

1 *Title:* Does father-child conflict mediate the association between fathers' postnatal depressive symptoms and  
2 children's adjustment problems at 7 years old?

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8 Word count: 5,531

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13 **Financial support:** This research received no specific grant from any funding agency, commercial or not-for-  
14 profit sectors.

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29 **Background:** Paternal depressive symptoms are associated with children's emotional and behavioural  
30 problems, which may be mediated by negative parenting. But there is no research on the influence of paternal  
31 depressive symptoms on children's emotion regulation and limited literature investigating fathers' parenting as a  
32 mediator in the pathway between paternal depressive symptoms and children's externalising and internalising  
33 problems. We aimed to investigate the mediating role of father-child conflict (at 3 years) in the association  
34 between postnatal paternal depressive symptoms (at 9-months) and children's emotional and behavioural (at 7  
35 years) (aim 1). We also examined whether mediation pathways were more pronounced for boys or for girls (aim  
36 2).

37 **Methods:** Secondary data analysis was conducted on the Millennium Cohort Study, when children were 9-  
38 months, 3-years and 7-years-old (n=3,520). Main study variables were measured by self-report questionnaires.  
39 Fathers completed the Rutter Scale (depressive symptoms) and the parent-child relationship questionnaire  
40 (father-child conflict), while mothers completed the Strengths and Difficulties questionnaire and the Social  
41 behaviour questionnaire (child emotional and behavioural problems, emotion regulation). We used structural  
42 equation modelling to estimate direct, indirect and total effects of paternal depressive symptoms on child  
43 outcomes, mediated by father-child conflict whilst adjusting for relevant covariates (maternal depressive  
44 symptoms, child temperament, marital conflict, and socio-economic factors such as poverty indicator and  
45 fathers' education level). Multi-group and interaction analysis was then conducted to determine the differential  
46 effect by gender of the association between paternal depressive symptoms on child outcomes via father-child  
47 conflict.

48 **Results:** Father-child conflict mediated the association between paternal depressive symptoms and emotion  
49 regulation problems (SIE – CI: -0.03 - -0.01, p<0.001; STE–CI: -0.03 - -0.01, p<0.05) (aim 1). Father-child  
50 conflict mediated a larger proportion of the effect in boys (SIE CI: -0.03- -0.01, p<0.001, STE–CI: -0.05- -0.00,  
51 p=0.063) than it did in girls (SIE–CI: -0.02- -0.01, p<0.001, STE–CI: -0.04 - 0.01, p=0.216) (aim 2).

52 **Conclusions:** Father-child conflict may mediate the association between postnatal paternal depressive  
53 symptoms and children's emotion regulation problems. Paternal depressive symptoms and father-child conflict  
54 resolution may be potential targets in preventative interventions.

55

56 **Key words:** Paternal depressive symptoms, parenting, father-child conflict, behavioural problems, emotion  
57 regulation.

58

## 59 **Introduction**

60 Postnatal depressive symptoms in fathers are associated with behavioural and emotional problems in children  
61 (Davé *et al.*, 2008, Fletcher *et al.*, 2011, Ramchandani *et al.*, 2005, Ramchandani *et al.*, 2008b), but there is  
62 limited understanding about the underlying mechanisms that explain these associations. Childhood behavioural  
63 and emotional problems are associated with poor outcomes during adulthood, including academic  
64 underachievement, psychiatric problems, relationship difficulties, substance abuse and dependency on services  
65 (Caspi *et al.*, 1996, Fergusson *et al.*, 2005). This causes considerable burden on public services and has huge  
66 costs on society (Scott *et al.*, 2001, Snell *et al.*, 2013). Improved understanding of how paternal depressive  
67 symptoms influence children's behavioural and emotional outcomes during childhood may improve theoretical  
68 understanding about the transmission of risk from parents to children and might provide targets for interventions  
69 involving fathers (Garfield, 2015, Ramchandani and Murphy, 2013).

70

71 Using longitudinal data from the Millennium Cohort Study (MCS), Malmberg and Flouri (2011) found that  
72 paternal depressive symptoms at 9 months old predicted behavioural problems in children when they were 3  
73 years old via lower overall quality (lower warmth and higher conflict) in father-child relationship. Using another  
74 large cohort study (Longitudinal Study of Australian Children: LSAC study), Giallo *et al.* (2014b) reported that  
75 paternal depressive symptoms during infancy were associated with children's emotional and behavioural  
76 problems at 4-5 years old, and the association was mediated via increased hostile parenting. Child gender did  
77 not appear to moderate this association. In both studies, fathers' parenting and children's outcomes were  
78 measured at the same time-point, therefore causality cannot be assumed. Finally, a study of fathers with children  
79 aged 5-9 years old found inconsistent discipline practices mediated the association between paternal depressive  
80 symptoms and their sons' hyperactivity, but not their daughters' (Dette-Hagenmeyer and Reichle, 2014).  
81 Although there was a longitudinal element to this study, paternal depressive symptoms and parenting were  
82 measured simultaneously and the measure of child outcomes was collected 6-months later, making the analysis  
83 almost cross-sectional.

