outcome reduced model fit
	Family received Child and Family Services (CFS) support	Binary variable of whether child was "in care" (removed from family of origin) during the study period	Since children were removed from the family of origin for some or all of the study period, their exposure to mother's mood/anxiety was potentially limited, so this variable was removed.
Healthy Child Manitoba BabyFirst Screen	Prolonged postpartum maternal separation	Binary variable of whether mother had prolonged separation from child after birth	Inclusion in Family Context latent construct did not load above threshold
	Assessed lack of bonding	Binary variable of whether mother had assessed lack of bonding with child after birth	Inclusion in Family Context latent construct did not load above threshold
	Relationship distress	Binary variable of whether mother had relationship distress at time of child's birth	Inclusion in Family Context latent construct would require dropping 20% of sample who did not have BabyFirst screen
	Maternal education	Binary variable of whether mother completed grade 12 education	Inclusion in Family Context latent construct would require dropping 20% of sample who did not have BabyFirst screen

[viii] Aggregated Diagnosis Groups (ADGs) are part of the The Johns Hopkins ACG(r) Case-Mix System that groups ICD-9 and ICD-10 diagnosis codes into 32 illness categories, including major and minor illness. (Johns Hopkins Bloomberg School of Public Health, Version 10)

Appendix 4: Model Diagrams

Figure A4.1: Path diagram for overall study period – Social Competence (n=18,331)

