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*Citation for published version (APA):*

Nath, S., Psychogiou, L., Kuyken, W., Ford, T., Ryan, E. G., & Russell, G. (Accepted/In press). The prevalence of depressive symptoms among fathers and associated risk factors during the first seven years of their child's life: findings from the Millennium Cohort Study. *BMC Public Health*.

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1 The prevalence of depressive symptoms among fathers and associated risk factors during the first seven years of  
2 their child's life: findings from the Millennium Cohort Study

3

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31 **Abstract**

32 **Background:** Increasing evidence suggests that postnatal paternal depression is associated with adverse  
33 emotional, behavioural and cognitive outcomes in children. Despite this, few studies have determined the  
34 prevalence of fathers' depressive symptoms during the first few years of their children's lives and explored what  
35 factors are related to these symptoms. We estimated the prevalence and examined associated risk factors of  
36 paternal depressive symptoms in a nationally representative sample of fathers with children aged between 9  
37 months and 7 years old from the Millennium cohort study. The risk factors examined were maternal depressive  
38 symptoms, marital conflict, child temperament, child gender, paternal education, fathers' ethnic background,  
39 fathers' employment status, family housing, family income and paternal age.

40 **Methods:** Secondary data analysis was conducted using the UK Millennium cohort study, which consisted of  
41 data from England, Scotland, Wales and Northern Ireland of families with infants born in the year 2000/2001.  
42 Data from four sweeps were used from when children in the cohort were aged 9 months, 3 years, 5 years and 7  
43 years old (n=5,155-12,396).

44 **Results:** The prevalence of paternal depressive symptoms over time was 3.6% at 9 months, 1.2% at 3 years old,  
45 1.8% at 5 years and 2.0% at 7 years (using Kessler cut-off points to categorise high depressive symptoms vs low  
46 depressive symptoms). Linear regression trends (using continuous measures of depressive symptoms) indicated  
47 that both paternal and maternal depressive symptoms decreased over time, suggesting similar patterns of  
48 parents' depressive symptoms after the birth of a child, but the decrease was more evident for mothers. Paternal  
49 depressive symptoms were consistently associated with fathers' unemployment, maternal depressive symptoms  
50 and marital conflict. Socioeconomic factors such as rented housing when child was 9 months and low family  
51 income when child was 5 and 7 years were also associated with higher paternal depressive symptoms.

52 **Conclusions:** Paternal depressive symptoms decreased among fathers when their children were aged between 9  
53 months to 3 years old. Paternal unemployment, high maternal depressive symptoms and high marital conflict  
54 were important risk factors for paternal depressive symptoms. In light of our findings, we would recommend a  
55 more family centred approach to interventions for depression in the postnatal period.

56

57 **Key words:** Paternal, fathers, depressive symptoms, unemployment

58

59

60

## 61 **Background**

62 Despite government policy and research acknowledging the importance of fathers in children's development,  
63 parenting programs and interventions are still primarily targeted at mothers [1-5]. Growing evidence suggests  
64 that the postnatal period may be associated with higher prevalence of depressive symptoms in fathers as well as  
65 in mothers and may also be associated with adverse emotional, behavioural and cognitive outcomes in children  
66 [6-11]. To understand the influence of paternal depression on children's emotional, behavioural and cognitive  
67 outcomes in more depth, we need to determine fathers' depressive symptoms during the first few years of their  
68 children's lives and the associated risk factors. This might enable clinicians to identify when effective  
69 interventions can be implemented for the best developmental outcomes in both children and adults, as well as  
70 indicating to what extent the development of paternal depressive symptoms itself may be related to sensitive  
71 periods after birth. The aim of the current paper is to describe the fluctuation in paternal depressive symptoms  
72 within the first 7 years of their children's lives and the associated risk factors using a nationally representative  
73 sample of fathers.

74  
75 Research on paternal depressive symptoms has mostly focused on the prevalence of symptoms during the first  
76 year after a child's birth as this is a sensitive period in which parental depressive symptoms may influence  
77 children's development [8, 12]. The prevalence of paternal depressive symptoms from the first trimester to 12-  
78 months after birth has been reported as 10.4 % from a meta-analysis consisting of 43 studies, where the highest  
79 rates of depressive symptoms were reported amongst fathers when their infants were 3 – 6 months old [9].  
80 However, an integrative review of 20 studies reported a more varied prevalence ranging between 1.2% - 25.5%  
81 during the postpartum period [12]. These variations in the rates of paternal depressive symptoms are likely to be  
82 due to the use of different assessment methods and populations in previous research. Studies that conduct  
83 clinical interviews might under-represent paternal depression compared to self-report measures and some  
84 studies have utilised liberal cut-off points which may over represent mild depressive symptoms in the clinical  
85 range [9, 12]. In addition, these studies also used a sample of fathers that were predominantly Caucasian, so the  
86 finding may not be applicable to the general population consisting of ethnic minorities.