84

85 Evidence suggests that poor emotion regulation in children may be associated with increased externalising and  
86 internalising behavioural problems (Eisenberg *et al.*, 2010). Difficulty with regulating anger and impulsivity  
87 (under-regulation) has been linked with externalising problems, whereas inability to control cognition and  
88 attention (over-regulation involved in rumination and negative bias) have been associated with internalising

89 problems (Gross, 1998). Studies have also focused on the effects of maternal depression on children's emotion  
90 regulation, and have reported that children of depressed mothers have poorer emotion regulation compared to  
91 children of non-depressed mothers (Silk *et al.*, 2006). This may be due to the environmental influence of  
92 depressed mothers' inability to parent sensitively or children modelling mothers' maladaptive emotion  
93 regulation strategies (Eisenberg *et al.*, 2001, Hoffman *et al.*, 2006). Although there have been studies on the  
94 importance of fathers to the development of emotion regulation among children (Cabrera *et al.*, 2007, Kiel and  
95 Kalomiris, 2015, Wilson *et al.*, 2014), to our knowledge there are no studies that examine the association  
96 between paternal depressive symptoms and children's emotion regulation.

97

98 There are some studies that provide evidence for the potential mechanisms by which paternal depressive  
99 symptoms may influence children's emotional and behavioural problems. One hypothesis proposes that paternal  
100 depressive symptoms may influence children's development via fathers' impaired parenting (Ramchandani and  
101 Psychogiou, 2009). Depression in parents has been associated with negative parent-child interactions  
102 (Psychogiou and Parry, 2014, Sethna *et al.*, 2015) and a meta-analysis of 28 studies reported paternal depressive  
103 symptoms to be associated with increased negative (intrusive, hostile, harsh, controlling, and critical) and  
104 decreased positive parenting behaviours (sensitive responding, accepting, warm, affectionate, and supporting)  
105 towards children (Wilson and Durbin, 2010). One study found that fathers' disengaged parenting when their  
106 infants were 3-months old predicted externalising problems at 1 year in their sons, but not daughters  
107 (Ramchandani *et al.*, 2013). Another meta-analysis consisting of 6 studies reported that father-child conflict  
108 mediated the association between paternal depressive symptoms and children's emotional problems (Kane and  
109 Garber, 2004). However, the studies in this meta-analysis included children with a wide age range (from 3 to 14  
110 years) and most studies were cross-sectional. To infer mediation, it is necessary to study the exposure of  
111 paternal depressive symptoms, fathers' parenting and children's outcomes longitudinally (Selig and Preacher,  
112 2009). Thus, the variables need to be measured at different time-points. Additionally, given that there were only  
113 6 studies on father-child conflict, mediation requires further investigation.

114

115 Although studies have found a link between paternal depressive symptoms and children's behavioural and  
116 emotional problems (Davé *et al.*, 2008, Ramchandani *et al.*, 2005, Ramchandani *et al.*, 2008b), there are mixed  
117 findings about the influence of paternal depressive symptoms regarding child gender-specific pathways of risk  
118 transmission. Postnatal depressive symptoms in fathers 8 weeks after child birth were associated with children's

119 psychopathology at 3 and 7 years old in the UK Avon Longitudinal Study of Parents and Children (ALSPAC)  
120 (Ramchandani *et al.*, 2005, Ramchandani *et al.*, 2008b); sons of fathers with high depressive symptoms were  
121 reported to display more conduct problems compared to daughters. In contrast, findings from the LSAC  
122 suggested that the daughters of fathers with high depressive symptoms in the first post-natal year were more  
123 likely to have emotional and conduct problems when they were 4-5 years old, whereas sons were more likely to  
124 exhibit hyperactivity problems and lower levels of prosocial behaviour (Fletcher *et al.*, 2011). Exploring gender-  
125 specific pathways may help explain the possible father to child transmission of risk which may subsequently  
126 enable us to identify whether girls and/or boys are more vulnerable to their fathers' depressive symptoms. This  
127 could influence the content and direction of interventions with depressed fathers.

128

129 [Insert Figure 1 here]

130

131

132 This study aims to address these gaps in the current literature using a large representative sample of fathers from  
133 the MCS in the UK. The primary objective is to test the proposed model (Figure 1) and investigate whether  
134 father-child conflict mediates the association between paternal depressive symptoms and children's emotional  
135 and behavioural outcomes. The exposure of paternal depressive symptoms during infancy has been identified as  
136 a potential sensitive period where paternal depressive symptoms may influence children's later outcomes  
137 (Ramchandani *et al.*, 2008a). The mediator variable father-child conflict was measured at 3 years old during the  
138 preschool year when fathers' become more involved in parenting their children (Bruce and Fox, 1999,  
139 Grossmann *et al.*, 2002, MacDonald and Parke, 1986). Previous literature has associated father-child conflict  
140 with paternal depression and negative outcomes in children (Kane and Garber, 2004, 2009). Additionally, using  
141 the MCS dataset, a recent study found an association between paternal depressive symptoms and father-child  
142 conflict, but not father-child warmth or fathers' involvement in parenting activities, suggesting that father-child  
143 conflict may be an important construct that is influenced by paternal depressive symptoms (Nath *et al.*, 2015).  
144 Children's outcomes were measured at 7 years old. This is a developmentally challenging period as children  
145 learn new behaviour and emotion management skills and problems with adjustment at this age predict poor  
146 outcomes in adulthood (Fergusson *et al.*, 2005, Pianta *et al.*, 1995). Given that maternal depression, marital  
147 conflict, child temperament, child gender, and family socio-economic status may be associated with fathers'  
148 depressive symptoms, parenting and children's emotional and behavioural outcomes (Flouri *et al.*, 2014,

