

Title: Paternal Depression in the Postnatal Period and Offspring Depression at 18 Years

Subtitle: Paternal and Offspring Depression

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Abbreviations: ALSPAC - Avon Longitudinal Study of Parents and Children; EPDS - Edinburgh Postnatal Depression Scale; SDQ - Strengths and Difficulties Questionnaire.

Keywords: ALPAC, fathers, mothers, postnatal depression, adolescent depression, parenting and family conflict.

ABSTRACT

Importance: Paternal depression during the postnatal period has been associated with adverse child outcomes. Family environment has been reported as a pathway for risk transmission from fathers to children. The effect of paternal depression during the postnatal period on offspring depression remains to be clarified.

Objective: To investigate the association between paternal depression in the postnatal period and offspring depression; to explore potential mediating and moderating factors that influence any association between paternal and offspring depression.

Design: Prospective investigation of associations between paternal depression during the postnatal period and offspring depression at age 18. We tested hypothesized moderator (i.e., gender). Path analysis examined hypothesized mediators (i.e., depression in the other parent, couple conflict, paternal involvement, emotional problems, conduct problems, and hyperactivity at 3.5 years) of the associations between both paternal and maternal depression and offspring depression.

Setting: UK community based birth cohort (ALSPAC).

Participants: 4,500 parents and their adolescent offspring.

Exposure: Depression symptoms in fathers at 8 weeks after the birth of their child.

Main Outcome and Measure: Offspring depression symptoms, aged 18, using ICD-10.

Results: 3,176 fathers and offspring were analyzed (females=1,764; males=1,412). Paternal mean age (SD) at delivery was 29.6 (9.6) years. Offspring of fathers who have depression during the postnatal period are at increased risk of experiencing depression symptoms at 18 years ($\beta=0.053$, 95% CI= 0.02-0.09). The association is mediated by maternal depression at 8 months [21% (0.011/0.053); $\beta=0.011$, 95% CI=0.0008-0.02]

and conduct problems at 42 months [7.5% (0.004/0.053); $\beta=0.004$, 95% CI=-0.00004-0.009]. Couple conflict and paternal involvement do not mediate such association. The increased risk is seen in females but not in males (interaction $\beta=0.095$, $p=0.009$).

Conclusions and Relevance: The association between paternal depression postnatally and depression in females at 18 years is partially explained by maternal depression. Couple conflict and paternal involvement were not found to play a role in the risk of transmission. This contrasts with the role that couple conflict was found to play in the risk of childhood behavior problems. Conduct problems in childhood appears to be a pathway for risk transmission between paternal depression and subsequent depression at 18 years.

Key points

Questions. Which are the mechanisms of risk transmission from paternal depression during the postnatal period to offspring depression at 18 years?

Findings. Paternal depression postnatally is associated with offspring depressions at 18 years. Paternal depression appears to exert its influence on late emotional problems in females partially through maternal depression. Early conduct disorder in children appears to be a mechanism of risk transmission.

Meaning. Depression in fathers in the postnatal period has potential implications for family and child functioning into late childhood and adolescence. Paternal depression should be thought about in perinatal services, and both parents should be considered when one parent presents with depression.

INTRODUCTION

The prevalence of depression in adolescence is between 4 and 5%. The incidence of depression increases after puberty and is twice as high in females as in males ¹. The rate of depression increases by age, from 5.7% among youth aged 12–17 to 7.4% among adults aged 18-39 in the U.S population ². A recent review study reported that the strongest risk factors for depression in adolescents are a family history of depression and exposure to psychosocial stress ³.

The impact of maternal depression in the postnatal period on adolescent depression has previously been reported ⁴⁻⁶. Mechanisms of risk transmission have also been investigated. Some longitudinal studies have suggested that the effects of early maternal depression are mediated through exposure to later maternal depression or associated psychosocial adversity ^{5,7-11}. Insecure attachment to the mother in infancy was a predictor of depression in adolescence at 16 years. In addition, marital conflict and ongoing maternal depression have been found to partially mediate the effects of maternal postnatal depression on adolescent depression ⁴.