87  
88 Knowledge about paternal depressive symptoms past the first year of child's life is limited. In the Longitudinal  
89 Study of Australian Children (LSAC) 1.9% fathers reported psychological distress measured using the Kessler  
90 Scale when their child was 3 – 12 months old, 1.4% when their child was 2 - 3 years old and 2.2% when their

91 child was 4 - 5 years old [13]. This study showed relatively little change in paternal depressive symptoms rates  
92 over time. The authors acknowledged that this might be an underestimation of paternal depressive symptoms as  
93 the sample was not representative of socioeconomically disadvantaged fathers in Australia. Using a more  
94 representative sample of 7,247 fathers participating in the Medical Expenditure Panel Survey (MEPS) from the  
95 USA, paternal depressive symptoms using the Patient Health Questionnaire-2 (PHQ-2) were reported at 6.19%  
96 in fathers with children aged 5 - 17 years [14]. Another study from the USA, using the National Longitudinal  
97 Study of Adolescent Health, found that resident fathers' depressive symptoms increased from child birth until 5  
98 years of age, followed by a decrease between 5-10 years of age [15]. The current study will build on the  
99 literature by investigating paternal depressive symptoms from 9-months to 7 years old, using a large nationally  
100 representative sample of fathers in the UK including ethnic minorities, which should lead to more consistent  
101 findings compared to the mixed reports in previous literature.

102

103 To gain a better understanding of paternal depressive symptoms and prevention methods, we need to determine  
104 associated risk factors. Many studies have reported high correlations between maternal and paternal depressive  
105 symptoms with up to 50% of fathers likely to experience depressive symptoms if their partner is experiencing  
106 depression [9, 12, 16-18]. This could be due to the direct influence of mothers' mental states on their partners,  
107 that both parents are exposed to other similar socioeconomic factors that predispose them to become depressed  
108 or depressive symptoms being correlated from the beginning of their relationship due to assortative mating  
109 patterns [19]. Therefore, it is important to compare the levels of paternal and maternal depressive symptoms  
110 over time, as it is important to target both parents in interventions. Marital conflict has also been identified as a  
111 significant risk factor for paternal depression [20, 21] and Giallo et al. [16] reported higher psychological  
112 distress amongst fathers in unhappy marital relationships.

113

114 Child factors may also influence paternal depressive symptoms including child's temperament and gender [22].  
115 Using data from the Avon Longitudinal study of Parents and Children, Hanington and Colleagues [23] reported  
116 paternal depressive symptoms during the first year of an infant's life to be associated with more difficult child  
117 temperament when boys were 2 years old. There was no significant relationship for daughters. Other research  
118 has also shown paternal depressive symptoms to be associated with behavioural outcomes in boys but not for  
119 girls [7]. This might be because fathers spend more time with their sons compared to their daughters as they  
120 may identify more with them and feel that they are able to participate in more joint play activities [10, 24].

121 Socioeconomic factors have also been associated with paternal depressive symptoms such as unemployment,  
122 poverty, younger age, low educational level, low income and ethnicity [14, 25-27]. The UK recession that  
123 commenced in 2008-09 impacted many families, and the resultant financial and social hardship may potentially  
124 have influenced the development of paternal depressive symptoms [28, 29]. It is, therefore, important and timely  
125 to investigate the association of paternal depressive symptoms with socioeconomic variables, such as  
126 unemployment, household income, and housing.

127  
128 Our primary objective is to estimate the prevalence of depressive symptoms in the UK population of fathers  
129 using data from the Millennium cohort study when children were 9 months, 3 years, 5 years and 7 years old. In  
130 addition, we assess the association between paternal depression, family and socioeconomic contextual factors.  
131 We hypothesise that paternal depressive symptoms would be higher immediately after birth and decrease over  
132 time and that paternal depressive symptoms would be strongly associated with maternal depressive symptoms,  
133 higher marital conflict and difficult child temperament. We also predict that paternal depressive symptoms will  
134 be associated with low socio-economic factors.

## 135 136 **Methods**

### 137 **Sample**

138 Secondary data analysis was carried out using the first four waves of the Millennium Cohort Study (MCS). The  
139 MCS is large-scale survey of infants (n=19,519) born in four constituent countries of the United Kingdom [30].  
140 Full details of the survey, objectives, content of survey and sampling can be found in the documentation  
141 attached to the data deposited with the UK Data Archive at Essex University (UK Data Archive 2004 and 2006).  
142 The sample design allowed for over-representation of families living in areas with high rates of child poverty or  
143 high proportions of ethnic minorities in England and the three smaller countries (Northern Ireland, Wales, and  
144 Scotland). More details on the sampling strategy can be found elsewhere [31, 32].

