

Associations between maternal depression symptoms and internalising problems in the offspring: the role of maternal and family factors

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Conflict of interest

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ABSTRACT

Background: Maternal depression symptoms (MDS) are a robust risk factor for internalising problems (IP) in the offspring. However, the relative importance of MDS and other factors associated with it (i.e. other types of maternal psychopathology, maternal parenting practices, family characteristics) is not well understood.

Objectives: To a) identify a group of children with high levels of IP between 6 and 12 years using combined maternal and teacher assessments and b) to quantify the associations between trajectories of MDS during early childhood and children's IP trajectories before and after controlling for family factors associated with MDS.

Methods: MDS and family factors were assessed in a population-based sample in Canada (n=1537) between 5 months and 5 years. The outcome variable was membership in trajectories of teacher- and mother-rated IP between ages 6 and 12 years. Family factors were included as covariates in a multinomial logistic regression model.

Results: There was a strong association between MDS and children's atypically high levels of IP in unadjusted analyses (OR=4.14 [95% CI=2.60;6.61]). The association was reduced but remained strong (2.60 [1.55;4.36]) when maternal psychopathology, maternal parenting, and family socioeconomic status were entered in the model. MDS, maternal anxiety, and low parental self-efficacy were associated with offspring's high IP trajectories.

Conclusion: MDS is associated with high levels of children's IP independently of other maternal and family characteristics. Intervention targeting maternal psychopathology and parenting self-efficacy and testing the impact on children's IP would provide information on the putative causal pathways between maternal and offspring's symptomatology.

Keywords: child development, maternal depression symptoms, internalising problems,
family factors

BACKGROUND

Depressive and anxiety disorders are among the top ten leading causes of disability in the world [1, 2]. Children with high levels of internalising problems (i.e. depressive and anxiety symptoms) are twice as likely to suffer from depression as adults [3, 4], and are at significant risk for other problems such as substance use and abuse, suicidal behaviours, and premature death [5, 6]. Internalising problems (IP) during middle childhood are a significant public health issue given their relatively high prevalence (3-10% in middle childhood) [7], their tendency to increase with age [8], and their impact on child functioning and mental health in adolescence and young adulthood [4, 9, 10]. Maternal depression symptoms (MDS) have been identified as a risk factor for child psychopathology, including IP [11-15], with predictions extending into middle childhood [16], adolescence [17, 18] and early adulthood [19, 20]. However, it is not clear whether MDS per se are the main factors involved in the development of children's IP, or whether the maternal and family factors highly correlated with MDS are the main explanatory variables.

Other factors within the family of depressed mothers, such as mother-child interactions, parenting practices, family functioning, and socioeconomic factors have also been identified as potential risk factors for child psychopathology [14, 15]. First, with respect to mother-child interactions, depressed mothers tend to be less responsive to their child's emotional and affective states, and to express more anger, criticism and sadness than non-depressed mothers [21-23]. Second, families with a depressed mother differ from those of non-depressed mothers. Poor parenting practices, family conflicts, [21-26] and

harsh discipline [27] were shown to be more prevalent among families with depressed mothers. These factors also forecasted IP in children [28]. Accounting for mother-child interactions and/or parenting and family functioning could have an impact on the predictive association between MDS and children's IP.

Maternal depression symptoms also tend to co-occur with other psychopathology such as anxiety [29] and antisocial behaviours [30]. Thus, other forms of psychopathology could account for part of the association between MDS and child outcomes. In one longitudinal study, antisocial personality disorder symptoms in depressed mothers was found to account for 18 to 29% of the effect of MDS on children's antisocial behaviours at ages 5 and 7 years [30]. In two other studies, accounting for comorbid maternal mental health problems and other contextual variables attenuated the strength of the association between MDS and children's antisocial behaviour [31] and verbal abilities [32]. These results point to the importance of considering, at both the conceptual and statistical level, maternal comorbidity and its influence on child outcomes in studies on the impact of MDS .

Previous studies provide evidence that associations between MDS and elevated levels of children's IP appear as early as the preschool years [33, 34]. Specifically, in a previous investigation, we found that child difficult temperament and maternal lifetime major depression at 5 months were associated with a high-rising (mother-rated) depressive and anxiety symptom trajectory between 1½ and 5 years [33]. Recent studies have reported similar findings between MDS and membership in high IP trajectories in early childhood [35-37]. These studies rely on multiple assessments of child IP over time, a methodological

strength which allows us to understand the development of symptoms. However, none of these studies accounted for a major methodological challenge in this line of research – the common rater bias.

