Maternal Depression in Early Childhood and Developmental Vulnerability at School Entry

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abstract

OBJECTIVES: To assess the relation between exposure to maternal depression before age 5 and 5 domains of developmental vulnerability at school entry, overall, and by age at exposure.

METHODS: This cohort study included all children born in Manitoba, Canada, who completed the Early Development Instrument between 2005 and 2016 (N = 52 103). Maternal depression was defined by using physician visits, hospitalizations, and pharmaceutical data; developmental vulnerability was assessed by using the Early Development Instrument. Relative risk of developmental vulnerability was assessed by using log-binomial regression models adjusted for characteristics at birth.

RESULTS: Children exposed to maternal depression before age 5 had a 17% higher risk of having at least 1 developmental vulnerability at school entry than did children not exposed to maternal depression before age 5. Exposure to maternal depression was most strongly associated with difficulties in social competence (adjusted relative risk [aRR] = 1.28; 95% confidence interval [CI]: 1.20–1.38), physical health and well-being (aRR = 1.28; 95% CI: 1.20–1.36), and emotional maturity (aRR = 1.27; 95% CI: 1.18–1.37). For most developmental domains, exposure to maternal depression before age 1 and between ages 4 and 5 had the strongest association with developmental vulnerability.

CONCLUSIONS: Our finding that children exposed to maternal depression are at higher risk for developmental vulnerability at school entry is consistent with previous findings. We extended this literature by documenting that the adverse effects of exposure to maternal depression are specific to particular developmental domains and that these effects vary depending on the age at which the child is exposed to maternal depression.

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WHAT'S KNOWN ON THIS SUBJECT: Exposure to maternal depression is associated with problematic development in offspring, although the specific nature of these difficulties and their association with age at exposure is not well understood.

WHAT THIS STUDY ADDS: We documented specificity in the effects of children's exposure to maternal depression in early childhood, with the strongest effects on social competence and emotional maturity and among children who were exposed to maternal depression shortly before starting school.

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Early childhood development is affected by a wide range of genetic, biological, social, and psychological factors.[1,2] Maternal mental health has been identified as a particularly important factor affecting childhood development, influencing children's growth, cognitive development, and psychosocial well-being.[3] In this context, the most common maternal mental health condition is depression, affecting ~1 in 7 women overall and 1 in 8 women during the postpartum period.[4–7] Researchers have found that children whose mothers have high levels of depressive symptoms are characterized by significantly poorer cognitive development than children whose mothers have few or no depressive symptoms.[8,9] However, most researchers studying the relation between maternal depression and early childhood development have used survey results from a small number of mother-child pairs and/or have examined development using composite scores such as the Bayley Scales of Infant Development.[8,10] Moreover, researchers have measured child development at different ages (from a few months to 5 years), both within and across studies, and have rarely examined children's age at exposure to maternal depression as a factor affecting their development.[8]

To address these limitations, we linked several population-based clinical and social databases from Manitoba, Canada. Specifically, we assessed the relation between maternal depression and children's developmental vulnerability at school entry and assessed whether discrete areas of development are affected differentially by exposure to maternal depression before age 5 years. In addition, we examined whether the relation between exposure to maternal depression and developmental vulnerability at school entry varies on the basis of the age at which children are exposed to their mother's depression.

METHODS

Setting and Data

Manitoba is a central Canadian province and had 1.3 million residents at the time of the 2016 census.[11] Approximately 30.2% of Manitoba children were vulnerable in at least 1 area of development at age 5 years, a figure higher than the Canadian average of 26%.[12]

The Manitoba Population Research Data Repository contains province-wide, routinely collected individual data for each resident.[13] In this study, data from the population registry were linked with individual-level information from physician claims, hospital discharge abstracts, pharmaceutical claims, BabyFirst (before 2003) and Families First (2003 onward) Screen data (administered by the Healthy Child Manitoba Office), Early Development Instrument (EDI) data (administered by the Healthy Child Manitoba Office), and the Canadian Census. An anonymized personal health number allowed for linkage of these deidentified data sets. Information on linkage methods, confidentiality, privacy, and validity has been fully documented.[14,15]