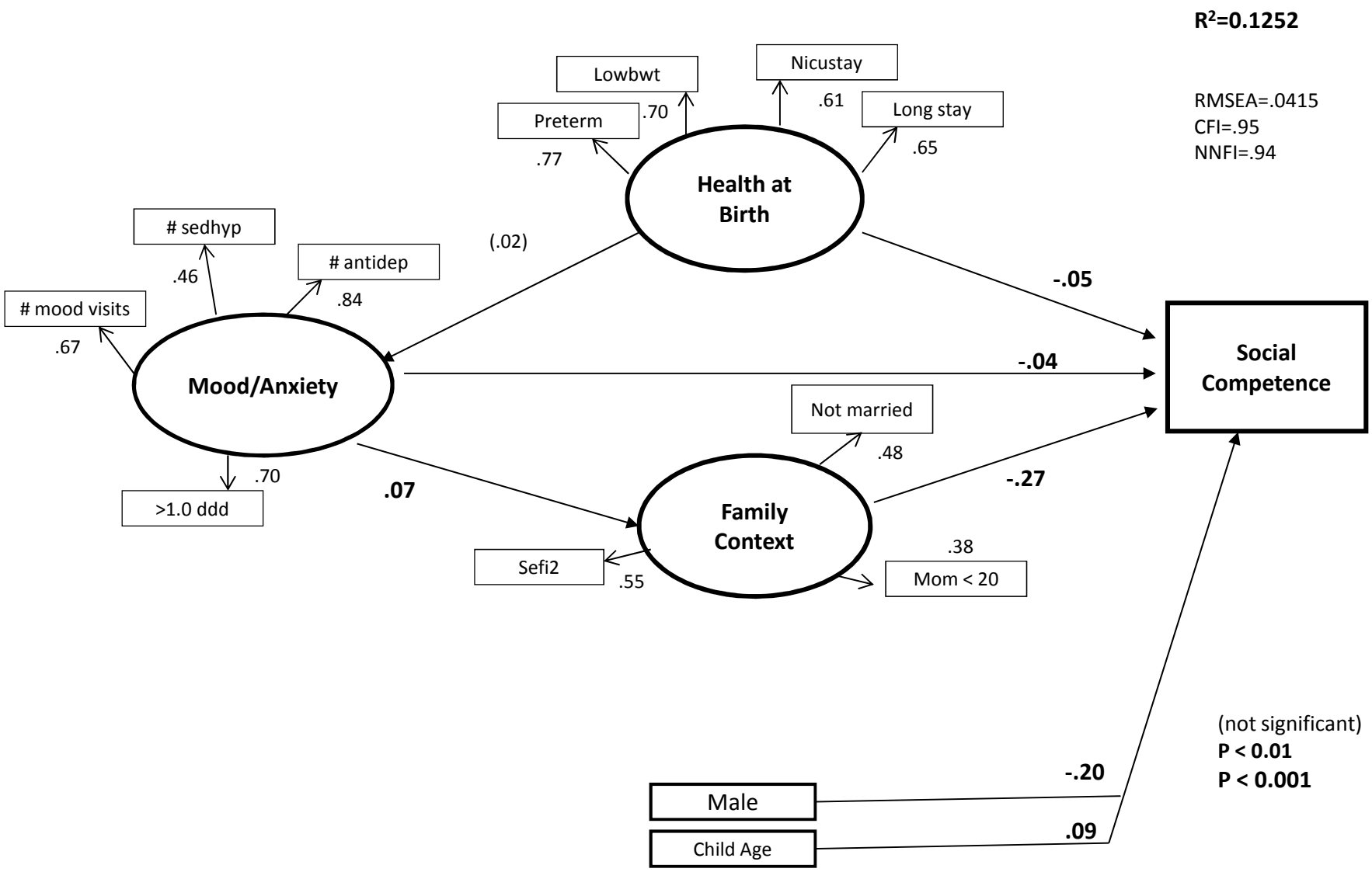

Figure A4.2: Path diagram for Prenatal period – Social Competence (n=18,331)