The common rater bias has hampered the study of the associations between MDS and child outcomes in population-based samples. Population-based (non-clinical) studies typically rely on maternal ratings of both MDS and child behaviours and such ratings can be tainted by maternal depressive/negative cognitions [38]. Reliance on an additional source of evaluation may provide a better estimation. In non-clinical samples, teachers are often used as raters of children's behaviours as they have an excellent sense of normative versus atypical behaviours. Furthermore, if multiple teacher ratings are used over many years, the resulting assessment is that of independent raters who spent many hours per day with the child.

The objectives of the present study were 1) to identify a group of children with high levels of internalising problems (IP) between 6 and 12 years using combined maternal and teacher assessments 2) to quantify the associations between trajectories of maternal depression symptoms (MDS) during early childhood and children's IP developmental trajectories before and after controlling for family factors associated with MDS. We hypothesised that: 1) Children exposed to high levels of MDS will be at risk of following elevated trajectories of IP compared to those with low levels of exposure and 2) the associations will be reduced but remain significant after the introduction of child, maternal, and family covariates.

METHODS

Participants

Data were drawn from the Québec Longitudinal Study of Child Development, whose protocol was approved by the Québec Institute of Statistics (Québec City, Canada) and the Ste-Justine Hospital Research Centre (Montreal) ethics committees. Participants were selected via the Québec Birth Registry using a stratified procedure based on living area and birth rate. The initial sample included a total of $n=2120$ infants representative of children born in the province of Québec in 1997-1998 and followed yearly from 5 months to 7 years and every two years from 7 to 12 years. Informed written consent was obtained from all participants. Trained interviewers conducted home interviews with the mothers/fathers (and/or spouses) about family characteristics, parental, and child behaviours. The average response rate over 11 years of data collection was 82.22% (range:65.8%–100%). The study sample included $n=1537$ participants for whom the estimation of trajectories of depressive and anxiety symptoms from 6 to 12 years-old was possible (data for at least one IP assessment by both informants). This sample was reduced to $n=1218$ in regression analyses due to missing data for confounders. Multiple imputation was used to test whether the results were sensitive to loss of confounder data [39]. The pattern of results with and without imputed data were similar, therefore only the former is reported. In our sample of $n=1537$, fifty-two percent (51.9%) of children were females, six percent (6.1%) came from single-mother homes, the majority of mothers were employed (71.8%) and were 21 years or older at the birth of the target child (94.3%) [Insert Table 1].

Measures

Main exposure variable: maternal depression symptoms (MDS) in early childhood

Maternal depression symptoms were assessed at 5 months, 1½, 3½ and 5 years using a short version of the Centre for Epidemiologic Studies Depression Scale (CES-D) [40]. Specifically, 5 to 12 CES-D questions were asked between 5 months and 5 years. Responses were converted to a score varying between 0 and 10. The CES-D is a valid and reliable measure of non-clinical depression, assessing the occurrence and severity of depression symptoms during the previous week (e.g. “I felt alone”, “I felt depressed”, “I had the blues”, “what I did was an effort”). Response categories range between 0 (none) to 3 (all the time). Short versions of the CES-D are highly correlated with the original CES-D, and have been used in several studies [41]. A threshold of 2.67 (out of 10) was used to approximate the conventional cut-off (16/60) for elevated MDS from the original CES-D [42, 43]. To maximise our repeated measurements of MDS, we calculated trajectories using group-based trajectory modelling [44]. The estimation of MDS trajectories in this cohort has been previously reported [45]. The model had two trajectories of MDS: a high symptom group (18.3%) and low symptom group (81.7%). All mothers in the high symptom group had a CES-D score $\geq 2.67/10$. Membership to the high symptom trajectory was dummy-coded as 1 and membership in the low trajectory as 0. The two stable trajectories of MDS are presented in Figure 1.