149 Goodman, 2004, Gutierrez-Galve *et al.*, 2015, Hanington *et al.*, 2012, Hanington *et al.*, 2010, Kiernan and  
150 Huerta, 2008, Malmberg and Flouri, 2011), we controlled for these factors in our models. Our secondary  
151 objective was to test the moderating influence of child gender on any potential associations. We predicted that  
152 higher father-child conflict at 3 years old would mediate the association between higher paternal depressive  
153 symptoms at 9-months old and children's increased behavioural-emotional outcomes at 7 years. We expected  
154 that child gender would moderate this mediation, but did not expect a specific direction given the mixed  
155 literature.

156

157

## 158 **Methods**

159

### 160 *Participants*

161 This secondary data analysis was conducted using the first (S1), second (S2) and forth (S4) sweeps of the  
162 Millennium Cohort Study (MCS), when children were 9 months, 3 years and 7 years old. The MCS is a large-  
163 scale survey of infants (n=19,519) born in four constituent countries of the United Kingdom (Dex and Joshi,  
164 2005). The sample design allowed for over-representation of families living in areas with high rates of child  
165 poverty or high proportions of ethnic minorities in England and the three smaller countries in the UK (Northern  
166 Ireland, Wales, and Scotland). Full details of the survey, objectives, content of survey and sampling strategy can  
167 be found in the documentation attached to the data deposited with the UK Data Archive and elsewhere (Hansen,  
168 2014, Plewis and Ketende, 2006). MCS had informed consent from participants and ethical approval (Hansen,  
169 2012). Our work was a secondary analysis of anonymised data that is publically available on the website  
170 (<http://discover.ukdataservice.ac.uk/series/>) requiring no direct contact with the individual participants, so  
171 further ethical approval was not required.

172

173 The first wave (S1) of data was collected from 2001-2002 on 18,533 families, with a total of 18,819 infants aged  
174 between 9-11 months. The same sample were then invited to follow-up with 15,590 families in the second wave  
175 (S2) when the children were approximately 3 years old and 13,857 in the fourth wave (S4) when children were  
176 approximately 7 years old.

177

178 The MCS collected data from main respondents (usually mothers) and partner respondents (fathers, step fathers,  
179 same sex partners). For the current study, the sample was limited to biological fathers (partner respondents) and  
180 mothers (main respondents). Fathers who were main respondents were excluded to simplify analysis as main  
181 and partner questions were not identical. Part-time resident and step-fathers were also excluded due to  
182 insufficient numbers. A small sample of twins and triplets were excluded to avoid the need to include an extra  
183 level of analysis that would have accounted for intra-family variability. Thus, only one child per family (the first  
184 cohort member) was studied. See Figure 2 for details of eligibility, sample size at each stage and final sample  
185 used for main analysis.

186

187 [Insert Figure 2 here]

188

### 189 *Measures*

#### 190 Paternal depressive symptoms

191 Rutter’s 9-item Malaise Inventory (S1 – 9 months old) was used as an indicator for depressive symptoms in S1  
192 completed by fathers (Dex and Joshi, 2004, Rutter *et al.*, 1970). This is the shortened version of the Rutter’s 24-  
193 item Malaise Inventory self-completion questionnaire measuring psychological distress (Bartley *et al.*, 2004,  
194 Johnson, 2012, Rutter *et al.*, 1970). The 9-item short form included items “feel tired most of the time”, “feel  
195 miserable or depressed”, “worried about things”, “often get into a violent rang”, “suddenly become scared for no  
196 good reason”, “easily upset or irritated”, “constantly keyed up and jittery”, “every little thing gets on nerves and  
197 wears you out”, and “heart race like mad”. Scores from these were summed to create a continuous scale. This  
198 scale has been used in previous studies as an indicator of depressive symptoms (Kiernan and Huerta, 2008,  
199 Malmberg and Flouri, 2011). Using Cronbach’s alpha ( $\alpha$ ) coefficient the internal consistency of the scale was  
200 0.75 for mothers and 0.71 for fathers which is similar to previous validation studies on the scale (Rodgers *et al.*,  
201 1999). The original scale has also shown acceptable validity (Area Under the Curve (AUC) = 0.74 with mental  
202 health problems , AUC = 0.77 with psychiatric diagnosis, AUC = 0.87 with depression) (Rodgers *et al.*, 1999).