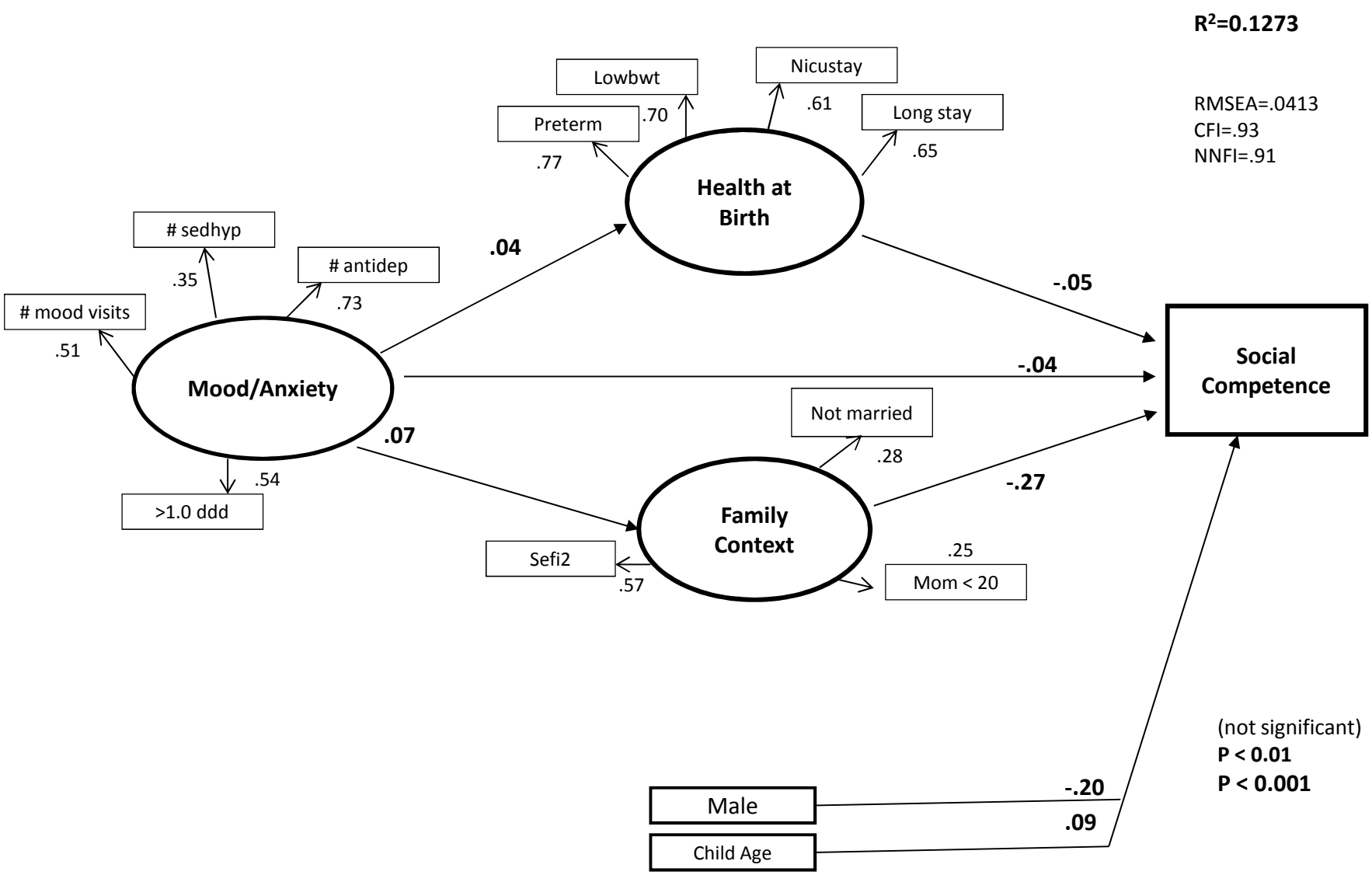

Figure A4.3: Path diagram for Postnatal period – Social Competence (n=18,331)

