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Research paper

Trajectories of maternal depressive and anxiety symptoms and child's socio-emotional outcome during early childhood

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ABSTRACT

Maternal symptoms of depression and anxiety during pregnancy and early postnatal years are suggested to impose differential negative effects on child's socio-emotional development depending on the characteristics of the symptoms, such as timing, intensity, and persistence. The aim of this study was to identify trajectories of maternal depressive and anxiety symptoms from pregnancy until 2 years postpartum and to examine their relationship with child socio-emotional problems and competence at 2 and 5 years of age.

The sample included 1208 mother-infant dyads from FinnBrain Birth Cohort study. Latent growth mixture modelling (LGMM) was utilized to model the trajectories of maternal depressive symptoms, measured using the Edinburgh Postnatal Depression Scale (EPDS), and general anxiety, measured with Symptom Checklist-90 (SCL-90) at 14, 24, and 34 weeks' gestation (gw) and at 3, 6 and 24 months postpartum. Maternal depression was also assessed at 12 months. Child socio-emotional problems and competence were evaluated using the Brief Infant Toddler Social Emotional Assessment (BITSEA) at 2 years and Strengths and Difficulties Questionnaire (SDQ) at 5 years. Relevant background factors and maternal concurrent symptomatology were controlled for.

The trajectories of maternal depressive and anxiety symptoms were associated negatively with differential aspects of child long term socio-emotional outcomes from early toddlerhood to preschool years. The trajectories of depressive symptoms and high-level persistent symptoms that continued from pregnancy to two years of child age had the strongest negative association with child outcomes. This highlights the importance of identifying and treating maternal symptomatology, especially that of depression, as early as possible.

1. Introduction

Strong evidence suggests that maternal depression and anxiety in pregnancy and postpartum predict offspring behavioral and socio-emotional problems from infancy to adolescence (Field et al., 2010a; Hartman et al., 2020; Korja et al., 2017; Madigan et al., 2018; O'Donnell et al., 2014; Rees et al., 2019). Despite the broad literature on these exposures, knowledge on the roles of the severities, timings, and temporal courses of these maternal symptoms, with regard to later child development, remains incomplete. More understanding is also needed on how maternal depression and anxiety may affect negatively specific dimensions of child long term socio-emotional development. Delineating the differential trajectories of maternal mental health pre- and postnatally, as well as the specific dimensions of child development that may be affected, is important for the reliable assessment of the long-term risks for adverse offspring outcomes.

The estimated prevalence of clinically significant socio-emotional problems in childhood varies from 7 to 25 % from toddlerhood until

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preschool years, depending on the utilized time points and measures (Alakortes et al., 2015; Briggs-Gowan et al., 2001; Sourander, 2001). Problems in socio-emotional development typically present as emotional and behavioral symptoms that can be divided into two broad categories: externalizing and internalizing symptoms (Martin et al., 2011; Briggs-Gowan et al., 2004; Campbell et al., 2000; Achenbach and Edelbrock, 1978). In young children, externalizing symptoms include aggressive and externally directed behaviors, such as conduct problems, impulsive and hyperactive behavior, and destructive or oppositional behavior (Briggs-Gowan et al., 2004; Achenbach and Edelbrock, 1978). In turn, internalizing symptoms in toddlers or preschoolers include symptoms of anxiety and depression and pronounced withdrawal (Briggs-Cowan et al., 2006; Achenbach and Edelbrock, 1978). Of note, early childhood externalizing and internalizing symptoms often overlap -the psychiatric phenotypes are still less differentiated compared to later age. Longitudinal studies have indicated that socio-emotional problems in early childhood are relatively stable and predict later psychiatric disorders (Haapsamo et al., 2012; Briggs-Gowan and Carter, 2008) as well as children's daily functioning and quality of life (Mathiesen and Sanson, 2000; Mesman et al., 2001; Van Zeijl et al., 2006; Alink et al., 2006).

Socio-emotional competence is another key aspect of child development. A child with high socio-emotional competence is able to collaborate with others, understand social cues, and form and maintain developmentally adequate relationships with peers and adults (Denham et al., 2009; Rubin et al., 2006). Hence, deficits in socio-emotional competence are important to identify when evaluating developmental outcomes and early childhood psychopathology (Huber et al., 2019). Children who do not have age-appropriate socio-emotional competencies may have heightened risk for the development or maintenance of socio-emotional problems (Cicchetti, 1993; Masten and Coatsworth, 1995). Conversely, early socio-emotional problems may interfere with the development of socio-emotional competencies (Briggs-Gowan et al., 2001).

Clinically significant depressive symptoms affect approximately 10–20 % of mothers during pregnancy (Figueiredo and Conde, 2011; Skouteris et al., 2009; Teixeira et al., 2009) and 13 %–19 % of mothers during the postnatal period (O'Hara & McCabe, 2013; Figueiredo and Conde, 2011; Skouteris et al., 2009). The prevalence of maternal anxiety symptoms varies from 10 to 29 % during pregnancy (Figueiredo and Conde, 2011; Heron et al., 2004; Skouteris et al., 2009; Teixeira et al., 2009) and from 10 to 19 % postpartum (Figueiredo and Conde, 2011; Skouteris et al., 2009; Heron et al., 2004). Maternal pre- and postnatal depressive and anxiety symptoms may both have persistent effects on child socio-emotional development (Madigan et al., 2018; Rees et al., 2019). Co-morbidity between depression and anxiety is high during the perinatal period (Skouteris et al., 2009; Ibanez et al., 2012, Field et al., 2010a, 2010b) In the study of Falah-Hassani et al. (2017) the prevalence of co-morbid anxiety and depression across the three trimesters was 9.5 % and postnatally, 8.2 %%. Despite the high comorbidity depression and anxiety are at least partially distinct conditions, supported by the notions of differential symptom course trajectories (Penninx et al., 2011; Korja et al., 2017), clinical prognostic factors (Penninx et al., 2011, Almeida et al., 2012) and pathophysiology (Lemche et al., 2013).