Cohort

The Manitoba Government began administration of the EDI in the 2005–2006 school year; information from 7 EDI cycles was available for this study: 2005–2006, 2006–2007, 2008–2009, 2010–2011, 2012–2013, 2014–2015, and 2016–2017. This study included children who had a valid EDI score, who were linked to their birth mothers in the data, who lived in Manitoba from birth to their fifth birthday, whose mothers lived in Manitoba from 2 years before their birth to their fifth birthday, who were not placed in out-of-home care before their fifth birthday, whose mothers had completed a BabyFirst or Families First Screen, and who had no

missing values on covariates (final N = 52 103; Fig 1).

Developmental Vulnerability

Developmental vulnerability at school entry was measured by the EDI, a 103-item questionnaire administered by kindergarten teachers in their classrooms in the second half of the school year.[16] This questionnaire is used to assess 5 areas of development in kindergarten by using binary and Likert-scale items: physical health and well-being, social competence, emotional maturity, language and cognitive development, and communication skills and general knowledge.[17] Results are comparable across contexts, and significant correlations have been reported with other developmental tests.[18]

Each area of development encompasses a range of characteristics: (1) the physical health and well-being domain includes the child's physical readiness for the school day, physical independence, and gross and fine motor skills; (2) the social competence domain includes responsibility and respect, approaches to learning, and readiness to explore new things; (3) the emotional maturity domain includes prosocial and helpful behavior, anxious and fearful behavior, and hyperactivity and inattention; (4) the language and cognitive development domain includes basic literacy, interest in literacy and numeracy, advanced literacy, and basic numeracy; and (5) the communication skills and general knowledge domain includes skill to communicate effectively, symbolic use of language, and age-appropriate knowledge about the world.[19] The scores for each domain are converted to a score from 1 (most vulnerable) to 10 (most ready); children scoring in the lowest 10th percentile (based on national norms) in any domain are considered vulnerable.[20] Following previous research, in this study, we
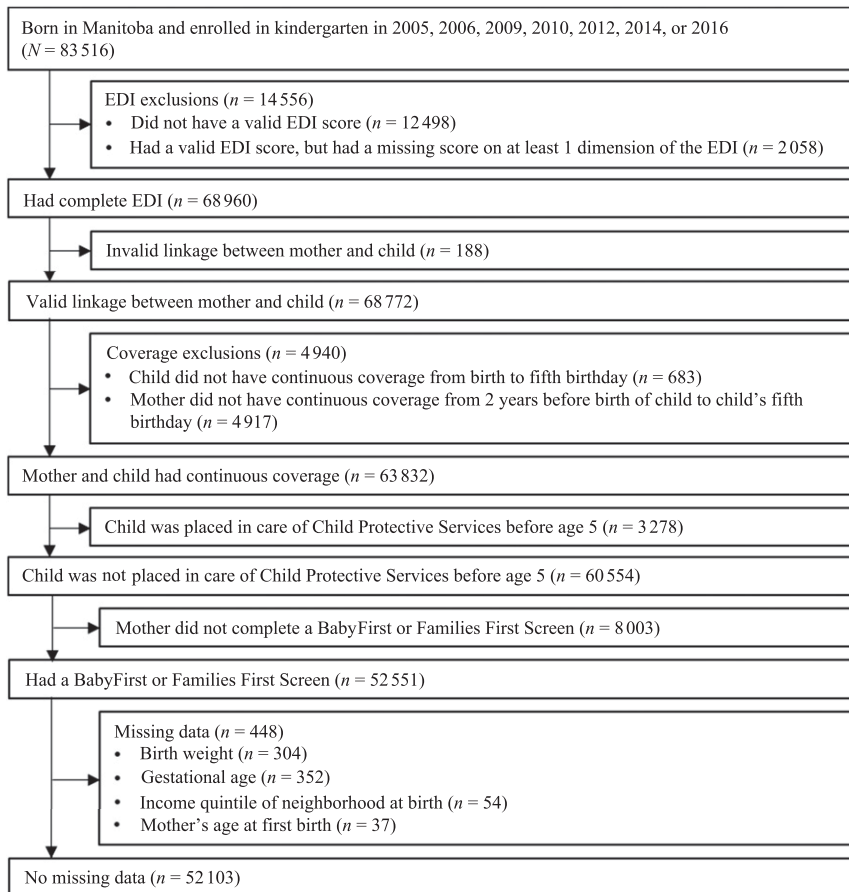
FIGURE 1
Cohort selection process.