A recent longitudinal study using the ALSPAC cohort reported that offspring of mothers and fathers with depression in the postnatal period were more likely to develop depression at age 18 years in families with low educational level. Conversely, having parents who suffer from depression postnatally did not appear to be a risk factor if parents have a high level of education ¹². However, the pathways for risk transmission between paternal depression and subsequent offspring depression still remain to be determined.

The moderating effect of gender on the association between maternal depression and offspring depression at 18 years has been previously reported. Maternal antenatal

depression was associated with an increased risk of depression in females and maternal postnatal depression was associated with an increased risk of depression in males¹³.

There is very limited evidence regarding the potential impact of paternal depression in the postnatal period on the development of adolescent depression. However, there is clear evidence that paternal depression postnatally is associated with subsequent child behavioral and emotional problems at 4 years¹⁴ and 7 years¹⁵. We have previously reported on mechanisms of risk transmission from paternal depression to child behavioral problems. We found that nearly two-thirds of the association between paternal depression and child outcomes were explained by the mediating role of maternal depression and couple conflict¹⁶.

Using the same cohort, in this study we sought to explore the association between paternal depression in the postnatal period and offspring depression at age 18 years. We also aimed to explore key potential mediating and moderating factors influencing the association between paternal and offspring depression⁴. First, we hypothesized that paternal depression symptoms in the postnatal period would be associated with offspring depression symptoms at age 18. Second, we hypothesized that pathways for risk transmission from paternal depression to offspring depression at age 18 would not differ to those seen in children with behavioral difficulties at age 4. Furthermore, emotional problems, conduct problems and hyperactivity at age 4 would be pathways for risk transmission from paternal depression to offspring depression. Finally, we hypothesized that the effect of paternal depression could be stronger in females than males. There is evidence suggesting the impact of father's involvement on later mental health problems in females but not in males¹⁷.

METHODS

Participants

The sample comprised participants from the Avon Longitudinal Study of Parents and Children (ALSPAC;¹⁸⁻²⁰). ALSPAC is an ongoing population-based cohort study in the South-West of England. ALSPAC recruited 14,541 pregnant women resident in Avon, UK with expected dates of delivery 1st April 1991 to 31st December 1992. 14,541 was the initial number of pregnancies for which the mother enrolled in the ALSPAC study, however an additional 713 children were enrolled during Phases II and III. The total sample size for analyses was 15,247 pregnancies, resulting in 15,458 fetuses. Of this total sample, 14,775 were live births and 14,701 were alive at 1 year of age. Questionnaires were sent to mothers and fathers at regular points during and after pregnancy. Detailed information about ALSPAC is available online (<http://www.bris.ac.uk/alspac>) and the study website also contains details of all the data that is available through a fully searchable data dictionary (<http://www.bris.ac.uk/alspac/researchers/data-access/data-dictionary/>). Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and local Research Ethics Committees. Written informed consent was obtained from all study participants. In this paper, we focus on paternal depression during the postnatal period and offspring depression at 18 years.

Procedures and Measures

Paternal depression

We used the *Edinburgh Postnatal Depression Scale* (EPDS) to assess depression symptoms in mothers and fathers at 8 weeks and 8 months after the birth of their baby. The EPDS is a 10 item self-report questionnaire²¹ which was initially developed to screen for depression in women within the first 6-8 weeks of giving birth. It is also useful in the assessment of mothers across and beyond the first postnatal year and has been validated in men^{22,23}. The majority of studies utilizing the EPDS use a cut off

score of greater than 12^{14,24} although other studies have used other cut offs e.g., 9²⁵. We primarily used the continuous scores to make full use of all variation in symptoms.

Offspring depression

Depression in the offspring was measured using the computerized version of the Clinical Interview Schedule-Revised (CIS-R)²⁶. The CIS-R is a computerized interview, which derives a diagnosis of depression according to ICD-10 criteria as well as symptom severity score for depression. The interview is fully standardized and equally reliable whether conducted by a clinically trained interviewer or self-administered on the computerized version²⁶⁻²⁸. The CIS-R is designed for, and has been widely used within, community samples including the National Surveys of Psychiatric Morbidity and the 1958 birth cohort²⁸⁻³¹. We used a total depressive symptom score derived by summing scores for depression, depressive ideas, fatigue, sleep, and concentration problems, on a scale of 0-4 (depressive ideas 0-5).

