ISER Working Paper Series

Does Postpartum Depression Predict Emotional and Cognitive Difficulties in 11 Year Olds?

Maria Elena Komodromou
Institute for Social and Economic Research
University of Essex

No. 2018-02
January 2018

INSTITUTE FOR SOCIAL & ECONOMIC RESEARCH

University of Essex

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

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Non-technical summary

Postpartum depression (PPD) is a prevalent, major depressive disorder following childbirth with long-term effects on the mother and her offspring. Research into the long-term impact of postpartum depression on child development indicates different impacts at different points in time over the child's early years and potentially negative consequences for the child's cognitive, social, and emotional spheres. However, there is no consensus since some researchers support the view that chronic or recurrent maternal depression, rather than postpartum depression per se, is likely to relate to later effects on the child whereas others attribute a strong role to PPD. Previous research has demonstrated that emotional and behavioural problems in childhood can persist into later life, leading to educational difficulties, lower earnings and possibly to a lifelong disability, so that establishing the impact of PPD on child outcomes is of great policy relevance.

This paper contributes to the current debate on the effect of PPD on children's emotional and cognitive outcomes. We focus on child outcomes at age 11. The focus on the 11-year-old group enhances our insight into the role of maternal PPD since age 11 is an important stage of development and a significant period of transition which has not been the focus of research, except for a few clinical studies with relatively small sample sizes. The present study uses data from the Millennium Cohort study (MCS), a longitudinal cohort study with a large sample size. The use of multiple measures of child outcomes provided by three different informants (mothers, teachers, and children) presents a broader picture of the complex interactions between children and their environment, thus increasing our understanding of the role played by postpartum depression on children's outcomes. The results show that, at age 11, PPD impacts on child emotional difficulties only when these are reported by the mother; when reported by the children themselves PPD has no association either with boys' or girls' emotional problems; whereas there is a strong association regarding boys' emotional problems when these are reported by teachers. Cognitive ability tests using BAS (British Ability Scales) and CGT (Cambridge Gambling Task) show no association between PPD and children's cognitive performance at age 11. The results of the present study demonstrate the complex role of PPD and its consequences for children's emotional development.

Does Postpartum Depression Predict Emotional and Cognitive Difficulties in 11 Year Olds?[i]

Maria Elena Komodromou[ii]
Institute for Social and Economic Research, University of Essex

December 2017

Abstract

This paper examines the role of postpartum depression (PPD) on the emotional and cognitive development of 11-year olds, a key stage of transition in child development before entering adolescence. The present study uses data from the MCS, a longitudinal cohort study with a large and representative sample of the UK population. The results show that PPD impacts on child emotional difficulties when these are reported by the mother or the teacher; child-reported measures of emotional problems do not show any correlation with PPD Cognitive ability tests show no association between PPD and children's cognitive performance at age 11. The results of the paper have enhanced our insight regarding a significant period of transition which has not previously been the focus of research and demonstrate the impact PPD has on children's emotional development.

Keywords: postpartum depression; adolescents; cognitive inequalities; emotional inequalities

JEL codes: J13, I14, I24.

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[i] I am thankful to Emilia DelBono, Sonia Bhalotra, and Alita Nandi for helpful comments and suggestions. I also appreciate comments received from seminar participants at various conferences.
[ii] Institute for Social and Economic Research, University of Essex. Contact: mekomo@essex.ac.uk

1. Introduction

Postpartum depression (PPD) is a prevalent, major depressive disorder following childbirth with long-term effects on the mother and her offspring (O'Hara, 2009). Although its symptoms last between one and six months, its consequences for the child are not restricted to infancy alone, but might extend into toddlerhood, preschool age and even school age (Bernard-Bonnin, 2004). Research into the long-term impact of postpartum depression on child development indicates different impacts at different points in time over a child's development and potentially negative consequences for the child's cognitive, social, and emotional spheres. However, there is no consensus since some researchers support the view that chronic or recurrent maternal depression, rather than postpartum depression per se, is likely to relate to later effects on the child (Grace et al., 2003; Agnafors et al., 2013) whereas others attribute a strong role to the PPD effect (Cogill et al., 1986; Sharp et al., 1995; Essex et al., 2003; and Pawlby et al., 2008).

From the standpoint of the child, it appears that children born to postpartum mothers are likely to start life at a disadvantage compared to children of non-depressed mothers. Furthermore, these children are at increased risk of developing mood disorders (Thapar et al., 2012) or even psychiatric disorders (Pawlby et al., 2008). Previous research has demonstrated that emotional and behavioural problems in childhood can persist into later life, leading to educational difficulties, lower earnings and possibly to a lifelong disability.

From the standpoint of a woman, maternal depression in the postpartum period is associated with ongoing maternal difficulties because of the condition's recurrent nature and chronic course (Burke, 2003). Thus, PPD might lead to substantial impairments in the ability of the mother to handle daily responsibilities (O'Hara, 2009) and cope with the demands of motherhood.

The purpose of the current study is to investigate the specific role and influence of mothers' postpartum depression on children's emotional and cognitive outcomes at age 11 – a key stage of transition in child development before entering adolescence. The study seeks to provide new information on the cognitive and socio-emotional outcomes of 11-year-old children, identifying the strength of possible associations between maternal PPD and children's outcomes, through multiple evidence provided by mothers, teachers, and children.

What the current study brings to the forefront is the variation observed in the assessments of the child's socio-emotional skills provided by mothers, teachers and children, thus presenting a broader picture of the role played by postpartum depression in children's outcomes while avoiding the possibility of biased or one-sided reports. The results show that, at age 11, PPD impacts on child emotional difficulties only when reported by the mother; when reported by the children themselves PPD has no association either with boys' or girls' emotional problems; whereas there is a strong association regarding boys' emotional problems when these are reported by teachers. Cognitive ability tests using BAS (British Ability Scales) and CGT (Cambridge Gambling Task) show no association between PPD

and children's cognitive performance at age 11, in contrast with the main body of research.

2. Literature Review

The interconnections between maternal health problems and children's outcomes have been the subject of an extensive body of empirical research focusing on different age groups and key stages of child development (ranging from birth to early adulthood). Age 11 represents a key stage of transition in child development, before the start of adolescence and the onset of puberty (Remscmidt, 1994; Kessler et al., 2001; Agnafors et al., 2013). As Patton and Viner (2007) explain, puberty is initiated in late childhood and is accompanied by physical, psychological and emotional changes. Despite indications of significant implications for children and their future trajectories, only three prior studies set in the UK have focused specifically on the outcomes of 11-year-olds in relation to maternal postpartum depression. The most recent is by Pawlby et al. (2008) which examined postpartum depression and emotional disorders in 11-year-olds based on 147 women drawn from two general practices in South London. The second is by Hay et al. (2003) and examined pathways to violence in the 11-year-old children of postpartum depressed mothers compared to children of non-depressed mothers using a sample of 132 families from an urban British community. The third is a study by Hay et al. (2001) which focused on intellectual problems shown by 11-year-old children whose mothers had postpartum depression, based on 132 children and 132 women from two general practices in South London. All three are clinical studies with rather limited sample sizes.

The question raised here is, why choose this specific age group as the time period of investigation in the current study? Firstly, focusing on a specific age group (as opposed to a wide age range) enhances our insight into the problems observed at this particular stage of development – a significant stage of transition in the life of children before entering adolescence and before reaching puberty when psychological development is intense (Patton and Viner, 2007). Secondly, research findings have indicated that different stages of development are characterised by particular problems and disorders. For instance, the plethora of major emotional changes and psychological difficulties observed in adolescence are rarely met in childhood and, as Kessler et al. (2001, p.1) noted, "major depression is comparatively rare among children, but common among adolescents, with up to a 25% lifetime prevalence by the end of adolescence". Depression is also prevalent in the adult population, unlike in childhood where its existence is considered as relatively uncommon but, as research findings indicate, somewhere between childhood and adulthood its prevalence shows a dramatic increase (Allgood-Merten et al., 1990).

2.1.Multiple informant approach

For the assessment and ratings of children's socio-emotional outcomes in the current study, the multiple informant approach is used to obtain information from three sources: mothers, teachers and children. This approach enables researchers to obtain evaluations from different perspectives. Another advantage is that through the multiple informant approach the possibility of biased reports or 'contaminated' information from impaired mothers is avoided.

A number of studies exploring the issue of bias have indicated that mother's emotional impairment may affect her perceptions of her child and consequently maternal reports (Fergusson et al., 1993; Boyle and Pickles, 1997; Najman et al. 2001). Several explanations have been put forward to account for the issue of bias on the part of impaired mothers. For their part Najman et al. (2001) argued that if impaired mothers are "biased" in their observations of the world around them, there is a possibility that this "biased observation" is likely to be reflected in their response to their children and also to other relationships, life events, etc. As observed by Barry et al. (2005, p. 265) the mother's symptoms might be associated "with a stressful home environment," exacerbating child behaviour problems and eventually leading to "a reciprocal relation between symptomatology in mothers and children". Reviewing a number of hypotheses Kroes et al. (2003, p.201) indicated that mothers might project symptoms of their own psychological states on their children in accordance to the projection hypothesis whereas the social attribution theory supports that "ambiguous environmental stimuli" (internalizing behaviour problems) have a greater tendency to inference and distortion of social perception compared to more obvious stimuli (externalizing behaviour problems). For their part, Youngstrom et al. (1999) found strong evidence regarding correlations between maternal dysphoria and descriptions of child functioning. Another possibility according to Najman et al. (2000) is the impaired mother's lesser capacity to control her child rather than the child's behaviour.

The views on the issue of maternal bias discussed in this section indicate that there is growing evidence that mothers' distress or psychopathology is related to emotional and behaviour problems in their children and that may lead to small or

moderate parental reporting distortions. However, some studies support that there are considerable advantages to using caregivers as informants about child functioning. As Youngstrom et al. (1999) explained caregivers (in particular mothers) observe the child over a longer time and in broader developmental contexts than would any other adult and that for researchers and psychologists, mothers' reports of child behaviour are a central piece of data because of the high-intensity link between the mother and her child over a long period of time. Luoma et al. (2004, p.50) also support that in both clinical and research settings the mother is still "the primary source of information concerning infants and young children", because usually is the person who knows her child best.

As regards disagreements or low levels of agreement observed between informants' reports on the functioning of a child, these can be viewed as valuable sources of information in so far as each source provides a unique viewpoint (Kolko and Kazdin, 1993). They can alternatively be considered as "variations in judgements of the child's functioning across situations and interaction partners" (Achenbach et al., 1987, p.228). Regarding the choice of informant, this depends on the type of disorder being investigated. Goodman et al. (2000) point out that information from parents is considered slightly more useful for detecting emotional disorders (internalizing disorders) while information from teachers is slightly more useful for detecting conduct and hyperactivity disorders (externalizing disorders). This view is also reflected in findings by Berg-Nielsen et al. (2003) who observed that even non-pathological levels of depressive symptoms in mothers may represent a bias when mothers report internalizing symptoms in their adolescents. However, Kroes et al. (2003, p.201) pointed out that internalizing child behaviour problems associated

with maternal psychopathological symptoms, displayed at home, might not be manifested in other situations, or they might be manifested in different ways under different circumstances.