define the overall construct of developmental vulnerability as being vulnerable in ≥1 developmental area.[19,21,22]

Maternal Depression

For all children, we examined whether their mother was diagnosed with depression at any time between their birth and fifth birthday. Maternal depression was defined as the mother having (1) ≥2 physician visits resulting in a depression diagnosis (*International Classification of Diseases, Ninth Revision, Clinical Modification* code of 296, 309, or 311) within a 1-year window, (2) ≥1 physician visit with a depression diagnosis and ≥1 filled antidepressant prescription (Anatomical Therapeutic Chemical Classification code N06A) within a 1-year window, or (3) ≥1

hospitalization with a depression diagnosis (*International Classification of Diseases, Ninth Revision, Clinical Modification* codes 296.2, 296.3, 296.5, 300.4, 309.x, and 311.x before April 1, 2004; *International Classification of Diseases, 10th Revision, Canada* codes F20.4, F31.3–F31.5, F32.x, F33.x, F34.1, F41.2, and F43.2 on or after April 1, 2004).[23]

Covariates

To account for maternal and child characteristics that could confound the relation between maternal depression and childhood developmental vulnerability, we adjusted for a range of covariates. Specifically, the BabyFirst or Families First Screen provided information about maternal characteristics at the birth of the child: education (did not

finish high school or finished high school), social isolation (yes or no), marital status (married or unmarried), smoking during pregnancy (yes or no), and drug or alcohol use during pregnancy (yes or no). From the Health Insurance Registry, we obtained information about neighborhood location at the birth of the child (linked to the census to identify neighborhood income quintile), mother's age at first birth, child's birth order, and child's sex. And from the birth hospitalization discharge abstract, we identified the child's gestational age (<37 weeks [preterm] or ≥37 weeks [term]).

Statistical Analysis

We first calculated the frequency, unadjusted relative risk, and adjusted relative risk (aRR) of developmental vulnerability by maternal depression status for each of the 5 domains and 1 overall vulnerability score (vulnerable on at least 1 domain) using log-binomial regression models.

In addition to adjusting for a range of covariates, we conducted a preliminary analysis addressing the contribution of genetics and shared environment to the association between maternal depression and developmental vulnerability by limiting the population to "discordant cousins," that is, children of sisters who are discordant with respect to depression status. In this analysis, we compared the developmental vulnerability of children who had a mother diagnosed with depression before the child turned 5 years of age with that of their cousins who had a mother (ie, a sister of a mother with depression) who was not diagnosed with depression before the child turned 5. We obtained unadjusted relative risks and aRRs from generalized estimating equations models.

Finally, we examined whether the relation between maternal depression and childhood developmental

TABLE 1 Maternal and Child Characteristics at Birth of Child, by Maternal Depression Diagnosis Between Child's Birth and Fifth Birthday