203

#### 204 Fathers’ parenting: Father-child conflict

205 Fathers’ parenting was measured using The Child-Parent Relationship Scale reported by fathers (CPRS; Short  
206 form, (Johnson, 2012, Pianta and Steinberg, 1992). In this study, father-child conflict refers to the  
207 communication and relationship between the parent and the child which is measured by 8 self-report items on a

208 5-point Likert scale (ranging from 1=definitely does not apply to 5= definitely applies). All items were summed  
209 to create a continuous scale. Items include “child and I always seem to be struggling with each other”, “child  
210 uncomfortable with physical affection or touch by me”, “child easily becomes angry with me”, “child remains  
211 angry/resistant after discipline”, “dealing with my child drains my energy”, “when child wakes up in bad mood,  
212 I know we’re in for a long and difficult day”, “child’s feelings towards me can be unpredictable or change  
213 suddenly” and “child is sneaky or manipulative with me”. This scale has been used by other studies as an  
214 indicator of parenting (Kiernan and Huerta, 2008, Mensah and Kiernan, 2011, Nath *et al.*, 2015) and the items  
215 originate from attachment theory, Attachment Q-set and literature on parent-child relationships to form a  
216 subscale looking at negative approach towards father-child relationship (conflict). Higher scores on the scale  
217 indicated higher conflict in relationship. Fathers’ reports are comparable to mothers’ reports and have been  
218 validated against observational data on parent-child interactions which has shown conflict ratings on the CPRS  
219 to correlate with observational coding of hostility (Driscoll and Pianta, 2011). The scale had adequate internal  
220 consistency ( $\alpha=0.73$ ).

221

222 Child behavioural and emotional problem

223 The Strengths and Difficulties Questionnaire (SDQ; (Goodman, 2001)) completed by mothers was used to  
224 assess child emotional and behavioural problems (S4, 7 years old). The SDQ is validated for children aged 3-16  
225 years old and was developed as a clinical tool to identify psychopathology. There are 25 items in total consisting  
226 of five continuous subscales: emotional symptoms, conduct problems, hyperactivity, peer problems and  
227 prosocial behaviour. The scores for each subscale range between 0-10. All sub-scales were used in the analysis.  
228 Higher scores indicate greater problems on the emotional, conduct, hyperactivity, and peer problems, whereas  
229 higher scores on the prosocial scale indicated more prosocial behaviour. The internal consistencies from the  
230 MCS were: conduct problems  $\alpha= 0.55$ , emotional problems  $\alpha=0.68$ , hyperactivity  $\alpha= 0.78$ , peer problems  
231  $\alpha=0.59$  and prosocial  $\alpha=0.71$ . These are similar to internal consistencies reported in other studies using non-  
232 clinical samples of children (Muris *et al.*, 2003, Niclasen *et al.*, 2012). The scale has also been reported to have  
233 sufficient validity against diagnostics of DSM-IV disorders (specificity=96%, sensitivity=49%) (Goodman,  
234 2001) and Child Behaviour Checklist (CBCL;  $r=0.76$ ) (Stone *et al.*, 2010).

235

236 Child emotion regulation



237 The MCS team selected items from the Child Social Behaviour Questionnaire (CSBQ) (Hogan *et al.*, 1992,  
238 Johnson, 2012) that were completed by mothers and used to generate three continuous sub-scales; 1) self-  
239 regulation defined as children's ability to adapt to situations independently, 2) emotion dysregulation defined as  
240 children's inability to deal with difficult/frustrating situations, and 3) cooperation defined as children's ability to  
241 cooperate with others. The self-regulation and the reverse of emotion dysregulation scales were significantly  
242 correlated ( $r=0.32$ ,  $p<0.001$ ) and were summed to create an emotion regulation scale for the analysis. The  
243 cooperation subscale was not used because it does not belong to the emotion regulation construct. Higher scores  
244 on the emotion regulation scale indicated more adaptive emotion regulation. The internal consistency of the  
245 scale was  $\alpha=0.72$ . This scale devised by the MCS team has been used in other studies to measure emotion  
246 regulation (Flouri *et al.*, 2014).

247

248 Family context covariates

249 Maternal depressive symptoms (S1- 9 month) were measured using the Rutter Malaise Inventory as above (Dex  
250 and Joshi, 2004, Johnson, 2012, Rutter *et al.*, 1970). Children's temperament (S1- 9 months) was measured with  
251 mothers' reports on the Carey Infant Temperament Scale (Carey and McDevitt, 1978). Fourteen items from the  
252 original scale were selected by the MCS team to measure regularity (4 items), approach withdrawal (3 items),  
253 adaptability (2 items) and mood (5 items), and has also been used in other studies as an indicator of child  
254 temperament (Flouri and Malmberg, 2012, Kiernan and Huerta, 2008). Items were on a 5-point scale (almost  
255 never, rarely, usually does not, often, almost always). All scores were on a continuous scale ranging from (14 –  
256 70) consisting of the total score of all items. Higher scores indicated easier infant temperament and lower scores  
257 indicated more difficult temperament. The internal consistency of the scale was  $\alpha=0.66$ . Marital conflict (S1- 9  
258 months) was measured using the modified version of the Golombok Rust Inventory of Relationship State (Rust  
259 *et al.*, 1990). The original 28-item questionnaire had high content validity and reliability of Cronbach's alpha =  
260 0.91 (men) and 0.87 (women). The MCS selected seven items at S1 and S2, and three items at S4 (Johnson,  
261 2012). These were summed to create continuous scales where higher scores indicate higher levels of relationship  
262 conflict.