Apart from maternal bias in reporting, endogeneity in the informants' responses can be due to omitted variables. Although in this study we control for a variety of observed confounders the responses might be biased due to an unobserved factor. For example, teachers might report higher levels of emotional difficulties in children if they perceived that the school district has a high criminality rate, or mothers might report higher levels of emotional difficulties in their children due to relationship concerns. If these unobserved factors also affect children's emotional well-being then an endogeneity problem would occur.

2.2.The scale and multi-faced causes of PPD

Maternal postpartum depression is a well-described phenomenon but its risk factors and symptoms can still elude diagnosis (Beck, 2006). Its prevalence in Western societies and in the UK is approximately 15% (Grace et al., 2003; Murray et al. 2010), and its long-term effects on the mother, her offspring, and family are well documented in a large body of literature (Cooper and Murray, 1998; Brockington, 2004; Beck, 2006; Hay et al., 2008; O'Hara, 2009). Research findings indicate that postpartum depression interferes with self-care and parenting, and offspring are at risk of disturbances in development (O'Hara, 2009). Most research points to the factor of heritability; the transmission of risk for disorder via genetic factors, which is estimated at approximately 37% for depressive disorder (Sullivan et al., 2000 cited in Halligan et al., 2007). On the other hand, there is a growing body of research

which indicates that parenting behaviour is a major mechanism by which parental psychopathology, marital difficulties, major life events, and economic hardship come to be associated with depression in children and adolescents (Sheeber et al., 2001). However, there is no common understanding as regards all the mechanisms through which parental mental health problems impact on children or on the complex interaction of genetic and environmental influences and the influence of correlated mediating factors (Smith, 2004).

2.3.Child Gender

Gender seems to play a significant role. Numerous studies indicate that boys are at greater risk of poor development in childhood than girls when faced with maternal postpartum depression and that pre-pubertal boys have a slightly higher rate of depressed mood than girls. This difference reverses in early adolescence, when there is a dramatic increase in depression among girls but not boys (Hankin and Abramson, 2001; Kessler et al., 2001). Thus, being female is significantly associated with depression in adolescents and adults, but before adolescence the rate of depressive disorders is about equal in girls and boys (Garber, 2006). The female preponderance for depression begins to emerge around age 13 (Hankin and Abramson, 2001). During early to middle adolescence, the rate of depressive symptoms in girls rises to two to three times that of boys, and this gender difference is partly attributed to hormonal changes, increased stress, different socialization experiences, and other factors (Anderson et al., 1987 and Costello et al., 1996 cited in Garber, 2006). In view of the above, regression models in this study are fitted separately for boys and girls in order to explore whether PPD has a different effect on each gender's emotional problems.

As regards cognitive functioning and intellectual development, findings in the literature indicate that boys and girls are affected in different ways, with boys more at risk than girls who appear relatively protected against the effects of their mothers' illness (Cogill et al., 1986; Sharp et al., 1995; Essex et al., 2003; Grace et al., 2003). Exploring intellectual problems in 11-year-old children of mothers who had depression at 3 months postpartum, Hay et al. (2001) find that adverse experiences in infancy predict cognitive ability and academic performance a decade later (lower IQ scores, attentional problems, difficulties in mathematical reasoning and special educational needs). Academic performance at age 16, which was explored by Murray et al. (2010), shows that the adverse effects of postpartum depression on male infants' cognitive functioning may persist throughout development, but not in the case of girls.

2.4.Time of exposure

The time of exposure to maternal depression is another factor linked with increased risk of depression both in adolescence (Halligan et al., 2007; Hammen et al., 2008; Hay et al., 2008) but also with negative outcomes in childhood (Essex et al., 2001; Hay et al., 2003; Beck, 2006; Kiernan and Huerta, 2008). The findings of these studies point to the harmful effects of maternal postpartum depression on children's emotional and behavioural development, particularly when the exposure takes place in infancy, "an important time for the development of a secure mother-infant attachment, which in turn provides a framework for the infant's regulation of emotion" (Essex et al., 2001, p.154). As Pawlby et al. (2008) emphasised, children of mothers who were clinically diagnosed with postpartum depression at 3 months

were 4 times as likely to suffer from a psychiatric disorder themselves at 11 years of age. A view emerging from the evidence above is that infancy is a crucial period for children's development. This is in line with the theory of attachment which posits that early interaction is a particularly important determinant of the quality of attachment that develops between the mother-child dyad, as observed by Campbell and Cohen (1997), who also stressed that the timing and chronicity of depression in infancy is of great importance given the infant's dependency on the mother as the primary caregiver. Evidence from prior studies suggest that infants who experience a prolonged period of maternal withdrawal or inconsistent behaviour will be more likely to show disorganised patterns of attachment and security in toddlerhood compared to children of controlled mothers (Campbell and Cohen, 1997; Essex et al., 2001).

As regards the effect of PPD on children's developmental outcomes, Agnafors et al. (2013, p.170) support that "ongoing maternal depressive symptoms (as distinct from PPD) was the strongest predictor of child behaviour problems at age 12". Beck (2006) reviewing results of several studies concerning the effect of postpartum depression on children's cognitive development (covering different stages from infancy to childhood), concludes that the results were mixed, in contrast with findings of studies on children's emotional and behavioural development which demonstrated the adverse effect of PPD. Grace et al. (2003) in a review of articles on the effects of postpartum depression on cognitive and behavioural outcomes, underlined that chronic or recurrent maternal depression, rather than postpartum depression per se, was likely to relate to later effects on the child, and that girls and boys are affected in different ways in terms of cognitive development, such as

language and IQ. Murray et al. (1996) find that there was no evidence of an adverse effect of PPD on cognitive functioning after the age of 5, even amongst vulnerable subgroups of children. Recent evidence by Maselko et al. (2015) regarding 7-year-old children and peripartum depression, also find no effect on cognitive outcomes. On the other hand, Cogill et al. (1986) reported significant intellectual deficits in 4-year-old children whose mothers had suffered with depression, but only when this depression occurred in the first year of the child's life. Along the same lines, Sharp et al. (1995) found that postpartum depression affected the intellectual development of the infant sons of women who were depressed in the first year postpartum. Hay et al. (2001) showed that maternal diagnosis of depression at 3 months postpartum predicts deficits in the children's cognitive abilities and academic performance a decade later. In view of the strong associations observed in a number of studies between maternal postpartum depression and children's outcomes and particularly the findings in the studies by Hay et al. (2001) and Pawlby et al. (2008) concerning the impact of PPD on 11-year-olds, it is anticipated that the present investigation would also lead to similar results as regards the long-term impact of PPD on children's emotional and cognitive outcomes.

3. Data and Methods

The Millennium Cohort Study (MCS) was used for the analysis in the present paper The MCS is a large-scale survey of children born in the four constituent countries of the United Kingdom. The sample design allows for over-representation of families living in areas of England with high rates of child poverty or high proportions of ethnic minorities, and the three smaller countries of the UK. Full details about the survey, its origins, objectives, sampling and content of the sweeps are provided in

the documentation attached to the data.[1] For the present analysis, the chosen sample consisted of 11-year-old children whose main respondents were the natural mothers who responded to all five sweeps. Observations with missing values were excluded, resulting in 5,397 observations for the main sample. Given the sampling design (clustering), the non-response rates and the sampling attrition from subsequent sweeps of the MCS, all results are weighted (to correct for the above) unless indicated otherwise.

3.1.1. Sample selection

The MCS teachers' survey at age 11 (MCS5) was conducted only in England and Wales, resulting in 7,430 observations for children. This sample is further restricted for the natural mother who was the main respondent in all sweeps of the MCS in order to obtain information regarding maternal mental health problems at ages 3-7 (MCS2-MCS4). The vast majority - nearly 96% at age 11 - of all the main respondents in the MCS are the natural mothers (see MCS technical report on response). We excluded 15 observations in which the natural mother was not the main respondent. Restricting for the natural mother as the main respondent in all sweeps of the MCS reduces the sample size to 5,635 observations. This reduction (attrition) is corrected in the MCS using the survey weights as described above. Regarding item non-response, most of the missing values result from the mother-reported SDQ (137 observations). Other non-response items vary from 1 (mother born in the UK) to 43 (baby was born late post-term), missing values (see Appendix I, Table 1a). Restricting for item non-response reduces the sample to 5,397 observations.

[1] A Guide to the Datasets (Seventh Edition). Available at: http://discover.ukdataservice.ac.uk/series/?sn=2000031

In order to see whether the average individual in this sample differs in their characteristics from the individual excluded from the sample, tests that assess whether the means of the selected sample versus the means of the missing sample in each variable are statistically equal were performed (see Appendix I, Table 1b). Although the outcome variables show no statistical difference in the means, tests regarding the main independent variable PPD indicate sample selection (the missing sample had higher means for PPD relative to the selected sample) (see Appendix I, Table 1b). Hence, the results of this study cannot be generalised but only applied to this specific sample.

3.1.2. Outcome measures

Children's Emotional Distress – Child Reported

Child self-reported measures of wellbeing were derived from the MCS5 child questionnaire. As an observed inventory or a unique measure of emotional distress/mental difficulties of children was not available at age 11 (in MCS5), exploratory factor analysis (EFA) was implemented in order to examine the variation in the data and construct an index of the latent measure of children's emotional distress. The questions imputed as possible factors were: "In the last four weeks, how often did you feel happy?"; "In the last four weeks, how often did you get worried about what would happen to you?"; "In the last four weeks, how often did you feel sad?"; "In the last four weeks, how often did you feel afraid or scared?"; "In the last four weeks, how often did you laugh?"; and, "In the last four weeks, how often did you get angry?". The questions were answered using a 5 point Likert scale

ranging from 'never' to 'almost always'.[2] The scores were reversed in the first and last questions. Given the ordered nature of the variables, polychoric correlations instead of Pearson's correlations were estimated in Stata using the polychoric package in accordance with the literature (Kolenikov 2004).[3] The factors were extracted using principal factor and the loadings were retained using the Kaiser Criterion (Eigen values>1) and scree plot test (see Appendix I, Figure 3), both of which resulted in just one factor (see Appendix I, Table 2 and 3).[4]

Children's Emotional Distress – Mother and Teacher Reported

Emotional distress for 11-year-olds was derived from the Strengths and Difficulties Questionnaires (SDQ) (Goodman, 1997), reported separately by the mothers and the teachers. The SDQ is a brief behavioural screening questionnaire for 4 to 16-year-olds. The questionnaire consists of 25 items that cover the following five aspects of children's behaviour: conduct problems; emotional symptoms; inattention-hyperactivity; peer problems; and pro-social behaviour. The items are rated in a Likert scale (0-2) ranging from 'not true' to 'certainly true'. The same version should be completed by parents and teachers. SDQ is a well-known instrument and has been used extensively in many studies to measure socio-emotional development (O'Connor et al., 2003; Kiernan and Huerta, 2008; Prady and Kiernan, 2012; Pearce et al., 2013). According to Goodman et al. (2000) the SDQ can be used to predict mental difficulties in children whereas Thapar et al. (2012) noted that SDQ provides additional screens for attention deficit hyperactivity disorder (ADHD) and disruptive behaviour symptoms.