There is strong evidence indicating that both prenatal and postnatal maternal psychiatric symptoms are independently associated with child's behavioral and socio-emotional problems from infancy to adolescence (Field et al., 2010a; Hartman et al., 2020; Korja et al., 2017; Madigan et al., 2018; O'Donnell et al., 2014; Rees et al., 2019). There are at least partly different mechanisms behind prenatal and postnatal exposures which may potentially cause differences in the effects of depression/anxiety on child outcomes. During pregnancy, maternal depressive or anxiety symptoms are suggested to affect the child mainly through different intrauterine processes, including altered HPA axis activity, placental functioning, immunological milieu, or nutritional supply (Egliston et al., 2007; O'Donnell et al., 2009; Van den Bergh et al., 2017). Consequences have been traced up until adulthood (Goodman et al., 2011; Weissman et al., 2017), underscoring the need to consider the role of maternal prenatal mental health in developmental psychopathology. Postnatal maternal depressive and anxiety symptoms solely may also affect negatively on child long-term socio-emotional and behavioral outcomes (Rees et al., 2019; Gjerde et al., 2020; Goodman et al., 2011). After pregnancy, plausible causal mechanisms include the impact of maternal mental health on parenting behavior and general family functioning. Especially the negative impact of depressive and anxiety symptoms on caregiving quality has been widely demonstrated (Field et al., 2010a, 2010b; Hakanen et al., 2019; Leerkes et al., 2009). However, the effects of maternal mental health on child socio-emotional outcomes can also be explained by direct genetic inheritance, as maternal and child psychiatric symptoms may indicate a shared underlying genotype (Glover, 2011; Hannigan et al., 2018; O'Donnell and Meaney, 2017).

Previous studies have indicated that that continuously elevated and high maternal symptom levels from pregnancy to toddlerhood (Pietikäinen et al., 2020; Porter and Hsu, 2003) or from infancy to toddlerhood (Prenoveau et al., 2017) predict offspring socio-emotional problems from toddlerhood to school years. Knowing that there is heterogeneity in the prevalence and course of maternal symptoms, person centered approaches would be beneficial in longitudinal trajectory studies as they may capture the heterogeneity better than correlational, mixed methods or latent growth curve modelling. One-person centered modelling approach is latent class modelling which can be applied to longitudinal data by using latent growth mixture modelling (Ram and Grimm, 2009). Studies using that approach in modelling maternal depressive and anxiety symptoms during the pre- and postnatal period have identified at least stable low and high trajectories (Baron et al., 2017; Kiviruusu et al., 2020; Ahmed et al., 2019). However, many studies also identify "transient high" trajectories representing either increasing, decreasing or variable symptoms over the course peripartum – e.g., reflecting only pre- or only postnatal distress trajectories (Baron et al., 2017; Putnick et al., 2020; Ahmed et al., 2019.

Depression and anxiety not only have differences in their biological correlates (Karlsson et al., 2017) but may also induce distinct effects on fetal development (Davis et al., 2004; Nolvi et al., 2016) as well as on maternal caregiving behavior (Hakanen et al., 2019). Based on a recent meta-analysis, the association between maternal depressive symptoms and child socio-emotional problems is typically more robust than the association between maternal anxiety and child problems (Madigan et al., 2018). Another recent meta-analysis showed that after adjustment for other risk factors, maternal prenatal general and pregnancy-specific anxiety as well as postnatal anxiety symptoms was related to child socio-emotional problems significantly but with relatively small effect sizes (Rees et al., 2019). Thus, the role of maternal anxiety symptoms is especially unclear, and more so, when considering the timing and duration of symptoms (prolonged vs. limited exposure). The aim of this study was to examine the trajectories of maternal depressive and anxiety symptoms from pregnancy to 2 years of child age in relation to child socio-emotional problems and socio-emotional competence at 2 and 5 years of age in the FinnBrain Birth Cohort Study. We identified maternal trajectories of depressive and anxiety symptoms across the three pregnancy trimesters and three or four postpartum time points using latent growth mixture modelling (LGMM). Child socio-emotional outcomes including both internalizing and externalizing symptoms as well as socio-emotional competence/prosocial behavior were measured at 2 and at 5 years of age.

2. Methods

2.1. Participants

The sample consisted of N = 1208 mother-infant dyads from the FinnBrain Birth Cohort Study (Karlsson et al., 2017). The families were

recruited to the study during the first trimester pregnancy ultrasound at 12 weeks' gestation (gw). The inclusion criteria for the study were a verified pregnancy and a knowledge of either Finnish and/or Swedish (the official languages in Finland). The sample of the present study included dyads where the mother reported her own symptoms at least once during the follow-up and the child's emotional and behavioral symptoms at 24 months postpartum and at 5 (or 4) years of child age. The 4-year data was used to complement the missing 5-year data for some dyads (N = 127). The descriptive statistics of the participants are shown in Table 1. Compared to the baseline cohort, the mothers included in the current study were older (M = 31.7) than their non-responder counterparts (M = 30.3) (t[3801] = −8.94, p < 0.001). The mothers in the sample were also more highly educated (χ^2[2] = 119.9, p < 0.001), with more mothers in the high vs. in the low education class (44.1 % vs. 27.3 %) compared to the baseline cohort (26.7 % vs. 44.1 %) and more often primiparous (55.2 % vs 44.8 %; χ^2[1] = 10.07, p = 0.002) than their non-responder counterparts (49.3 % vs. 50.7 %). The participating mothers also had less depressive and anxiety symptoms during pregnancy, and less depressive symptoms at 6 months of age (ps <0.03), but no differences were observed at 3 months or in anxiety symptoms at 6 months of age.

2.2. Procedures

Families were recruited to the study at gw 12. Written informed consent was obtained from the parents. Mothers reported their depressive and anxiety symptoms using the Edinburgh Postnatal Depression Scale (Cox et al., 1987) and the anxiety scale of the Symptom Checklist -90 (Derogatis et al., 1973) at gw 14, 24 and 34, as well as at 3, 6 and 12 months (only EPDS) and at 2 and 5 years postpartum. Maternal report of child symptoms at 2 years of age was collected using Brief Infant Toddler Social-Emotional Assessment (Briggs-Gowan and Carter, 2002) and at 4 and 5 years of age using Strengths and Difficulties Questionnaire (Goodman, 2001). The descriptive statistics of maternal and child symptoms are shown in the Table 2. Background information on maternal education was gathered at baseline (gw 14) and mothers reported on their use of alcohol and tobacco twice during pregnancy, at gw 14 and 34. Information on duration of gestation, child sex and date of birth, and maternal obstetric complications were drawn from the Finnish Medical Birth Register kept by the Finnish institute for health and welfare (www.thl.fi). A more detailed description of the background factors is in the Supplement. The Ethics Committee of Western Finland has approved the study protocol (14.6.2011 ETMK: 57/180/2011 § 168) and the study was conducted in compliance with the Declaration of Helsinki.

