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Research internship report

MATERNAL DEPRESSION TRAJECTORIES AND CHILDREN'S SCHOOL ADJUSTMENT

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ABSTRACT

Background: Few studies have addressed the impact of maternal depression on children's school adjustment from a longitudinal perspective. This study aimed to examine whether maternal depression trajectories in the first five years of life have an impact on the child's school adjustment at 8 and 11 years.

Methods: Mothers-child pairs (n=880) from the French EDEN mother-child birth cohort study were followed until 8 years and 538 until 11 years old. Five maternal depression trajectories have previously been established in this population. Children's academic adjustment was measured using a composite score for academic difficulties and subscales from the Strengths and Difficulties Questionnaire (SDQ) to assess academic behavior and socialization. Multivariate logistic regression models were used to examine the effects of maternal depression trajectories on child's school adjustment, adjusting for potential confounders. In case of interaction effects, analyses were stratified on child sex and parental educational level.

Results: Logistic regression analyses revealed that children of mothers with persistently high levels of depressive symptoms were significantly more likely to experience academic behavior and socialization difficulties compared with children of mothers with no depressive symptoms. This association was moderated by the child's sex; boys appeared especially vulnerable compared to girls, as well as children from parents with a lower educational level.

Conclusions: Maternal depression has an impact on children's school adjustment, particularly academic behavior and socialization problems. Improving mother's mental health could contribute to better school adjustment in the child.

Keywords: Maternal depression trajectories, school adjustment, longitudinal cohort study

RESUME

Contexte: Peu d'études ont abordé l'impact de la dépression maternelle sur l'adaptation scolaire de l'enfant. Cette étude vise à examiner si les trajectoires de dépression maternelle ont un impact sur l'adaptation scolaire de l'enfant à l'âge de 8 et 11 ans. Les potentiels effets modérateurs du sexe de l'enfant ainsi que le niveau d'éducation parentale seront explorés.

Méthodes: Des paires mère-enfants (n=880) de la cohorte EDEN ont été suivies jusqu'à 8 ans et 538 jusqu'à 11 ans. Cinq trajectoires de dépression maternelles ont été précédemment établies dans cette population. L'adaptation scolaire des enfants a été mesurée en utilisant un score composite pour les difficultés scolaires et des sous-échelles du questionnaire SDQ pour le comportement scolaire et la socialisation. Les effets des trajectoires de dépression maternelle sur l'adaptation à l'école de l'enfant ont été explorés par des modèles de régression logistique multi variés, en ajustant sur les variables de confusion. En cas d'effets d'interaction, les analyses ont été stratifiées.

Résultats: Les enfants de mères présentant des niveaux de symptômes dépressifs persistants sont significativement plus susceptibles de connaître des problèmes avec les pairs et de socialisation que les enfants de mères non dépressives. Les garçons étaient particulièrement vulnérables, ainsi que les enfants de parents avec un faible niveau d'éducation.

Conclusion: La dépression maternelle a un impact sur l'adaptation scolaire des enfants, en particulier le comportement scolaire ainsi que la socialisation. Améliorer la santé mentale de la mère sera un point d'entrée pour éviter ces problèmes d'adaptation scolaire de l'enfant.

Mots-clés: Trajectoires de dépression maternelle, adaptation scolaire de l'enfant, étude de cohorte longitudinale

INTRODUCTION

Depression in women is an important mental health issue during the childbearing years (1). The prevalence of this disorder ranges from 10% to 20% (2). Although a depressive episode may be transient, some of the symptoms persist or reappear later on (3). Studies have shown the negative impact that maternal depression can have on children's development (4–9). Recently, several studies have explored the impact of maternal depression trajectories on child development. These showed that children whose mothers had persistent depressive symptoms were more likely to have emotional and behavioral problems (10,11), as well as reduced IQ scores at age 5 years compared to those whose mother had no symptoms (12,13). Other studies indicate that chronic symptoms of depression are associated with lower levels of school reading and language development from 36 months to first grade (14). These early difficulties can persist and have repercussions on the child's social, intellectual and linguistic skills, ultimately hindering school adjustment and impacting his academic success (15).

School adjustment represents an important skill in a child's academic career. It can be defined as the process of adapting to the role of being a student and to various aspects of the school environment. School adjustment is generally based on a child's academic achievements, academic behavior (defined as attitudes towards school, attention and peer relationships) and socialization (16). Friendship support and mutual friendships are associated with more positive attitudes towards school and better academic skills (17). It shows that socialization is a key element for optimal school adjustment. Failure to adjust can lead to mental health issues and school refusal or school dropout and may require school counselling (16).

Most studies examining the impact of maternal depression on school adjustment have focused on academic achievements. These studies show that parental depression has a negative influence on adolescent's school achievements, including test scores (18) or level of qualifications by the end of secondary education (19). Nevertheless, relatively few studies have examined the impact of maternal depression on younger children's school adjustment. Upon entering the school system in kindergarten or primary education, children acquire competences that form the basis for their future academic and social success. Claessens et al (2015) showed that maternal mental health is associated with young (5 - 6 years old) children's school behaviors, academic achievement and school absences (18). The impact of maternal depression on the child's educational adjustment differs depending on the timing of the mother's depression (18). In particular, children of persistently depressed mothers missed

more school and had less optimal approaches to learning, lower achievement and more externalizing and internalizing behavior problems (18). This is likely due to the fact that the home is the primary influence on young children's development (20,21) a having a depressed mother during a child's early school career can have cumulative negative effects on child outcomes (18,20), including school adjustment.