Figure 1. Maternal depression symptoms trajectories (5 months – 5 years)

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*This line represents a threshold of 2.67/10 on the short CES-D scale. It is the equivalent of the cut-off of 16/60 used to indicate elevated depressive symptoms on the full length CES-D scale.

Outcome: children's trajectories of internalising problems (IP) during the elementary school years rated by teachers and mothers.

When the children were aged 6, 7, 8, 10 and 12 years, their home room teacher was asked to rate whether the child never (0), sometimes (1) or often (2) exhibited the following IP (in the past 12 months): 'unhappy, sad, depressed', 'not as happy as other children', 'has difficulties having fun', 'lack of energy', 'appears fearful or anxious', 'appears worried' and 'is nervous or very tense'. Mother-reported IP were also assessed at ages 6 and 8 years. Items were added up to create a total score for each age which was then re-scaled to a range of 0 to 10. Children therefore had five teacher-rated and two mother-rated IP scores. These

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symptoms were selected from the Preschool Behaviour Questionnaire [46]. They have been used to assess anxious/depressive symptoms [47] in large population studies and shown adequate psychometric properties [48]. The internal consistencies ranged between 0.79 and 0.83 for teacher-reported symptoms and 0.68 and 0.69 for mother-reported symptoms. To maximise our repeated measurements of child IP and to combine the information from multiple informants, we estimated multi-group trajectories [49] of mother-reported and teacher-reported IP using group-based trajectory modelling [44].

Putative confounding variables. The following variables are factors within the family environment that are associated with both the outcome (MDS) and exposure (children's IP) variables and have the potential to bias the association between them.

Mother-child interactions were observed at home by a trained research assistant at age 5 months using the Home Observation Measurement of the Environment [50]. Two dimensions reflected the quality of mothers' early interactions with their infant: verbalisation (e.g. 'mother responds verbally to her child'; 'mother expresses positive emotions to the child'; 'mother praises her child', etc.) and stimulation (e.g. 'mother encourages progress of the child'; 'mother uses educational toys/games').

Parenting. The Parental Cognitions and Conduct toward the Infant Scale PACOTIS [51] was used to assess maternal parenting practices at 5 months. The PACOTIS consists of six dimensions of parenting practices: self-efficacy (e.g. "I feel that I am able to calm my child"), parental impact (e.g. "I have little effect on the development of my child's personality"), coercion (e.g. "I have gotten angry at my child when he/she has been

particularly difficult”), affection (e.g. “I often play with my child. For example, I regularly take time to have fun with him/her”), overprotection (e.g. “I want my baby to be close to me at all times”), perception of child’s qualities (e.g. “I feel that my child is very curious compared to other children”). Responses to each item ranged from 0 (not at all what I think or did) to 10 (exactly what I think or did), with higher scores indicating greater endorsement of a given parenting dimension.

Family functioning. The General Functioning scale (a sub-scale of the McMaster Family Assessment Device) is a validated instrument completed by the parents at baseline and including 8 items measuring how well the family operates on a daily basis (e.g. “planning family activities is difficult because we misunderstand each other”; “in times of crisis we can turn to each other for support”) [52] . Responses to each item range from 1 (totally agree) to 4 (totally disagree). Scores from all items are summed up (positive items are reverse-coded) and re-scaled to produce a final overall score on a range from 0 to 10. Higher values indicate higher levels of relationship difficulties in the family.

Maternal anxiety and antisocial behaviours. To isolate the role of MDS in children’s IP, we controlled for two main types of maternal psychopathology symptoms that may co-occur with MDS. General, trait-like maternal anxiety was assessed when the target child was 4½ years using validated items inspired by DSM-IV criteria[53]. The reliability coefficient of these items was 0.87. The presence of maternal antisocial behaviours in adolescence was assessed via a questionnaire to the mother when the child

was 5 months. Mothers were asked whether they had exhibited five different conduct problems [54]. The scale ranged from 0 to 5 and the internal consistency of items was 0.33.

Child and family characteristics. Child sex, and mother-rated difficult temperament at 5 months were considered as potential covariates [8]. Child temperament was assessed with items from the difficult temperament scale of the well-validated Infant Characteristics Questionnaire ICQ [55]. Internal consistency of items was 0.80.

Socio-economic status (SES) of the family was derived from five variables including maternal education (years of schooling), spouse's education and occupational status, maternal occupational status and household income. The final SES composite was standardised for all families (mean = 0, SD = 1) [56].