Table 1
The sociodemographic characteristics of the study sample (N = 1208).

Mother-child dyads	Mean (SD), range	No. (%)
Maternal characteristics		
Maternal age at childbirth	31.7 (4.3), 19–45	
Race/ethnicity, White/Caucasian		99.9%[a]
Educational level		
Secondary education or lower		314 (26)
Vocational tertiary (applied university/ polytechnics)		330 (27)
University degree		513 (43)
Missing		51 (4)
Parity		
Primiparous		638 (53)
Multiparous		516 (43)
Missing		54 (4)
Complications during pregnancy[b]		217 (18)
Smoking		
During pregnancy		136 (11)
1st trimester		90 (7)
3rd trimester		46 (4)
Child Characteristics		
Infant sex, male		658 (55)
Birth weight	3548 (523), 940–5470	
Duration of gestation	39.8 (1.6), 26–43	
Born < gestational week 37		54 (4)
APGAR at 5 min after birth, ≤ 6		83 (7)
Child age at 2-year assessment	2.05 (0.05), 2.0–2.7	
Child age at 5-year assessment	5.20 (0.20), 4.7–6.0	
Analyses complemented by 4-year assessments	4.06 (0.34), 4.0–6.0	

[a] There were fewer than 5 mothers with ethnic origin other than White/ Caucasian.
[b] Hypertension, pre-eclampsia, gestational diabetes or prenatal anemia.

2.3. Measures

2.3.1. Maternal symptoms of depression and anxiety

Maternal symptoms of depression were assessed using the EPDS. The EPDS has been studied extensively and it is suggested to be a valid screen for both pre- and postnatal depression (Cox, 1996; Cox et al., 1987, Chaudron and Wisner (2014), Boyce et al., 1993, Eberhard-Gran et al., 2001. The EPDS consists of 10 items rated from 0 to 3. The symptom score ranges from 0 to 30, higher scores reflecting greater levels of depressive symptoms. A cut-off value of 10 or higher is used to identify mild and a cut-off value of 13 or higher is used identify moderate level of clinical depression. The anxiety symptoms were assessed using the 10-item anxiety subscale of the SCL-90 questionnaire, a validated and widely used measure of anxiety in clinical and research settings (Derogatis et al., 1973; Holi, 2003). The SCL-90 items are responded to on a scale from 0 to 5, with the sum ranging from 0 to 50, higher scores reflecting greater levels of anxiety symptoms. There is no clinical cut off for the SCL-90 questionnaire. However, 15.5 has presented to be a valid value for the screening anxiety symptoms (Holi, 2003). Measures from pregnancy, 3 and 6 months and 2 years postpartum were used to model the symptom trajectories. Additionally, symptoms at 5 years of child age were used to control for concurrent symptoms in the models' testing associations with child outcomes at 5 years. Both measures showed adequate to good internal consistency within the sample of the present study (Cronbach's alphas for the EPDS = 0.82 to 0.86 and for the SCL-90 = 0.81 to 0.86). The factor structures of maternal depressive symptoms in EPDS questionnaire and of maternal anxiety symptoms in SCL-90 questionnaire are presented in the Supplement.

2.3.2. Child behavioral symptoms

Child behavioral symptoms were evaluated based on the maternal reports at the child's age of 2 years using the questionnaire of Brief Infant Toddler Social Emotional Assessment (BITSEA, Briggs-Gowan and Carter, 2002). The Brief version of ITSEA is a screening tool for 12 to 36-month-old children in pediatric settings (Briggs-Gowan et al., 2004). The measure consists of 42 items that form two main scales: social competence (11 items) and social-emotional problems (31 items), of which the latter is further divided to internalizing and externalizing symptoms and to the scales of dysregulation and autism spectrum. Parents respond to the items on a scale from 0 to 2 based on their child's behavior during the past month. Higher scores in the symptom scales reflect more pronounced symptoms, and higher scores in the competence scale reflect higher social competence. In the present study, the following scales were used in the analyses: social-emotional competence scale (Cronbach's alpha = 0.60), total social-emotional problems scale (α = 0.70), internalizing (α = 0.64) and externalizing symptom scales (α = 0.61), showing low to adequate internal consistency, in line with the previous studies in the Finnish general population using BITSEA

Table 2
The descriptive statistics of maternal and child symptoms.