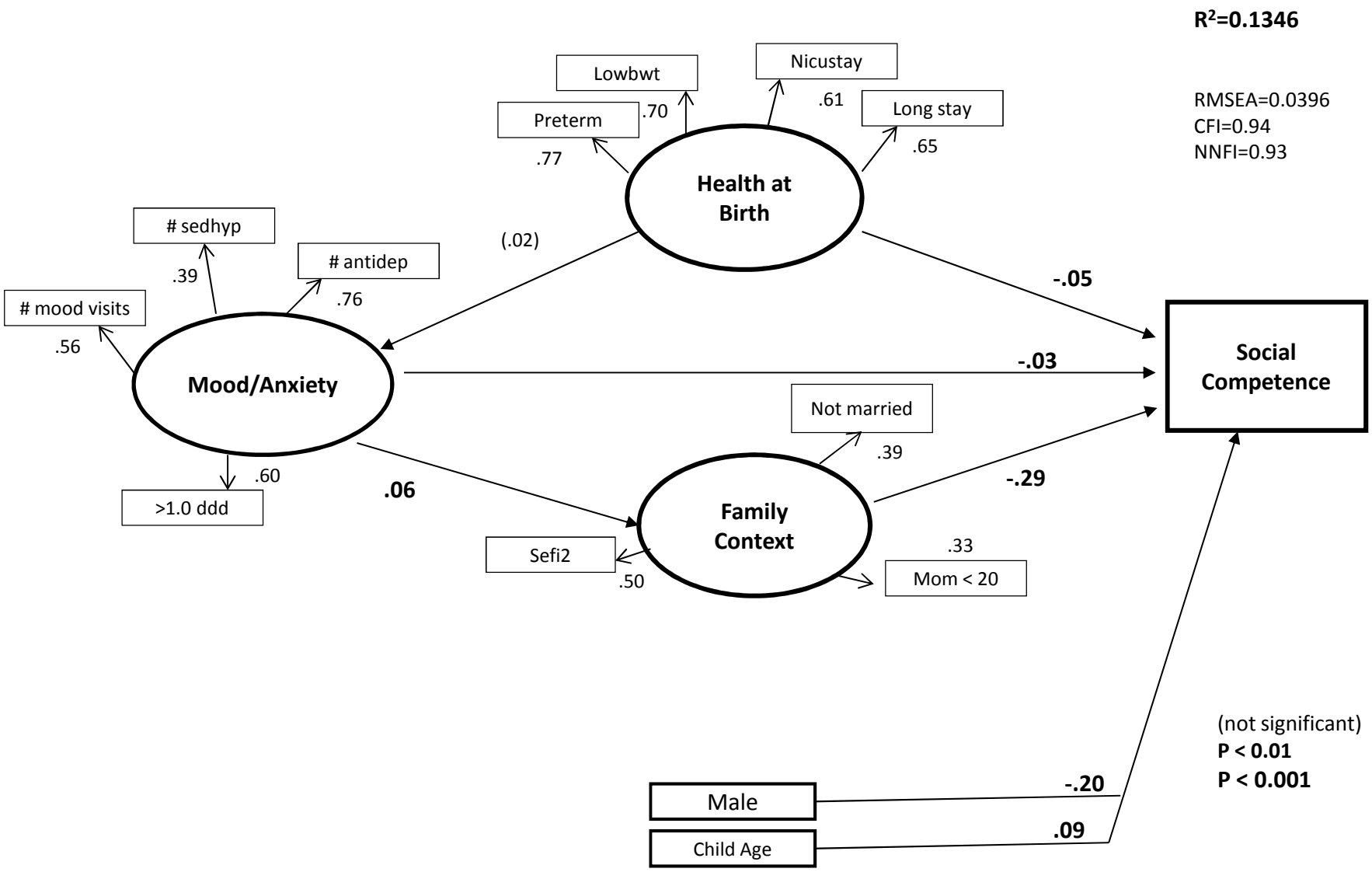

Figure A4.4: Path diagram for Toddler period – Social Competence (n=18,331)