[2] Through personal communication it was indicated that some of the child-reported questions were extracted from the PEDSQL questionnaire, though the emotional functioning component is not available in its entirety in the MCS. PEDSQL is available at http://pedsql.org/about_pedsql.html

[3] Available at http://web.missouri.edu/~kolenikovs/stata

[4] See Fabrigar and Wegener (2012) on the use of principal factor versus principal component factors for EFA.

In the present study, the total strengths and difficulties score was used, which adds the first four aspects of children's behaviour (except the pro-social behaviour aspect). Hence the total difficulties score ranges from 0 to 40, and is counted as missing if one of the 4 behavioural aspect scores are missing. Frequency distribution graphs illustrating the association between PPD and non-PPD mothers, and total difficulties scores, are shown in Appendix I (Figures 1(a)-2(b)). Most of the children (96.6% of children in the mother reported SDQ and 97.1% in the teacher reported SDQ) fall within the borderline and normal ranges of the total difficulties score of the SDQ (0-15), for both PPD and non-PPD mothers. Regarding British norms of SDQ, it is observed that in this study, the mean SDQ teacher reported total difficulties score differs from the British mean total difficulties SDQ teacher norms by nearly 1 point for boys and 0.8 points for girls, whereas regarding the mother reported SDQ this difference is 0.5 points for both genders (Appendix I, Table 4).[5] Although the values are similar, the differences could be due to the fact that SDQ norms are presented for age ranges (in this case age 11-15) instead of a specific age (age 11), as is the case in this study. In general, we observe that boys have on average higher SDQ total difficulties scores (mother or teacher reported) than girls. However, the average scores in the child index for both genders are similar (Appendix I, Table 4). As expected, there is a moderate to high correlation between the two SDQ measures, but a low to moderate correlation between the child index and the SDQ measures (Appendix I, Table 5). Regarding children's cognitive outcomes, the average scores on all three measures are similar for both genders, and

[5] SDQ British norms can be accessed at http://www.sdqinfo.org/norms/UKNorm4.pdf Males 11-15, SDQ Total Difficulties Parent Questionnaire: 8.8 (5.9); SDQ Total Difficulties Teacher Questionnaire: 7.6 (6.5). Females 11-15, SDQ Total Difficulties Parent Questionnaire: 7.6 (5.6); SDQ Total Difficulties Teacher Questionnaire: 5.0 (5.4); Mean scores (standard deviation).

all three measures have low correlations between them for both boys and girls (Appendix I, Tables 4 and 5).

Children's Cognitive outcomes – British Ability Scales.

The British Ability Scales (BAS) has become established as a leading standardised measurement for assessing a child's cognitive ability and has been used in many longitudinal studies. Children's verbal reasoning and verbal knowledge are assessed through Verbal Similarities. Three words are read out to the child who must explain how the three words are similar. This assessment is designed to be used with children aged from 5 years to 17 years and 11 months. All of the children at age 11 (MCS5) start at the 16th item, the starting point for their age. There are decision points after items 28 and 33 at which it is decided whether the test stops or continues, according to the child's performance, taking into account the number of failures and passes obtained. After five consecutive failures, the test is automatically stopped, provided that at least three items have been passed prior to this, otherwise they are routed back to the previous starting point. In this study, the variable utilised is the standardised BAS ability scores. This was chosen because the scores have been adjusted for both item difficulty and age so as to facilitate the performance comparison of younger and older cohort members (Connelly, 2013).[6]

Children's Cognitive outcomes – Cambridge Gambling Task

The Cambridge Gambling Task (Rogers et al., 1999 cited in Brown and Sullivan, 2014) tests decision-making and risk-taking behaviour. Each child is presented with a row of 10 boxes, of which some are red and some are blue, and told that a yellow

[6]Age adjustment is made within three-month age bands, so some variation could exist within each band.

token is hidden in one of the boxes. The child must first decide whether the token is hidden in a red box or a blue box (decision-making). Secondly, the child must decide how many points (from an initial 100 points) wishes to gamble on being correct (risk-taking). The likelihood of each choice being correct is indicated on each trial by the ratio of red to blue boxes displayed. Possible values of bets are presented every 5 seconds. Generated outcomes of this test are: quality of decision making; deliberation time; delay aversion; risk-taking; overall proportion bet; and risk adjustment. As indicated in Brown and Sullivan (2014) quality of decision-making and risk-adjustment can be attributed to wider cognitive skills and are the two measures examined in this study.

3.1.3. Main independent variable PPD

PPD is assessed using the Malaise Inventory (Rutter et al., 1970 cited in Johnson 2012). This measure is a psychometrically valid measure of psychological distress (Rodgers et al., 1999 cited in Flouri et al., 2010). [7] According to this measure, 14.6% of mothers in this sample – 7.36% for boys and 7.26% for girls – had experienced depressed mood 9 months after the birth of their child (scoring 4 and above in the Malaise Inventory), in accordance with the literature (Appendix I, Table 6).

3.1.4. Control variables

As has been noted in many studies, certain factors contribute to differences in emotional outcomes in children by exacerbating or moderating the effects of

[7] The variable indicating whether the mother had ever been diagnosed by a doctor with depression was asked in MCS1, which is the same sweep in which the variable used for deriving antepartum depression was asked, and the other psychological questions used to construct PPD (Malaise Index) were answered. However, the timing of when the diagnosis was made is not indicated. As a result, this variable is not used as a background variable as it is not clear whether it captures previous history of depression, antepartum depression or current (postpartum) depression.

maternal depression. As Sinclair and Murray (1998) stressed, family social class and the child's gender have the most pervasive influences on adjustment. Mensah and Kiernan (2010) also note that their exploration of gender differences showed that the effects of mothers' mental health were stronger for boys than for girls. According to Hay et al. (2008), repeated exposure to maternal depression rather than early exposure to maternal depression may explain its effects on children. Additionally, socio-demographic variables, including race or ethnicity (minority), family income level (poverty), age of mother (an adolescent mother), and marital status (single parent families), are considered important as this set of variables helps to define the context of the lives of children and, when conceptualized as stressors, is likely to contribute significantly to the development of psychopathology in the children of depressed mothers (Goodman and Gotlib, 1999). As regards poverty, Dearden et al. (2011) find that there are substantial differences in cognitive and socio-emotional development between children from rich and poor backgrounds, even at the age of 3, and that this gap widens by the age of 5. In terms of family structure, it is possible that the elevated rates of behavioural problems in children of depressed mothers who have gone through divorce are related to the additional stresses of divorce or marital conflict on children. On the other hand, the presence of a father may moderate the impact of maternal depression on children's functioning by decreasing the childcare burden on the depressed mother or by providing an alternative, potentially healthier, parenting style for children.

4. 3.2 Methods

Linear regressions were separately applied to assess the possible association between PPD and the child's outcome measures (emotional distress/cognitive

ability) in boys and girls of 11 years of age.[8] The equations were estimated first as a base model controlling for time invariant predictors and socio-demographics (for example mother's age at birth, ethnicity, worked while pregnant, baby's age, preterm, post term), Model 1, then adjusting for history of maternal mental illness in subsequent sweeps at ages 3-7 (MCS2-MCS4), Model 2, adjusting for cohort baby's risk factors at birth (MCS1) (potentially time variant), Model 3. In Model 2, we do not control for maternal mental illness at age 11. Controlling for risk factors at age 11 will not facilitate the assessment of whether PPD is associated with children's outcomes at age 11, as the directionality of the risk factors with the children's outcomes when both are measured at age 11 will not be clear. For example, maternal mental illness at age 11 could affect 11-year-old children's emotional problems and vice versa. Additionally, regarding Model 3, we acknowledge that some of the potentially time-varying factors (for example, the mother's physical long-term illness), may change during the 11 year time period and could potentially affect the association between PPD and children's outcomes, by mediating this effect in later years. However, this is not the purpose of this study so, as mentioned above, the potential time-varying predictors are measured at age 9 months (MCS1). The sequential structure of the above models facilitates a broader evaluation of the mechanisms of each set of predictors regarding the association between PPD and the emotional and cognitive outcomes of 11-year-old children.

[8] Separate regressions examining the potential association between PPD and child outcomes (emotional, cognitive) by gender of the child and maternal highest qualification (tertiary/ non-tertiary education) are not presented because of the small subpopulation sizes. Additionally, we tried to estimate a confirmatory factor analysis model of two hypothesised latent constructs (emotional distress, cognitive ability), using the children's outcomes as indicators. Stata package confa, available at: http://fmwww.bc.edu/repec/bocode/c/confa.ado. However, this was not pursued as there are no model fit indices available for complex survey data.

The main equation, which was applied separately for boys and girls, to examine the association between PPD and the child's outcome measures is:

$$Y_{it_5} = a + bPPD_{it_1} + cX_{it_1} + dMH_{it_4} + gMH_{it_3} + kMH_{it_2} + e_{it_{1-5}}$$

where Y_{it_5} is the outcome variable (emotional difficulties, cognitive ability) at age 11 (MCS5), i is the individual, t_5 is the MCS sweep (subscript denotes sweep, in this case MCS5, age 11), PPD_{it_1} is postpartum depression, X_{it_1} is a vector of background variables measured at MCS1, MH_{it_4} is maternal mental health problems in subsequent sweeps (subscript denotes sweep, in this case maternal mental health problems in MCS4, age 7 of the child) and $e_{it_{1-5}}$ is the error term. Dependent variables have been standardised to facilitate comparison.

3.2.1. Models

Control variables are grouped within the three models as follows: Model 1 controlling for socio-demographics which include: maternal age at birth; baby's age in months; baby's weight at birth; whether the baby was very early pre-term; whether the baby was very late post-term; whether the mother was born in the UK (omitted variable foreign born); maternal ethnic identity category to which she felt she belonged, utilising the categories corresponding to the UK census (White, Indian, Pakistani and Bangladeshi, Mixed Ethnicity, Black, omitted variable 'other ethnicity'); and maternal highest educational qualification achieved (Higher degree, First degree, Diplomas in higher education, A / AS / S levels, O level / GCSE grades A-C, GCSE grades D-G, Other academic qualifications (incl. overseas), omitted

category ‘no qualifications’).[9] Model 2 additionally adjusted for history of maternal mental illness (using the Kessler K6 scale) in subsequent sweeps at ages 3 years, 5 years, and 7 years. Model 3 further adjusted for cohort baby’s risk factors at birth which are potentially time variant (can be changed in the course of the child’s life) but we measured at MCS1 (age 9 months) using the following variables: the OECD median poverty rate; maternal longstanding illness; whether the mother smoked before pregnancy; whether the mother consumed alcohol before pregnancy; and whether the baby has other siblings. All background variables except episodes of maternal mental health problems (MCS2-MCS4) were taken from MCS1.

5. Results

The estimates presented in Appendix II show the association between PPD and the emotional and cognitive outcomes (standardised score) experienced by 11-year-old children, adjusted for non-time variant predictors and socio-demographics (Model 1), then adjusted for history of maternal mental illness in subsequent sweeps (Model 2), and finally adjusted for cohort baby’s risk factors at birth (Model 3). Table 1 summarises the main findings regarding children’s emotional problems.

[9] Due to a high number of missing cases the variable that indicates whether the baby was in ICU was not included, but the variables ‘whether baby was very early pre-term’ and ‘whether the baby was very late post-term' are used as proxies.