Family status at 5 months was coded as 1 for single-parent families and 0 for biparental families (including blended families). The age of the mother was treated as a binary variable reflecting 21 years or younger at the birth of the target child (0) or older than 21 years (1). Becoming a mother before age 21 was previously shown to be a valid indicator of risk in the Québec population [57]. The mother's professional activity at baseline was coded as 1 for mother has a job (full time or part-time) and 0 for not.

Data analyses

Data analyses included 2 steps. In the first, we estimated multi-group trajectories of mother and teacher IP ratings. In the second, we estimated regression models of the association between MDS trajectories and child IP trajectories.

We used group-based trajectory modelling [44], a statistical method designed to identify groups of individuals that are following similar trajectories based on a single outcome variable. Multi-trajectory modelling [49] extends the basic model by defining trajectory groups in terms of multiple outcome variables. Both the basic model and the multi-trajectory generalisation are applications of finite mixture modelling. The multi-trajectory method applied here combined the trajectories of IP based on maternal reports (6 to 8 years) with trajectories of IP based on teacher reports (from age 6 to 12 years). Thus, the multi-trajectories are the product of combined estimation procedures for each group's trajectories across both raters. Two criteria were used to determine the number of groups to include in the multi-trajectory modelling, BIC and substantive significance [44].

Multinomial logistic regression models were used to estimate the association between MDS and children's IP while controlling for family factors and other confounders. We selected putative confounders on the basis of a) previous literature indicating a link between a given risk factor and MDS and/or children's IP and b) epidemiological guidelines for modelling longitudinal data, whereby potential confounders are selected at baseline and not at subsequent time points [58, 59]. Four models were estimated: (I) In the first, we tested the unadjusted association between MDS trajectories and childhood IP trajectory groups; (II) in the second, we added a block of child characteristics variables (i.e. sex and temperament); (III) in the third, we added maternal characteristics and behaviours variables (e.g. maternal psychopathology, mother-child interactions, and parenting practices); and finally (IV) in the fourth, we added family environment characteristics

variables (e.g. family dysfunction) so that all blocks of covariates were included in this model.

To account for attrition, we estimated the regression analyses using the fully conditional specification (FCS) imputation method [39] (number of imputations = 10) in the n=1537 sample to address missing data in confounders. Imputation was based on the assumption that data were missing at random. We also repeated analysis on a data set without imputation. The pattern of results in both analyses were similar therefore we report only results obtained on the imputed data sets.

RESULTS

Multi-group trajectories of mother and teacher-rated internalising problems (IP).

We identified 4 groups of children following distinct IP trajectories: 1) low IP by both mothers and teachers (low; 22.8%), 2) high IP by teachers and increasing IP by mothers (high-increasing; 24.5%), 3) low IP by teachers and moderate by mothers (low-moderate; 41.3%), and 4) high by both mothers and teachers (high; 11.5%). The trajectories of IP are presented in figure 2.

Figure 2. Multi-trajectory model of teacher- and mother-reported internalising problems in middle childhood (6-12 years)

Child's age (years)

Multinomial logistic regression models estimating the association between maternal depression symptoms (MDS) and children's internalising problems (IP).

Selection of confounding variables. Table 1 presents the bivariate associations between childhood IP trajectory groups and study variables. Child's sex, levels of MDS, maternal psychopathology (anxiety and antisocial behaviour), stimulation in mother-child

interactions, maternal parenting practices (e.g. overprotection and perception of parental impact), whether or not the mother was employed, socioeconomic status, and family functioning differed significantly across childhood IP trajectory groups. These variables were treated as confounders in the main analyses and entered in the regression models in blocks representing child, maternal, or family variables.