Other measures

*Rutter revised preschool scales*³² were completed by mothers at 42 months. Each item describes a characteristic or behavior. Individual items combine to form three problem scales (*emotional problems, conduct problems, and hyperactivity*), and a *prosocial behaviors scale*. All problem behaviors combine to give a *total problems scale*.

Parental age. Fathers and mothers reported their age at the time of the child's birth.

Parental education. In week 32 of the pregnancy, mothers were asked about the highest educational qualification of themselves and their partners. Education up to age 16 (compulsory education only) was categorized as low education and post 16 education as high.

Couple conflict. At 8 months after the birth of their baby, mothers were asked about the relationship with their partner. A nine-item scale was used which included questions

such as ‘Do you get angry with your partner?’ and ‘Does your partner listen when you want to talk about your feelings? Possible answers range from ‘almost always’ to ‘never’. The scale was developed specifically for the ALSPAC study, and has been used in other research³³. A single factor structure (Cronbach's alpha > 0.8 for maternal and paternal data), explained the data generating an overall measure of couple conflict.

Paternal involvement. At 18 months after birth, mothers were asked how often their partners undertook 10 different activities with their child, including: bathing, singing, reading, and putting him/her to bed. Responses were on a 5-point scale, from ‘never’ to ‘every day’. A sum of all responses was the final score.

Statistical analysis

Statistical analysis was carried out with Stata 12.0. We calculated the prevalence of depression in adolescents and then we conducted logistic regression analysis to assess the effect of paternal depression on offspring depression.

Bivariate correlations analyzed the degree of association between paternal depression at 8 weeks and 8 months after birth, maternal depression at 8 weeks and 8 months, couple conflict, paternal involvement, emotional problems, conduct problems, and hyperactivity at 42 months and offspring depression at 18 years.

We conducted Structural Equation Modeling (SEM) to investigate hypothesized mediators between paternal and offspring depression symptoms. The model included paternal depression at 8 weeks (independent variable); maternal depression at 8 weeks and 8 months, paternal depression at 8 months, couple conflict, paternal involvement, emotional problems, conduct problems, and hyperactivity at 42 months (mediators); and offspring depression (dependent variable). We controlled for paternal education and age. We examined two types of relationship between variables i) Direct effect: a direct relationship between paternal depression and offspring depression; ii) Indirect effect:

effect of paternal depression on offspring depression through each mediator (Figure 1A and B). Moderate to strong correlations were seen between paternal and maternal education ($r=0.54$, $p<0.001$) and paternal and maternal age ($r=0.36$, $p<0.01$). SEM was performed using maximum likelihood estimation. Indirect effects were calculated using non linear combination of parameters (nlcom). In order to avoid relying on normality assumptions, a non-parametric bootstrap with replacement, with 1000 replicates, was used.

In order to investigate the moderating effect of gender on the association between paternal depression during the postnatal period and offspring depression, we repeated the SEM model stratifying by gender.

We also assessed hypothesized mediators in the association between maternal depression at 8 weeks after birth (independent variable) and offspring depression (dependent variable). Mediating factors were paternal depression at 8 weeks and 8 months, maternal depression at 8 months, couple conflict, paternal involvement, emotional problems, conduct problems, and hyperactivity at 42 months. We controlled for maternal education and age.

RESULTS

Maternal postnatal depression was assessed in 11,833 of 13,351 (89%) mothers and paternal depression postnatally in 8,431 of 12,884 (65%) male partners. Age 18, 4,566 adolescents completed the CIS-R and 235 of the 3,165 (7.4%) adolescents with information about paternal depression at 8 weeks after birth had a primary diagnosis of depression: 10 of 93 (10.8%) adolescents of fathers with depression and 225 of 3,072 (7.3%) of fathers without depression [OR=1.52, 95% Confidence Interval (CI) = 0.78-2.98]. The effect of paternal depression symptoms on offspring depression symptoms is

shown in Table 1. Bivariate correlations are shown in eTable 1. All variables were correlated.