Other studies also showed that maternal depression has a greater impact on school and social adjustment among girls than boys (22,23), probably because girls are more sensitive to the effects of maternal depression (24–26). Alvarez et al's suggest that daughters might maintain closer contact with their depressed mother than sons, making it more difficult for girls to overcome the emotional unavailability of the mother (23). However, other studies showed that boys are more sensitive to maternal depressive symptoms in infancy than girls (21,29–31), setting them up for poorer psychosocial functioning later on in their development (27). Furthermore, it has been observed that a low parental educational level is associated with both maternal depression (28,29) and more school difficulties in children (13). Especially children whose mothers are from disadvantaged backgrounds and are persistently have lower educational levels than their peers whose mothers never experience depression. These children were less likely to attend preschool and had fewer children's books in their homes (18). Other studies have shown that a higher maternal education level is also associated with children's greater social competence (27). However, the impact of these gender and parental educational level differences on children's school adjustment remains to be explored.

Most research on the association between maternal depression and child's school adjustment has been based on cross-sectional data. Only longitudinal data collected in a prospective and repeated manner permits to study the association between maternal depression at different points in time and the school adjustment of children at different periods in their educational careers. This question has been little studied internationally, and to our knowledge, never in France in a large sample of children from the general population.

In France, 80% of dropouts in the school system, that is to say, those who will leave at 16 years old without knowing how to read, write or count, are already in difficulty in first grade ("*cours préparatoires*"). Moreover, from 2019 schooling in France will become compulsory as early as age three, compared to age 6 in most other European countries (32). Thus, identifying whether young children whose mother is depressed are at increased risk for school adjustment difficulties is important so as to provide them with timely support.

The objective of this study is to examine whether maternal depression trajectories have an impact on the child's school adjustment at both the primary education level (CE2) and early secondary education (6^{ème}). In particular we seek to highlight:

- I) If children at 8 and 11 years old whose mother has depression have worse school adjustment compared to the children of mothers without depression
- II) If the potential link between maternal depression trajectories and children's school adjustment varies according to the sex of the child and the parental educational level.

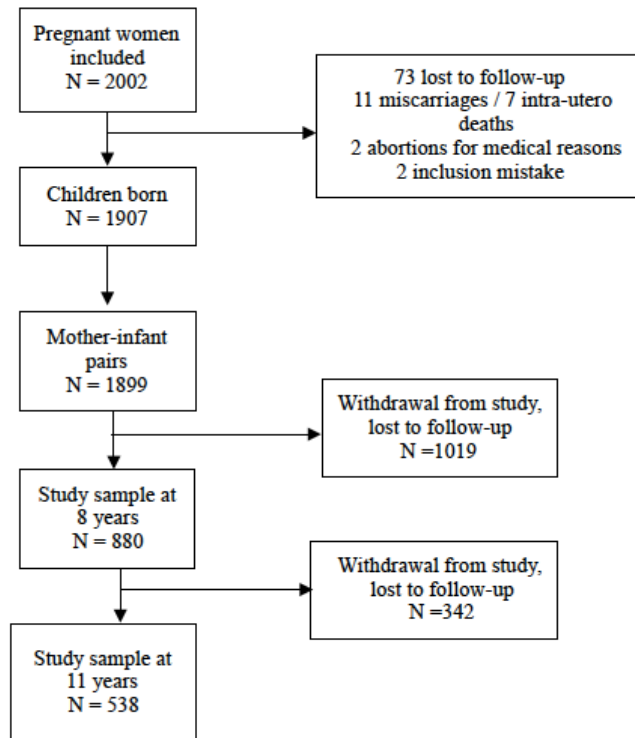
METHODS

Study design and sample

The EDEN (Etude sur les déterminants pré et post natals précoces du Développement psychomoteur et de la santé de l'ENfant) study is the first mother-child cohort study conducted in France. This cohort was set up to assess the pre- and postnatal nutritional, social and environmental determinants of infant and child development and health (30). Pregnant women were recruited before 24 weeks of gestations from Obstetrics and Gynecology departments of the French University Hospitals of Nancy and Poitiers. Recruitment started in 2003 and lasted until January 2006. Exclusion criteria were multiple pregnancies, a history of diabetes, intention to deliver outside the university hospital or move out of the study region within the next 3 years, and the inability to speak and read French. Among 3758 eligible women invited to participate in the study, 53% (n=2002) were enrolled. Birth data were obtained from 1899 mother-infant pairs. During pregnancy and after birth (4, 8, 12, 24 months, 3, 4, 5 and 8 years) sociodemographic and biomedical data on the mother and child were gathered from medical records, in face to face interviews with the mother, and by mother's self-completed questionnaires. A subsample of the EDEN cohort was followed up until 11-12 years through the DysEDEN study, which studies social determinants of psychological disorders and learning in school-aged children (figure 1).

By the year 8 follow-up, data were available for 880 (46.3%) participating mothers and children. Attrition was greatest in mothers with history of mental health problems, those with low educational level and those with low socioeconomic situation. Additionally, the 342 (38.9%) mothers who did not consent to continue with the DysEDEN follow-up, were more often those with a lower educational level or from a low socioeconomic situation. Written consent was obtained from the mother for herself at inclusion and for her newborn child after delivery. The EDEN and DysEDEN study was approved by the *Comité Consultatif de Protection des Personnes dans la Recherche Biomédicale* (Ethics Committee, Kremlin Bicêtre Hospital) and by the *Commission Nationale de l'Informatique et des Libertés* (National Committee for Processed Data and Freedom (CNIL)).