	Mean (SD)							
Maternal symptom trajectories	Gw 14	Gw 24	Gw 34	M3	M6	M12	2 yr	5 yr
Depressive symptoms (EPDS)	4.7 (3.9)	4.6 (3.9)	4.6 (4.0)	4.2 (3.8)	4.3 (4.1)	4.7 (4.0)	4.5 (4.2)	4.9 (4.5)
Postnatal N = 28	4.5 (2.3)	5.3 (3.0)	6.7 (3.6)	8.2 (3.6)	12.6 (5.8)	12.4 (4.9)	14.1 (4.4)	9.6 (5.5)
Prenatal N = 59	13.3 (3.7)	12.4 (4.4)	10.6 (4.0)	7.7 (3.5)	7.5 (3.6)	7.4 (2.8)	5.9 (3.1)	7.8 (5.3)
Elevated stable N = 272	5.5 (3.1)	5.7 (3.3)	6.0 (3.8)	6.5 (3.4)	6.8 (3.6)	8.1 (2.9)	7.9 (3.4)	7.1 (4.1)
High and stable N = 44	11.6 (4.0)	11.1 (4.3)	12.2 (3.7)	12.1 (3.9)	13.7 (4.3)	13.7 (4.1)	12.7 (3.6)	11.9 (5.9)
Low and stable N = 796	3.5 (2.8)	3.2 (2.8)	3.1 (2.7)	2.7 (2.7)	2.5 (2.3)	2.7 (2.2)	2.5 (2.4)	3.5 (3.5)
Anxiety symptoms (SCL-90)	3.1 (3.8)	3.6 (4.1)	3.0 (3.8)	2.5 (3.4)	2.6 (3.8)	–	2.7 (3.8)	3.9 (4.8)
Postnatal N = 64	6.1 (3.4)	8.8 (4.4)	8.7 (4.4)	9.6 (4.4)	12.0 (5.2)	–	12.2 (5.7)	12.0 (7.6)
Prenatal N = 104	10.1 (3.9)	9.6 (4.5)	7.8 (4.3)	5.6 (3.9)	5.0 (3.2)	–	4.4 (3.4)	7.4 (6.0)
High and decreasing N = 10	21.8 (6.8)	23.1 (4.7)	18.3 (7.8)	13.0 (4.8)	12.4 (8.1)	–	10.2 (5.5)	11.4 (6.4)
Low and stable N = 1018	2.0 (2.0)	2.5 (2.5)	2.0 (2.2)	1.7 (2.2)	1.8 (2.4)	–	1.9 (2.5)	3.1 (3.7)
Child symptoms	**M (SD)**	**Range**						
At 2 years, total (BITSEA)	7.4 (4.2)	0–34						
Internalizing	3.3 (2.4)	0–23						
Externalizing	2.6 (2.0)	0–11						
Social competence	18.1 (2.5)	6.6–22						
At 5 years, total	8.8 (5.0)	0–27						
Emotional symptoms	1.2 (1.3)	0–8						
Conduct problems	2.8 (2.0)	0–9						
Prosocial behavior	1.6 (1.5)	1–10						

(Alakortes et al., 2015; Kovaniemi et al., 2018).

At 5 years of age (or at 4 years of age for N = 127 participants), the behavioral symptoms were assessed using the Strengths and Difficulties Questionnaire (SDQ) that is a widely used and validated tool for the screening of socio-emotional problems of 3 to 16-year-old children in a range of countries (Goodman, 2001), including Nordic countries (Borg et al., 2014; Obel et al., 2004; Koskelainen et al., 2000). The 25-item questionnaire is comprised of the main scale of total difficulties (20 items) which can further be divided to scales of emotional symptoms, conduct problems, hyperactivity/inattention and peer relationship problems, each rated based on 5 items. Additionally, there is a scale of prosocial behavior (5 items): The parents rate each item on a scale from 0 to 2 with sum scores ranging from 0 to 10 for the subscales and 0–40 for the total problems score. Higher scores reflect more symptoms, except for the prosocial scale, where higher scores reflect higher prosocial behavior. In the present study, the following scales were used in the analyses: the scales of conduct problems (Cronbach's α = 0.79) prosocial behaviors (α =0.73) total problems (α = 0.66) and emotional symptoms (α = 0.53). The scales showed low to adequate internal consistency, which is in line with several previous studies that showing that regardless of the low alphas, the original factor structure of the measure can still be confirmed (Stone et al., 2015; Croft et al., 2015).

2.4. Statistical analyses

2.4.1. Trajectories of maternal depressive and anxiety symptoms.=

The trajectories of maternal pre- and postnatal depressive and anxiety symptoms across pregnancy and at 3, 6 and 12 months (only depressive symptoms) and 2 years postpartum were modelled using Latent Growth Mixture Modelling (LGMM; Muthén & Muthén, 2000). In this approach, growth curves of depressive/anxiety symptoms (in separate models) are estimated for each individual, and then prototypic growth curves are identified for subgroups. The aim is to select the latent curves (i.e. the developmental patterns in symptoms) that most optimally describe the data. Moreover, the real-life interpretability of the latent curves is also used to determine the optimal model. Participants with missing data on symptoms were incorporated in the analyses to minimize bias (Nagin, 2005) by using maximum likelihood under the missing-at-random assumption (Graham, 2009), allowing to retain data from 1199 participants including 9 mothers of twins (thus providing trajectory data for 1208 children).

The number of latent growth curves was established by increasing the number of subgroups in the LGMM models and comparing fit indexes of the outputs with an increasing number of subgroups (see Table 3 for fit indices). Decision about the optimal number of groups, separately for each symptom category, was based on Bayesian Information Criteria (BIC, where lower value indicates better model fit; Nylund et al., 2007), the posterior probability (i.e., the probability of an individual belonging to a group) for each trajectory group (a score of 0.80 or above is

Table 3
The fit indices for the symptom trajectory group solutions.

	Log L.	AIC	BIC	Entropy	VLMR, LMR	Class Proportions	Average latent class posterior probabilities
Depressive symptoms/EPDS							
1 Class	−20,412.518	40,849.036	40,910.107	1.000	–	1.000	1.000
2 Class	−20,325.895	40,681.789	40,758.128	0.79	0.0033, 0.0041	0.85/0.15	0.95/0.85
3 Class	−20,268.958	40,573.916	40,665.523	0.82	0.0115, 0.0135	0.14/0.07/0.79	0.82/0.84/0.94
4 Class	−20,236.569	40,515.137	40,622.012	0.81	0.1042, 0.1124	0.65/0.04/0.06/0.25	0.93/0.82/0.88/0.81
5 Class	−20,215.928	40,479.856	40,601.998	0.82	0.1401, 0.1502	0.02/0.05/0.66/0.04/0.23	0.84/0.80/0.93/0.79/0.81
6 Class	−20,881.560	40,817.119	40,959.380	0.81	0.0822, 0.0874	0.06/0.58/0.01/0.04/0.26/0.06	0.80/0.91/0.91/0.84/0.80/0.81
Anxiety symptoms/SCL-90							
1 Class	−17,059.987	34,141.973	34,197.955	1.000	–	1.000	1.000
2 Class	−16,841.536	33,711.073	33,782.322	0.94	0.1065, 0.1161	0.92/0.08	0.99/0.91
3 Class	−16,736.666	33,507.332	33,593.850	0.90	0.2299, 0.2381	0.17/0.79/0.04	0.88/0.97/0.98
4 Class	−16,668.526	33,377.051	33,478.836	0.93	0.3872, 0.3960	0.84/0.01/0.09/0.06	0.98/0.96/0.87/0.91
5 Class	−16,607.318	33,260.636	33,377.689	0.93	0.4824, 0.4890	0.11/0.03/0.80/0.05/0.01	0.89/0.92/0.97/0.85/1.00
6 Class	−15,668.604	31,387.208	31,518.966	0.94	0.0000, 0.0000	0.10/0.30/0.56/0.03/0.01/0.00	0.94/0.94/0.96/0.95/0.00

preferred; Nagin, 2005), and Entropy rate indexing classification accuracy (> 0.80 indicating excellent accuracy; Lubke and Muthen, 2007). Additionally, the overlap across anxiety and depressive classes were also calculated using a set of crosstabulations, and the associations between demographic characteristics and anxiety and depressive classes were analyzed using a set of Pearson correlation coefficients, *t*-tests and analysis of variance.