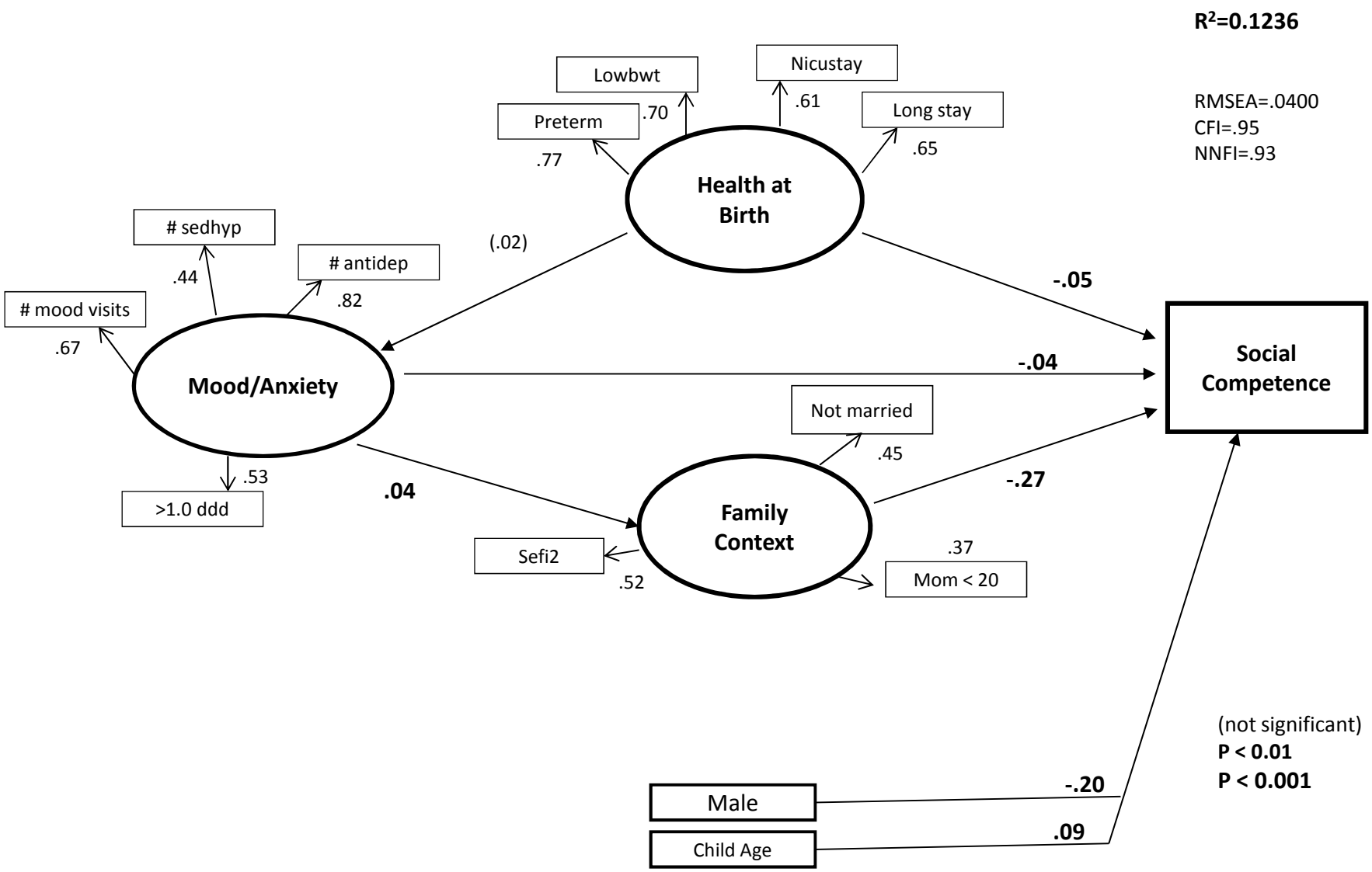

Figure A4.5: Path diagram for YBE period – Social Competence (n=18,331)

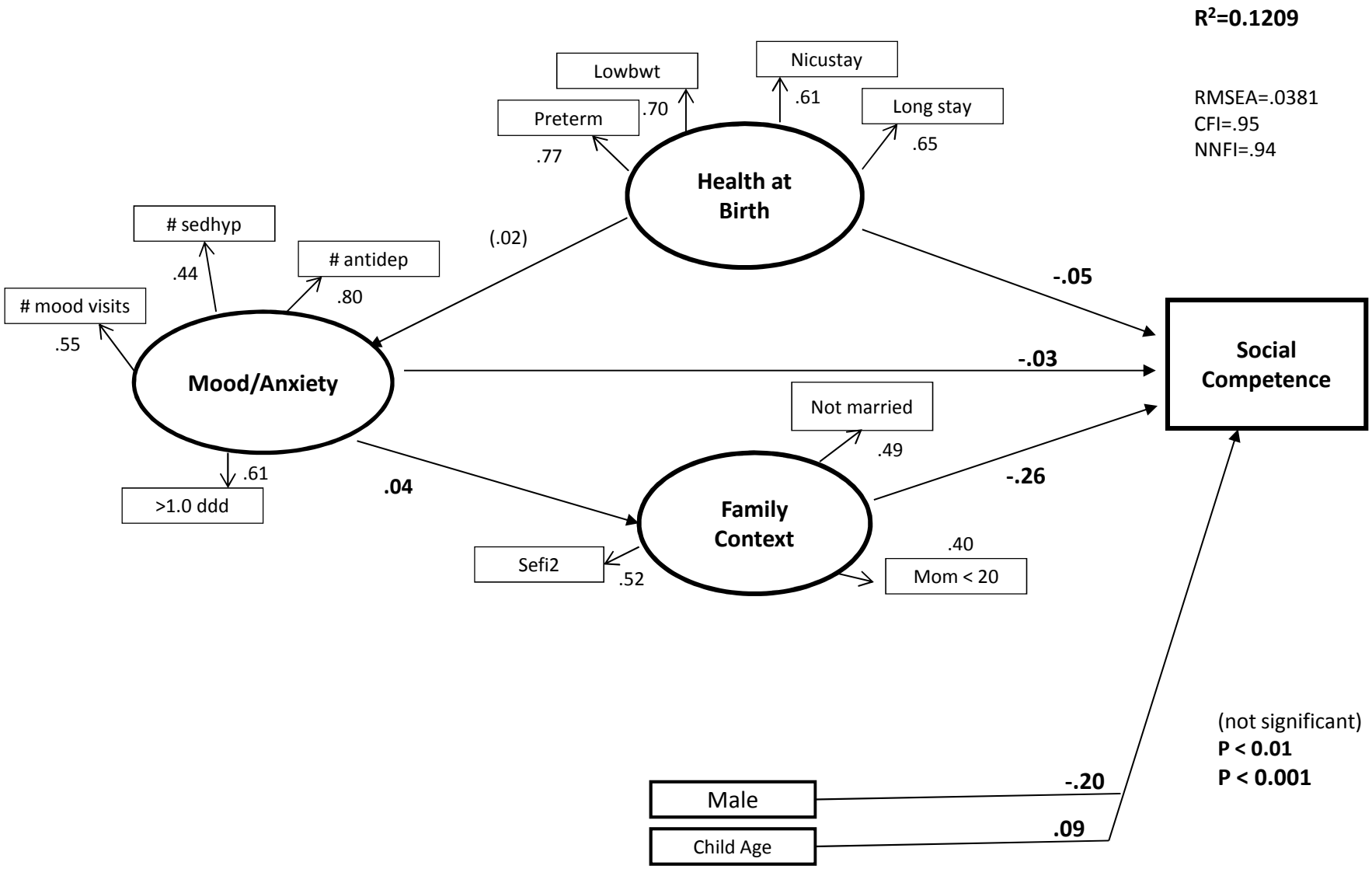

Figure A4.6: Path diagram for Mood/Anxiety recurrence/persistence – Social Competence (n=18,331)