Figure 1. Flow chart



Measures

Maternal Depressive Symptoms

Maternal symptoms of depression during pregnancy and at 3 and 5 years' follow-up were assessed using the Center for Epidemiological Studies Depression (CES-D) questionnaire (31), a 20-item questionnaire measuring the number of symptoms over the preceding week (range 0-60) with high reliability and validity (32). Although not specifically designed to measure depression in pregnancy, the CES-D has been used previously in pregnant women (33,34). The average Cronbach alpha across the 3 measurement moments was 0.88. Maternal symptoms of depression during the first year after the child's birth (4, 8, and 12 months postpartum) were measured using the Edinburgh Postnatal Depression Scale (EPDS), a 10 item questionnaire constructed to assess postnatal depression (range 0-30) (35). Cronbach alpha for our sample was 0.85. Based on these six available scores, we previously calculated trajectories of mothers' depressive symptoms using a semi-parametric mixture model (PROC TRAJ in SAS 9.3) (36). Detailed information on the trajectories and modeling procedure can be found in van der Waerden et al (12). Trajectories in the five-group model were conceptually interesting while having a good model fit. The five trajectories of maternal

symptoms of depression from pregnancy up until the child's 5th year were as follows: no symptoms (63.6%, n=560), persistent intermediate-level depressive symptoms (24.4%, n=215), persistent high depressive symptoms (2.7%, n=24), high symptoms in pregnancy only (3.3%, n=29), high symptoms in the child's preschool period only (5.9%, n=52) [Annex I].

School adjustment

Following our conceptual framework, children's school adjustment at ages 8 and 11 was based on 3 domains: child's academic difficulties, academic behavior and socialization (16), all reported by the child's mother from self-completed questionnaires.

Academic difficulties were measured using a composite score for any reported academic difficulties in the following domains: reading, writing, mathematics, and graphics (no vs yes). When a student reported at least one positive answer across domains, they were classified as having academic difficulties.

Academic behavior and *socialization* were based on subscales from the Strengths and Difficulties Questionnaire (SDQ), a questionnaire designed to evaluate the behavior and emotions of 3 to 16 year old children (37). The SDQ consists of 25 items that are divided into 5 subscales (range 0-10): emotional symptoms, conduct problems, symptoms of hyperactivity/inattention, peer relationship problems, and prosocial behavior [Annex II]. All subscales (except prosocial behavior) can be summed to obtain a score of children's overall behavioral problems (range 0 to 40). The SDQ has good psychometric characteristics and is similar to other measures such as the Child Behavioral Checklist (37). To assess academic behavior we used the SDQ peer relationship problems scale, where higher scores are indicative of more problems. To assess socialization we used the SDQ prosocial behavior scale, where lower scores indicate less prosocial behavior. For both outcomes we dichotomized the scores in normal vs. abnormal scores based on the validated cut-off scores (37).

Covariates

Covariates included in the multivariate analysis comprised maternal, child and family characteristics determined at the 8-year data sweep unless specified otherwise and associated ($p < .20$) with child outcomes and maternal depressive symptoms.

Maternal characteristics included: history of mental health problems (no vs. yes) and maternal prenatal substance use (smoking, alcohol, illicit drugs: no vs. yes).

Child characteristics included: child's sex (male vs. female), premature birth (≤ 37 vs. > 37 weeks of gestation), birth order (firstborn, additional), small for gestational age (no vs. yes), center (Poitiers vs. Nancy). Presence of special aids for learning conditions/disabilities (including special needs assistant (*Auxiliaire de Vie Scolaire*); network of specialized help for pupils in difficulty (*Réseau d'Aides Spécialisées aux Elèves en Difficulté*); and Mobile Special Education Services (*Service d'Education Spéciale et de Soins A Domicile*)). In case of a positive answer on at least one of the items, a binary variable (yes vs.no) was created. Presence of a personalized school project because of health problems (including individualized welcome project (*Projet d'Accueil Individualisé*); personalized project of schooling (*Projet Personnalisé Scolaire*)) was also assessed. In case of a positive answer on at least one of the items, a binary variable (yes vs.no) was created.

Family characteristics were: socio-economic position of mother and father (manager profession, artisan, manual laborers/farmers, student/no occupation), parental average number of years of schooling, number of siblings living at home.

Statistical analyses

Our aim was to assess whether maternal depression trajectories have an impact on the child's school adjustment. First, for the descriptive analyses we calculated percentages for the qualitative variables and the mean and standard deviation for the quantitative variables. Second, we tested associations between maternal depression trajectories and each of the school adjustment outcomes (academic difficulties, academic behavior and socialization) at the ages of 8 and 11 by means of univariate and multivariate logistic regressions with the « no depression » group serving as the reference category. We ran sensitivity analysis using Multivariate linear regressions, to test whether the outcomes from the continuous SDQ scores were in the same direction as dichotomized outcomes. Third, we used moderation analyses to examine possible interactions between maternal depressive symptoms and child sex and parental educational level with regard to child's school adjustment. In case of significant interactions we ran the multivariate analyses by stratifying on child sex and parental educational level. Missing data on covariates were handled by MICE package under R by using multiple imputations by fully conditional specification. All analyses were conducted with R version 3.6.0.

RESULTS

Samples characteristics

Table 1 presents child, maternal and family characteristics of the 880 study participants with complete data at the 8-year wave, as well as those at the 11-year assessment (n=538). The proportion of boys was 52.6% (n = 463) age 8 and 51.5% (n=277) age 11. At age 8, the mean number of years of parental education was 13.8 (SD 2.3). Concerning maternal socio professional category at age 8, 42.1% (n=367) of mothers belonged to intermediate professions and artisan category and 42.6% (n=369) of fathers belonged to employee, manual laborer and farmer categories.