2.4.2. Trajectories of maternal symptoms and child socio-emotional outcomes.=

The analyses examining the associations between maternal symptom trajectory groups and child socio-emotional outcomes were run with adjusted analyses that were controlled for the pre-determined theoretically relevant covariates of child sex, maternal education and parity, obstetric complications, alcohol use during pregnancy, smoking during pregnancy, duration of gestation and child age at the assessment. Additionally, the models for the child outcomes at 5/4 years were controlled for maternal concurrent symptoms at the assessment of child symptoms (the modelled trajectories of maternal symptoms only extended until 2 years postpartum). The associations were modelled using general linear models in SPSS 27.0 and the figures were drawn using R program (R Core Team, 2018). Multiple comparison corrections for the different analyses were not conducted, because all the F comparisons were $p < 0.001$. However, the unadjusted within-comparison differences between the groups were additionally corrected using Bonferroni correction. Finally, a set of sensitivity analyses was performed excluding children born before gw 37.

3. Results

3.1. Descriptive statistics

Demographic characteristics of the sample are displayed in Table 1. The descriptive information on the measures used in the study are shown in Table 2. The associations between symptom trajectories and demographic characteristics are seen in the supplement in the Table 1.

3.2. Trajectories of maternal pre- and postnatal depressive and anxiety symptoms

In the LGMM modelling for depressive symptoms (EPDS), the BIC scores continued to improve up to the 5-group model (Table 3.). Also, the posterior probability scores for the 5-group model were satisfactory, and the Entropy rate was good (posterior probability scores for 5-group model 0.84/0.80/0.93/0.79/0.81; Entropy 0.82, indicating a good model; Muthen, 2002), so this solution was adopted. The solution included the following trajectory groups: "Postnatal" (N = 28, Estimate of intercept = 4.39, Estimate of slope = 1.59, $p < 0.001$), "Prenatal" (N = 59, Estimate of intercept = 12.43, Estimate of slope = −1.22, $p < 0.001$), "Elevated stable" (N = 272, Estimate of intercept = 5.19, Estimate of slope = 0.41, $p < 0.001$), "High and stable" (N = 44, Estimate of intercept = 11.00, Estimate of slope = 0.35, p = 0.001), "Low and stable" (N = 796, Estimate of intercept = 3.40, Estimate of slope = −0.17, $p < 0.001$) (see Fig. 1).

In the LGMM modelling for anxiety symptoms (SCL-90), the fit indices were good until the 5-group model (Table 3). However, the comparison between the 4- and 5-group models showed that the clinical interpretability of the different groups was better for the 4-group solution that was thus chosen as the final model. This solution included the following groups: "Postnatal" (N = 64, Estimate of intercept = 6.76, Estimate of slope = 0.97, p = 0.002), "Prenatal" (N = 104, Estimate of intercept = 9.60, Estimate of slope = −1.04, $p < 0.001$), "High and decreasing (N = 10, Estimate of intercept = 22.98, Estimate of slope = -2.45, p = 0.002) and "Low and stable" (N = 1018, Estimate of intercept = 2.10, Estimate of slope = −0.066, p = 0.003) (see Fig. 2). The overlaps across anxiety and depressive symptom categories were calculated and are shown in the supplement in Table 2.

3.3. Associations between maternal symptom trajectories and child socio-emotional development at 2 years of age

The associations between maternal trajectories and child socio-emotional symptoms at 2 years are displayed in Tables 5 and 6

Socio-emotional problems. When compared to maternal trajectory "Low and stable symptoms", all symptom trajectories (both depressive and anxiety) were associated with higher scores of total problems; child internalizing and externalizing symptoms at 2 years of age after adjustment for the covariates (child sex, maternal education, maternal use of alcohol and tobacco during pregnancy, maternal obstetric complications during pregnancy, parity, duration of gestation and child age at assessment). The pattern of magnitudes indicated that the "High and stable", "High and Decreasing" and "Postnatal" symptom trajectories had the largest effects on each scale.

Social competence. The "Elevated stable" depressive symptoms class and "Postnatal" anxiety symptoms class were associated with poorer social-emotional competence of the child at 2 years after controlling for the covariates.

Pairwise comparisons to correct for multiple comparisons. The unadjusted within-comparison differences between the groups are included in the Supplement. Even after the multiple comparison correction, the differences between the "Low and stable" trajectories and other trajectories in predicting child outcomes at 2 years remained significant except for socio-emotional competence. Further, the "High and stable" trajectory of depressive symptoms remained significantly different from the "Prenatal" and "Elevated stable" symptom trajectories in predicting total and internalizing problems. The other group differences were not

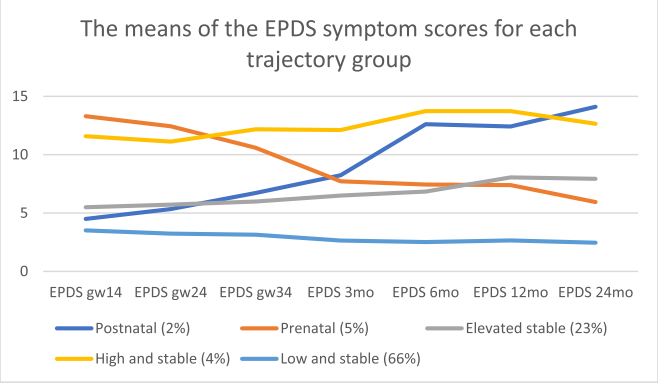

Fig. 1. The means of depressive symptoms scores for each trajectory group in each assessment point from gestational week 14 to two years postpartum.