Table 1: Child Emotional Problems as Reported by Mothers, Teachers and Children: Association with PPD

Postpartum Depression	Model 1	Model 2	Model 3
Teacher Reported SDQ Total Difficulties Boys	0.229*	0.216*	0.208*
	(0.089)	(0.094)	(0.093)
Teacher Reported SDQ Total Difficulties Girls	0.040	0.043	0.038
	(0.057)	(0.057)	(0.057)
Mother Reported SDQ Total Difficulties Boys	0.419**	0.352**	0.339**
	(0.072)	(0.070)	(0.071)
Mother Reported SDQ Total Difficulties Girls	0.290**	0.231**	0.221**
	(0.074)	(0.076)	(0.075)
Child Index Boys	0.100*	0.082	0.076
	(0.049)	(0.049)	(0.049)
Child Index Girls	0.059	0.045	0.041
	(0.063)	(0.064)	(0.064)

Note: Results from 18 separate OLS estimations. Standardised coefficients; Standard errors in parentheses. *p<0.05 **p<0.01. Dependent variables measured at age 11 (MCS5), mean and standard errors of dependent variables (see Appendix I Table 4); Independent variable measured at age 9 months (MCS1); Model 1 adjusts for time invariant predictors and socio-demographics; Model 2 adjusts for characteristics in Model 1 and history of maternal mental illness (ages 3-7); Model 3 adjusts for characteristics in Model 2 and potential time risk factors at birth (see Appendix II for complete tables). Observations: Teacher's SDQ, boys: 2673; Teacher's SDQ, girls: 2724; Mother's SDQ, boys: 2673; Mother's SDQ, girls: 2724; Child Index, boys: 2528; Child Index, girls: 2612.

In the teacher's reported SDQ (Table 1) there is an association between PPD and the average child total difficulties for boys. However, no association between PPD and child difficulties was found in any of the three models for girls. In Model 1, PPD increases the mean of the total difficulties score by almost 0.229 standard deviation points for boys, while adjusting for subsequent maternal mental health problems (Model 2) slightly reduces this negative association with the mean total difficulties score for boys to 0.216 standard deviation points. Adjusting for risk factors at birth (Model 3), reduces the association between PPD and the average total difficulties score by 0.208 of the standard deviation. Overall, the adjustment in Model 2 and Model 3 has not affected the size of the association between PPD and teacher reported mean total difficulties in boys. Furthermore, examining the relationship between PPD and subsequent maternal mental health episodes (at ages 3, 5 and 7) in Model 2, reveals that there is no statistical significance with the SDQ teacher reported children's difficulties at age 11 (see Appendix II, Tables 1-2). In general,

for 11-year-old boys and girls no association is found between maternal mental health problems (future episodes) and SDQ teacher reported child difficulties (see Appendix II, Tables 1-2) but there is an association with antepartum depression and SDQ teacher reported child difficulties for girls (see Appendix II, Table 2).

In contrast to the teacher reported SDQ measure, PPD is associated with children's difficulties for both genders at age 11 using the SDQ mother reported measure (Table 1). Specifically, PPD increases the average total difficulties score by 0.42 of a standard deviation for boys in Model 1, while adjusting for subsequent maternal mental health problems reduces this negative association with boys' average total difficulties score to 0.352 of a standard deviation, which reduces further when adjusting for risk factors at birth to 0.339 (Model 3). In the case of girls, PPD is strongly associated with an increase in the difficulties score, but by a much smaller scale. In Model 1 PPD increases the average total difficulties score by 0.29 of a standard deviation, while adjusting for subsequent maternal mental health problems reduces this relationship to 0.231 points of a standard deviation, which remains relatively unchanged for Model 2 and Model 3. Subsequent episodes of maternal mental health problems affect boys' emotional difficulties to a larger extent than girls (an increase of around 0.8 of a standard deviation for boys at age 7). For girls, however, maternal mental health problems show an association with the average total difficulties score at ages 5 and 7 (see Appendix II, Tables 3 and 4).

In the case of the child index (Table 1) there is no association between PPD and child difficulties in all but one of the three models for boys and girls.

Table 2: Child Cognitive Outcomes: Association with PPD

Postpartum Depression	Model 1	Model 2	Model 3
British Ability Scales: Verbal Similarities Boys	-0.012	0.009	0.009
	(0.063)	(0.065)	(0.065)
British Ability Scales: Verbal Similarities Girls	-0.049	-0.047	-0.041
	(0.055)	(0.057)	(0.058)
CANTAB: Quality of Decision Making Boys	-0.056	-0.050	-0.043
	(0.066)	(0.065)	(0.066)
CANTAB: Quality of Decision Making Girls	0.011	-0.004	-0.003
	(0.059)	(0.058)	(0.058)
CANTAB: Risk Adjustment Boys	-0.046	-0.057	-0.045
	(0.072)	(0.073)	(0.073)
CANTAB: Risk Adjustment Girls	-0.119	-0.098	-0.096
	(0.068)	(0.070)	(0.070)

Note: Results from 18 separate OLS estimations. Standardised coefficients; Standard errors in parentheses. *p<0.05 **p<0.01. Dependent variables measured at age 11 (MCS5), mean and standard errors of dependent variables (see Appendix I Table 4); Independent variable measured at age 9 months (MCS1); Model 1 adjusts for time invariant predictors and socio-demographics; Model 2 adjusts for characteristics in Model 1 and history of maternal mental illness (ages 3-7); Model 3 adjusts for characteristics in Model 2 and potential time risk factors at birth (see Appendix II for complete tables). Observations: BAS, boys: 2636; BAS, girls: 2694; CANTAB Decision Making, boys: 2554; CANTAB Decision Making, girls: 2614; CANTAB Risk Adjustment, boys: 2055; CANTAB Risk Adjustment, girls: 2058.

Regarding children's cognitive outcomes (Table 2), there is no association between PPD and BAS verbal similarities in any of the three Models for boys and girls as well as for the two CANTAB measures. Furthermore, examining the relationship between PPD and subsequent maternal mental health episodes (at ages 3, 5 and 7) in Model 2, there is no statistical significance for BAS verbal similarities at age 11. In general, for 11-year-old children no association is found between maternal mental health problems (either ante or postpartum or future episodes) and BAS verbal similarities as well as for the two CANTAB measures (see Appendix II, Tables 7-12).

Furthermore, as a robustness check the association of PPD with the emotional and cognitive outcomes of 11-year-old children was re-estimated using chronic/lingering maternal mental health episodes as a single variable (the mother experiences mental health episodes in all sweeps; at ages 3, 5 and 7) in Model 2. The estimations do not

change the main results (qualitative results) of this study (see Appendix III, Tables 1-2). As a second robustness check we re-estimated all the models, except the teacher reported SDQ measures, for the full sample, including observations where teacher's assessments were missing (whole of the UK). We find that the qualitative results of this study do not change except in the child-reported index for boys, where we find a strong association of PPD and boys' emotional difficulties (see Appendix IV, Tables 1-2).

6. Discussion

This study has examined the role of maternal postpartum depression on children's emotional and cognitive outcomes at age 11, using a large MCS sample comprised of 5,397 children. The analysis indicates that PPD impacts on mother reported measures of their children's emotional development, whereas no residual variation is found when using child reported measures. Teacher reported measures show an association for boys only. No association between PPD and children's cognitive outcomes was found in any of the models.

What characterises the results is the heterogeneity observed in the assessments provided by mothers, teachers and children, leading to three different perceptions. The results showed that PPD impacts on child emotional difficulties at age 11 only when these are reported by the mother; when reported by the teacher there is a strong association with boys' emotional problems only; while it has no association with either boys' or girls' emotional problems at age 11 when reported by the children themselves.

The strong association between PPD and emotional distress in 11-year-old children (when the depressed mother is the source of information) was an expected result. According to Goodman et al. (2011), the association between maternal depression and child outcomes would be stronger when the depressed mother is the source of information on the child, relative to teachers and children themselves. The indication of a strong association between PPD and emotional distress in 11-year-old children, even when controlling for subsequent depressive episodes (age 3-7) and socio-demographics, seems to be in agreement with the findings of other empirical studies which have investigated the association between PPD and children's outcomes (Essex et al., 2003; Josefsson and Sydsio, 2007; Agnafors et al., 2013) and also with the findings of Pawlby et al. (2008) and Hay et al. (2001; 2003), indicating that adverse experiences in infancy are associated with children's poor outcomes in later life (emotional, intellectual, behavioural). The strong association with boys' emotional problems based on teacher-reported information is in line with findings from prior research as regards the factor of a child's gender (Hankin and Abramson, 2001; Kessler et al., 2001; Garber, 2006; Goodman et al., 2011) whereas the finding that PPD has no association with either boys or girls based on reports by children was an unexpected one and needs further investigation.

Ratings by multiple informants offer a broader picture, while taking into consideration concerns about biased reports on the part of affected mothers raised by a number of researchers (Fergusson et al., 1993; Boyle and Pickles, 1997; Goodman et al., 2011; Johnston et al., 2014). Much of the research on the impact of PPD on children's outcomes relies on reports by mothers and on self-reports by children, together or separately, through interviews or questionnaires, in order to obtain

information on the mental status and behavioural problems faced by offspring, as well as information about children's cognitive and intellectual abilities. Teacher reports (less common) are also utilised to obtain information on children's behaviour or their adjustment to the school environment or as an independent source of information.

The heterogeneity observed in the assessments between the three types of informants in the current study might be the result of different evaluation thresholds and perceptions by the respondents (mothers, teachers and children) that result in different pictures of the same child, particularly regarding assessment of children's psychological wellbeing (Johnston et al., 2014). The heterogeneity in the assessments by the mothers and teachers might be due to children's different behaviours in different contexts (Boyle and Pickles, 1997).

Given the association between depression and negative perceptions (Fergusson et al., 1993; Boyle and Pickles, 1997; Goodman et al., 2011) the possibility of bias cannot be excluded taking into account the strong association observed in the current study between maternal depression and child outcomes when the mother was the informant of data regarding the child. Apart from the possibility of mothers' perceptions being biased, it can be considered that depressed mothers may be more sensitive to signs of emotional and behavioural disturbances in their children than are other informants (Goodman et al., 2011). Concerns over the issue of bias in mothers' reports were raised in separate studies by Sinclair and Murray (1998), Essex et al. (2001), and Josefsson and Sydsjo (2007) who argued that women with postpartum depressive symptoms were likely to have negative perceptions of child

behaviour, which influenced their selection of informants. Concerns over the possibility of mothers' ratings being distorted systematically by their emotional state were discussed by Boyle and Pickles (1997) who at the same time underlined the powerful relationship mothers share with their children, making them an important source of information for research studies. They also cautioned against automatically interpreting the rating errors in the reports of mother-informants as bias because they might simply be the result of children's different behaviours in different environments such as the family and school contexts. No studies to my knowledge have re-evaluated respondents' SDQ assessments of children, when these children reached adulthood.