The proportions of academic difficulties at age 8 was 31.1% (n=274) and 8.1% (n=40) at age 11. When the children were 8 years of age, academic behavior score was score was 1.4 (SD 1.6) in the mean socialization score was 8.3 (SD 1.7). At age 11, the mean academic behavior score was 1.2 (SD 1.5) and 8.5 (SD 1.7) for socialization.

Maternal depression trajectories and children's school adjustment age 8

In the unadjusted analyses, mother's depression trajectories were significantly associated with several aspects of children's school adjustment (**table 2**). Children had a higher risk for academic difficulties when their mothers had « high symptoms in pregnancy only » (OR: 2.60 [1.21; 5.54]) or « persistent intermediate symptoms » (OR: 1.72 [1.23; 2.39]). Children whose mothers had « high symptoms in pregnancy only » (OR: 2.43 [1.26; 4.50]), « persistent intermediate symptoms » (OR: 1.97 [1.34; 2.88]) or « persistent high depressive symptoms » (OR: 3.9 [1.63; 9.01]) showed probability of academic behavior problems. Finally, there was a significant higher risk for socialization problems in children whose mothers had « high symptoms in pregnancy only » (OR: 4.13 [1.11; 12.60]) or « persistent high depressive symptoms » (OR: 7.08 [1.52; 24.75]). Table 2 also shows the outcomes for the fully adjusted analyses for children aged 8. While the associations were attenuated, they remained in the same direction for academic difficulties, with children from the « high symptoms in pregnancy only » (OR: 2.68 [1.15; 6.21]) and « persistent intermediate symptoms » (OR: 1.47 [1.01; 2.12]) being more at risk. Children whose mothers had « persistent high depressive symptoms » had increased levels of academic behavior difficulties (OR: 7.4 [2.66; 19.55]).

Finally, socialization difficulties were present in children whose mothers had « high symptoms in the child’s preschool period only » (OR: 5.68 [1.44; 18.96]) or « persistent high depressive symptoms » (OR: 8.04 [1.46; 34.83]).

Table 1. Child, Mother and family characteristics of EDEN and DysEDEN cohort study participants,

	Child at 8 years N=880		Child at 11 years N=538	
	No. (%)	Mean (SD)	No. (%)	Mean (SD)
Child characteristics				
Sex				
Male	463 (52.6)		277 (51.5)	
Preterm birth (<37 wk), yes	49 (5.6)		33 (6.1)	
Birth order				
Firstborn	416 (47.3)		247 (45.9)	
Additional	464 (52.7)		291 (54.1)	
Small for gestational age, yes	84 (9.5)		42 (7.8)	
Aids for learning conditions, yes	43 (4.9)		36 (7.3)	
Personalized school project because of health problems, yes	82 (9.4)		27 (5.5)	
Academic difficulties, yes	274 (31.1)		40 (8.1)	
Academic behavior problems	84 (9.6)	1.4 (1.6)	46 (9.3)	1.2 (1.5)
Socialization problems	25 (2.8)	8.3 (1.7)	12 (2.4)	8.5 (1.7)
Maternal characteristics				
Maternal history of mental health problems, yes	35 (4)		25 (4.6)	
Smoking during pregnancy, yes	161 (18.3)		87 (16.2)	
Alcohol during pregnancy, yes	250 (29.7)		160 (31.2)	
Cannabis during pregnancy, yes	7 (0.8)		2 (0.4)	
Maternal depression trajectories				
No symptoms	560 (63.6)		343 (63.7)	
Persistent intermediate-level symptoms	215 (24.4)		135 (25.1)	
High symptoms in the child’s preschool period	52 (5.9)		31 (5.8)	
High symptoms in pregnancy	29 (3.3)		17 (3.2)	
Persistent high depressive symptoms	24 (2.7)		12 (2.2)	
Family characteristics				
Center				
Poitiers	416 (47.3)		258 (48)	
Nancy	464 (52.7)		280 (52)	
Mother’s socio-professional category				
Executive	107 (12.3)		75 (14.1)	
Intermediate professions, artisan	367 (42.1)		254 (47.7)	
Employee, manual laborer, farmer	255 (29.3)		134 (25.2)	
Student, no profession	142 (16.3)		69 (13)	
Father’s socio-professional category				
Executive	156 (18)		119 (22.3)	
Intermediate professions, artisan	333 (38.5)		204 (38.2)	
Employee, manual laborer farmer	369 (42.6)		206 (38.6)	
Student, no profession	8 (0.9)		5 (0.9)	
Parental years of education		13.8 (2.3)		14.1 (2.3)
Child’s number of siblings		1.8 (0.9)		0.8 (0.9)

No. (%) for qualitative variables or mean (SD) for continuous variables.

Table 2. Child's school adjustment at 8 years of maternal depression trajectories; EDEN cohort study, N = 880, 2003–2011, France unadjusted and adjusted OR (95% CI),

	No symptoms	High symptoms in pregnancy	High symptoms in the child's preschool period	Persistent intermediate-level symptoms	Persistent high depressive symptoms
	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>
Unadjusted					
Academic difficulties	0 (ref)	2.60 (1.21 ; 5.54)	1.74 (0.95 ; 3.11)	1.72 (1.23 ; 2.39)	1.99 (0.84 ; 4.54)
Academic behavior	0 (ref)	1.49 (0.54 ; 3.57)	2.43 (1.26 ; 4.50)	1.97 (1.34 ; 2.88)	3.9 (1.63 ; 9.01)
Socialization problems	0 (ref)	/	4.13 (1.11 ; 12.60)	1.67 (0.61 ; 4.29)	7.08 (1.52 ; 24.75)
Adjusted					
Academic difficulties	0 (ref)	2.68 (1.15 ; 6.21)	1.35 (0.70 ; 2.56)	1.47 (1.01 ; 2.12)	1.13 (0.41 ; 2.90)
Academic behavior	0 (ref)	1.33 (0.20 ; 4.98)	1.98 (0.76 ; 4.60)	1.61 (0.92 ; 2.76)	7.4 (2.66 ; 19.55)
Socialization problems	0 (ref)	/	5.68 (1.44 ; 18.96)	1.71 (0.60 ; 4.55)	8.04 (1.46 ; 34.83)