Covariates at Birth of Child	All (N = 52 103)	Maternal Depression Diagnosis Between Child's Birth and Fifth Birthday	
		Yes (n = 9938)	No (n = 42 165)
	n (%)	n (%)	n (%)
Maternal characteristics			
Age at first child's birth, y			
<25	9137 (17.5)	2165 (21.8)	6972 (16.5)
25–34	40 432 (77.6)	7308 (73.5)	33 124 (78.6)
≥35	2534 (4.9)	465 (4.7)	2069 (4.9)
Less than grade 12 education	10 979 (21.1)	2173 (21.9)	8806 (20.9)
Social isolation	2586 (5.0)	652 (6.6)	1934 (4.6)
Unmarried	5170 (9.9)	1345 (13.5)	3825 (9.1)
Smoking during pregnancy	8612 (16.5)	2278 (22.9)	6334 (15.0)
Drug or alcohol use during pregnancy	5566 (10.7)	1273 (12.8)	4293 (10.2)
Urban neighborhood	32 000 (61.4)	6288 (63.3)	25 712 (61.0)
Neighborhood income quintile			
1 (lowest)	9112 (17.5)	1891 (19.0)	7221 (17.1)
2	10 767 (20.7)	2135 (21.5)	8632 (20.5)
3	11 226 (21.6)	2211 (22.6)	9015 (21.4)
4	10 875 (20.9)	1988 (20.0)	8887 (21.1)
5 (highest)	10 123 (19.4)	1713 (17.2)	8410 (20.0)
Child characteristics			
Birth order			
1	21 433 (41.1)	3853 (38.8)	17 580 (41.7)
2	18 576 (35.7)	3645 (36.7)	14 931 (35.4)
3+	12 094 (23.2)	2440 (24.6)	9654 (22.9)
Male sex	26 538 (50.9)	5085 (51.2)	21 453 (50.9)
Preterm (<37 wk)	3499 (6.7)	740 (7.5)	2759 (6.5)

vulnerability differed on the basis of the age at which the child was exposed to maternal depression. For each year before their fifth birthday (0–1, 1–2, 2–3, 3–4, and 4–5 years old), we compared the developmental outcomes of children whose mothers had a diagnosis in that time period with those of children whose mothers did not have a diagnosis of depression in that time period. For these analyses, children were defined as being exposed to maternal depression during a specific year if their mother had met criteria for a diagnosis of depression before the child's fifth birthday (described previously) and had at least 1 diagnosis of depression (physician visit or hospitalization) or filled at least 1 antidepressant prescription in that time period. All data management, programming, and analyses were conducted by using

TABLE 2 Frequency and Relative Risk of Developmental Vulnerability by Maternal Depression Diagnosis Between Child's Birth and Fifth Birthday (N = 52 103)

Developmental Domain	Maternal Depression Diagnosis Between Child's Birth and Fifth Birthday		Relative Risk (95% CI)	
	Yes (n = 9938)	No (n = 42 165)		
	Vulnerable on Domain, n (%)	Vulnerable on Domain, n (%)	Unadjusted	Adjusted[a]
≥1 domain	2930 (29.5)	10 297 (24.4)	1.29 (1.23–1.36)	1.17 (1.11–1.23)
Specific domain				
Physical health and well-being	1473 (14.8)	4555 (10.8)	1.44 (1.35–1.53)	1.28 (1.20–1.36)
Social competence	1312 (13.2)	4098 (9.7)	1.41 (1.32–1.51)	1.28 (1.20–1.38)
Emotional maturity	1307 (13.2)	4246 (10.1)	1.35 (1.27–1.45)	1.27 (1.18–1.36)
Language and cognitive development	1175 (11.8)	4171 (9.9)	1.22 (1.14–1.31)	1.07 (1.00–1.15)
Communication skills and general knowledge	920 (9.3)	3909 (9.3)	1.00 (0.93–1.08)	0.91 (0.83–0.98)

[a] Adjusted for maternal characteristics at birth (age at first birth, education, social isolation, marital status, smoking during pregnancy, drug or alcohol use during pregnancy, neighborhood location, and income quintile) and child characteristics at birth (birth order, sex, and gestational age).