145  
146 The first wave (MCS1) of data was collected from 2001-2002 on 18,533 families, with a total of 18,819 infants  
147 aged between 9-11 months. The same sample were then invited to follow-up (MCS2) when the children were  
148 approximately 3 years old. 14,898 families from MCS1 were followed-up and 692 new families were recruited  
149 into the cohort at MCS2. This totalled to 15,590 families in the second wave (MCS2) when the children were  
150 approximately 3 years old. 15,246 families were then followed up in the third wave (MCS3) when children were

151 approximately 5 years old and 13,857 in the fourth wave (MCS4) when children were approximately 7 years  
152 old. The reduction in overall sample was due to drop-out. According to the MCS technical report of responses,  
153 families from socio-economically disadvantaged or ethnic backgrounds had higher attrition rates compared to  
154 socio-economically advantaged families [32].

155

156 Biological mothers were identified from main respondents interviews and biological fathers from partner  
157 respondents. Step-fathers and part-time resident fathers were excluded from the current study as there was not a  
158 large enough sample size for analysis of these groups. Fathers who were main respondents were also excluded  
159 to simplify analysis since main and partner questions were not always the same. Given the small numbers of  
160 twins or triplets in the sample, multiple births were excluded so that only one child per family was studied to  
161 avoid the need to include an extra level of analysis that accounted for intra-family variability. Table 1 shows the  
162 sample size of biological mothers and fathers who took part across all sweeps and used for analysis.

163

164 **Table 1** Sample size of biological mothers and fathers across all sweeps in the Millennium Cohort Study

Parent	Sweep 1 (9 months)	Sweep 2 (3 years)	Sweep 3 (5 years)	Sweep 4 (7 years)
	N	N	N	N
<b>Mothers</b>	18,497	14,645	12,792	12,175
<b>Fathers</b>	12,882	11,253	9,710	8,803

165

## 166 **Measures**

### 167 *Paternal depressive symptoms*

168 Rutter's 9-item Malaise Inventory (sweep 1) was used as an indicator for depressive symptoms [33]. This is the  
169 shortened version of the Rutter's 24-item Malaise Inventory self-completion questionnaire [34] measuring  
170 psychological distress. The 9 items selected were based on items with the highest loading first principle factor  
171 and showed adequate reliability of at least 0.70 using Cronbach's alpha coefficient[35].

172

173 The Kessler 6 (K6) scale (sweeps 2-4) [36] was used as an indicator of current depressive symptoms in sweep 2,  
174 3 and 4. It has an internal consistency and reliability of 0.89 using the Cronbach's alpha coefficient [36, 37] and  
175 has shown to detect current depression [38]. We used a strict cut-off of  $\geq 13$  commonly taken to indicate clinical  
176 levels of distress [13]. Continuous scales on depression scores were created. Cut-off points were then used to

177 determine categorical groups of K6 scores 0-12 (low depressive symptoms) and 13-24 (high depressive  
178 symptoms).

179

### 180 *Family context factors*

181 Maternal depressive symptoms (Sweeps 1-4) were measured using the Rutter Malaise and Kessler scales as  
182 above. Groups of mothers with high versus low levels of depressive symptoms were derived by applying the  
183 same method that was used for fathers.

184

185 Marital conflict was measured at all sweeps using the modified version of the Golombok Rust Inventory of  
186 Marital State [35, 39]. The original 28-item questionnaire had high content validity and reliability of 0.91 (men)  
187 and 0.87 (women) using the Cronbach's alpha coefficient. The MCS selected seven items at sweeps 1, 2 and 3,  
188 and three items at sweep 4. Higher scores indicated higher levels of marital conflict. The scale was standardised  
189 (Mean=0, SD=1) and mean scores for each sweep were derived for analysis.

190

191 Children's temperament was measured at Sweep 1 using mothers' reports on the Carey Infant temperament  
192 scale [40]. Fourteen questions from the original scale were used, which included items on subscales of infant's  
193 mood (five items), regularity (four items), and adaptability (5 items). On a 5-point scale (almost never, rarely,  
194 usually does not, often, almost always), higher scores indicated easier infant temperament and lower scores  
195 indicated more difficult temperament. All scores were on a continuous scale ranging from (14 – 70) consisting  
196 of the total score of all three subscale categories including mood, adaptability and regularity.

197

### 198 *Socioeconomic factors*

199 Paternal education and fathers' ethnic background were reported at sweep 1. Fathers chose one of the following  
200 options: Higher degree, First degree, Diplomas in higher education, A / AS / S levels, O level / GCSE grades A-  
201 C, GCSE grades D-G, Other academic qualifications (incl. overseas) or None of these qualifications. Answers  
202 were reduced to two categories of no qualification or school level, degree or higher.