OR, Adjusted odds ratio; CI, confidence interval

Adjusted for sex, preterm birth, birth order, small for gestational age, aids for learning conditions, personalized school project because of health problems, center, mother's socio-professional category, father's socio-professional category, parental years of education, Child's number of siblings.

Maternal depression trajectories and children's school adjustment age 11

In the unadjusted analyses at age 11, a higher risk for academic difficulties was found when their mothers had « high symptoms in the child's preschool period only » (OR: 3.54 [1.09; 9.82]) (**table 3**). Children whose mothers had « high symptoms in the child's preschool period only » also showed higher risk of problems with academic behavior (OR: 4.68 [1.79; 11.45]). Finally, the results demonstrated higher risk for socialization problems in children whose mothers were in « persistent high depressive symptoms » group (OR: 14.71 [1.93; 78.80]). Table 3 also represents the outcomes for the fully adjusted analyses for children aged 11 years. The results showed higher risk of academic difficulties for children whose mothers had « persistent intermediate-level symptoms » (OR: 3.63 [1.33; 10.42]). Children whose mothers had maternal « high symptoms in the child's preschool period only » had increased levels of academic behavior difficulties (OR: 4.37 [1.53; 11.74]). Finally, it was observed a higher level of socialization difficulties for children whose mothers had maternal « persistent high depressive symptoms » (OR: 19.73 [1.67; 167.98]).

When SDQ scores were treated as a continuous variable in sensitivity analyses the associations remained in the same direction for both the 8 and 11 years outcomes [Annex III].

Table 3. Child's school adjustment at 11 years of maternal depression trajectories; EDEN cohort study, N = 538, 2003–2011, France unadjusted and adjusted OR (95% CI)

	No symptoms	High symptoms in pregnancy	High symptoms in the child's preschool period	Persistent intermediate-level symptoms	Persistent high depressive symptoms
	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>
Unadjusted					
Academic difficulties	0 (ref)	2.40 (0.36 ; 9.54)	3.54 (1.09 ; 9.82)	1.79 (0.84 ; 3.72)	1.95 (0.10 ; 11.44)
Academic behavior	0 (ref)	0.79 (0.04 ; 4.20)	4.68 (1.79 ; 11.45)	1.06 (0.49 ; 2.17)	/
Socialization problems	0 (ref)	/	1.98 (0.10 ; 12.21)	1.26 (0.26 ; 4.84)	14.71 (1.93 ; 78.80)
Adjusted					
Academic difficulties	0 (ref)	5.17 (0.35 ; 48.54)	2.22 (0.45 ; 9.50)	3.63 (1.33 ; 10.42)	7.40 (0.33 ; 62.65)
Academic behavior	0 (ref)	1.03 (0.05 ; 6.45)	4.37 (1.53 ; 11.74)	1.02 (0.46 ; 2.16)	/
Socialization problems	0 (ref)	/	2.32 (0.11 ; 16.60)	1.14 (0.22 ; 4.70)	19.73 (1.67 ; 167.98)

OR, Adjusted odds ratio; CI, confidence interval

Adjusted for sex, preterm birth, birth order, small for gestational age, aids for learning conditions, personalized school project because of health problems, center, mother's socio-professional category, father's socio-professional category, parental years of education, Child's number of siblings.

Effects by child sex and parental educational level

We found statistically significant interactions for between maternal depressive symptom trajectories and children's school adjustment at age 8 according to child sex (Academic difficulties: p-value = 0.02; Academic behavior: p-value = 0.006; Socialization problems: p-value = 0.01) and parental educational level (Academic difficulties: p-value = 0.01; Academic behavior: p-value = 0.006; Socialization problems: p-value = 0.02).

Child sex

Adjusted analyses stratified by child sex showed that at 8 years old, boys had a higher risk for school adjustment difficulties across domains compared to girls. Boys have more academic behavior and socialization difficulties compared to girls in case of mothers with « Persistent high depressive symptoms » (**table 4**). For the children whose mothers had « high symptoms in the child's preschool period only » socialization difficulties were higher in boys (OR: 5.56 [1.15; 20.99]) compared to girls (OR: 4.13 [1.11; 12.59]).

Parental educational level

At age 8, children whose mothers were in the « persistent high depressive symptoms » group had a higher risk of academic difficulties in case of low parental educational level (socialization problems (OR: 7.37 [1.50; 28.60]) and academic behavior (OR: 5.3 [1.73; 14.96])) (**table 5**). Furthermore children whose parents had a lower educational background had more socialization problems when their mothers was depressed in pregnancy (OR: 7.37 [1.50; 28.60]) or had « persistent intermediate-level symptoms » (OR: 1.51 [1.01; 2.29]). High parental educational level was only associated with increased risk for Academic difficulties when mothers experienced intermediate level symptoms (OR: 1.84 [1.01; 3.29])

Due to the small number of participants at age 11, moderation analyses could not be performed due to too few observations for some of the tested interactions.