Models of mediation

A total of 3,176 fathers and adolescents were included in the path analysis. The total effect of paternal depression postnatally on offspring depression at 18 years controlling for paternal education and age was $\beta=0.053$, 95% CI =0.02-0.09, $p=0.004$, Bootstrapped 95% CI= 0.02-0.10. This total effect was explained by the indirect effect of maternal depression at 8 months [21% (0.011/0.053); $\beta=0.011$, Bootstrapped 95% CI=0.0008-0.02] and conduct problems at 42 months [7.5% (0.004/0.053); $\beta=0.004$, Bootstrapped 95% CI=-0.00004-0.009]. Couple conflict ($\beta=0.002$, $p=0.721$) and paternal involvement ($\beta=0.004$, $p=0.121$) did not explain this association (see Figure 1A and B).

When stratified by gender, a total of 1764 females and 1412 males were included in the path analysis. The association between paternal depression symptoms and total symptoms of depression in adolescents was stronger in females than males (paternal depression by gender interaction $\beta=0.095$, $p=0.009$; total effect of paternal depression on females at 18 years: $\beta=0.097$, 95% CI= 0.04-0.15, $p< 0.001$, Bootstrapped 95% CI= 0.04 - 0.15; males at 18 years: $\beta=-0.002$, 95% CI=-0.05-0.05, $p=0.936$). The total effect of paternal depression on offspring depression in females was explained by the indirect effect of maternal depression at 8 months [18% (0.017/0.097); $\beta=0.017$, Bootstrapped 95% CI= 0.003-0.03] and conduct problems at 42 months [9.3% (0.009/0.097); $\beta=0.009$, Bootstrapped 95% CI=0.0013-0.016]. The association between paternal and offspring depression was not mediated by couple conflict and paternal involvement (eFigure 1A and B). Paternal depression during the postnatal period was not associated with offspring depression in males.

We repeated the analysis for maternal depression at 8 weeks after the birth of the child as the exposure variable and offspring depression. A total of 4062 mothers and adolescents were included in the analysis. The total effect of postnatal maternal depression on offspring depression was $\beta=0.097$ (95% CI=0.07-0.12, $p<0.001$). This association was explained by the effect of maternal depression at 8 months [50% (0.048/0.097)] and maternal depression at 8 weeks [31% (0.03/0.097)] and minimally explained by the indirect effect of paternal involvement [3.3% (0.003/0.097)] and conduct problems [7.2% (0.007/0.097)]. Paternal depression and couple conflict did not explain this association (eFigure 2A and B). There was no gender interaction ($\beta=0.033$, $p=0.211$).

DISCUSSION

This study explores the effect of paternal depression symptoms at 8 weeks postnatally and offspring depression symptoms at 18 years in a large community sample. We also explored eight potential environmental causal pathways that may explain this association. In order to conduct pathway analysis we used continuous measures of depression (i.e., symptoms) instead of caseness. Responses for a dichotomous variable are heavily skewed towards one response and comparison of two groups could not be possible since too few participants met the threshold for caseness³³.

Our findings indicate that adolescents of fathers who have depression during the postnatal period are at increased risk of experiencing depression symptoms at 18 years even after paternal age and education had been controlled for. The effect size is small, but it is still significant after 18 years follow-up. The increased risk is seen in females but not in males. The mediating effect of maternal depression at 8 months explains one-fifth of the total effect of paternal depression postnatally on offspring depression and conduct problems at 3.5 year explains almost one-tenth of this association. Conversely,

the total effect of postnatal maternal depression on subsequent offspring depression is minimally explained by paternal involvement and conduct problems.

Our findings suggest that paternal depression during the postnatal period appears to exert its influence on late emotional problems in females at least in part through maternal depression. Maternal depression has been previously associated with impaired parenting, particularly with sensitive parenting³⁴. Mothers with depression show less maternal responsiveness or sensitivity, less verbal and visual interaction, and more intrusiveness during interaction with their infants^{35,36}.

We had previously reported that couple conflict mediated the relationship between postnatal depression in fathers and child outcomes at 3.5 years^{16,37}, however the role of couple conflict appears to be less important for offspring adolescents with depression than for child behavioral problems. Paternal involvement was not found to play a role in the risk of offspring depression although we did not have suitable data to explore the quality of parent-infant interaction. In addition, mediators were measured early in child life and we did not measure these variables throughout the time period.