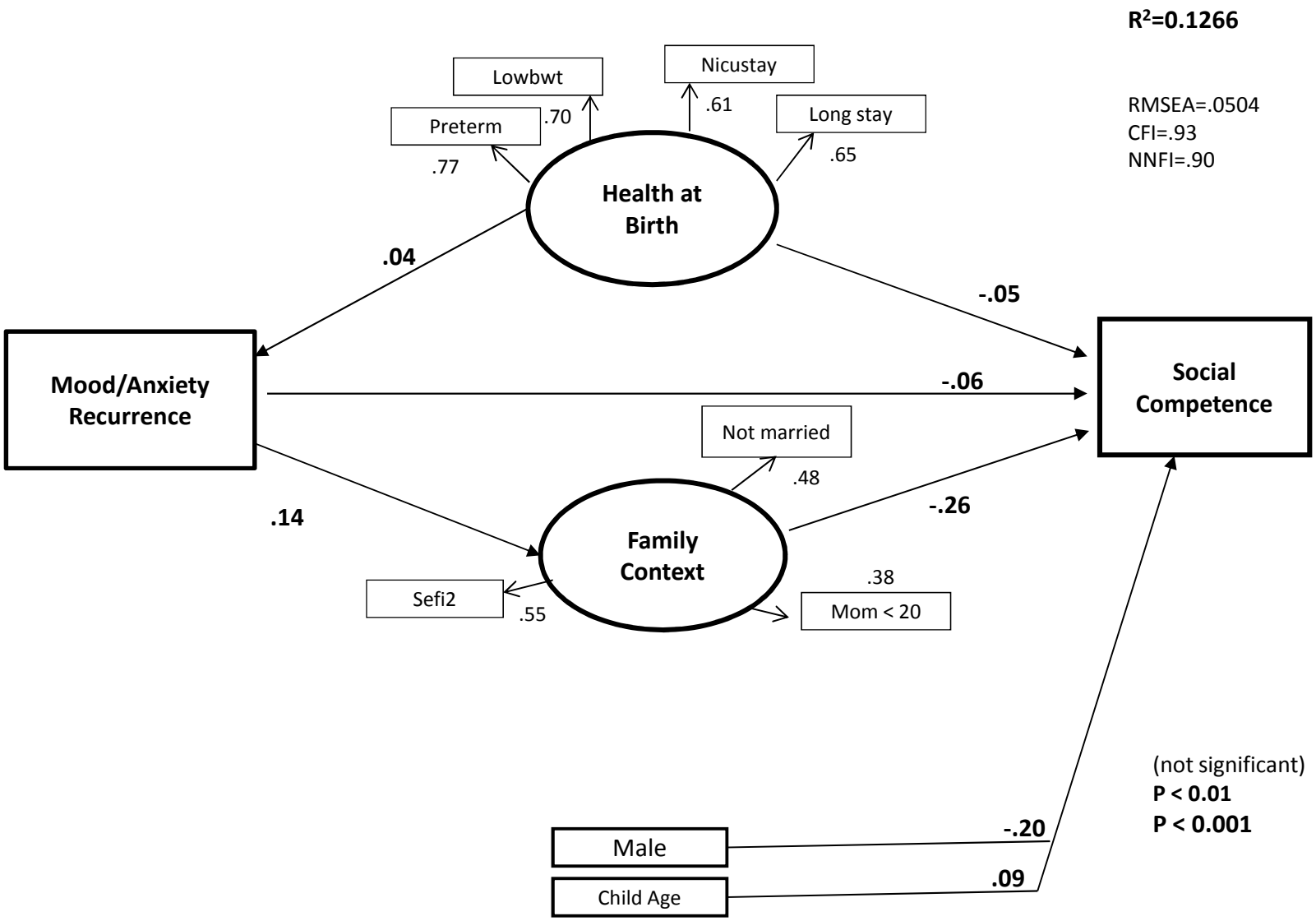

Figure A4.7: Path diagram for Mood/Anxiety severity – Social Competence (n=18,331)