Table 4. Child's school adjustment at 8 years of maternal depression trajectories stratified by child sex ; EDEN cohort study, N = 880, 2003–2011, France, adjusted OR (95% CI)

	No symptoms	High symptoms in pregnancy	High symptoms in the child's preschool period	Persistent intermediate-level symptoms	Persistent high depressive symptoms
	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>
Girls					
Academic difficulties	0 (ref)	2.98 (1.05 ; 8.43)	1.57 (0.66 ; 3.49)	1.21 (0.72 ; 2)	1.65 (0.49 ; 4.98)
Academic behavior	0 (ref)	0.86 (0.04 ; 4.65)	1.49 (0.33 ; 4.79)	1.04 (0.41 ; 2.41)	3.53 (0.75 ; 12.57)
Socialization problems	0 (ref)	/	4.13 (1.11 ; 12.59)	1.66 (0.60 ; 4.29)	7.08 (1.51 ; 24.75)
Boys					
Academic difficulties	0 (ref)	2.25 (0.70 ; 6.98)	2.02 (0.83 ; 4.78)	2.35 (1.49 ; 3.71)	2.63 (0.71 ; 9.69)
Academic behavior	0 (ref)	1.01 (0.05 ; 5.56)	2.36 (0.65 ; 6.87)	1.94 (0.98 ; 3.77)	11.2 (2.94 ; 42.87)
Socialization problems	0 (ref)	/	5.56 (1.15 ; 20.99)	1.06 (0.23 ; 3.74)	15.91 (3.02 ; 70.27)

OR, Adjusted odds ratio; CI, confidence interval.

Table 5. Child's school adjustment at 8 years of maternal depression trajectories stratified by parental educational level ; EDEN cohort study, N = 880, 2003–2011, France, adjusted OR (95% CI)

	No symptoms	High symptoms in pregnancy	High symptoms in the child's preschool period	Persistent intermediate-level symptoms	Persistent high depressive symptoms
	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>	<i>OR (95% CI)</i>
Low Parental Educational (≤ 14)					
Academic difficulties	0 (ref)	1.60 (0.59 ; 4.18)	1.81 (0.92 ; 3.52)	1.51 (1.01 ; 2.29)	1.60 (0.59 ; 4.18)
Academic behavior	0 (ref)	1.25 (0.19 ; 4.70)	1.52 (0.49 ; 3.93)	1.28 (0.64 ; 2.49)	5.3 (1.73 ; 14.96)
Socialization problems	0 (ref)	7.37 (1.50 ; 28.60)	2.99 (0.63 ; 10.8)	0.81 (0.17 ; 2.86)	7.37 (1.50 ; 28.60)
High Parental Educational (> 14)					
Academic difficulties	0 (ref)	0.56 (0.03 ; 3.19)	0.41 (0.02 ; 2.19)	1.84 (1.01 ; 3.29)	2.26 (0.30 ; 11.95)
Academic behavior	0 (ref)	/	2.77 (0.40 ; 11.60)	1.86 (0.76 ; 4.28)	6.94 (0.91 ; 38.30)
Socialization problems	0 (ref)	/	7.57 (0.36 ; 64.90)	4.62 (0.99 ; 23.90)	/

OR, Adjusted odds ratio; CI, confidence interval

DISCUSSION

Main findings

This aim of this study was to explore the association between maternal depressive symptom trajectories and children's school adjustment during middle childhood. We found that maternal depression, irrespective of timing, had an adverse impact on several domains of children's school adjustment. In particular, compared to children of never depressed mothers, children of mothers who have persistently high levels of depressive symptoms have more academic behavior and socialization difficulties at ages 8 and 11. This association appears to be stronger in boys and in children whose parents have a lower educational level.

Interpretations

Academic difficulties

Children had a higher probability of academic difficulties at 8 years when their mothers experienced depression during pregnancy. Pregnancy is a sensitive period for the development of neurological structures, and prenatal maternal depression is associated with subsequent impairments in child cognitive development (8,9,38–40), which is likely to be associated with a child's subsequent academic achievement.. Previously, in the EDEN cohort, maternal « persistent high depressive symptoms » trajectories were found to be associated with a lower IQ at age 5 (13). Surprisingly, we did not find evidence that persistent maternal depression impacted children's academic difficulties at either 8 or 11 years follow-up. One explanation may be that the children who had lower overall IQ age 5 were identified early on and benefited from special aids in their schooling, resulting in fewer academic difficulties at age 8 and 11. Alternatively, it could be that due to selective attrition in the EDEN cohort, children with lower IQ scores no longer participated at the 8 and 11 years follow-up. Additionally, as our measure of academic difficulties did not include grades or other aspects of academic achievement, it could be that we did not capture those aspects of academic difficulties that are usually associated with children's IQ, such as test scores..

At 11 years, children for whose mother had « high depressive symptoms in preschool » also had higher risk for academic difficulties. To our knowledge, there are no previous studies which have found a similar association. However, mothers who are depressed during the earliest years of schooling may negatively affect a child's trajectory with regard to academic achievement (18,19). This might be due to the fact that these children were less likely to attend preschool and had fewer children's books in their

homes (18). As depressed mothers are less engaged in these activities that prepare for formal schooling, their children may have been less prepared for school, which could precede academic difficulties.

Academic behavior

Persistent maternal depressive symptoms, at either intermediate or high level were associated with children's academic behavior problems. Academic behavior, and peer relationships in particular, is very important for the child's school adjustment as has been found to predict later academic achievement (41). Maternal depression has previously been found to be associated with children's relationships problems, (42). Indeed, previous studies demonstrated that adolescents whose mother has chronic depression had high levels of peer relationship problems (27,43). Mother's home-based involvement and parenting has been found to be a promotive factor for academic adjustment and protective factor for the pathway from risk to children's behavior problems (44,45). As parental involvement is generally compromised in the case of depression, this might explain why maternal depressive symptoms have a negative impact on academic behavior and peer relationships in particular (10).