Table 1. Sample characteristics according to teacher- and mother-reported childhood internalising problems (IP) trajectory groups

	Children's Internalising problems (IP) Trajectory Group between 6 and 12 years				Total sample (<i>n</i> =1537)	p-value on χ^2 test or ANOVA F-test
	Low (<i>n</i> =350 22.8%)	High- increasing (<i>n</i> =376 24.5%)	Low-high (<i>n</i> =634 41.3%)	High (<i>n</i> =177 11.5%)		
Child Characteristics						
Sex [n, (%)]						0.006
<i>Boys</i>	166(22.4)	206(27.8)	271(36.7)	97(13.1)	740(48.1)	
<i>Girls</i>	184(23.1)	170(21.3)	363(45.6)	80(10.0)	797(51.9)	
Difficult temperament [mean (SD)]	2.62(1.6)	2.74(1.6)	2.67(1.5)	2.88(1.7)	2.70 (1.6)	0.310
Maternal Characteristics						
Maternal depression symptoms [n, (%)]						<.0001
<i>Low</i>	314 (25.0)	299 (23.8)	523 (41.6)	120 (9.6)	1256 (81.7)	
<i>High</i>	36 (12.8)	77 (27.4)	111 (39.5)	57 (20.3)	281 (18.3)	
Age at birth [n, (%)]						0.192

<i>< 21 years-old</i>	14(15.9)	29(33.0)	35(39.8)	10(11.4)	88(5.73)	
<i>≥ 21 years old</i>	336(23.2)	347(23.9)	599(41.3)	167(11.5)	1449(94.3)	
Maternal anxiety [mean (SD)]	0.95(1.0)	1.38(1.3)	1.27(1.2)	1.84(1.4)	1.28 (1.3)	<.0001
Maternal youth antisocial behavior [mean (SD)]	0.69(0.9)	0.86(1.0)	0.84(0.9)	0.83(0.9)	0.81 (0.9)	0.046
Mother-child interaction [mean (SD)]						
<i>Stimulation</i>	4.80(2.3)	4.45(2.4)	4.95(2.3)	4.91(2.4)	4.79 (2.4)	0.021
<i>Verbalization</i>	6.72(1.6)	6.54(1.7)	6.79(1.5)	6.85(1.6)	6.72 (1.6)	0.100
Parenting practices [mean (SD)]						
<i>Self-efficacy</i>	9.03(0.9)	9.01(1.0)	8.99(0.9)	8.85(1.0)	8.99 (0.9)	0.234
<i>Parental Impact</i>	8.43(1.8)	8.23(1.8)	8.61(1.7)	8.29(2.0)	8.44 (1.8)	0.008
<i>Coercion</i>	1.03(1.2)	1.12(1.3)	1.00(1.1)	1.21(1.1)	1.06 (1.2)	0.142
<i>Affection</i>	9.66(1.6)	9.69(0.7)	9.67(0.7)	9.70(0.8)	9.68 (0.7)	0.918
<i>Overprotection</i>	4.41(2.2)	4.89(2.2)	4.43(2.2)	4.84(2.2)	4.58 (2.2)	0.002
<i>Perception of child</i>	7.90(1.6)	7.91(1.8)	8.01(1.7)	7.99(1.5)	7.96 (1.7)	0.723
Maternal employment [n, (%)]						<.0001

<i>Yes</i>	89(20.7)	129(30.0)	144(33.5)	68(15.8)	430(28.3)	
<i>No</i>	261(23.9)	239(21.9)	484(44.3)	108(9.9)	1092(71.8)	
Family Environment Characteristics						
Family status [n, (%)]						0.878
<i>Intact</i>	329(22.8)	348(24.2)	598(41.5)	165(11.5)	1440(94.9)	
<i>Single-mother</i>	21(22.3)	26(27.7)	36(38.3)	11(11.7)	94(6.1)	
Socioeconomic Status [mean (SD)]	0.15(1.0)	-0.17(0.9)	0.21(1.0)	-0.19(1.0)	0.05 (1.0)	<.0001
Family functioning [mean (SD)]	1.52(1.4)	1.77(1.4)	1.68(1.5)	1.88(1.3)	1.69 (1.4)	0.024

Table 2 presents the results of the multinomial logistic regression models. The lowest trajectory group is used as the reference in all analyses.