203 Fathers' response on ethnic background was captured in four categories: White, Indian, Pakistani &

204 Bangladeshi, Afro-Caribbean & British afro-Caribbean and Mixed, and Other Ethnicity.

205

206 Housing, family income, poverty indicator, fathers' employment and paternal age were all reported at sweeps 1-  
207 4. Family housing was categorised into two categories; rented and home owner. Both mothers and fathers were  
208 asked about the household income. Equivalised family income was derived at each sweep (adjusted for the  
209 number of children per family), with household classed as living in poverty if their income was equal to or less  
210 than 60% of the median household income for the UK. The definition of poverty set by the UK government  
211 [41]. Fathers indicated if they were currently doing paid work, had a paid job but on leave, had worked in the  
212 past but no current paid job or never had a paid job. This information was used to create a derived variable  
213 stating if respondent was in employment at each sweep. Paternal age was reported by fathers in the partner  
214 interview questions at each time point of the study. There were no fathers in the 12-19 years age category after  
215 sweep 1.

216

### 217 **Statistical analysis**

218 As the sample was stratified, sampling weights were used in all analyses. This adjusted for the disproportionate  
219 number of ethnic minorities and low socio-economic participants initially recruited into the sample at sweep 1,  
220 therefore making the sample representative of the UK population. It also accounts for the effect of attrition by  
221 sweep 4. All analyses were conducted using Stata for Windows version 13 [42].

222

### 223 ***Fathers' depressive symptoms across the four waves***

224 Trends of depression during the early years of childhood were assessed using scores from the Kessler and Rutter  
225 Malaise. To make these scores comparable, Rutter Malaise scores were recalibrated from a 9-time scale to a 24-  
226 time scale to fit the Kessler scale, creating a continuous scale of depressive symptoms at each time point. The  
227 continuous scales at each time point were split into dichotomous scales of high and low depressive symptoms  
228 using the Kessler clinical cut-offs to determine prevalence of depressive symptoms among mothers and fathers  
229 over time. Data from biological parents who were full-time resident in household and reported depressive  
230 symptoms at all four time points (complete data) were used for analysis. Therefore, there were 9,611 biological  
231 mothers full-time resident in the house, and 5,220 biological fathers who were full-time resident in household  
232 who reported depressive symptoms scores at all time points.

233

234 A linear trend analysis was conducted for mothers and fathers to compare the trend of depressive symptoms in  
235 the population as a whole by treating depression as a continuous variable and analysing over time.

236 As a sensitivity analysis to explore whether the linear trend in depressive symptoms was robust to the effect of  
237 birth of further children after the cohort member, the linear trend analysis was repeated on a sample that was  
238 limited to parents with no subsequent births. This sample comprised 5,612 full cases for mothers' depression  
239 scores and 2,845 full cases for fathers' depression scores.

240

#### 241 *Family context and socioeconomic factors associated with paternal depressive symptoms*

242 The influence of family context and socio-economic factors used all cases available for the following analysis  
243 ranging from 5,155-12,396 cases depending on the variable used. Mean scores and proportions of each predictor  
244 for low depressive symptoms (K6 scores 0-12) and high depressive symptoms (K6 scores 13-24) were plotted  
245 for each time point. Then, to check whether predictors were associated with paternal depressive symptoms, we  
246 conducted a series of linear regressions using the continuous scale of paternal depressive symptoms scores as  
247 outcome, and family context and socio-economic factors as predictors in an unadjusted univariate analysis.  
248 Predictors that were significantly associated with paternal depressive symptoms ( $p < 0.01$ ) were taken forward  
249 into multivariable regression to test which covariates were independently associated with paternal depression.  
250 Finally, predictors that were significantly associated with paternal depressive symptoms in the multivariable  
251 regressions were taken forward into one mixed effects model in Stata (using xtmixed command).

252

## 253 **Results**

### 254 **Fathers' depressive symptoms across the four waves**

255 The prevalence of paternal depressive symptoms over time as defined by the Kessler cut-off point was 3.6% at 9  
256 months, 1.2% at 3 years, 1.8% at 5 years and 2.0% 7 years (Figure 1).