The children's perceptions appear to be in disagreement with the mothers' assessments of a PPD association with boys' and girls' emotional problems and with the teachers' reports of an association with boys only, and are not in line with previous research findings which indicated that boys are at greater risk of poor development in childhood relative to girls. The harmful associations of maternal postpartum depression with children's emotional and behavioural development, particularly regarding the sons of depressed mothers, are well-documented in a large body of research (Sharp et al., 1995; Campbell and Cohen, 1997; Hay et al., 2003; Beck 2006). The timing of children's early exposure to maternal PPD in infancy (assessed at 9 months postpartum in this study) is also considered a strong predictor of children's mental health problems and other disturbances, e.g. lower IQ scores (Hay et al., 2001), significant intellectual deficits (Cogill et al., 1986) and serious violent symptoms (Hay et al., 2003). As indicated in the robustness check for the full sample, (see the results section) the estimates show that PPD is a strong

predictor for boys' emotional difficulties. This is in accordance with the main body of research evidence. However, one must consider that our index is not validated whereas the SDQ questionnaires are validated for measuring mental health difficulties in Britain. The comparisons using the children's self-reported index could be re-estimated in the two samples (full and reduced), when the boys reach adulthood, in order to see which of the two constructed measures is the best predictor of emotional problems. Despite the caveat of the inconsistency in the boys' self-reported indicator we opt to use the reduced sample results because in this way we can have a comparison between all three of the informants (mothers, teachers, and children). Additionally, the reduced sample enables us to have a comparison between the two validated measures mother-reported SDQ and teacher-reported SDQ. Furthermore, the estimates in both samples show that the mother-reported SDQ and the girls' self-reported index are consistent. Besides, all three measures are consistent when using chronic/ lingering maternal mental health episodes as a robustness check.

Teachers' reports are mostly utilised to obtain information on children's behaviour or adjustment to the school environment or as an independent source of information. Pawlby et al. (2008) observed an agreement between informants' ratings, whereas in the current study, the informants' ratings are characterised by heterogeneity. Teachers' reports as an independent source of information for research were employed in a number of studies investigating the impact of maternal depression on children's outcomes at different stages of development. Hay et al. (2001, p. 877) described teachers' ratings as an "uncontaminated" measure, while Sinclair and Murray (1998) and Essex et al. (2001) opted to use only teachers reports in separate

studies, as a measure for rating the children's adjustment to school in the first study and in the second study for assessing children's mental symptoms in kindergarten. Another point to emerge is that maternal reports can prove a valuable source of data and a reliable predictor of a child's functioning if compared and evaluated together, or against information from other respondents (fathers, teachers, and health specialists). Thus, maternal reports cannot be ignored due to fear of bias as mothers might be more sensitive to signs of emotional problems in their children, because, as Boyle and Pickles (1997) point out, mothers share a unique and intense relationship with their children.

Our findings on cognitive outcomes also reflect the evidence provided by Murray and al. (1996) and Maselko et al. (2015). The first study examined the effect of postpartum depression on later cognitive competence by age 5, while the second one examined the influence of peripartum depression on 7-year-old children in a randomized control trial in Pakistan. Both studies found no effect on cognitive outcomes. However, the majority of evidence from previous research on cognitive outcomes points to mixed results (Beck, 2006) and suggests that boys and girls are affected in different ways in terms of cognitive development such as language and IQ, with boys more at risk (Grace et al., 2003) – see the literature review section of this paper.

The difference between the emotional and cognitive outcomes of 11-year-old children in the present study can be interpreted as an indication of the complex interactions and multiple ways through which postpartum depression can impact on children's outcomes at different stages of the life cycle. A point to be noted is that

only interviewer-assessed tests were used to measure cognitive outcomes in this study. Therefore, there is a need for further research into the issue of the effect of PPD on children's cognitive outcomes employing different assessment methods.

7. Strengths and Limitations

This study would have benefited from a strengths and difficulties child-reported questionnaire, which is not available at age 11 (in MCS5), as this could have facilitated the comparison between the three different categories of respondents (mothers, teachers, and children) on the same measure of emotional distress (the SDQ). Additionally, clinical interviews/ diagnosis of the children would have facilitated the identification of bias in children's responses.

Despite its limitations, this study has contributed to the debates on PPD and children's emotional outcomes as well as the respondents' perception bias. One of the strengths of this study is the use of multiple evidence and perceptions by three different types of informants (mothers, children, and teachers), thereby offering a broader picture while taking into account concerns raised by some researchers over the issue of biased reports, based on respondents' perceptions – through over-reporting by affected mothers (Fergusson et al., 1993 and Goodman et al., 2011) or teachers' negative perceptions (Johnston et al., 2014). The focus on the 11-year-old group has enhanced our insight into the role of maternal PPD regarding an important stage of development and a significant period of transition which has not previously been the focus of research, with the exception of three clinical studies with relatively small sample sizes. The present study uses data from the MCS, a longitudinal cohort study with a large sample size. Additionally, there is an opportunity to draw a

comparison between the findings of this observational study and the findings of other studies such as clinical ones or studies using different methods. If examined together or in parallel, they can provide possibilities of different evaluations, increasing understanding of the complex interactions between children and their caregiving environment for policy makers and designers of preventive strategies regarding children's wellbeing and future trajectories outcomes.

8. Conclusion and policy implications

The findings of the current study only relate to a specific stage of development (end of late childhood period). However, what happens at the threshold of adolescence is of significance from the perspective of policy intervention and prevention strategies because, as many studies have indicated, emotional disorders and behavioural problems in late childhood can persist into later life, leading to educational failure in early adolescence (Hay et al., 2001) and the possibility of lower earnings in adult life. As emphasised in the recent Mental Health Taskforce (2016) report, prevention is of significance particularly as regards key stages of development in a child's life. Age 11, the time period investigated in the current study, is an important stage in children's development before they enter adolescence and reach puberty. Thus, the findings of the present study have important implications for educational authorities, health professionals and policy makers as they add to the growing body of research on the long-term influence of postpartum depression on children's socio-emotional outcomes (observed 11 years after the birth) and also confirm that a significant percentage of mothers – over 14% in the sample – experienced depressed mood nine months after the birth of their child. These findings point to the need for intervention through programmes aiming at creating healthy early environments in

infancy – a crucial period for children's development - and enabling quality parenting at all key stages of development, because health and wellbeing during childhood are believed to shape future health and learning outcomes later in adolescent and adult life. Mothers constitute infants' first "social environment" (Grace et al., 2003, p. 263) and quality of parenting must therefore be a priority in the government's plans and strategies that are aimed at counteracting the emotional consequences of PPD for affected mothers during the postpartum period and beyond. Additionally, to be successful, intervention strategies must be designed to target both the mother and the child, taking into consideration the specific problems and needs of subgroups within the population. The long-term effect of maternal PPD on children's outcomes must be a cause for concern to policy makers, given that in the UK one in ten children aged 5-16 has a diagnosable mental health problem and one in five mothers suffers from depression, anxiety or even psychosis during the perinatal period (Mental Health Taskforce, 2016). Mental health policies must consider the crucial role of maternal mental health for the health and wellbeing of future generations, given the complex role of postpartum depression and its potential consequences for both mother and child outcomes.

9. References

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Appendix I Figures and Descriptive Statistics