263

264 Socioeconomic Status (SES)

265 Households were classed as living in poverty if their income was equal to or less than 60% of the median  
266 household income for the UK (dichotomous scale), the definition of poverty set by the UK government

267 (Ketende and Joshi, 2008). Paternal education was reported by fathers and was categorised into two groups: no  
268 qualification or school level, degree and higher degree (NVQ level or equivalent, undergraduate and post-  
269 graduate degree).

270

#### 271 *Statistical analysis*

272 Structural Equation Modelling (SEM) using Stata for Windows version 13 was used to test the mediation model  
273 illustrated in Figure 1, i.e., whether ‘father-child conflict’ (3 years) mediated the association between ‘paternal  
274 depressive symptoms’ (9 months) and ‘child outcomes’ at 7 years old (conduct problems, emotional problems,  
275 hyperactivity, peer problems, prosocial and emotion regulation). The model estimated standardised direct,  
276 indirect and total effects, as well as adjusting for a number of relevant covariates (maternal depressive  
277 symptoms, marital conflict, child temperament, child gender and SES) (model 1). Outcomes that were  
278 significantly associated with paternal depressive symptoms in model 1 were taken forward into a multi-group  
279 SEM analysis. This investigated whether child gender moderated the associations between ‘paternal depressive  
280 symptoms’ and ‘child outcomes’ mediated by ‘father-child conflict’ while controlling for maternal depressive,  
281 symptoms, marital conflict, child temperament and SES (model 2). The SEM mediation model was run again  
282 using interaction terms to further investigate whether gender interacted with the exposure or mediator to  
283 influence the outcome child variables while controlling for maternal depressive symptoms, marital conflict,  
284 child temperament and SES (model 3). Finally, we further controlled for marital conflict in subsequent sweeps  
285 to increase the validity of any associations found in model 3 (model 4).

286

287 As the sample was stratified, sampling weights were used in all analyses to adjust for the disproportionate  
288 number of participants from ethnic minority and low socio-economic status backgrounds initially recruited into  
289 the sample at S1. Weights aimed to return the sample to the structure of the UK population and also to account  
290 for the effect of attrition and multi-stage cluster sampling strategy used by the MCS. The use of the weights is  
291 recommended by the MCS team and available with the dataset. Missing data were not analysed. Only data with  
292 complete cases on variables of interest across time-points were included in the analysis. In order to check that  
293 the results in the ‘complete cases’ model were robust to the effects of attrition, missing data were imputed from  
294 all variables included in the analysis. A sensitivity analysis was conducted to check that results were broadly  
295 replicated when missing data were imputed.

296

297 **Results**

298 *Descriptive statistics*

299 Table 1 shows descriptive statistics for the study main measures (exposure, mediator and outcomes). Logistic  
300 regression analyses were used to test for gender differences. Compared to boys, girls had lower odds of conflict  
301 with their fathers (OR: 0.99, 95% CI: 0.98-0.98, p=0.011), conduct problems (OR: 0.84, 95% CI: 0.80-0.87,  
302 p=<0.001), hyperactivity (OR: 0.85, 95% CI: 0.83-0.88, p=<0.001), and peer problems (OR: 0.92, 95% CI:  
303 0.89-0.96, p=<0.001), but higher odds of prosocial problems (OR: 1.25, 95% CI: 1.21-1.30, p=<0.001) and  
304 adaptive emotion regulation (OR: 1.54, 95% CI: 1.41-1.68, p=<0.001). There was no significant associations  
305 between child gender and fathers depressive symptoms (OR: 0.98, 95% CI: 0.95-1.01, p=1.135) or child  
306 emotional problems (OR: 1.03, 95% CI: 0.99-1.07, p=0.100).

307

308 The predictor (paternal depressive symptoms), mediator (father-child conflict) and outcomes (child emotional  
309 and behavioural problems) were significantly correlated, a necessary requirement for mediation to occur (Table  
310 2).

311

[Insert Table 1 here]

313

[Insert Table 2 here]

315

316 *Attrition and missingness*

317 Attrition (i.e. fathers who did not take part in Sweeps 2 (3 years) and 4 (7 years)), and missingness (i.e fathers  
318 who did not provide complete answers to survey questions) were associated with low socio-demographic factors  
319 (Table 3). Fathers had a higher odds of dropping out by both follow-up sweeps if they were below the 60%  
320 median of the poverty indicator (S2 –OR: 3.14, 95% CI: 2.63-3.74, p=<0.001; S4 - OR: 2.31, 95% CI:1.96-2.72,  
321 p=<0.001) and had lower odds if they were educated (S2 –OR: 0.45 , 95% CI: 0.35–0.50, p=<0.001; S4 - OR:  
322 0.63, 95% CI:0.53-0.75, p=<0.001). Fathers with higher depressive symptoms also had higher odds of dropping  
323 out (S2 –OR: 1.08, 95% CI: 1.06-1.11, p=<0.001; S4 - OR: 1.07, 95% CI: 1.04-1.10, p=<0.001).