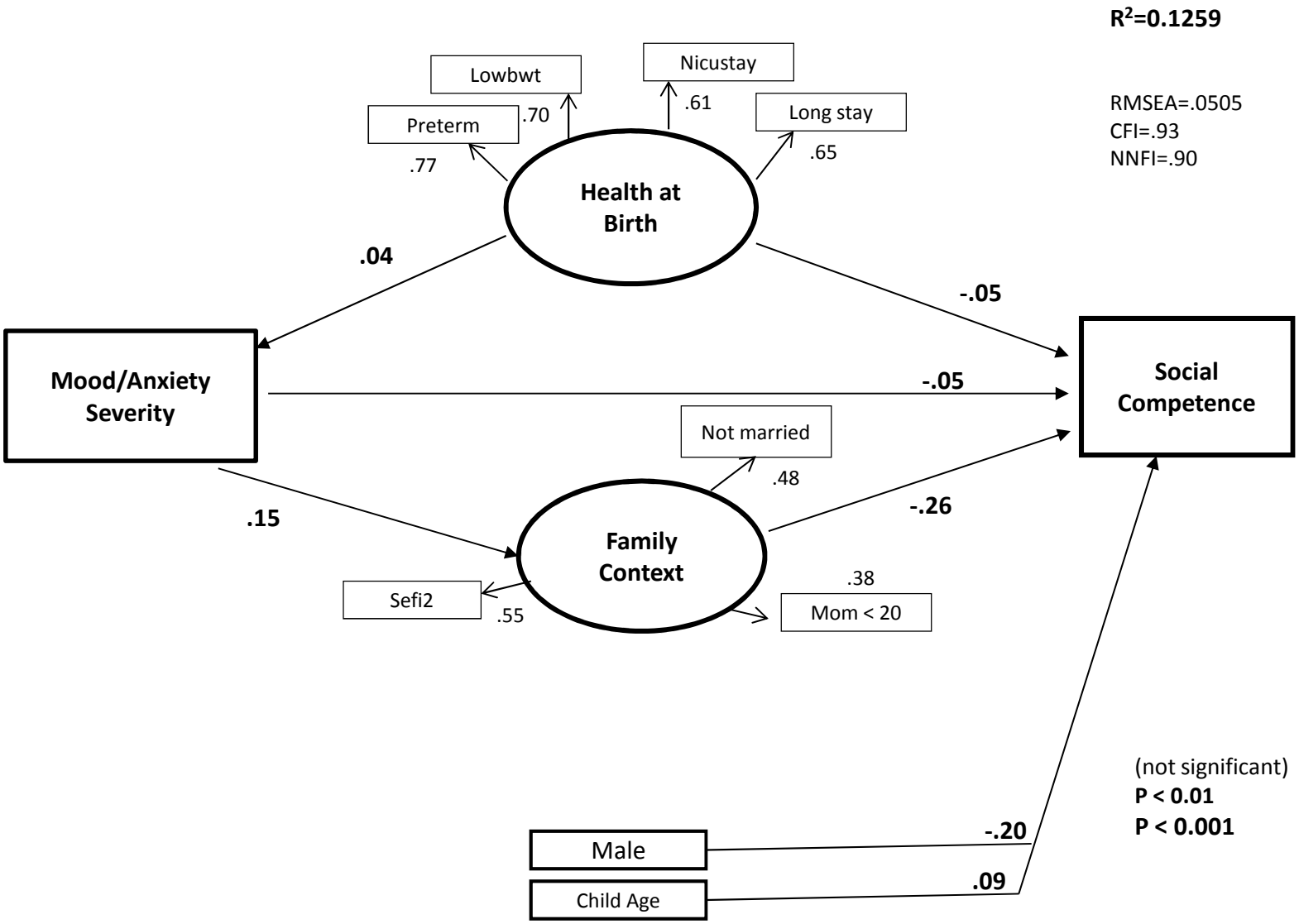

Figure A4.8: Path diagram for low-mid SES – Social Competence (n=9179)