257

258 [Insert Figure 1 here]

259

260 **Figure 1** Percentage of mothers (n=9,611) and fathers (n=5,220) with high levels of depressive symptoms for  
261 biological full-time resident mothers and fathers across time in the Millennium Cohort Study (full-cases and  
262 weighted)

263

264 Mothers' (4.09, 3.10, 2.95, and 3.01) and fathers' (3.27, 2.71, 2.77, and 2.89) mean scores for each sweep were  
265 used to construct a linear trend. The linear trend showed a significant decrease in depressive symptoms over

266 time for mothers (beta = -0.19, CI: -0.20 – -0.17, p < 0.001) and fathers (beta = -0.06, CI: -0.08 - -0.04, p <  
267 0.001), but the decrease was greater for mothers than for fathers. Among mothers, depressive symptoms  
268 declined from 9 months to 7 years old, whereas among fathers, the difference was less marked although the  
269 decrease was statistically significant according to a linear model.

270

271 The sensitivity analysis excluded children who had younger siblings (42%) to check whether the observed  
272 patterns were affected by subsequent births. The linear trends remained for both mothers (beta = -0.21, CI: -0.23  
273 - -0.18, p < 0.001) and fathers (beta = -0.08, CI: -0.01 - -0.05, p < 0.001) with depressive symptoms  
274 significantly decreasing over time and slightly stronger than those with subsequent children. Therefore, the  
275 exclusion of subsequent births seemed to strengthen the linear trend, as subsequent births may have contributed  
276 to the maintenance of depressive symptoms over time.

277

## 278 **Family context and socioeconomic factors associated with paternal depressive symptoms**

### 279 *Descriptive statistics*

280 Table 2 shows differences between fathers with low and high levels of depressive symptoms according to each  
281 predictor. Across all time points, fathers with high levels of depressive symptoms had partners with higher mean  
282 depression scores, higher levels of marital conflict, children with a more difficult temperament and were more  
283 socio-economically disadvantaged compared to fathers with lower levels of depressive symptoms.

284

285 [Insert Table 2 here]

286

### 287 *Unadjusted univariate analysis*

288 In the unadjusted analysis, higher levels of paternal depressive symptoms were significantly associated with  
289 higher levels of maternal depressive symptoms, higher levels of marital conflict, more difficult child  
290 temperament, unemployment, living in rented accommodation and lower family income (p<0.01, Table 3) at all  
291 sweeps. Paternal age was significantly associated with depressive symptoms at sweep 1 only, with higher  
292 depressive symptoms among younger fathers. Paternal education was significantly associated with paternal  
293 depressive symptoms at sweep 1 and 3, with more depressive symptoms amongst those with no qualifications.  
294 Compared to white fathers, Indian Asian and mixed fathers reported more depressive symptoms, whereas Afro-  
295 Caribbean fathers reported fewer depressive symptoms.

296

297 ***Multivariable regression analysis***

298 After adjusting for factors that were significantly associated ( $p < 0.01$ ) with paternal depressive symptoms in a  
299 multivariable regression (Table 3), maternal depressive symptoms, higher marital conflict and paternal  
300 unemployment were significantly associated with higher levels of paternal depressive symptoms at all sweeps.  
301 When the cohort children were 9 months old, no qualifications and living in rented housing were significantly  
302 associated with higher levels of paternal depressive symptoms. Indian, Pakistani and Bangladeshi ethnicity was  
303 associated with higher levels of paternal depressive symptoms compared to white fathers at ages 3 and 5 years.  
304 Finally, at 5 and 7 years, lower family income was associated with higher levels of depressive symptoms  
305 amongst fathers.

306 The overall models' fit  $R^2$  values were 13%, 18%, 19% and 16%.

307

308 [Insert Table 3 here]

309

310 ***Longitudinal repeated measures model***

311 We fitted a mixed effects model where the outcome was paternal depressive symptoms and included time point,  
312 maternal depressive symptoms, marital conflict, paternal education, paternal ethnic background, employment  
313 status, family housing and household income as fixed effects. This included a random intercept for each  
314 individual and a random slope for time effect to allow for correlation between the repeated measures. Table 4  
315 shows that paternal depressive symptoms decreased over time, with the decrease from sweep 1 to sweep 2 being  
316 the steepest. It also shows that maternal depressive symptoms, higher marital conflict and paternal  
317 unemployment were highly significantly associated with higher levels of paternal depressive symptoms across  
318 all sweeps ( $p < 0.001$ ). Family housing and income were also significantly associated with paternal depressive  
319 symptoms across all sweeps.