Socialization problems

Previous studies showed that academic socialization positively influences academic achievement and school behavior (46–49). Socialization difficulties due to maternal depressive symptoms have also been found to be associated children's school adjustment (50). In our study, children whose mother had « persistent high depressive symptoms » had higher risk of socialization problems at age 8 compared to those with a never depressed mother. Generally, parental attitudes and practices provide the foundation for children's development of schemas about social interactions that are also important in the school setting and are critical determinants of children's early school experiences (51). Previous studies demonstrated that maternal depressive symptoms during infancy and childhood predict worse social outcomes for children (11,52,53).

Impact of child sex and parental educational level

While it is generally thought that especially girls are impacted by their mother's depression, we found that boys were more affected by maternal depression trajectories at age 8 with predominance of socialization problems. However, our results are in line with results from previous studies (27,54–56). It has also been thought that girls are adaptable and prosocial than boys when mothers have maternal depressive symptoms (57). This could be because girls are more resilient than boys (58) or arise from a tendency on the part of depressed mothers to respond better to their daughters than their sons (57).

Additionally, children whose mother is depressed appear to have more academic behavior difficulties and socialization problems when their parents have low educational level. The results of previous studies (10,28,50,59) showed the same trend concerning the impact of low parental educational level on academic problems. Besides the direct impact of parental educational level on children's school outcomes, lower educational level is also associated with increased risk for maternal depression (29). Thus, children of low educated mothers are at increased risk for problems with school adjustment through this combination of risk factors. Families with higher socio-economic position often have higher levels of parental involvement and higher expectations about children's future level of education (60,61). This lack of involvement may negatively influence the child's academic behavior and socialization at school (46–49). However, Hine's study proved that although families had low educational level, they were able to provide support and encouragement to their children which led them to excel in school (62). Furthermore there is an association between parental education levels and cognitive performance (55) and particularly to attention and memory abilities (64).

Strengths and limitations

The current study has several strengths including a large community sample at 8 years, a follow-up until 11 years after birth, the use of validated measures to assess peer relation problems, socialization and maternal mental health, and the control of several confounding variables. Yet, some limitations of the current study should be noted. Firstly, attrition from the cohort has generated a small effective at the 11 year wave and this induced a low statistical power to test our interaction analyses in particular. Moreover, attrition from the DysEDEN study was selective. Mainly parents with a higher socioeconomic position and with children who did well at school participated at age 11, making it difficult to find associations with school adjustment problems. Secondly, we relied on maternal reports of depressive symptoms rather than diagnoses to define depression. It is therefore possible that these results concern only mothers with different longitudinal patterns of distress and not women with clinical of major depressive disorder. Thirdly, we relied on measures of maternal report for the children's adjustment, which may more easily biased by their own mental state. Teachers observe children in a group context where they can compare different children's behaviors; they may have a better understanding of normative child development (65). Integrating the evaluations of both mothers and teachers might allow predicting more accurately whether a child is at risk of academic adjustment problems. Finally, it is unfortunate that we don't have school grades for children at 8 and 11 years. These would have allowed us to have a more objectives measures for academic difficulties.

Recommendations for research and practice

The results of the current study provide several suggestions for research on children who are impacted by maternal depressive symptoms, specifically on school adjustment. Future research needs to examine if the association found between maternal depression and child's school adjustment will continue to have an impact on both academic achievement, as well as later professional status. The identification of the impact of maternal depression on school adjustment (specifically on academic behavior and socialization problems) draws attention to the need for specific mental health planning practices for families (42). The current results also emphasize the importance of intervention and prevention efforts targeting maternal depressive symptoms from an early age. Home-based interventions to promote parental involvement, especially for socioeconomically disadvantaged families, as well as providing children as risk with adequate school support (18,42) appear to be promising interventions. It could further be interesting to target children with academic behavior or socialization problems and organize activities with them. The goal is to give them the attention they do not have with their mother suffering from maternal depression (42).

Conclusions

The present study provided evidence of the impact maternal depressive symptom trajectories on different aspects of child's school adjustment. Children of mothers who have persistently high levels of depressive symptoms have more academic behavior and socializations difficulties, which may ultimately contribute to a less than optimal academic career. As this might impact their future socioeconomic position, it is important to intervene as early as possible.