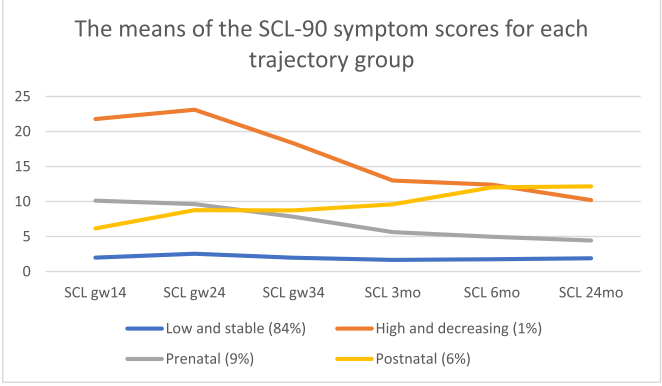

Fig. 2. The means of anxiety symptoms scores for each trajectory group in each assessment point from gestational week 14 to two years postpartum.

significant after the correction.

3.4. Associations between the maternal symptom trajectories and child socio-emotional development at 5 years of age

The associations between maternal symptom trajectory classes and child socio-emotional symptoms at 5 years of age are displayed in Tables 4 and 5..

Socio-emotional problems. When adjusted for the covariates and maternal symptoms at 5 years of child age, "High and stable" and "Elevated stable" depressive symptom classes were associated with a higher amount of child total symptoms and conduct symptoms. In addition, the "High and stable" depressive symptom class associated with higher child emotional symptoms at 5 years.

Social competence When adjusted for the covariates and the maternal symptoms at 5 years of child's age, the "Prenatal" and "High and stable" depressive symptom classes associated with child poorer prosocial behavior at 5 years of age.

Pairwise comparisons to correct for multiple comparisons. The unadjusted within-comparison differences between the groups are included in the Supplement. In terms of the 5-year-olds' development, after controlling for multiple comparisons, the "Low and stable" trajectories of depressive and anxiety symptoms remained significantly different from most other trajectories in predicting child problems and also prosocial behavior. In terms of maternal depressive symptoms, the "High and stable" trajectory additionally differed from the "Prenatal" and "Elevated stable" trajectories in predicting a variety of child problems (but not prosocial behavior) at 5 years.

3.5. Sensitivity analyses

When the analyses were performed without infants born before gw 37, the results remained essentially unchanged.

4. Discussion

The aim of this study was to examine the trajectories of maternal pre- and postnatal depressive and anxiety symptoms in relation to child socio-emotional problems and competence at 2 and 5 years. We identified five trajectories of maternal depressive symptoms and four trajectories of maternal anxiety symptoms differentiated by the severity, timing and temporal course, as assessed from early pregnancy to two years postpartum. The depressive symptom trajectories were categorized as "Postnatal", "Prenatal", "Elevated Stable", "High and Stable" and "Low and Stable". Regarding anxiety symptoms, the trajectories of "Postnatal", "Prenatal", "High and Decreasing" and "Low and Stable" symptoms were identified.

Our findings showed that all maternal depressive and anxiety symptom trajectories were associated with increased child total problem scores, as well as with externalizing and internalizing symptom scores at 2 years of age when contrasted with the "Low and Stable" trajectories. At 5 years of age, maternal "High and Stable" and "Elevated Stable" depressive symptom trajectories were associated with child total and externalizing symptom scores when contrasted with the "Low and Stable" trajectory. Moreover, again with the "Low and Stable" category as the reference, the "High and Stable" depressive symptom group associated with elevated internalizing symptoms. These findings were found after correction for multiple comparisons and adjustment for covariates and current symptoms at 5 years of child's age.

Maternal psychiatric symptoms during pregnancy and postpartum were not only related to the child's socio-emotional symptom scores but also affected negatively the child's social competence, although the latter associations were less robust. The trajectory of "Elevated stable" depressive symptoms was associated with poorer social competence at 2 years, whereas at 5 years, the "Prenatal" and "High and Stable" depressive symptom groups associated with poorer child prosocial skills, again with the "Low and Stable" category as the reference, and after adjustment for the covariates and correction for multiple comparisons. The associations of prenatal and high and stable depressive symptoms with poorer prosocial skills only at the 5-year time point of child assessment may suggest that certain areas of challenges in socio-emotional skills or competencies are not yet seen during toddlerhood (by the reporting parents). The associations between elevated depressive symptoms and social competence at 2 years may reflect the role of maternal caregiving behavior in the development of socio-emotional skills especially during early years. Especially the earliest characteristics of socio-emotional competence, that could be molded by maternal psychiatric symptoms, are still poorly understood.

Concerning the harmful impact of the severity and the course of maternal depressive and anxiety symptoms on child development, our findings are supported by several previous studies suggesting that high and chronic depressive or anxiety symptoms have the strongest negative associations with offspring socio-emotional problems and socio-emotional competence (Cents et al., 2013; Kingston et al., 2018; Pietikäinen et al., 2020; Porter and Hsu, 2003; Vanska et al., 2013). In clinical settings, recognizing parents with consistently elevated levels of symptoms is indeed impactful. Of note, we also found support for the significance of elevated but continuous maternal symptoms on child social-emotional problems and competence, also in line with others (Cents et al., 2013; Giallo et al., 2015; Kingston et al., 2018). This specific subgroup of mothers is not necessarily recognized in the clinical practice if symptoms are screened infrequently and with certain (i.e., higher) cut-off levels.

The effects of the more timing-wise clustered "Prenatal" or "Postnatal" symptom trajectories on child socio-emotional development were less consistent. The prenatal and postnatal depressive and anxiety symptom courses were associated with child socio-emotional problems at 2 years, whereas we found only few associations, between the differential exposures and outcomes, that would have persisted until the child age of 5 years, when the effects of maternal concurrent symptoms were controlled for. Only the trajectory of prenatal depressive symptoms associated with child lower socio-emotional competence at 5 years. This is in line with previous studies indicating that the effect size of prenatal distress is low, and if followed by an adequate care environment and stimuli early in childhood, these associations may be attenuated (Madigan et al., 2018; Rees et al., 2019). Thus, in our general population-based study sample, a range of resilience factors, such as sensitive and responsive caregiving behavior, may have counteracted some of the potential negative effects of either prenatal or postnatal stress exposures, on offspring socio-emotional development.