Our group previously reported that males were more vulnerable to the effect of paternal depression than females in the early years¹⁴. However, we have found that females of fathers with depression during the postnatal period are at risk of developing depression after puberty, but such risk is not seen in males. One study has reported an association between parenting father-infant interaction and later emotional development only in females¹⁷. The effect of paternal depression during the postnatal period through father-infant interaction might affect males in the short term and females in the longer term. In this study we were unable to include this pathway, as this was not assessed.

The association between maternal and offspring depression differed from that seen in fathers. Other studies have found these differences are explained by other factors such

as maternal depression⁹, mother-child interaction³⁴, higher genetic loading in mothers³⁸⁻⁴⁰ or transmission of cognitive style⁴¹. Additionally, the association between maternal depression during the postnatal period and depression in offspring did not show a gender specific effect. A previous meta-analysis reported no differences by gender in the relationship between maternal depression and internalizing problems¹⁰.

In this study, we found that early-onset conduct problems mediated the association between fathers with depression during the postnatal period and adolescent depression; however early emotional problems did not explain such an association. This finding is consistent with previous research that reported conduct problems in early childhood are a strong risk factor for subsequent depression^{3,42}.

Strengths and Limitations

This study has a number of strengths. The sample size is large and based on a community sample, limiting the possibility of selection bias. This is a long-term follow-up study, with the proposed mediating factors measured at a time point between predictor and outcome. Paternal depression was first measured 18 years earlier than the measure of offspring depression as a result reverse causality is implausible. A clinical interview was used for the offspring outcome.

There were a number of limitations of the study. Adolescents who attended the 18-year assessment were more likely to come from families of higher SES than those in the original sample. A further limitation was the lack of a measure of paternal depression when the child was 18. It is also important to note that the paternal depression measure was a self-report rather than a diagnostic interview. The use of questionnaires to assess father involvement, with no directly observed measures, did not allow us to assess the effect of paternal depression through parenting interaction. Depression in the adolescents was assessed using a computerized interview. Any form of measurement

has some limitations, however rates of depression diagnoses yielded from the computerized CIS-R assessments are generally similar to those produced by other structured interview assessments^{27,30}. Finally, the lag time between the mediator and the outcome variable was significantly larger than between the independent variable and the mediator.

CONCLUSIONS

This study suggests that there is an association between depression in fathers during the postnatal period and subsequent depression in females at 18 years. Such an association is explained predominantly by the effect of maternal depression (21%). In contrast, the association between depression in mothers and adolescent outcome differs from that seen in fathers. Other research suggests that it may be better explained by other factors including effects of depression on mother-infant interaction, genetic loading and transmission of negative cognitions. Early conduct disorder in children appears to be a mechanism of risk transmission between depression in fathers and subsequent depression at 18 years.

Overall these findings highlight the importance of recognizing and treating depression in fathers during the postnatal period and considering both parents when one parent presents with depression.

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Author Contributions: Prof Ramchandani and Dr Gutierrez-Galve had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: All authors.

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Drafting of the manuscript: All authors.

Critical revision of the manuscript for important intellectual content: All authors.

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Table 1. Crude and adjusted association between symptoms of paternal depression during the postnatal period and symptoms of offspring depression at 18 years.