TABLE 3 Frequency and Relative Risk of Developmental Vulnerability by Maternal Depression Diagnosis Between Child's Birth and Fifth Birthday, Discordant Cousin Cohort (n = 1672)

Developmental Domain	Maternal Depression Diagnosis Between Child's Birth and Fifth Birthday		Relative Risk (95% CI)	
	Yes (n = 836)	No (n = 836)		
	Vulnerable on Domain, n (%)	Vulnerable on Domain, n (%)	Unadjusted	Adjusted[a]
≥1 domain	252 (30.4)	211 (25.2)	1.29 (1.06–1.57)	1.27 (1.02–1.57)
Specific domain				
Physical health and well-being	122 (14.6)	107 (12.8)	1.16 (0.90–1.51)	1.12 (0.85–1.48)
Social competence	121 (14.5)	75 (9.0)	1.72 (1.27–2.33)	1.74 (1.26–2.38)
Emotional maturity	114 (13.6)	79 (9.5)	1.51 (1.12–2.04)	1.48 (1.09–2.01)
Language and cognitive development	101 (12.1)	92 (11.0)	1.11 (0.83–1.49)	1.24 (0.88–1.73)
Communication skills and general knowledge	81 (9.7)	65 (7.8)	1.27 (0.92–1.76)	1.05 (0.77–1.42)

[a] Adjusted for maternal characteristics at birth (age at first birth, education, social isolation, marital status, smoking during pregnancy, drug or alcohol use during pregnancy, neighborhood location, and income quintile) and child characteristics at birth (birth order, sex, and gestational age).

SAS version 9.4 (SAS Institute, Inc, Cary, NC).

This study was approved by the Health Research Ethics Board at the University of Manitoba (H2019:110) and the Health Information Privacy Commission at Manitoba Health, Seniors and Active Living (2018/2019-70). Because we used deidentified administrative data files, we were not required to obtain informed consent from participants.

RESULTS

Of the 52 103 children in our cohort, 9938 (19.1%) had a mother who was diagnosed with depression between their birth and fifth birthday. Compared with mothers without a diagnosis of depression, mothers diagnosed with depression before their child's fifth birthday were more likely to be <25 years of age when they had their first child, to live in social isolation, to be unmarried, and to live in a low-income neighborhood at the birth of their child; they were also more likely to have smoked or used drugs or alcohol during pregnancy (Table 1). Children whose mothers had a diagnosis of depression before they turned 5 were more likely to have been born preterm. All of these variables were included as covariates in the primary analyses.

Early Childhood Maternal Depression

Children whose mother had a diagnosis of depression before they reached age 5 years had a 1.17 (95% confidence interval [CI]: 1.11–1.23) times increased risk of having a developmental vulnerability at school entry (Table 2). Developmental domains associated most strongly with maternal depression during early childhood were social competence (aRR = 1.28; 95% CI: 1.20–1.38), physical health and well-being (aRR = 1.28; 95% CI: 1.20–1.36), and emotional maturity (aRR = 1.27; 95% CI: 1.18–1.36).

Children of Sisters Discordant for Depression

In 836 families, 1 mother had a diagnosis of depression in the 5 years after the birth of her child, but her sister did not. In this comparison, children of mothers with depression showed lower levels of social competence (aRR = 1.74; 95% CI: 1.26–2.38) and emotional maturity (aRR = 1.48; 95% CI: 1.09–2.01) (Table 3); the domain of physical health and well-being, which was found (as mentioned previously) to be related to exposure to maternal depression, did not distinguish children of sisters who were discordant for depression.

Age at Exposure to Maternal Depression

The number of children exposed to maternal depression increased from 3656 (7.0%) who were exposed between birth and their first birthday to 4738 (9.1%) who were exposed between their fourth and fifth birthday. For the 3 domains in which maternal depression was related to children's developmental vulnerability (physical health and well-being, social competence, and emotional maturity), the greatest risk of vulnerability was among children exposed to maternal depression between their fourth and fifth birthday (Fig 2). Unadjusted relative risk and aRR of developmental vulnerability by age at exposure are presented in Supplemental Table 4.