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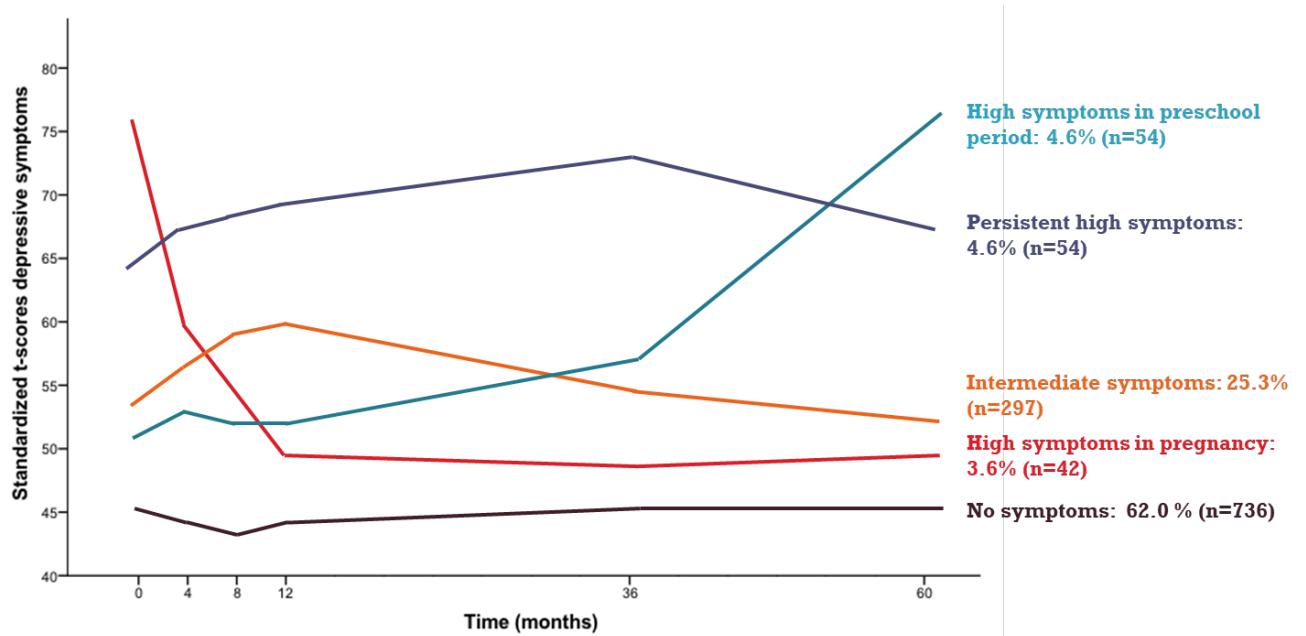
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A N N E X E S

Annex I: Trajectories of maternal symptoms of depression by child's age in months in the EDEN cohort study



Based on van der Waerden et al, Psychol Med. 2015 Jul;45(9):1999-2012

Annex II: Scoring the Informant-Rated Strengths and Difficulties Questionnaires

The 25 items in the SDQ comprise 5 scales of 5 items each. It is usually easiest to score all 5 scales first before working out the total difficulties score. Somewhat True is always scored as 1, but the scoring of Not True and Certainly True varies with the item, as shown below scale by scale. For each of the 5 scales the score can range from 0 to 10 if all 5 items were completed. Scale score can be prorated if at least 3 items were completed.

<u>Peer Problems Scale</u>	Not True	Somewhat True	Certainly True
Rather solitary, tends to play alone	0	1	2
Has at least one good friend	2	1	0
Generally liked by other children	2	1	0
Picked on or bullied by other children	0	1	2
Gets on better with adults than with other children	0	1	2

<u>Prosocial Scale</u>	Not True	Somewhat True	Certainly True
Considerate of other people's feelings	0	1	2
Shares readily with other children	0	1	2
Helpful if someone is hurt, upset or feeling ill	0	1	2
Kind to younger children	0	1	2
Often volunteers to help others	0	1	2

Interpreting Symptom Scores and Defining "Caseness" from Symptom Scores

Although SDQ scores can often be used as continuous variables, it is sometimes convenient to classify scores as normal, borderline and abnormal. Using the bandings shown below, an abnormal score on one or both of the total difficulties scores can be used to identify likely "cases" with mental health disorders. This is clearly only a rough-and-ready method for detecting disorders – combining information from SDQ symptom and impact scores from multiple informants is better, but still far from perfect. Approximately 10% of a community sample scores in the abnormal band on any given score, with a further 10% scoring in the borderline band. The exact proportions vary according to country, age and gender – normative SDQ data are available from the web site. You may want to adjust banding and caseness criteria for these characteristics, setting the threshold higher when avoiding false positives is of paramount importance, and setting the threshold lower when avoiding false negatives is more important.

<u>Parent Completed</u>	Normal	Borderline	Abnormal
Total Difficulties Score	0 - 13	14 - 16	17 - 40
Emotional Symptoms Score	0 - 3	4	5 - 10
Conduct Problems Score	0 - 2	3	4 - 10
Hyperactivity Score	0 - 5	6	7 - 10
Peer Problems Score	0 - 2	3	4 - 10
Prosocial Behaviour Score	6 - 10	5	0 - 4

Annex III: Trajectories of maternal depression and child academic behavior and socialization problems at 8 and 11 multivariate linear regression analyses β (95% CI)

	No symptoms	High symptoms in pregnancy	High symptoms in the child's preschool period	Persistent intermediate-level symptoms	Persistent high depressive symptoms
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Adjusted : 8 years					
Academic behavior	0 (ref)	0.27 (0.73 ; 2.37)	0.77 (1.39 ; 3.34)	0.43 (1.20 ; 1.96)	1.29 (1.93 ; 6.87)
Socialization problems	0 (ref)	0.10 (0.57 ; 2.15)	-0.26 (0.46 ; 1.25)	-0.29 (0.56 ; 0.97)	-0.81 (0.21 ; 0.90)
Adjusted : 11 years					
Academic behavior	0 (ref)	0.49 (0.73; 3.63)	0.48 (0.90 ; 2.92)	0.24 (0.94 ; 1.73)	-0.0004 (0.37 ;2.66)
Socialization problems	0 (ref)	0.46 (0.64 ; 3.90)	-0.17 (0.43 ; 1.65)	-0.21 (0.56 ; 1.15)	-0.62 (0.17 ; 1.65)

β , Adjusted; CI, confidence interval.

Adjusted for sex, preterm birth, birth order, small for gestational age, aids for learning conditions, personalized school project because of health problems, center, mother's socio-professional category, father's socio-professional category, parental years of education, Child's number of siblings.