Several possible explanations for our findings can be considered. First, maternal and child socio-emotional problems may indicate a shared underlying genotype (Glober, 2011; Hannigant et al., 2018; O'Donnell and Meaney, 2017). During pregnancy, maternal depressive and anxiety symptoms may affect the fetus through programming effects via multiple mechanisms, including impacts on the developing HPA axis, the functioning of the placenta, and changes in the intrauterine immunological milieu or nutritional supply (Egliston et al., 2007; O'Donnell

Table 4
Overlap between anxiety and depressive symptoms trajectories.

%	Depressive symptom trajectory				
Anxiety symptoms trajectory	Postnatal N = 28	Prenatal N = 59	Elevated N = 272	High N = 44	Low and stable N = 796
Postnatal N = 64	12	9	46	27	6
Prenatal N = 104	1	25	29	11	34
High and decreasing N = 10	0	60	20	20	0
Low and stable N = 1018	2	2	20	1	75

$p < 0.001$, the distribution across groups is systematic

Table 5
The association between the trajectories of maternal depressive and anxiety symptoms and child socio-emotional problems.

	BITSEA total problems (at 2 yrs)				SDQ total problems (at 5 yrs)					
	Non-adj.		Model 1		Non-adj.		Model 1		Model 2	
	B	*p*	B	*p*	B	*p*	B	*p*	B	*p*
EPDS trajectories										
Postnatal	3.46	<0.001	3.58	<0.001	2.55	0.005	2.47	0.007	0.92	0.317
Prenatal	2.42	<0.001	2.23	<0.001	2.30	<0.001	1.74	0.011	0.96	0.162
Elevated stable	1.73	<0.001	1.68	<0.001	1.79	<0.001	1.76	<0.001	0.79	0.026
High and stable	5.17	<0.001	5.32	<0.001	6.78	<0.001	6.61	<0.001	4.44	<0.001
Low and stable	ref.									
Effect size (η_p^2)	0.09		0.09		0.09		0.09		0.03	
SCL trajectories										
Postnatal	3.89	<0.001	3.80	<0.001	3.89	<0.001	3.68	<0.001	1.24	0.057
Prenatal	1.89	<0.001	2.07	<0.001	1.95	<0.001	1.89	<0.001	0.57	0.271
High and decreasing	4.96	<0.001	4.75	<0.001	5.99	<0.001	5.33	0.001	3.04	0.050
Low and stable	ref.									
Effect size (η_p^2)	0.07		0.07		0.05		0.05		0.01	

	BITSEA internalizing (at 2 yrs)				SDQ emotional symptoms (at 5 yrs)					
	Non-adj.		Model 1		Non-adj.		Model 1		Model 2	
	B	*p*	B	*p*	B	*p*	B	*p*	B	*p*
EPDS trajectories										
Postnatal	1.98	<0.001	2.10	<0.001	0.85	0.001	0.79	0.002	0.43	0.095
Prenatal	0.95	0.003	0.95	0.007	0.42	0.014	0.42	0.028	0.24	0.217
Elevated stable	0.79	<0.001	0.74	<0.001	0.30	0.001	0.30	0.001	0.09	0.374
High and stable	2.56	<0.001	2.67	<0.001	1.50	<0.001	1.51	<0.001	1.05	<0.001
Low and stable	ref.									
Effect size (η_p^2)	0.07		0.07		0.06		0.06		0.02	
SCL trajectories										
Postnatal	1.70	<0.001	1.76	<0.001	0.84	<0.001	0.89	<0.001	0.27	0.123
Prenatal	0.75	0.002	0.92	<0.001	0.57	<0.001	0.59	<0.001	0.23	0.097
High and decreasing	1.93	0.011	1.72	0.033	1.50	<0.001	1.18	0.007	0.56	0.182
Low and stable	ref.									
Effect size (η_p^2)	0.04		0.04		0.04		0.04		0.01	

	BITSEA externalizing (at 2 yrs)				SDQ conduct problems (at 5 yrs)					
	Non-adj.		Model 1		Non-adj.		Model 1		Model 2	
	B	*p*	B	*p*	B	*p*	B	*p*	B	*p*
EPDS trajectories										
Postnatal	1.09	0.004	0.67	0.069	0.74	0.050	0.34	0.376	0.34	0.376
Prenatal	1.02	<0.001	0.57	0.028	0.51	0.072	0.30	0.291	0.30	0.291
Elevated stable	0.55	<0.001	0.68	<0.001	0.70	<0.001	0.47	0.002	0.47	0.002
High and stable	1.42	<0.001	2.05	<0.001	2.01	<0.001	1.53	<0.001	1.53	<0.001
Low and stable	ref.									
Effect size (η_p^2)	0.04		0.05		0.06		0.02		0.02	
SCL trajectories										
Postnatal	1.53	<0.001	1.53	<0.001	1.06	<0.001	0.96	<0.001	0.24	0.379
Prenatal	0.47	0.043	0.47	0.026	0.29	0.150	0.25	0.222	−0.15	0.482
High and decreasing	1.31	0.024	1.31	0.044	1.58	0.011	1.41	0.030	0.77	0.236
Low and stable	ref.									
Effect size (η_p^2)	0.04		0.04		0.02		0.02		0.00	

Model 1 is adjusted for child sex, maternal education, maternal use of alcohol and tobacco during pregnancy, maternal complications during pregnancy, parity, duration of gestation and child age at assessment.
Model 2 is adjusted for the same factors as the model 1 and maternal depressive or anxiety symptoms at the time of assessment (5 years of child's age).

et al., 2009; Van Batenburg-Eddes et al., 2013). During postpartum, maternal symptoms may affect child socio-emotional development also through non-optimal maternal caregiving behaviors. Mothers reporting elevated depressive or anxiety symptoms have demonstrated less optimal caregiving behavior with their infant, i.e. they may be less able to regulate the emotions and behavior of their children (Hakanen et al., 2019; Field et al., 2010a, 2010b; Lovejoy et al., 2000).