DISCUSSION

In this population-based cohort study, we found that children exposed to maternal depression in early childhood were at greater risk of experiencing developmental vulnerability at school entry than children not exposed to maternal depression. Importantly, exposure to maternal depression in early childhood was associated with specific forms of developmental vulnerability. Findings both from the full cohort and from a family-based
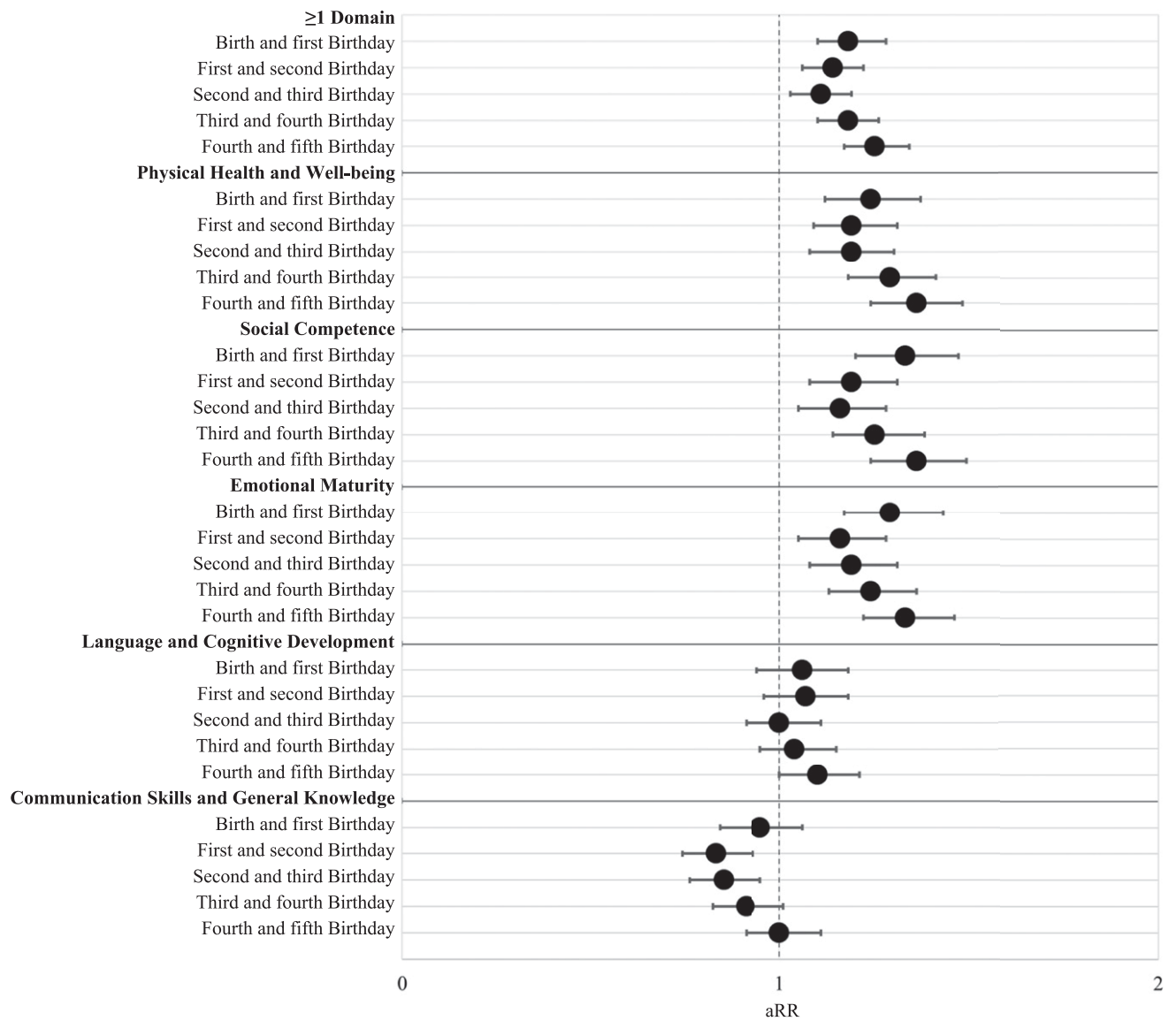
FIGURE 2
aRR of developmental vulnerability by maternal depression diagnosis in each year between child's birth and fifth birthday.

subcohort revealed that early childhood exposure to maternal depression was associated most strongly with vulnerabilities related to social competence and emotional maturity. In addition, exposure to maternal depression had the strongest effects on developmental vulnerability when children were exposed shortly before school entry.