Figure 1(a) Teacher SDQ frequencies-No PPD

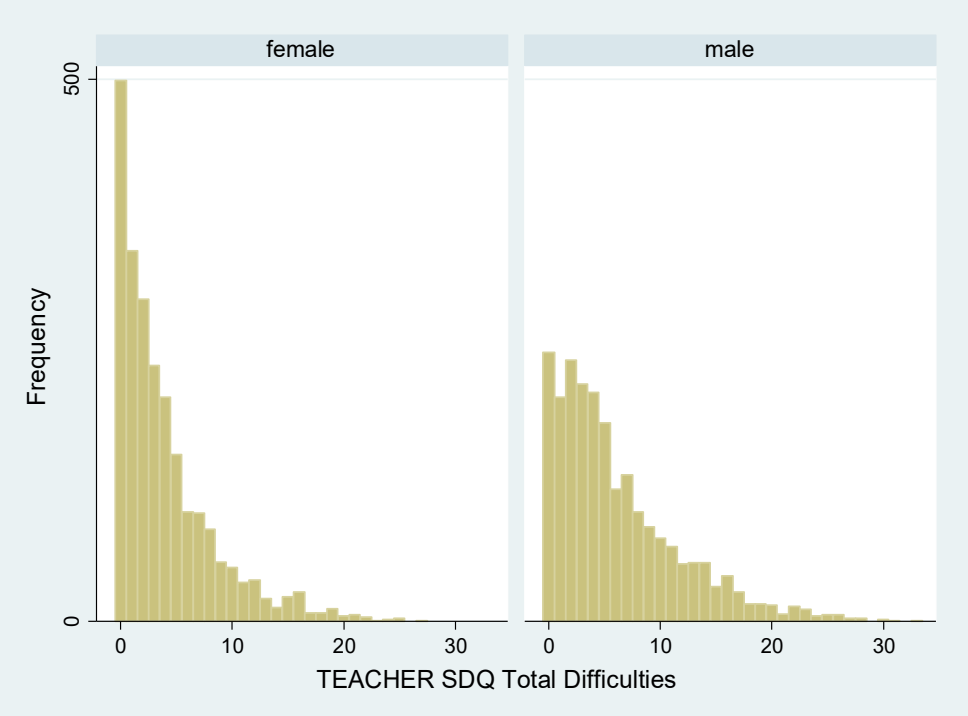

Figure 1(b) Teacher SDQ frequencies-PPD

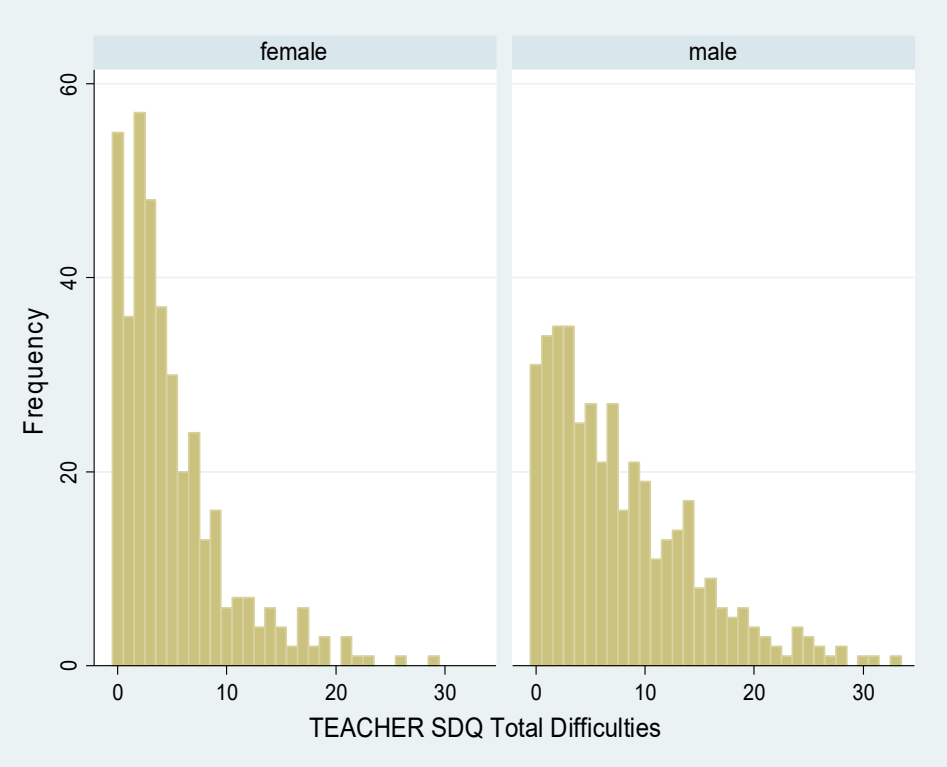

Figure 2 (a) Parent SDQ frequencies-No PPD

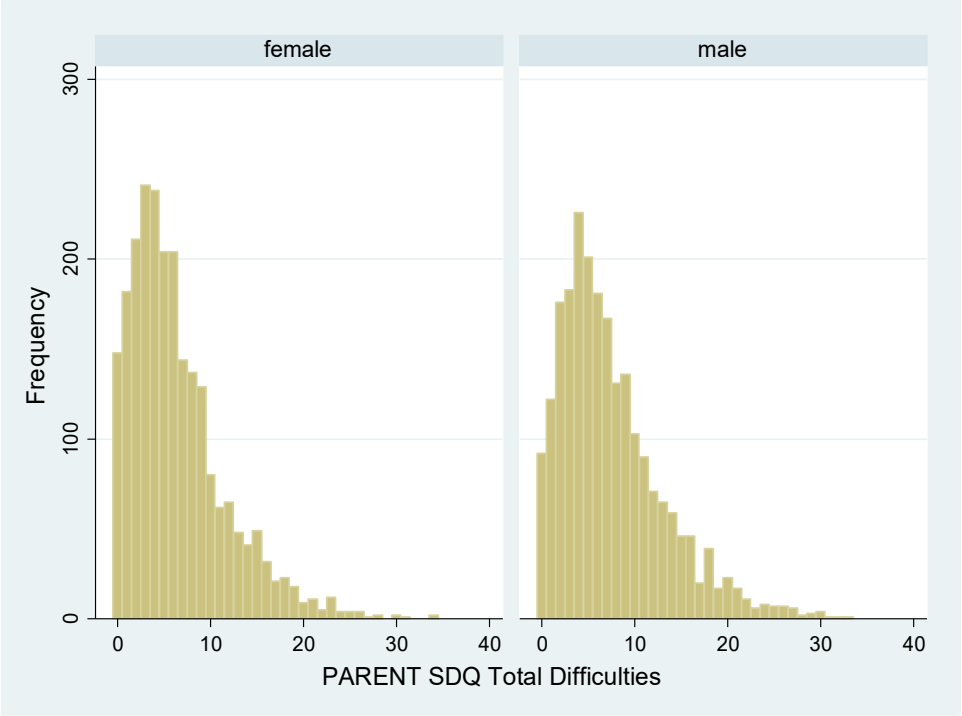

Figure 2(b) Parent SDQ frequencies-PPD

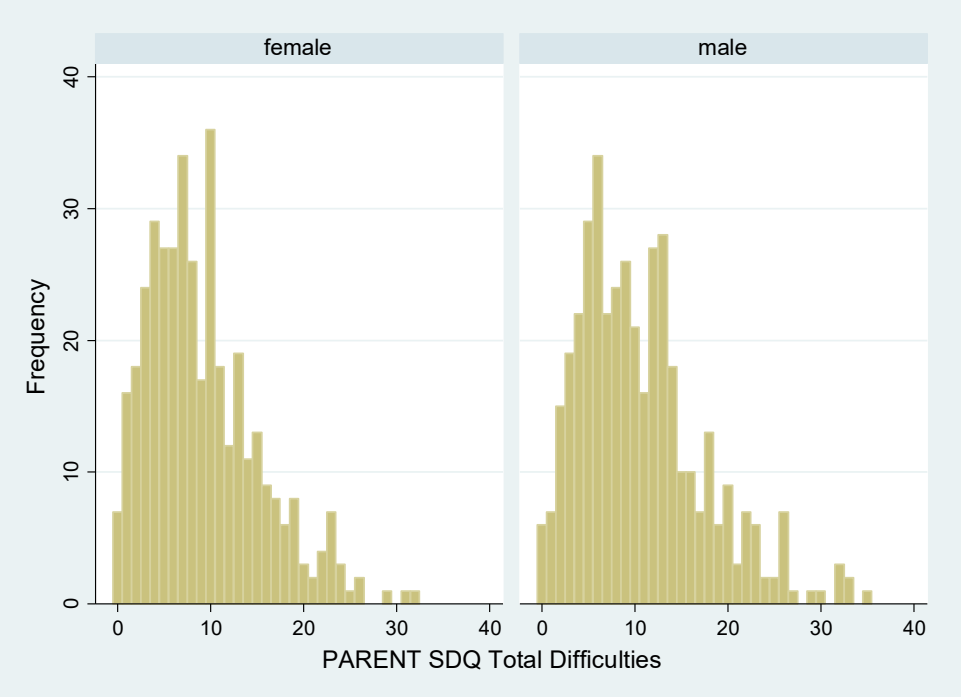

Figure 3 Scree plot of Eigenvalues of factor loadings

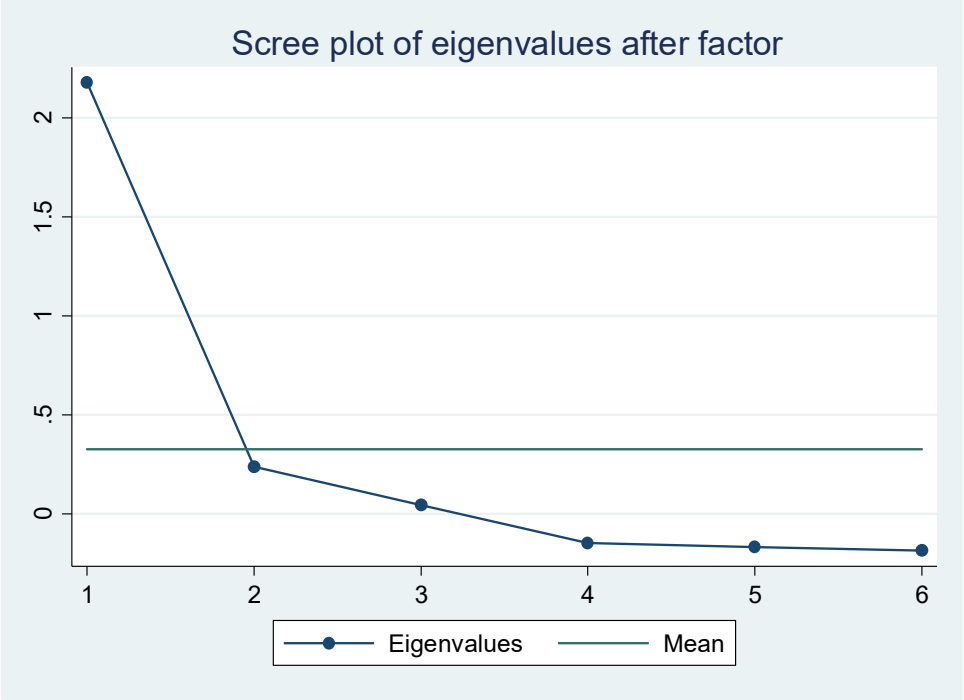

Table 1a: Item non-response

Variables	Values Missing
SDQ Teacher Reported	34
SDQ Mother Reported	137
Mother born in UK	1
Ethnic group	12
OECD below 60% median poverty indicator	6
Baby post term	43
Baby pre term	43
Birth weight in kilos	2
Highest academic qualification	4
Smoking	4
Longstanding illness	2

Note: Some observations have missing values on more than one variable

Table 1b: Sample selection tests

Variables	Mean Selected Sample	Mean Missing Sample	Mean Difference	Difference T-test P-Value Pr(|T|>|T|)
Outcome				
SDQ Teacher Reported	5.425	6.196	-0.771	0.153
	(0.107)	(0.538)	(0.539)	
SDQ Mother Reported	7.624	9.015	-1.391	0.063
	(0.124)	(0.728)	(0.745)	
Child Index	2.369	2.368	0.001	0.991
	(0.016)	(0.062)	(0.063)	
CANTAB Quality of Decision Making	0.818	0.814	0.004	0.732
	(0.003)	(0.013)	(0.013)	
CANTAB Risk Adjustment	1.070	1.018	0.051	0.507
	(0.017)	(0.077)	(0.077)	
BAS Verbal Similarities	59.075	58.696	0.379	0.611
	(0.297)	(0.772)	(0.743)	
Main Independent Variable				
Postpartum depression	0.146	0.308	-0.162	0.000
	(0.006)	(0.041)	(0.039)	
Controls				
Maternal depression age3 (MCS2)	0.107	0.325	-0.218	0.000
	(0.006)	(0.042)	(0.042)	
Maternal depression age5 (MCS3)	0.052	0.188	-0.136	0.000
	(0.004)	(0.035)	(0.034)	
Maternal depression age7 (MCS4)	0.051	0.176	-0.125	0.000
	(0.004)	(0.033)	(0.033)	
Maternal age at birth of CM	29.167	28.794	0.373	0.439
	(0.154)	(0.477)	(0.481)	
Worked pregnant	0.699	0.548	0.151	0.001
	(0.009)	(0.045)	(0.044)	
Mother born in UK	0.911	0.739	0.172	0.000
	(0.006)	(0.038)	(0.037)	
Married	0.620	0.577	0.043	0.344
	(0.012)	(0.046)	(0.046)	
Maternal ethnic group – White	0.905	0.607	0.298	0.000
	(0.010)	(0.048)	(0.046)	
Maternal ethnic group – Mixed	0.010	0.017	-0.007	0.531
	(0.002)	(0.011)	(0.011)	
Maternal ethnic group – Indian	0.019	0.040	-0.021	0.117
	(0.002)	(0.014)	(0.013)	
Maternal ethnic group – Pakistani	0.028	0.138	-0.110	0.001
	(0.005)	(0.036)	(0.033)	
Maternal ethnic group – Black	0.027	0.043	-0.016	0.168
	(0.005)	(0.013)	(0.012)	
OECD below 60% median poverty indicator	0.252	0.430	-0.178	0.000
	(0.011)	(0.044)	(0.042)	
Baby post term	0.010	0.014	-0.005	0.639
	(0.002)	(0.010)	(0.011)	
Baby preterm	0.076	0.135	-0.059	0.069
	(0.004)	(0.032)	(0.032)	

Note: Standard errors in parentheses; outcome variables measured at age 11 (MCS5); main independent variable measured at age 9 months (MCS1); control variables measured at age 9 months (MCS1), except maternal mental health measured at ages 3-7 (MCS2-4). Abbreviations: CM, cohort member, child.