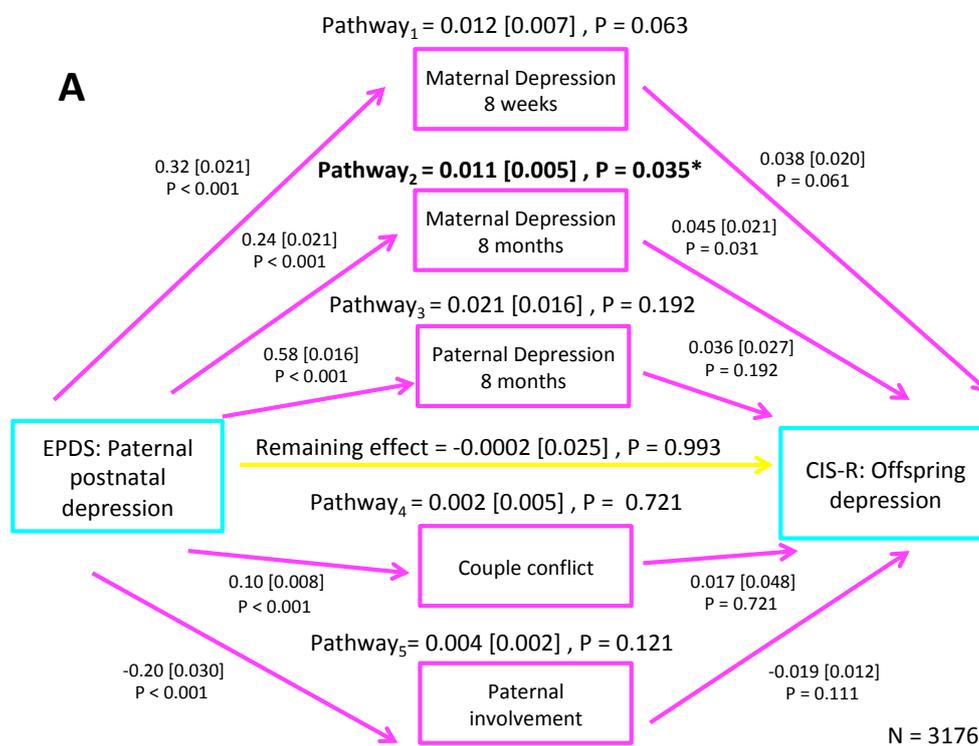
Paternal Depression Symptoms	Crude Beta (95% CI)	Adjusted*Beta (95% CI)
Offspring Depression Symptoms		
TOTAL N=3,176	$\beta=0.053$, 95% CI=0.02-0.09	$\beta=0.053$, 95% CI=0.02-0.09
FEMALES N=1,764	$\beta=0.097$, 95% CI=0.05-0.15	$\beta=0.097$, 95% CI= 0.04-0.15
MALES N=1,412	$\beta=-0.002$, 95% CI=-0.05-0.05	$\beta=-0.002$, 95% CI=-0.05-0.05

*Controlling for paternal education and paternal age

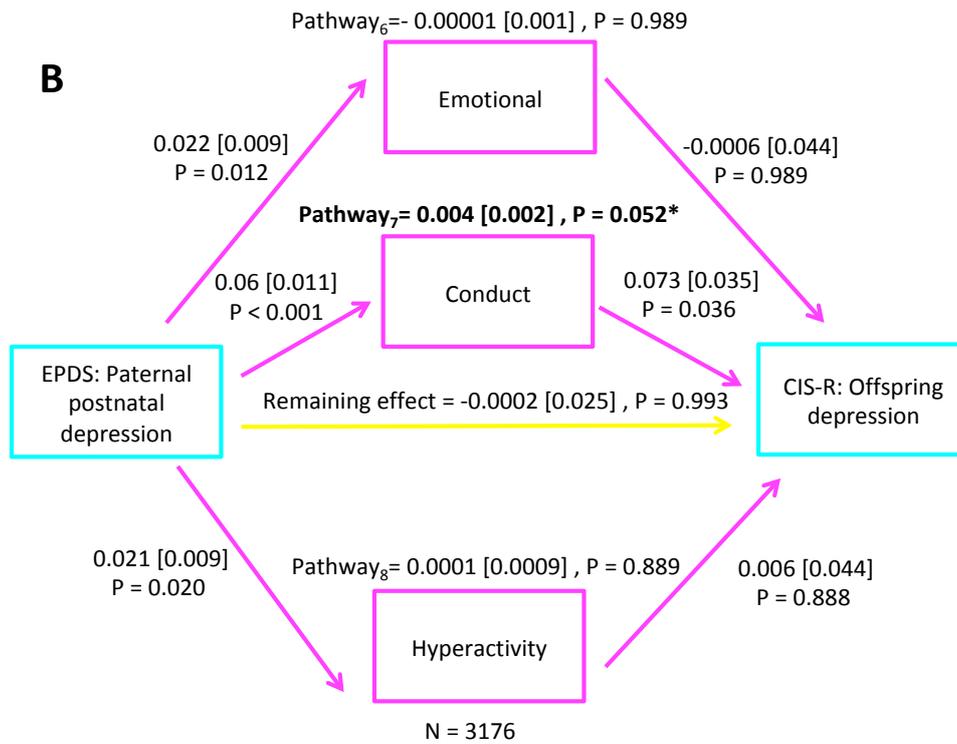
Figure 1. Hypothesized pathways in the association between *paternal depression symptoms* at 8 weeks after the birth of the child and *offspring depression symptoms* at 18 years. Model adjusted for paternal education and age.