Researchers have documented consistent associations between depression and difficulties in both social functioning and emotion regulation.[24–27] The finding in this study that children's exposure to maternal depression is associated with problematic functioning in these 2 domains at as early as 5 years of age extends the literature and offers insight into the origins of these psychosocial difficulties. It is noteworthy that these difficulties were reported by the children's teachers, avoiding negative biases inherent in having mothers with depression serve as informants.[28] It is also important to note that children's difficulties in these 2 domains were evident even when comparing with offspring of sisters discordant for depression, suggesting that this problematic functioning in young children exposed to maternal depression is not due solely to genetic factors.

We found little to no relation between exposure to maternal depression and language and cognitive development in children at

school entry. Previous studies have revealed that children who were exposed to maternal postpartum depression were slightly more likely to fail object concept tasks at 18 months (differences that were stronger in male than in female toddlers).[29] Importantly, alterations in cognitive development that may be a function of maternal depression seem to diminish over time. Consistent with our findings, researchers have reported that by age 5 years, children's performance on cognitive tasks were not associated with the mother's depression.[30,31] Instead, poorer cognitive function was associated with early experiences of insensitive maternal interaction, stimulation at home, and social class.[31]

The findings reported in this article need to be extended in future research. In particular, investigators should work to elucidate the mechanisms that underlie this intergenerational transmission to young children of mothers with depression at risk for social and emotional difficulties, focusing on aspects of the caregiving environments and behaviors to which these children are exposed. Investigators of these studies should also attend to protective factors that may confer resilience to children exposed to maternal depression.[32] Such research will have significant implications for prevention of what is likely to be a lifelong cascade of problematic psychosocial functioning in offspring of mothers with depression.[2]

This study has limitations that typify observational studies in general. First, we were limited to information that could be obtained from existing data files, requiring us to use proxies for some of our measures. For example, maternal depression was defined on the basis of recorded diagnoses and prescriptions. Importantly, because claims data are used to measure treatment for a condition, not the presence of a condition, the true prevalence of depression in the community is underestimated,[33] although we should note that this was not a study of the prevalence of maternal depression. Second, we do not know when the first onset of maternal depression occurred, only when the mother sought treatment of her depression, nor can we determine the severity of depression. Third, we are limited in the possible confounding variables for which we can adjust. For example, parenting style has been found to be related to early childhood development,[34] but we do not have data on parenting style. In this context, however, parenting style can be influenced intergenerationally, and sisters have been found to have similar parenting styles[35]; importantly, we were able to account for this, in part, in our discordant cousins analysis. Finally, we lack information on fathers. Although mothers tend to be the primary caregiver, researchers have found that exposure to maternal depression has stronger effects on child development in the presence of fathers who also have a psychiatric condition.[36]

CONCLUSIONS

This study revealed that children exposed to maternal depression (particularly if the exposure was before age 1 or shortly before school entry) were at higher risk of developmental vulnerability at school entry. Although children exposed to maternal depression were at increased risk of developmental vulnerability at school entry, ~70% of children exposed were not identified as vulnerable on any of the 5 developmental domains. To improve the outcomes of children exposed to maternal depression, future research should be focused on these children and what made them resilient to identify factors that could prevent young children of mothers with depression from experiencing developmental vulnerabilities.[32] In addition, the relations we observed between maternal depression and child development could be affected by other family-level factors, such as the presence and characteristics of siblings. In future research, investigators should examine whether and how having an older or younger sibling (and whether these siblings have developmental or mental health conditions) affects the relation between maternal depression and developmental difficulties in their offspring.

ABBREVIATIONS

aRR: adjusted relative risk
CI: confidence interval
EDI: Early Development
    Instrument

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