324

[Insert Table 3 here]

326

327 *Covariates*

328 All family and socio-economic covariates that were associated with higher paternal depressive symptoms,  
329 father-child conflict and child outcome, and therefore were controlled for in the analysis models (See online  
330 supplementary tables 1 and 2).

331

332 *Mediation model*

333 Table 4 (Model 1) shows that after adjusting for relevant covariates (maternal depressive symptoms, child  
334 temperament, marital conflict, child gender and family SES), higher father-child conflict mediated the  
335 association between high paternal depressive symptoms at 9-months and children's increased conduct problems,  
336 and emotion dysregulation at age 7 years old. The estimated total effects of paternal depressive symptoms on  
337 children's emotional, hyperactivity, prosocial behaviour and peer problems were not significant and therefore  
338 were not taken forward into model 2. Table 4 shows the coefficients for each outcome (Model 1).

339

340

[Insert Table 4 here]

342

343 *Moderation by gender*

344 Model 2 tested for child gender moderator effects (Table 4). This model included significant outcomes from  
345 model 1 (conduct problems and emotion regulation) and also adjusted for maternal depressive symptoms,  
346 marital conflict, child temperament and SES. Higher father-child conflict mediated the association between  
347 higher paternal depressive symptoms and boys increased conduct problems (Table 4, Model 2). This association  
348 was also marginally significant for emotion regulation. No significant effects were found for girls, which  
349 suggest that paternal depressive symptoms may have an effect via conflict on conduct and emotion regulation  
350 problems in their sons but not in their daughters.

351

352 After testing for interaction effects (Model 3), high father-child conflict still significantly mediated the  
353 association between higher post-natal paternal depressive symptoms and boys' conduct problems and emotion  
354 regulation. Table 4 (Model 3) shows the standardised coefficients for each outcome according to gender  
355 interaction with the exposure paternal depressive symptoms and mediator father-child conflict. For conduct  
356 problems, child gender interacted with both paternal depressive symptoms and father-child conflict while for

357 emotion regulation, child gender interacted significantly with father-child conflict. After further adjusting the  
358 model for marital conflict at all time-points (table 5, model 4), higher father-child conflict still significantly  
359 mediated the association between high post-natal paternal depressive symptoms and emotion regulation, but the  
360 association between paternal depressive symptoms and child conduct problems became non-significant. In this  
361 model, child gender interacted significantly with father-child conflict, but not paternal depressive symptoms in  
362 the association between paternal depressive symptoms and child emotion regulation. The model fit statistics  
363 show that model 4 is the best fit. The final overall model (model 4) explained 59% of the variance ( $R^2 = 0.59$ ).

364

#### 365 *Sensitivity analysis*

366 The sensitivity analysis using imputed data replicated the findings in the main analysis in that all effects  
367 remained significant. In fact, significant findings increased in the main analysis model 1 (see online  
368 supplementary table 3). Therefore, this suggests that we have underestimated the effects of paternal depressive  
369 symptoms on children's emotional and behavioural problems via father-child conflict; therefore further analysis  
370 was not undertaken using the imputed datasets on models 2, 3 and 4.

371

372

#### 373 **Discussion**

374 As hypothesised, higher paternal depressive symptoms at 9 months were significantly associated with children's  
375 emotion regulation at 7 years old, via higher father-child conflict when children were 3 years old. Thus,  
376 depressive symptoms in fathers may influence their mood. Therefore these fathers may struggle with conflict  
377 resolution with their toddlers and this negative interaction may later impact on their children's emotional  
378 development during early school years. These findings extend previous studies investigating the association  
379 between paternal depressive symptoms, fathers' parenting and children's emotional and behavioural problems  
380 (Dette-Hagenmeyer and Reichle, 2014, Giallo *et al.*, 2014b, Kane and Garber, 2009, Malmberg and Flouri,  
381 2011, Ramchandani *et al.*, 2005, Ramchandani *et al.*, 2008b) and add to literature by using longitudinal data  
382 from key time points. This study is also the first to our knowledge that has investigated the association between  
383 paternal depressive symptoms and children's emotion regulation. Our findings also extend the literature by  
384 adding that father-child conflict may mediate this association path. Furthermore, we found that gender had an  
385 interaction effect with father-child conflict and not fathers' depressive symptoms. These findings suggest that  
386 father-child conflict may be an important factor that could be targeted to reduce emotional and behavioural

387 problems in sons of fathers suffering from depression. Our findings that boys with poorer emotion regulation  
388 abilities had higher externalising problems is also in line with previous research (Eisenberg *et al.*, 2010).