Table 2. Odds ratios and 95% confidence intervals [95% CI] from multinomial logistic regression models of the association between maternal depression symptoms trajectories (0 to 5 years) and membership in children’s mother-reported and teacher-reported internalising problems groups (6 to 12 years) n=1537

*Model 1 = no covariates			
Model 2 = only child characteristics as covariates			
Model 3 = child and maternal characteristics as covariates			
Model 4 = child, maternal, and family environment characteristics as covariates			
Odds Ratios in bold are significant at p<.05			

	Children's internalising problems trajectory group											
	High-increasing				Low-moderate				High			
	Model 1*	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Main exposure variable												
High trajectory of Maternal depressive symptoms (5 months to 5 years)	2.25 [1.47;3.44]	2.22 [1.45;3.40]	1.69 [1.08;2.65]	1.63 [1.03;2.58]	1.85 [1.24;2.77]	1.85 [1.24;2.77]	1.68 [1.10;2.56]	1.63 [1.06;2.52]	4.14 [2.60;6.61]	4.04 [2.53;6.45]	2.68 [1.62;4.43]	2.60 [1.55;4.36]
Child characteristics												
Child's sex (boys)		1.33 [0.99;1.79]	1.28 [0.95;1.72]	1.29 [0.95;1.73]		0.82 [0.63;1.07]	0.78 [0.60;1.02]	0.78 [0.60;1.02]		1.33 [0.92;1.92]	1.20 [0.83;1.75]	1.21 [0.83;1.76]
Child difficult temperament		1.03 [0.94;1.13]	1.02 [0.93;1.13]	1.03 [0.93;1.14]		1.01 [0.93;1.10]	1.01 [0.93;1.11]	1.01 [0.92;1.10]		1.08 [0.97;1.21]	1.05 [0.93;1.19]	1.06 [0.94;1.20]
Maternal characteristics and behaviours												
Young mother at birth (< 21 years)			1.56 [0.78;3.10]	1.45 [0.71;2.95]			1.54 [0.79;3.00]	1.76 [0.89;3.52]			1.20 [0.49;2.92]	1.17 [0.46;2.93]
High Maternal anxiety			1.28 [1.10;1.48]	1.25 [1.08;1.46]			1.31 [1.14;1.50]	1.32 [1.14;1.52]			1.54 [1.31;1.82]	1.52 [1.29;1.80]
High maternal antisocial behaviour			1.17 [0.98;1.39]	1.14 [0.96;1.36]			1.19 [1.01;1.39]	1.21 [1.03;1.42]			1.11 [0.90;1.38]	1.09 [0.88;1.35]
Low stimulation			0.96 [0.88;1.03]	0.96 [0.88;1.04]			1.02 [0.95;1.10]	1.02 [0.95;1.10]			1.01 [0.92;1.12]	1.01 [0.92;1.12]
Low verbalisation			1.01 [0.89;1.13]	1.02 [0.90;1.15]			1.01 [0.90;1.12]	1.01 [0.90;1.12]			1.08 [0.93;1.26]	1.09 [0.94;1.27]
High self-efficacy			0.96 [0.78;1.18]	0.95 [0.77;1.17]			0.94 [0.78;1.13]	0.96 [0.79;1.16]			0.77 [0.60;0.99]	0.77 [0.60;0.99]
High parental impact			0.99 [0.91;1.08]	1.01 [0.92;1.10]			1.08 [0.99;1.17]	1.08 [0.99;1.17]			1.03 [0.92;1.15]	1.04 [0.93;1.16]
High coercion			1.00 [0.87;1.14]	0.99 [0.86;1.14]			0.91 [0.80;1.04]	0.91 [0.80;1.04]			0.99 [0.84;1.18]	1.00 [0.83;1.17]
Low affection			1.15 [0.89;1.49]	1.14 [0.88;1.48]			1.04 [0.83;1.31]	1.04 [0.83;1.31]			1.35 [0.96;1.89]	1.33 [0.95;1.87]
High overprotection			1.05 [0.97;1.13]	1.03 [0.96;1.13]			0.98 [0.92;1.05]	0.99 [0.92;1.06]			1.01 [0.92;1.11]	1.00 [0.93;1.12]
Low perception of child's qualities			0.99 [0.90;1.10]	1.01 [0.91;1.11]			1.04 [0.95;1.13]	1.03 [0.94;1.13]			1.05 [0.92;1.19]	1.06 [0.93;1.21]
Mother is employed			1.23 [0.86;1.74]	1.07 [0.72;1.58]			0.78 [0.56;1.08]	0.89 [0.62;1.29]			1.49 [0.97;2.30]	1.45 [0.83;2.54]
Family Environment Characteristics												
Single mother				0.71 [0.37;1.35]				0.86 [0.47;1.57]				0.59 [0.26;1.34]
Low SES				0.82 [0.67;1.01]				1.15 [0.96;1.37]				0.84 [0.65;1.10]
High family dysfunction				1.04 [0.92;1.17]				1.06 [0.95;1.18]				1.04 [0.90;1.20]