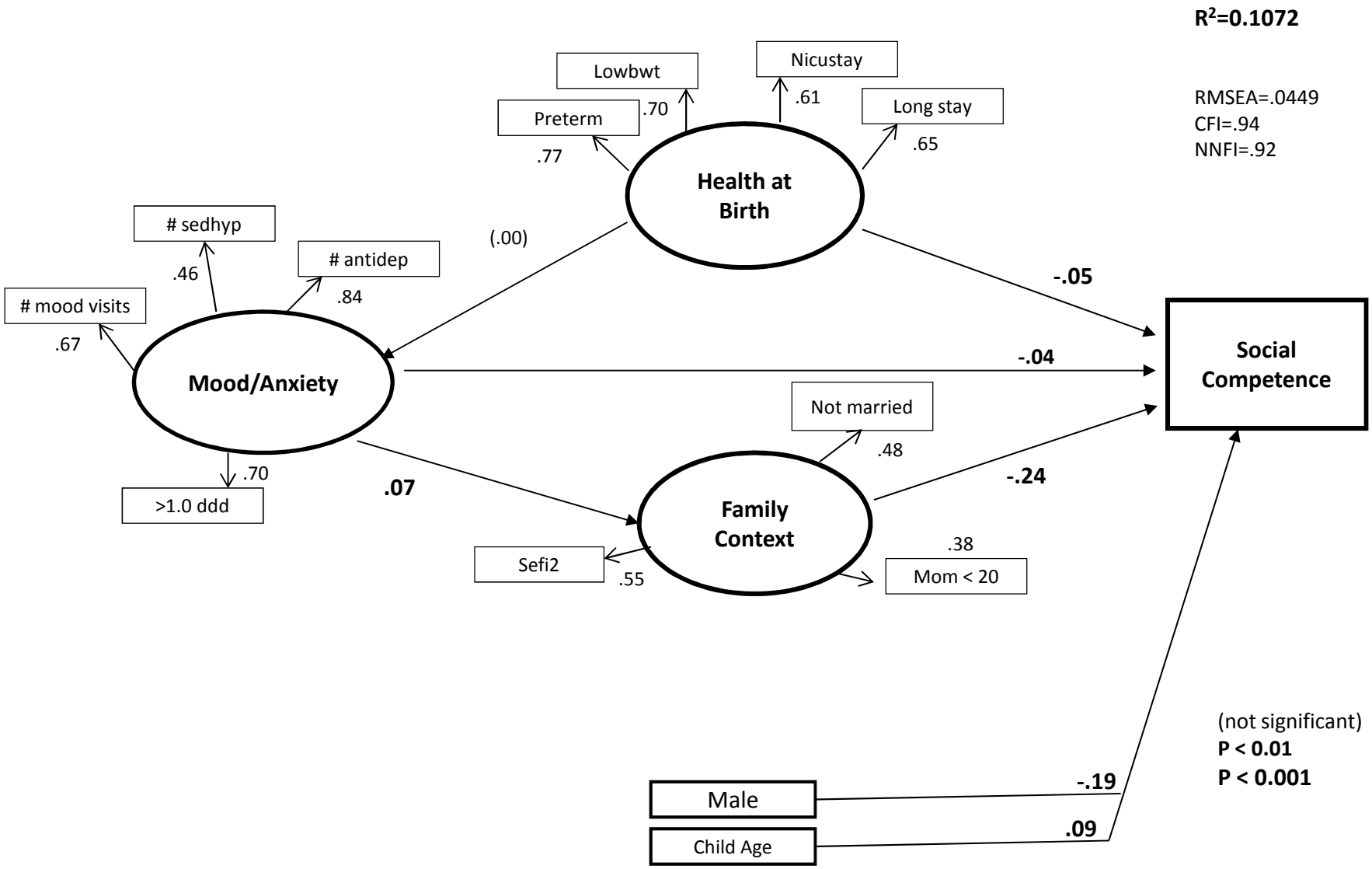

Figure A4.9: Path diagram for mid-high SES – Social Competence (n=9152)