389

390 Parental socialisation provides an environmental explanation for our findings (Eisenberg *et al.*, 2001). Previous  
391 studies have shown that maternal depression negatively impacts on their daughters' emotion regulation abilities  
392 but not sons' (Silk *et al.*, 2006). As emotion regulation abilities are learnt from socialisation with parents during  
393 early development, these results may indicate that same-gendered parents have a greater influence on their  
394 children in this process (Eisenberg *et al.*, 2001). Compared to mothers, fathers have been reported to respond  
395 more harshly and provide less support towards their son's emotional expressions, which according to role model  
396 theory may subsequently be imitated by boys (Brody and Hall, 2008, Brown *et al.*, 2015, Chaplin *et al.*, 2005,  
397 Fischer, 2000, Sanders *et al.*, 2015). This may cause conflict interactions between fathers and their sons, which  
398 may lead to emotional and behavioural problems (Kane and Garber, 2004, 2009). An alternative explanation is  
399 that our findings could be due to genetic heritability or an interplay between gene-environment (Natsuaki *et al.*,  
400 2014, Ramchandani and Psychogiou, 2009). Sons of depressed fathers could be genetically predisposed to  
401 developing depressive symptoms and also exposed to the family environmental factors associated with paternal  
402 depressive symptoms (Gutierrez-Galve *et al.*, 2015, Rutter, 2009, Rutter *et al.*, 1997), which may increase  
403 father-child conflict and child emotional problems. However, more research is needed to support both of these  
404 explanations. As the current study could not control for genetic influences, this is something that could be  
405 addressed by future research.

406

407 We also found that higher paternal depressive symptoms at 9 months were significantly associated with  
408 children's conduct problems at 7 years old, via higher father-child conflict when children were 3 years old after  
409 controlling for maternal depressive symptoms, child temperament, and family SES which was in line with  
410 previous literature (Ramchandani *et al.*, 2005, Ramchandani *et al.*, 2013, Ramchandani *et al.*, 2008b). However,  
411 after further controlling for marital conflict at all time-points, the overall associations between paternal  
412 depressive symptoms and child conduct problems became non-significant. One explanation for this could be that  
413 marital conflict may have a stronger influence on children's behavioural problems (Braithwaite *et al.*, 2015,  
414 Hanington *et al.*, 2012) compared to paternal depressive symptoms (predictor variable). Additionally, marital  
415 conflict and father-child conflict (mediator variable) are closely related variables that may jointly be influencing  
416 the association between paternal depressive symptoms and child outcomes within the model (Cummings and

417 Miller-Graff, 2015, Margolin *et al.*, 2001). Therefore, future studies should aim to differentiate and disentangle  
418 the effects of different conflictual relationships within the family in relation to child adjustment, perhaps with  
419 observational rather than self-report measures.

420

421 The current study has a number of strengths. First, the MCS is a unique dataset with a large representative  
422 sample of UK fathers (Hansen, 2014, Plewis and Ketende, 2006). Second, the MCS collected a large number of  
423 measures on mothers, fathers and children, most of which were well validated and reliable and we tested  
424 children's outcomes longitudinally (Johnson, 2012). Third, our findings are further strengthened by child  
425 outcomes being reported from mothers, decreasing any variances produced by same informant reporter bias of  
426 predictors and outcomes. Finally, the MCS (like other cohort datasets) is subjected to attrition and missing data.  
427 However, research indicates that even when dropouts are taken into account, regression models with large  
428 cohort studies are still robust (Wolke *et al.*, 2009). In addition, our analysis accounted for attrition/missing data  
429 by utilising sampling weights recommended by the MCS team (Ketende and Jones, 2011). This increased the  
430 representativeness and accounted for missing data/attrition rates that might have influenced or biased the results.  
431 We further conducted a sensitivity analysis using multiple imputation, a statistical method used in recent years  
432 to account for attrition in cohort studies (Niarchou *et al.*, 2015, Sterne *et al.*, 2009). This replicated our main  
433 finding, and if anything suggests that we have underestimated the effects.

434

435 There were also some limitations. Firstly, we lacked data on clinical diagnoses of depressive episodes using  
436 interview methods, which some might argue would be more informative. Parenting was also measured using  
437 self-reports, which might not be accurate due to biased reporting of positive parenting and inter-association with  
438 fathers reporting high depressive symptoms and higher conflict parenting. Parenting is often measured using  
439 observational methods of parent-child interactions (Aspland and Gardner, 2003). However, in both cases  
440 conducting studies using observational and interview methods with such a large sample size would be  
441 expensive, time-consuming, and impractical. Thus, the study of the influence of depressive symptoms is useful  
442 as results can later be tested experimentally using smaller clinical samples. Secondly, the coefficient effect sizes  
443 of the associations were small. Previous studies investigating mediation effects using large cohort studies have  
444 also reported small effect sizes of maternal and paternal depressive symptoms on child outcomes (Giallo *et al.*,  
445 2014a, Giallo *et al.*, 2014b, Malmberg and Flouri, 2011). Given that the MCS consisted of a normal population  
446 of fathers, clinically relevant high levels of depressive symptoms would have been underestimated due to the

447 likelihood of depressed fathers being less motivated to participate and therefore might have resulted in small  
448 effect sizes. A smaller scale study consisting of a clinical sample of depressed fathers may yield larger effect  
449 sizes. This is something for future studies to investigate. However, given the huge challenges with recruiting  
450 depressed fathers to participate in research with their children (Garber *et al.*, 2011, Pilowsky *et al.*, 2014, Sherr  
451 *et al.*, 2006), the findings from large cohort studies such as the MCS offers useful insight into the possible  
452 associations in this field of limited literature (Fagan, 2014, Niarchou *et al.*, 2015). These findings, if replicated  
453 with a clinical population, could suggest targets for development of clinical interventions.