In the first set of models, we tested the association between MDS and membership in children's IP groups without adjusting for covariates. Maternal depression symptoms were associated with higher odds of membership in the high-increasing, low-moderate, and high trajectory groups. In the second set of models, we tested the association between MDS and children's IP groups once child sex and temperament were entered into the model.

Again, exposure to MDS was associated with higher odds of membership in all 3 elevated trajectory groups. There were no differences with respect to child sex and temperament between the groups.

In the third set of models, we added maternal characteristics and behaviours variables into the model. Maternal depression symptoms were still associated with higher odds of membership in the 3 elevated trajectory groups, although the odds were weaker than in the two previous models. Additionally, maternal anxiety and low parenting self-efficacy were also associated with higher odds of membership in elevated IP trajectory groups. Finally, we added family environment variables in the fourth model. The association between MDS and higher odds of membership in elevated IP groups was still significant. There were no significant differences between the trajectory groups with respect to SES, family status (single-mother vs intact), and family dysfunction.

DISCUSSION

We used a 12-year longitudinal investigation of a population-based sample ($n=1537$) to determine whether exposure to maternal depression symptoms (MDS) during early childhood (5 months to 5 years) was related to higher odds of membership into a high internalising problems (IP) trajectory group during middle childhood (6 to 12 years). We specifically wanted to quantify the distinctive contribution of MDS while accounting for the wide range of child, maternal, and family variables including parenting, mother-child interactions, and socioeconomic factors. Using both teachers' and mothers' assessments of

child IP between 6 and 12 years, we identified 4 trajectory groups: 1) low IP by both mothers and teachers (low; 22.8%), 2) high IP by teachers and increasing IP by mothers (high-increasing; 24.5%), 3) low IP by teachers and moderate by mothers (low-moderate; 41.3%), and 4) high by both mothers and teachers (high; 11.5%). This method provides a robust estimate of the developmental patterns of IP across middle childhood in multiple contexts (at home and at school), according to multiple raters (the mother and 5 different teachers), over multiple years (i.e. 5 years).

We identified a group of children rated as having high IP according to both mothers and their teachers, indicating that these children were consistently exhibiting high levels of depressive and anxiety symptoms across different environments and multiple years. As hypothesised, exposure to MDS over the course of early childhood was related to membership in this high IP group. The association remained even after child characteristics, maternal psychopathology and socioeconomic factors were controlled in the models. Focusing on the risk of membership on the highest IP trajectory compared to the lowest, the odds ratio was 4.14 (95% CI = 2.60;6.61) when none of the covariates were in the model. This risk was reduced to 4.04 (2.53;6.45) when children's characteristics were included. The most important reduction occurred when maternal psychopathology and maternal behaviours were included, leading to an OR=2.68 (1.62;4.43). The risk of membership in high IP trajectory (OR= 2.6) was further reduced, albeit only slightly (from 2.68 to 2.60 (1.55;4.36), when the final block of covariates – family characteristics – were entered in the model.

These findings support previous research which suggests that maladaptive parenting practices and exposure to other forms of maternal psychopathology contribute significantly to the development of IP in the offspring [15, 30]. Indeed, parenting practices, particularly parental hostility, have been identified as mediators of the association between MDS and children's socio-emotional outcomes [60, 61]. Note that in the present study, our main exposure variable – MDS – was assessed over the first 5 years of the child's life, and parenting was assessed at the first MDS assessment (i.e. 5 months). Thus, we could not test the possible mediating role of parenting practices in the association between MDS and children's IP. This means that we cannot rule out the possibility that early postnatal – or antenatal and/or perinatal – depression symptoms impaired early parenting practices [62, 63] which could then increase the risk of children developing depressive and anxiety symptoms in middle childhood. Overall, these results are in line with earlier studies reporting associations between MDS and elevated levels of children's IP in early childhood [33-37]. However, this is the first study to quantify the association with a robust assessment across the entire middle childhood period (i.e. 6 to 12 years), in multiple contexts (at home and at school), according to multiple raters (the mother and 5 different teachers). Furthermore, this study is the first to quantify how the risk conferred by MDS changes as different types of covariates are entered in the model, thereby providing information on the relative importance of MDS.