The strongest effects were found for the persistent symptoms -this could suggest that the afore mentioned mechanisms may act together. A three-hit model has indeed been proposed to describe the vulnerability to stress related psychopathology (Daskalaskis et al., 2013). It suggests that the interaction of genetic factors (hit 1) with environmental stress factors during pregnancy or early infancy (hit 2) may cause altered epigenetic modifications or endocrine regulations. This programmed phenotype may then, together with environmental stress factors, after a critical period (hit 3), become compromised and increase the risk for psychiatric symptoms. In our study, children of mothers with continuous high distress may thus be exposed to "double or triple jeopardy". This may then lead to higher risk of behavioral problems and poorer prosocial skills. However, no biological mechanisms were explored in this study. In future studies, the cumulative or interactive effects of genotype, perinatal stress exposure and stress at later ages should be explored

Table 6
The trajectories of maternal depressive and anxiety symptoms and child social competence.

	BITSEA social competence (at 2 yrs)				SDQ prosocial behavior (at 5 yrs)					
	Non-adj.		Adjusted 1		Non-adj.		Adj 1		Adj 2	
	B	*p*	B	*p*	B	*p*	B	*p*	B	*p*
EPDS trajectories										
Postnatal	−0.36	0.447	−0.39	0.417	−0.20	0.576	−0.17	0.635	0.08	0.828
Prenatal	−0.34	0.309	0.026	0.942	−0.74	0.004	−0.71	0.011	−0.56	0.047
Elevated stable	−0.58	0.001	−0.60	0.001	−0.38	0.004	−0.35	0.011	−0.23	0.120
High and stable	−0.67	0.386	−0.70	0.071	−1.13	<0.001	−1.17	<0.001	−0.90	0.006
Low and stable	ref.									
Effect size (η_p^2)	0.01		0.01		0.02		0.02		0.01	
SCL trajectories										
Postnatal	−0.72	0.022	−0.72	0.025	−0.74	0.002	−0.59	0.016	−0.27	0.309
Prenatal	0.00	0.993	0.015	0.953	−0.23	0.235	−0.26	0.199	−0.10	0.628
High and decreasing	−1.31	0.097	−0.88	0.278	−0.15	0.807	−0.04	0.947	0.24	0.706
Low and stable	ref.									
Effect size (η_p^2)	0.01		0.01		0.01		0.01		0.00	

Model 1 is adjusted for child sex, maternal education, maternal use of alcohol and tobacco during pregnancy, maternal complications during pregnancy, parity, duration of gestation and child age at assessment.
Model 2 is adjusted for the same factors as the model 1 and maternal depressive or anxiety symptoms at the time of assessment (5 years of child's age).

more systematically.

In our study, the role of maternal depressive symptoms seemed more robust than that of anxiety symptoms. All anxiety trajectories were related to child socio-emotional problems and competence at 2 years. However, maternal anxiety symptom trajectories were not associated with child socio-emotional outcomes at 5 years after adjustment for current maternal symptoms. One possible explanation is that the sample size of the "High or Elevated " anxiety class was low. In addition, we did not identify a trajectory of a continuous level of anxiety symptoms as we did with depressive symptoms. A relatively small number of mothers thus reported continuous symptoms of anxiety. In summary, our findings are in keeping with previous studies -maternal persistent depression has a negative impact on child development (Goodman et al., 2011; Weissman et al., 2017), whereas results regarding maternal anxiety are more controversial.

One strength of the current study is that our design included several assessment points in the evaluation of maternal symptoms, from pregnancy until toddlerhood, as well as in the measuring of child outcomes, from toddlerhood to preschool years. The intense longitudinal design allowed us to get more detailed information of the timing, intensity, consistency and the type of the potential effects. A limitation of this study is that only maternal reports were used in the assessment of both maternal and child symptoms as opposed to diagnostic interviews or using partner's evaluations of child that may have yielded more unbiased information. However, the questionnaires employed in this study are widely used and reliable and have been shown to be robustly in line with clinical assessments. In addition, the effect of concurrent maternal symptoms was controlled which may decrease the possible reporting bias. Another limitation is that the sample sizes in the trajectory classes of postnatal depressive symptoms and especially in the class of high and decreasing anxiety symptoms were low. The small amount of high number of symptoms in maternal mental health and child's socio-emotional outcomes may explain the small effect sizes of the models. Third limitation is that for some scales of child's socio-emotional outcomes, internal consistency was low. However, previous studies have reported low internal consistency for the measures of BITSEA and SDQ while still reporting good or satisfactory fit of the factor). The measures are still recommended using in their traditional form (e.g. Smedje et al., 1999). In addition, it is important to notify that these scales are intended to be medical screeners. These measures are not measuring underlying concepts as much as the number of symptoms, resulting also in ordinal scales which may induce problems in consistency analysis. In future studies, the effect of co-morbid anxiety and depressive symptom trajectories on child's outcomes should be assessed to study whether they contribute differently than depressive or anxiety symptoms alone.

We conclude that maternal depressive and anxiety symptoms from pregnancy until 2 years of child age have potentially important influences on child long-term socio-emotional outcomes from toddlerhood to preschool years over and above the effects of relevant covariates and concurrent maternal symptoms. The association was most robust for persistent high or elevated symptom levels and more evident for depressive symptoms than anxiety symptoms, and observable across the follow-up. The effects were found both on child emotional and behavioral symptoms as well as on social competence. Our findings highlight the importance of identifying and treating maternal depressive and anxiety symptoms as early as possible, with a specific focus on chronicity.

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Riikka Korja: Conceptualization, Funding acquisition, Project administration, Writing – original draft, Writing – review & editing. **Saara Nolvi:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – review & editing. **Noora M. Scheinin:** Conceptualization, Methodology, Writing – review & editing. **Katja Tervahartiala:** Conceptualization, Methodology, Writing – review & editing. **Alice Carter:** Methodology, Writing – review & editing. **Hasse Karlsson:** Conceptualization, Funding acquisition, Project administration, Resources, Writing – review & editing. **Eeva-Leena Kataja:** Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing – review & editing. **Linnea Karlsson:** Conceptualization, Investigation, Project administration, Resources, Writing – review & editing.

Declaration of competing interest

No affiliation, financial agreement, or other involvement of the authors with any companies has affected the preparation of this manuscript. All other authors declare that they have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2023.12.076.

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