454

455 We also assumed causal direction due to the data originating at different time points across the child's life. We  
456 are assuming linear relationships when in fact the interrelationships between parental mental health, parenting  
457 and children's development is likely to be complex and these factors may amplify and feedback on each other.  
458 Therefore, our findings need to be replicated experimentally to draw firm conclusion about causal direction.  
459 This could only be done in by using treatment trials for paternal depression which provide an opportunity to see  
460 if father-child conflict and child emotional/behavioural problems are reduced among fathers who respond  
461 compared to those who do not respond to treatment.

462

463 Finally, we acknowledge that there are more statistically advance techniques for testing mediation using Cross-  
464 Lagged Panel Modelling (CLPM) and Latent Growth Mediation (LGM) Modelling (Selig and Preacher, 2009).  
465 These techniques account for autoregressive controls, reverse causality and trends (slopes and intercepts)  
466 between associations (Cole and Maxwell, 2003, Maxwell and Cole, 2007, Maxwell *et al.*, 2011). These methods  
467 have been used to investigate moderation and mediation in maternal depression, mothers' parenting and  
468 children's behavioural outcomes (Beauchaine *et al.*, 2005, Belsky *et al.*, 2007, Eisenberg *et al.*, 2005). However,  
469 these statistical techniques require all variables to be available at all time-points (Selig and Preacher, 2009),  
470 which was not the case in the MCS, restricting the analysis method we could utilise. Specifically with regards to  
471 our research question, it would be important to investigate family context factors that may change over time  
472 such as maternal and paternal depressive symptoms. Thus, future research work could expand the statistical  
473 analysis of this paper by using longitudinal multivariate analysis with more statistically advanced techniques to  
474 build on the findings of this paper once appropriate samples are available.

475



476 Despite some of the limitations, the findings of this study add to theoretical understanding of indirect effects of  
477 fathers' postnatal depressive symptoms to their children's outcomes. Postnatal paternal depressive symptoms  
478 were associated with boys' emotion regulation problems at 7 years old via higher father-child conflict at 3 years  
479 old. This association still remained significant after accounting for maternal depressive symptoms, child  
480 temperament, SES and marital conflict (at all time points). There are some specific implications that can be  
481 taken from the current study to inform parenting interventions. For example, parenting interventions could help  
482 with managing conflict parent-child relationships between depressed parents and their children. This may have  
483 potential to break the intergenerational transmission of risk. Parenting interventions involving fathers have been  
484 found to lessen behavioural problems in children mainly due to the change in fathers' parenting (Wilson *et al.*,  
485 2014), therefore involving depressed fathers in such interventions maybe beneficial. Like maternal depression,  
486 studies have shown paternal depression to have a cost on public health care services (Edoka *et al.*, 2011), but  
487 intervention programs are still primarily targeted at mothers (Panter-Brick *et al.*, 2014). In light of our findings  
488 we would encourage more research with fathers and involvement of fathers in parenting programs of depressed  
489 parents.

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506 **Required statements**

507 **Acknowledgements:** We would like to thank the Millennium Cohort Study families and Millennium Cohort  
508 Study team at the Centre of Longitudinal Studies, Institute of Education, London, United Kingdom for the use  
509 of these data and to the UK Data Archive and Economic and Social Data Service for making them available.

510 **Conflict of interest statement:** None

511 **Ethical standards:** The authors assert that all procedures contributing to this work comply with ethical  
512 standards of the relevant national and institutional committees on human experimentation. More specifically, the  
513 Millennium Cohort Study had informed consent from participants and ethical approval. Our work was a  
514 secondary analysis of anonymised data that is publically available on the website  
515 (<http://discover.ukdataservice.ac.uk/series/>) requiring no direct contact with the individual participants, so  
516 further ethical approval was not required.

517 **Contribution of each author statement:**

518 **Dr Selina Nath:** Conception and design, data analysis, interpretation of data, write-up of article, revising it  
519 critically for important intellectual content and final approval of the version to be published.

520 **Dr Ginny Russell:** Conception and design, provided guidance with data analysis, interpretation of data and  
521 analysis, revising it critically for important intellectual content and final approval of the version to be published.

522 **Prof Willem Kuyken:** Interpretation of data and analysis, revising it critically for important intellectual content  
523 and final approval of the version to be published.

524 **Dr Lamprini Psychogiou:** Conception and design, interpretation of data and analysis, revising it critically for  
525 important intellectual content and final approval of the version to be published.

526 **Prof Tamsin Ford:** Conception and design, interpretation of data and analysis, revising it critically for  
527 important intellectual content and final approval of the version to be published.

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