In the diagram, the arrows represent regressions and thus associations between variables. All regression path coefficients are standardized, so all effects sizes are directly comparable. The figure shows regression path coefficient, standard error [SE] and p value for each direct and indirect effect.

A. Maternal depression was measured at 8 weeks and 8 months after birth, paternal depression and couple conflict were measured at 8 months after birth and paternal involvement at 18 months.



B. Emotional problems, conduct problems and hyperactivity were measured at age 4.



Supplementary information

1 table and 4 Figures

eTable 1

eFigure 1A and B

eFigure 2A and B

eTable 1. Bivariate Pearson correlations among paternal depression at 8 weeks and 8 months, maternal depression at 8 weeks and 8 months, couple conflict, paternal involvement, child outcomes at 42 months and offspring depression at 18 years.

Variable	1	2	3	4	5	6	7	8	9	10
(Pearson correlation)										
1 Paternal depression 8 weeks										
2 Paternal	0.60**									

depression 8 months										
3 Maternal depression 8 weeks	0.27**	0.22**								
4 Maternal depression 8 months	0.21**	0.28**	0.61**							
5 Couple conflict	0.23**	0.26**	0.34**	0.41**						
6 Paternal involvement	-0.10**	-0.09**	-0.09**	-0.11**	-0.29**					
7 Emotional	0.07**	0.07**	0.19**	0.18**	0.13**	-0.04**				
8 Conduct	0.08**	0.07**	0.18**	0.17**	0.19**	-0.09**	0.25**			
9 Hyperactivity	0.07**	0.06**	0.15**	0.16**	0.13**	-0.06**	0.25**	0.40**		
10 Adolescent depression	0.05**	0.04*	0.11**	0.10**	0.07**	-0.07**	0.04*	0.06**	0.03*	