Table 1b (cont'd): Sample selection tests

Variables	Mean Selected Sample	Mean Missing Sample	Mean Difference	Difference T-test P-Value Pr(|T|>|T|)
Other siblings	0.574	0.616	-0.041	0.329
	(0.009)	(0.043)	(0.042)	
Birth weight in kilos	3.360	3.243	0.117	0.063
	(0.009)	(0.062)	(0.063)	
Baby's age in months	9.186	9.166	0.020	0.581
	(0.011)	(0.036)	(0.036)	
Ever tried to breastfeed	0.716	0.689	0.027	0.479
	(0.012)	(0.040)	(0.039)	
Gender child	0.499	0.583	-0.085	0.020
	(0.009)	(0.035)	(0.036)	
Highest academic qualification – Higher degree	0.032	0.022	0.010	0.287
	(0.003)	(0.009)	(0.009)	
Highest academic qualification – First degree	0.155	0.097	0.058	0.030
	(0.010)	(0.027)	(0.026)	
Highest academic qualification – Diploma	0.100	0.065	0.035	0.066
	(0.004)	(0.019)	(0.019)	
Highest academic qualification – A-Level	0.094	0.051	0.043	0.010
	(0.004)	(0.016)	(0.016)	
Highest academic qualification – O-Level [A-C]	0.358	0.270	0.088	0.008
	(0.011)	(0.032)	(0.033)	
Highest academic qualification – O-Level [D-G]	0.115	0.125	-0.010	0.731
	(0.007)	(0.028)	(0.028)	
Highest academic qualification – Other	0.017	0.050	-0.033	0.040
	(0.002)	(0.016)	(0.016)	
Smoking	0.502	0.568	-0.066	0.317
	(0.016)	(0.065)	(0.066)	
Alcohol	0.350	0.289	0.062	0.095
	(0.010)	(0.038)	(0.037)	
Longstanding illness	0.215	0.223	-0.009	0.794
	(0.007)	(0.033)	(0.033)	
Antepartum depression	0.004	0.004	0.000	0.865
	(0.001)	(0.001)	(0.001)	
Baby's father present at birth	0.867	0.687	0.179	0.000
	(0.007)	(0.044)	(0.043)	
Lived with both parents until 15	0.769	0.783	-0.014	0.710
	(0.008)	(0.038)	(0.038)	
Partner completed questionnaire	0.012	0.055	-0.043	0.003
	(0.002)	(0.015)	(0.015)	
N	5397	253		

Note: Standard errors in parentheses; outcome variables measured at age 11 (MCS5); main independent variable measured at age 9 months (MCS1); control variables measured at age 9 months (MCS1), except maternal mental health measured at ages 3-7 (MCS2-4). Abbreviations: CM, cohort member, child.

Table 2: Factor analysis (EFA)

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	2.151	1.856	1.091	1.091
Factor 2	0.296	0.254	0.150	1.241
Factor 3	0.042	0.196	0.021	1.263
Factor 4	-0.154	0.013	-0.078	1.184
Factor 5	-0.167	0.029	-0.085	1.099
Factor 6	-0.196	-	-0.099	1.000

Note: Extraction using principal factors. LR test: P>chi2 (15) = 0

Table 3: Factor loadings (pattern matrix) and unique variances

Variable	Factor 1	Uniqueness
"happy" (rev.)	0.454	0.794
"worried"	0.670	0.551
"sad"	0.771	0.406
"afraid"	0.726	0.472
"laugh" (rev.)	0.187	0.965
"angry"	0.583	0.661

Table 4: Descriptive of outcome variables by gender

	Male		Female	
	Mean	Std. Err.	Mean	Std. Err.
SDQ Teacher Reported	6.652	0.163	4.204	0.117
SDQ Mother Reported	8.270	0.164	6.981	0.145
Child Index	2.339	0.021	2.400	0.020
BAS Scores	59.345	0.349	58.807	0.317
Risk Assessment	1.089	0.021	1.050	0.022
Quality of Decision	0.812	0.005	0.824	0.004

Table 5: Correlation of outcome variables by gender

	Male			Female		
	Emotional outcomes					
	SDQ Mother Reported	SDQ Teacher Reported	Child Index	SDQ Mother Reported	SDQ Teacher Reported	Child Index
SDQ Mother Reported	1.0000			1.0000		
SDQ Teacher Reported	0.5344	1.0000		0.4884	1.0000	
Child Index	0.2919	0.2151	1.0000	0.2879	0.2197	1.0000
	Cognitive outcomes					
	BAS Scores	Risk Assessment	Quality of Decision	BAS Scores	Risk Assessment	Quality of Decision
BAS Scores	1.0000			1.0000		
Risk Assessment	0.1114	1.0000		0.1298	1.0000	
Quality of Decision	0.1064	0.1495	1.0000	0.0908	0.0831	1.0000

Note: Unweighted correlations

Table 6: Postpartum depression by gender

	Postpartum Depression		
	No	Yes	Total
Female			
Percentage	42.9	7.26	50.1
Observations	2334	390	2724
Male			
Percentage	42.5	7.36	49.9
Observations	2268	405	2673
Total	85.4	14.6	100
	4602	795	5397

Appendix II Estimations

Table 1: Teacher Reported SDQ -Total Difficulties Score for boys

	Model 1[iii]	Model 2[iv]	Model 3[v]
	Teacher Total Difficulties	Teacher Total Difficulties	Teacher Total Difficulties
Postpartum depression	0.229*	0.216*	0.208*
	(0.089)	(0.094)	(0.093)
Antepartum depression	0.942	0.954	0.979
	(0.775)	(0.790)	(0.826)
Maternal mental health problems-Age 3		-0.059	-0.068
		(0.099)	(0.097)
Maternal mental health problems-Age 5		0.130	0.125
		(0.183)	(0.178)
Maternal mental health problems-Age 7		0.126	0.118
		(0.192)	(0.183)
N	2673	2673	2673
R^2	0.143	0.144	0.152

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[iii] adjusting for non-time variant predictors and socio-demographics

[iv] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[v] adjusting for cohort baby's time variant risk factors at birth

Table 2: Teacher Reported SDQ -Total Difficulties Score for girls

	Model 1[i]	Model 2[ii]	Model 3[iii]
	Teacher Total Difficulties	Teacher Total Difficulties	Teacher Total Difficulties
Postpartum depression	0.040	0.043	0.038
	(0.057)	(0.057)	(0.057)
Antepartum depression	0.630*	0.622*	0.609*
	(0.291)	(0.296)	(0.289)
Maternal mental health problems-Age 3		-0.094	-0.086
		(0.064)	(0.065)
Maternal mental health problems-Age 5		-0.044	-0.038
		(0.094)	(0.092)
Maternal mental health problems-Age 7		0.171	0.152
		(0.105)	(0.106)
N	2724	2724	2724
R^2	0.091	0.093	0.097

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[i] adjusting for non-time variant predictors and socio-demographics

[ii] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[iii] adjusting for cohort baby's time variant risk factors at birth

Table 3: Mother Reported SDQ -Total Difficulties Score for boys

	Model 1[i]	Model 2[ii]	Model 3[iii]
	Parent Total Difficulties	Parent Total Difficulties	Parent Total Difficulties
Postpartum depression	0.419**	0.352**	0.339**
	(0.072)	(0.070)	(0.071)
Antepartum depression	-0.043	-0.019	-0.019
	(0.232)	(0.256)	(0.301)
Maternal mental health problems-Age 3		-0.045	-0.049
		(0.086)	(0.087)
Maternal mental health problems-Age 5		0.261	0.256
		(0.162)	(0.161)
Maternal mental health problems-Age 7		0.730**	0.723**
		(0.212)	(0.207)
N	2673	2673	2673
R^2	0.161	0.186	0.194

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[i] adjusting for non-time variant predictors and socio-demographics

[ii] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[iii] adjusting for cohort baby's time variant risk factors at birth

Table 4: Mother Reported SDQ -Total Difficulties Score for girls

	Model 1[i]	Model 2[ii]	Model 3[iii]
	Parent Total Difficulties	Parent Total Difficulties	Parent Total Difficulties
Postpartum depression	0.290**	0.231**	0.221**
	(0.074)	(0.076)	(0.075)
Antepartum depression	0.450	0.442	0.414
	(0.236)	(0.244)	(0.237)
Maternal mental health problems-Age 3		0.055	0.068
		(0.074)	(0.074)
Maternal mental health problems-Age 5		0.281*	0.295*
		(0.117)	(0.116)
Maternal mental health problems-Age 7		0.367**	0.338*
		(0.132)	(0.135)
N	2724	2724	2724
R^2	0.123	0.138	0.146

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[i] adjusting for non-time variant predictors and socio-demographics

[ii] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[iii] adjusting for cohort baby's time variant risk factors at birth

Table 5: Child Reported Index for boys

	Model 1[i]	Model 2[ii]	Model 3[iii]
	Child Index (Scores for Factor)	Child Index (Scores for Factor)	Child Index (Scores for Factor)
Postpartum depression	0.100*	0.082	0.076
	(0.049)	(0.049)	(0.049)
Antepartum depression	0.236	0.228	0.228
	(0.454)	(0.430)	(0.417)
Maternal mental health problems-Age 3		-0.036	-0.038
		(0.057)	(0.058)
Maternal mental health problems-Age 5		0.185	0.183
		(0.095)	(0.096)
Maternal mental health problems-Age 7		0.110	0.107
		(0.114)	(0.114)
N	2528	2528	2528
R^2	0.045	0.048	0.054

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[i] adjusting for non-time variant predictors and socio-demographics

[ii] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[iii] adjusting for cohort baby's time variant risk factors at birth

Table 6: Child Reported Index for girls

	Model 1[i]	Model 2[ii]	Model 3[iii]
	Child Index (Scores for Factor)	Child Index (Scores for Factor)	Child Index (Scores for Factor)
Postpartum depression	0.059	0.045	0.041
	(0.063)	(0.064)	(0.064)
Antepartum depression	0.194	0.182	0.170
	(0.210)	(0.222)	(0.216)
Maternal mental health problems-Age 3		-0.029	-0.022
		(0.062)	(0.063)
Maternal mental health problems-Age 5		0.008	0.002
		(0.103)	(0.103)
Maternal mental health problems-Age 7		0.226*	0.211
		(0.109)	(0.111)
N	2612	2612	2612
R^2	0.026	0.029	0.033

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[i] adjusting for non-time variant predictors and socio-demographics

[ii] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[iii] adjusting for cohort baby's time variant risk factors at birth

Table 7: BAS Verbal Similarities for boys

	Model 1[i]	Model 2[ii]	Model 3[iii]
	BAS Verbal Similarities	BAS Verbal Similarities	BAS Verbal Similarities
Postpartum depression	-0.012	0.009	0.009
	(0.063)	(0.065)	(0.065)
Antepartum depression	-0.039	-0.056	-0.054
	(0.164)	(0.170)	(0.158)
Maternal mental health problems-Age 3		0.010	0.006
		(0.086)	(0.084)
Maternal mental health problems-Age 5		-0.031	-0.007
		(0.115)	(0.115)
Maternal mental health problems-Age 7		-0.283	-0.294
		(0.152)	(0.155)
N	2636	2636	2636
R^2	0.135	0.138	0.148

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[i] adjusting for non-time variant predictors and socio-demographics

[ii] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[iii] adjusting for cohort baby's time variant risk factors at birth