Our results highlight the importance of being attentive to comorbidity of maternal mental health issues in the prevention of children's IP. The present results, together with

experimental treatment studies, suggest that targeting maternal psychopathology and improving the quality of parenting practices, particularly perceived self-efficacy, may represent a promising target for family-based prevention programs. For instance, in a family-based randomised controlled intervention including children aged 8-15 years whose parents were suffering from mood disorders, targeting parent-child interactions and increasing understanding of parental illness was efficient in reducing children's IP [64]. Beyond the treatment of maternal psychopathology, the results suggest that a promising intervention strategy should support depressed mothers to improve early parenting processes.

Limitations and strengths

This study presents a number of important strengths. First, it relies on analyses of a large population-based birth cohort with detailed and repeated assessments of the main variables, i.e., yearly IP assessments from 6 to 12 years-old by teachers, combined with two maternal assessments at 6 and 8 years; and 4 repeated assessments of MDS between 5 months and 5 years. The use of repeated assessments allowed us to model group-based developmental trajectories of MDS and IP – a valuable analytical method for examining how exposures and outcomes change over time according to distinct informants. Importantly, the reliance on multiple raters across multiple years substantially reduced measurement error and the putative impact of the common rater bias. It allowed us to capture differences in the exhibition of depressive and anxiety symptoms at home and at school. Teachers were independent raters (5 different teachers), known to have an excellent

sense of normative behaviours and spending substantial time (5 hours per day over 10 months) with the children. Despite the potential bias of relying on mothers to rate her child's IP [65], using mother-report combined with teacher reports enabled us to include information about the home environment.

Second, we relied on research assistants to assess the quality of mother child interactions as independent observers. Third, we accounted for carefully chosen risk factors correlated with MDS and children's IP that could confound the associations between them. For instance, we controlled for maternal anxiety and antisocial behaviour, two types of symptoms highly co-morbid with MDS and associated with children's socio-emotional development [15, 30, 31]. Furthermore, the association between exposure to high levels of MDS and children's IP was still significant in sensitivity analyses, supporting the robustness of results.

The study is limited by a number of factors. First, although our models include information on maternal comorbid conditions, quality of the mother child relationship, and socioeconomic conditions, we cannot rule out the possibility that unmeasured environmental or genetic risk factors explain part of the associations. Genetically informative studies are needed to disentangle the role of genetic from environmental factors in the mechanism linking MDS to children's psychopathology. In addition, our design did not allow us to test for mediation of the family factors in the association between MDS and children's IP trajectories. Importantly, this study is correlational and no causal inference can be made about the role of MDS in the development of depressive and anxiety symptoms in the offspring. Studies investigating whether a) treatment of MDS or b)

interventions aiming at modifying maternal parenting practices modify children's socio-emotional development could provide information on the putatively causal role of MDS and its related behaviours. Yet, the important body of knowledge reporting correlations between MDS and children's development suggest that the depressive symptomatology of mothers with young children should be the focus of support programs. Thus, in light of the present evidence, as well as that from previous studies on the associations between MDS and child internalising and externalising problems, developing interventions aimed at treating maternal psychopathology and buffering its effects on child development appear to be crucial [66]. Finally, we focused here on maternal psychopathology due to our inability to study paternal psychopathology in our sample (because of missing values), but further studies including fathers' psychopathology could shed light on the joint contribution of symptoms among both parents [67].

CONCLUSION

Maternal depression symptoms during early childhood were related to an increased risk of internalising problems during middle childhood (6 to 12 years) after accounting for maternal co-morbid psychopathology, maternal parenting behaviour and interaction with the child, as well as family functioning and family socioeconomic status in early childhood. Maternal anxiety and parenting are important factors in the family environment which are also associated with children's internalising problems. Experimental studies testing the role of distinct and joint treatment components – reducing maternal psychopathology and/or improving the quality of parenting – would provide information on the putatively causal role of these risk factors on offspring's internalising problems.

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