320

321 **Discussion**

322 Using a nationally representative sample of UK fathers, the current study has found the prevalence of paternal  
323 depressive symptoms to be 3.6% when child was 9 months old, 1.2% when child was 3 years old, 1.8% when  
324 child was 5 years old and 2.0% when child was 7 years old. This suggests a decrease in paternal depressive  
325 symptoms from the time that their children were 9 months to 3 years old and a very slight increase for the

326 subsequent time points until 7 years old. Maternal depressive symptoms followed the same pattern and reduced  
327 from 9 months to 3 years old, and the reduction was greater among mothers compared to fathers. These findings  
328 report prevalence at the lower end of the range compared to previous estimates that extend from 1.2% to 25.5%  
329 [9, 12, 14]. Our findings showed slightly higher paternal depressive symptoms compared to the LSAC study of  
330 fathers which used the same measure (K6) and cut-off which make our results directly comparable [13], and our  
331 finding are extended to children aged up to 7 years old. Taken together, the findings suggest that a small  
332 proportion of fathers experience significant levels of depressive symptoms throughout the first seven years of  
333 child's life, and as with maternal postnatal depression, symptoms were most common in the first year after birth.  
334 However, the peak was smaller and the decline was slower than that seen amongst mothers. Thus, it is a  
335 possibility that fathers could also suffer from postnatal depression. To our knowledge, this is the first study that  
336 has investigated paternal postnatal depressive symptoms in such a large representative cohort with fathers of  
337 children aged up to 7 years old.

338

339 The association of maternal with paternal depressive symptoms is consistent with previous literature and  
340 suggests that fathers are more likely to experience depressive symptoms if their partner also has depression [9,  
341 19]. We found that higher maternal depressive symptoms were associated with higher paternal depressive  
342 symptoms across time. Marital conflict was also associated with higher paternal depressive symptoms as  
343 predicted and consistent with previous literature [16, 20, 21]. However, child temperament was not significantly  
344 associated with paternal depressive symptoms [22, 23], which suggests that within the family context, there are  
345 associations with maternal factors but not with child characteristics.

346

347 Socio-economic factors such as low income and living in rented accommodation were found to be significantly  
348 associated with depressive symptoms, suggesting that fathers in families facing socioeconomic deprivation are  
349 more at risk of depressive symptoms, and which replicates the previous literature [26, 43]. Paternal  
350 unemployment was strongly and consistently associated with paternal depressive symptoms. This is consistent  
351 with previous literature on adult men and findings from one large cohort study of fathers in the United States  
352 with children aged 5-17 years old [14, 44]. However, to our knowledge this is the first study to show this  
353 finding in a national representative sample in the UK with fathers of children aged between 9 months to 7 years  
354 old. These findings suggest that unemployment is a significant risk factor that needs acknowledging by health

355 care providers when it comes to treating depression in fathers of young children, and is particularly salient given  
356 the current economic climate.

357

358 Fathers with no qualifications reported more depressive symptoms only at 9 months compared to fathers with  
359 school level or university level education, which suggests that education was only associated with depressive  
360 symptoms during the first year of a child's life. Similar findings were reported by Bergstrom et al. [26] in a  
361 Swedish sample of first time fathers when their infant was 3 months old. The association between ethnicity and  
362 paternal depressive symptoms were found when the child was 3 and 5 years old, and suggested that fathers from  
363 an Indian, Pakistani, or Bangladeshi background were more likely to have higher depressive symptoms  
364 compared to Caucasian fathers. In a study that also used the MCS sample in relation to maternal depression,  
365 ethnic density was reported as a major factor associated with maternal depression in mothers from different  
366 ethnic backgrounds. Living in an area with higher density was a protective factor for mothers from some  
367 backgrounds but the results were not conclusive [27]. In the current sample, the Indian, Pakistani or Bangladeshi  
368 ethnic group had a far larger sample size (n=1,255) compared to Afro-Caribbean (n=337) and mixed other  
369 (356), therefore these results should be interpreted with caution.

370

371 The current study has a number of strengths. Firstly, the data consisted of a representative and large sample size  
372 of the UK population with a good response rate. The study was unique in that it has data on such a large sample  
373 of fathers making them comparable to mothers [45]. The MCS also use well validated and reliable measures  
374 [35]. Secondly, sampling weights were used to account for attrition rates that might have affected the results. In  
375 addition to this, research indicates that even when drop outs are considered, associations found in regression  
376 models are still robust with such large cohort studies [46], suggesting our findings to be robust.

377

378 However, the study has a number of limitations. Firstly, depressive symptoms at the first sweep were measured  
379 at 9 months. Ideally a measure of depressive symptoms in the more immediate post-natal months following birth  
380 could have been more ideal, but we were constrained by available data. Depressive symptoms were also  
381 measured differently in the first sweep (Rutter Scale) to the later sweeps (K6), which could have influenced the  
382 decrease in depressive symptoms detected from sweep 1 to sweep 2. There was also a slight increase in  
383 depressive symptoms from sweeps 2 to 4 where the same scale (K6) was used to measure depressive symptoms.  
384 While the use of a different measure at sweep 1 was not ideal, it was important to assess depressive symptoms at