Table 8: BAS Verbal Similarities for girls

	Model 1[i]	Model 2[ii]	Model 3[iii]
	BAS Verbal Similarities	BAS Verbal Similarities	BAS Verbal Similarities
Postpartum depression	-0.049	-0.047	-0.041
	(0.055)	(0.057)	(0.058)
Antepartum depression	-0.575	-0.579	-0.557
	(0.492)	(0.488)	(0.478)
Maternal mental health problems-Age 3		-0.028	-0.040
		(0.061)	(0.060)
Maternal mental health problems-Age 5		-0.033	-0.029
		(0.102)	(0.101)
Maternal mental health problems-Age 7		0.057	0.065
		(0.106)	(0.107)
N	2694	2694	2694
R^2	0.127	0.128	0.137

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[i] adjusting for non-time variant predictors and socio-demographics

[ii] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[iii] adjusting for cohort baby's time variant risk factors at birth

Table 9: CANTAB Quality of Decision Making for Boys

	Model 1[i]	Model 2[ii]	Model 3[iii]
	Quality of Decision Making	Quality of Decision Making	Quality of Decision Making
Postpartum depression	-0.056	-0.050	-0.043
	(0.066)	(0.065)	(0.066)
Antepartum depression	0.025	0.084	0.118
	(0.161)	(0.171)	(0.194)
Maternal mental health problems-Age 3		-0.049	-0.053
		(0.088)	(0.088)
Maternal mental health problems-Age 5		-0.149	-0.146
		(0.136)	(0.138)
Maternal mental health problems-Age 7		0.115	0.114
		(0.140)	(0.144)
N	2554	2554	2554
R^2	0.054	0.055	0.065

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[i] adjusting for non-time variant predictors and socio-demographics

[ii] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[iii] adjusting for cohort baby's time variant risk factors at birth

Table 10: CANTAB Quality of Decision Making for Girls

	Model 1[i]	Model 2[ii]	Model 3[iii]
	Quality of Decision Making	Quality of Decision Making	Quality of Decision Making
Postpartum depression	0.011	-0.004	-0.003
	(0.059)	(0.058)	(0.058)
Antepartum depression	-0.117	-0.107	-0.079
	(0.216)	(0.212)	(0.197)
Maternal mental health problems-Age 3		0.007	-0.001
		(0.073)	(0.071)
Maternal mental health problems-Age 5		0.165	0.174
		(0.100)	(0.100)
Maternal mental health problems-Age 7		-0.010	0.007
		(0.116)	(0.119)
N	2614	2614	2614
R^2	0.052	0.055	0.067

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[i] adjusting for non-time variant predictors and socio-demographics

[ii] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[iii] adjusting for cohort baby's time variant risk factors at birth

Table 11: CANTAB Risk Adjustment for Boys

	Model 1[i]	Model 2[ii]	Model 3[iii]
	Risk Adjustment	Risk Adjustment	Risk Adjustment
Postpartum depression	-0.046	-0.057	-0.045
	(0.072)	(0.073)	(0.073)
Antepartum depression	-0.391	-0.493	-0.497
	(0.265)	(0.302)	(0.354)
Maternal mental health problems-Age 3		0.113	0.120
		(0.106)	(0.102)
Maternal mental health problems-Age 5		0.210	0.222
		(0.136)	(0.135)
Maternal mental health problems-Age 7		-0.126	-0.114
		(0.123)	(0.122)
N	2055	2055	2055
R^2	0.052	0.055	0.067

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[i] adjusting for non-time variant predictors and socio-demographics

[ii] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[iii] adjusting for cohort baby's time variant risk factors at birth

Table 12: CANTAB Risk Adjustment for Girls

	Model 1[i]	Model 2[ii]	Model 3[iii]
	Risk Adjustment	Risk Adjustment	Risk Adjustment
Postpartum depression	-0.119	-0.098	-0.096
	(0.068)	(0.070)	(0.070)
Antepartum depression	0.508	0.526	0.510
	(0.332)	(0.320)	(0.314)
Maternal mental health problems-Age 3		-0.062	-0.063
		(0.087)	(0.086)
Maternal mental health problems-Age 5		0.012	0.003
		(0.096)	(0.098)
Maternal mental health problems-Age 7		-0.176	-0.184
		(0.112)	(0.111)
N	2058	2058	2058
R^2	0.044	0.046	0.048

Note: Standardised coefficients; Standard errors in parentheses; * p<0.05** p<0.01; All models include controls for maternal age at birth, baby's age in months, baby's weight at birth, tried to breastfeed, baby pre-term, baby post-term, mother born in the UK, ethnicity, attending religious services, baby's father present at birth, mother lived with both parents until 15, baby's father completed questionnaire, regional residency, maternal highest educational qualification and constant term. Model 3 includes controls for the OECD median poverty rate, marriage, maternal longstanding illness, mother smoked, mother consumed alcohol, baby has other siblings.

[i] adjusting for non-time variant predictors and socio-demographics

[ii] adjusting for Model 1 and history of maternal mental illness (ages 3-7)

[iii] adjusting for cohort baby's time variant risk factors at birth

Appendix III Estimations: Using chronic maternal mental health episodes as a robustness check

Table 1: Child Emotional Problems as Reported by Mothers, Teachers and Children: Association with PPD

Postpartum Depression	Model 1	Model 2	Model 3
Teacher Reported SDQ Total Difficulties Boys	0.229*	0.222*	0.211*
	(0.089)	(0.089)	(0.089)
Teacher Reported SDQ Total Difficulties Girls	0.040	0.041	0.036
	(0.057)	(0.056)	(0.056)
Mother Reported SDQ Total Difficulties Boys	0.419**	0.403**	0.388**
	(0.072)	(0.071)	(0.071)
Mother Reported SDQ Total Difficulties Girls	0.290**	0.278**	0.270**
	(0.074)	(0.074)	(0.073)
Child Index Boys	0.100*	0.097*	0.090
	(0.049)	(0.049)	(0.048)
Child Index Girls	0.059	0.056	0.052
	(0.063)	(0.062)	(0.062)

Note: Results from 18 separate OLS estimations. Standardised coefficients; Standard errors in parentheses. *p<0.05 **p<0.01. Dependent variables measured at age 11 (MCS5), mean and standard errors of dependent variables (see Appendix I Table 4); Independent variable measured at age 9 months (MCS1); Model 1 adjusts for time invariant predictors and socio-demographics; Model 2 adjusts for characteristics in Model 1 and persistence of maternal mental illness (ages 3-7); Model 3 adjusts for characteristics in Model 2 and potential time risk factors at birth (see Appendix II for complete tables). Observations: Teacher's SDQ, boys: 2673; Teacher's SDQ, girls: 2724; Mother's SDQ, boys: 2673; Mother's SDQ, girls: 2724; Child Index, boys: 2528; Child Index, girls: 2612.

Table 2: Child Cognitive Outcomes: Association with PPD

Postpartum Depression	Model 1	Model 2	Model 3
British Ability Scales: Verbal Similarities Boys	-0.012	-0.008	-0.007
	(0.063)	(0.063)	(0.062)
British Ability Scales: Verbal Similarities Girls	-0.049	-0.049	-0.044
	(0.055)	(0.056)	(0.057)
CANTAB: Quality of Decision Making Boys	-0.056	-0.056	-0.050
	(0.066)	(0.066)	(0.066)
CANTAB: Quality of Decision Making Girls	0.011	0.003	0.005
	(0.059)	(0.059)	(0.058)
CANTAB: Risk Adjustment Boys	-0.046	-0.047	-0.033
	(0.072)	(0.072)	(0.071)
CANTAB: Risk Adjustment Girls	-0.119	-0.117	-0.116
	(0.068)	(0.068)	(0.068)

Note: Results from 18 separate OLS estimations. Standardised coefficients; Standard errors in parentheses. *p<0.05 **p<0.01. Dependent variables measured at age 11 (MCS5), mean and standard errors of dependent variables (see Appendix I Table 4); Independent variable measured at age 9 months (MCS1); Model 1 adjusts for time invariant predictors and socio-demographics; Model 2 adjusts for characteristics in Model 1 and persistence of maternal mental illness (ages 3-7); Model 3 adjusts for characteristics in Model 2 and potential time risk factors at birth (see Appendix II for complete tables). Observations: BAS, boys: 2636; BAS, girls: 2694; CANTAB Decision Making, boys: 2554; CANTAB Decision Making, girls: 2614; CANTAB Risk Adjustment, boys: 2055; CANTAB Risk Adjustment, girls: 2058.

Appendix IV Estimations: Using full sample as a robustness check

Table 1: Child Emotional Problems as Reported by Mothers and Children: Association with PPD

Postpartum Depression	Model 1	Model 2	Model 3
Mother Reported SDQ Total Difficulties Boys	0.414**	0.329**	0.318**
	(0.056)	(0.057)	(0.057)
Mother Reported SDQ Total Difficulties Girls	0.335**	0.260**	0.252**
	(0.058)	(0.060)	(0.059)
Child Index Boys	0.153**	0.132**	0.125**
	(0.038)	(0.038)	(0.038)
Child Index Girls	0.073	0.056	0.053
	(0.047)	(0.048)	(0.048)

Note: Results from 12 separate OLS estimations. Standardised coefficients; Standard errors in parentheses. *p<0.05 **p<0.01. Dependent variables measured at age 11 (MCS5), mean and standard errors of dependent variables; Independent variable measured at age 9 months (MCS1); Model 1 adjusts for time invariant predictors and socio-demographics; Model 2 adjusts for characteristics in Model 1 and history of maternal mental illness (ages 3-7); Model 3 adjusts for characteristics in Model 2 and potential time risk factors at birth. Observations: Mother's SDQ, boys: 4762; Mother's SDQ, girls: 4790; Child Index, boys: 4458; Child Index, girls: 4569.

Table 2: Child Cognitive Outcomes: Association with PPD

Postpartum Depression	Model 1	Model 2	Model 3
British Ability Scales: Verbal Similarities Boys	-0.035	0.002	-0.000
	(0.051)	(0.051)	(0.052)
British Ability Scales: Verbal Similarities Girls	-0.046	-0.036	-0.027
	(0.042)	(0.042)	(0.043)
CANTAB: Quality of Decision Making Boys	-0.056	-0.046	-0.041
	(0.051)	(0.051)	(0.051)
CANTAB: Quality of Decision Making Girls	0.014	0.001	0.001
	(0.044)	(0.045)	(0.045)
CANTAB: Risk Adjustment Boys	-0.026	-0.021	-0.013
	(0.057)	(0.058)	(0.057)
CANTAB: Risk Adjustment Girls	-0.064	-0.038	-0.034
	(0.052)	(0.054)	(0.055)

Note: Results from 18 separate OLS estimations. Standardised coefficients; Standard errors in parentheses. *p<0.05 **p<0.01. Dependent variables measured at age 11 (MCS5), mean and standard errors of dependent variables; Independent variable measured at age 9 months (MCS1); Model 1 adjusts for time invariant predictors and socio-demographics; Model 2 adjusts for characteristics in Model 1 and history of maternal mental illness (ages 3-7); Model 3 adjusts for characteristics in Model 2 and potential time risk factors at birth. Observations: BAS, boys: 4666; BAS, girls: 4718; CANTAB Decision Making, boys: 4491; CANTAB Decision Making, girls: 4562; CANTAB Risk Adjustment, boys: 3586; CANTAB Risk Adjustment, girls: 3520.