*Correlation significant at 0.05

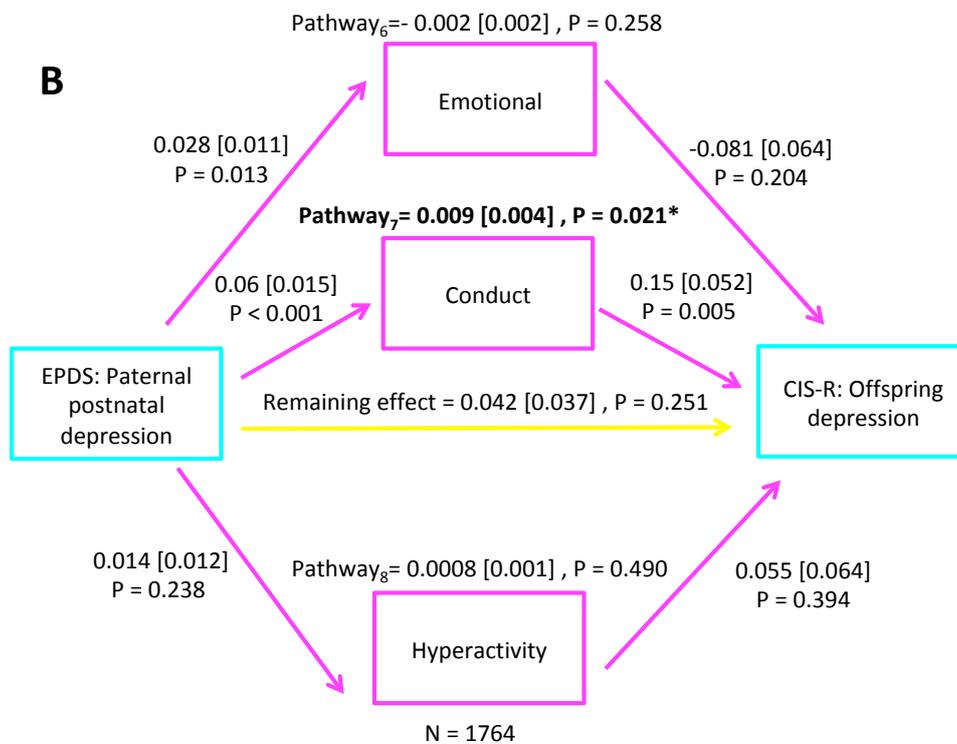
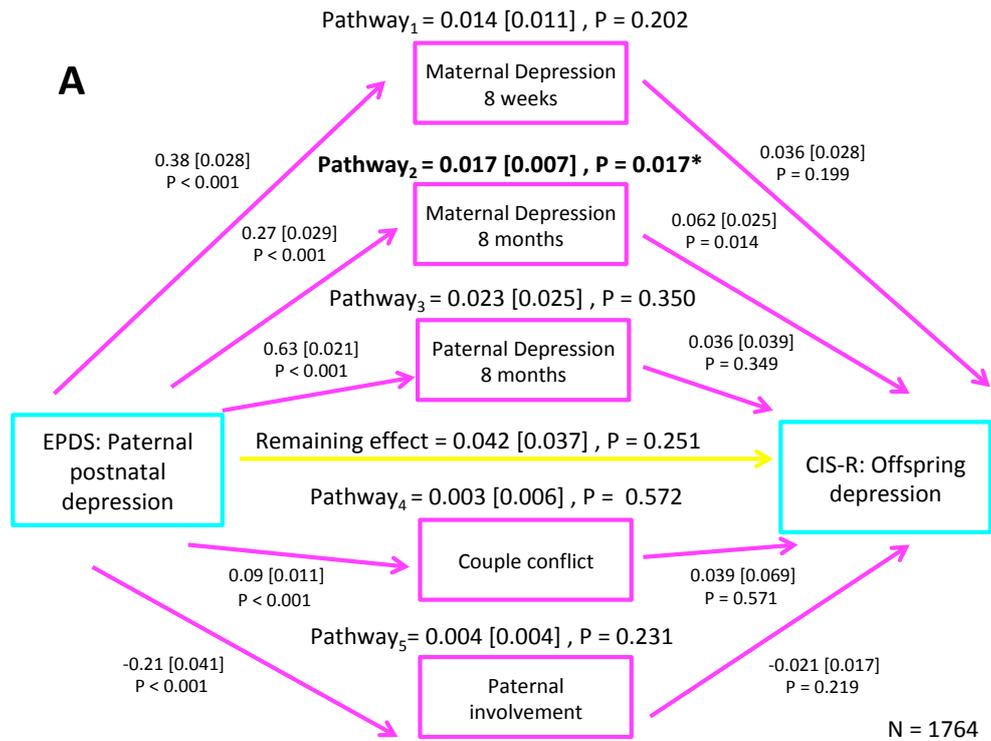
**Correlation significant at 0.01

eFigure 1. Hypothesized pathways in the association between *paternal depression symptoms* at 8 weeks after the birth of the child and *offspring depression symptoms* at 18 years in females. Model adjusted for paternal education and age.

In the diagram, the arrows represent regressions and thus associations between variables. All regression path coefficients are standardized, so all effects sizes are directly comparable. The figure shows regression path coefficient, standard error [SE] and p value for each direct and indirect effect.

A. Maternal depression was measured at 8 weeks and 8 months after birth, paternal depression and couple conflict were measured at 8 months after birth and paternal involvement at 18 months.

B. Emotional problems, conduct problems and hyperactivity were measured at age 4.



eFigure 2. Hypothesized pathways in the association between *maternal depression symptoms* at 8 weeks after the birth of the child and *offspring depression symptoms* at 18 years. Model adjusted for maternal education and age.

A. Paternal depression was measured at 8 weeks and 8 months after birth, maternal depression and couple conflict were measured at 8 months after birth and paternal involvement at 18 months.

B. Emotional problems, conduct problems and hyperactivity were measured at age 4.