385 this time, and secondary analyses are constrained by the available data. The mean scores and prevalence from  
386 the recalibrated Rutter scale at sweep 1 are similar mean scores of mothers' and fathers' depressive  
387 symptoms that have been reported by other studies using the K6 questionnaires [47, 48], suggesting that the  
388 recalibration of the scale was appropriate. Secondly, as a questionnaire was used to indicate depressive  
389 symptoms, reference to clinical diagnoses of depressive episodes could not be made. Although there are  
390 limitations with relying on self-report questionnaire measures to investigate depressive symptoms and it is  
391 arguably better to administer clinical interviews methods such as the Structural Clinical Interview for DSM-II-R  
392 (SCID) [49], conducting such clinical interviews with a large sample size would be costly, time-consuming and  
393 would impose burden on participants. Cairney and colleagues compared the K6 questionnaire with clinical  
394 interview diagnosis of current depression and reported it to be an "excellent screening instrument, especially for  
395 current depression" [50]. This suggests that the use of questionnaires such as the K6 in large epidemiological  
396 studies are informative of current depression and to some extent indicates impairments related to a clinical  
397 depressive episode. Thirdly, despite significant findings, our coefficient effect sizes of the associations and  
398 overall model fit values were small. Although this could be problematic, recruitment of clinically depressed  
399 fathers into studies with their children has been reported as particularly challenging [51-53]. Thus, findings from  
400 large cohort studies such as the MCS on paternal depressive symptoms offers understanding about the possible  
401 risk factors [54, 55]. These findings, if replicated in clinical studies with more in-depth measures, could suggest  
402 targets for development of clinical interventions with fathers and mothers.

403

404 Finally, the findings are limited to full-time resident fathers only and cannot be applied to general population of  
405 fathers who are separated, divorced or non-resident. Research indicates that non-resident fathers have higher  
406 levels of depressive symptoms compared to resident fathers who are married or cohabiting [13, 56]. Therefore,  
407 the current finding might under-represent the prevalence of depressive rates amongst fathers in general.

408 Although we were interested in investigating this, we were unable to due to the lack of data available on  
409 symptoms of depression for part-time and non-resident fathers.

410

411 Despite these limitations, the study has considerable strengths, and the findings are timely and add to theoretical  
412 understanding of paternal depression. The next-step would be to take associated factors and test for causal  
413 relations by using experimental design and longitudinal data analysis to determine if associated factors cause  
414 paternal depression or proceed after paternal depression. This could inform better targeted interventions and

415 treatment for fathers with depression. In addition to this, future work should account for other genetic and  
416 environmental risk factors associated with paternal depressive symptoms that could not be tested in the current  
417 study such as family history of depression, fathers' past depressive episodes and paternal substance abuse [10].

418

#### 419 **Conclusions**

420 In conclusion, there are two key findings from the current study. Firstly, the prevalence of paternal depressive  
421 symptoms decreased from the first year (9 months old) to 3 years old, in the same pattern as maternal depressive  
422 symptoms. Secondly, paternal depressive symptoms were associated with unemployment, marital conflict and  
423 maternal depressive symptoms at every time point, with low socioeconomic variables also playing a role. The  
424 key contribution to current theoretical knowledge is that paternal unemployment might be an important factor  
425 for paternal depression. Currently in the UK, healthcare cost of depressed fathers is comparable to mothers but  
426 interventions are still primarily tailored for mothers [57, 58]. In light of our findings, we would recommend a  
427 more family centred approach. Primary health care services, unemployment officers, job centres and health care  
428 professionals involved in post-natal care should aware that fathers of young children are at risk of depression  
429 and provide useful services to support such fathers accordingly. Provided suitable, accessible and effective  
430 services were available, the systematic screening of new fathers could be implemented alongside the systematic  
431 screening of new mothers by health visitors.

432

#### 433 **Declarations**

#### 434 **List of abbreviations**

435 Millennium Cohort Study (MCS), Longitudinal Study of Australian Children (LSAC), Medical Expenditure  
436 Panel Survey (MEPS), Patient Health Questionnaire-2 (PHQ-2), United Kingdom (UK), Kessler 6 (K6)

437

#### 438 **Ethics approval and consent to participants**

439 MCS had ethical approval and informed consent from participants. As our work comprised secondary analysis  
440 of anonymized data that is publically available (<http://discover.ukdataservice.ac.uk/series/?sn=2000031>) with no  
441 direct contact with the individual participants, therefore further ethical approval was not considered necessary.

442

#### 443 **Consent for publication**

444 Not applicable

445

446 **Availability of data and materials**

447 All data used in this paper is publically available on the UK data service website

448 <http://discover.ukdataservice.ac.uk/series/?sn=2000031>. It is free to access and can be downloaded in STATA or

449 SPSS format. All supporting documents (full details of sampling, methods and measures) can be found on the

450 Millenium Cohort Study (Centre of Longitudinal Studies) webpage

451 <http://www.cls.ioe.ac.uk/page.aspx?siteid=851>

452

453 **Competing interests**

454 The authors declare that they have no competing interests.

455

456 **Funding**

457 No funding was allocated to specifically support this work. Open access for this article was funded by King's

458 College London.

459

460 **Authors' contributions**

461 **Selina Nath:** Made substantial contributions to conception, design, data analysis (conducted data analysis),

462 interpretation of data, drafted the manuscript, revised manuscript critically for important intellectual content,

463 given final approval of the version to be published and agreed to be accountable for all aspects of the work in

464 ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated

465 and resolved.

466 **Lamprini Psychogiou:** Made substantial contributions to conception, design, interpretation of data, revised

467 manuscript critically for important intellectual content, given final approval of the version to be published and

468 agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity

469 of any part of the work are appropriately investigated and resolved.

470 **Willem Kuyken:** Made substantial contributions to conception, design, interpretation of data, revised

471 manuscript critically for important intellectual content, given final approval of the version to be published and

472 agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity

473 of any part of the work are appropriately investigated and resolved.

474 **Tamsin Ford:** Made substantial contributions to conception, design, interpretation of data, revised manuscript  
475 critically for important intellectual content, given final approval of the version to be published and agreed to be  
476 accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part  
477 of the work are appropriately investigated and resolved.

478 **Elizabeth Ryan:** Made substantial contributions to data analysis (longitudinal data analysis), interpretation of  
479 data, revised manuscript critically for important intellectual content, given final approval of the version to be  
480 published and agreed to be accountable for all aspects of the work in ensuring that questions related to the  
481 accuracy or integrity of any part of the work are appropriately investigated and resolved.

482 **Ginny Russell:** Made substantial contributions to conception, design, data analysis (provided guidance with  
483 data analysis), interpretation of data, revised manuscript critically for important intellectual content, given final  
484 approval of the version to be published and agreed to be accountable for all aspects of the work in ensuring that  
485 questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

486

#### 487 **Acknowledgements**

488 We would like to thank the Millennium Cohort Study team at the Institute of Education, London, United  
489 Kingdom, as well as the Millennium Cohort Study families. We are grateful to The Centre for Longitudinal  
490 Studies, UCL Institute of Education for the use of these data and to the UK Data Archive and Economic and  
491 Social Data Service for making them available. However, they bear no responsibility for the analysis or  
492 interpretation of these data.

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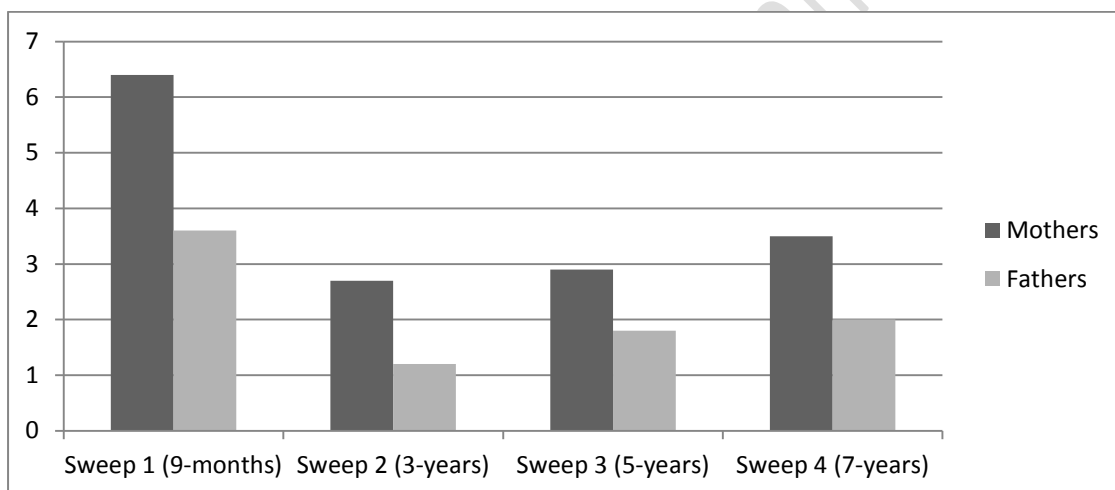
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**Figures**



669 **Figure 1** Percentage of mothers (n=9,611) and fathers (n=5,220) with high levels of depressive symptoms for  
 670 biological full-time resident mothers and fathers across time in the Millennium Cohort Study (full-cases and  
 671 weighted)  
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**Table 2** Descriptive statistics of fathers with low and high levels of depressive symptoms

Predictors <sup>a</sup>	Sweep 1(9 months old) <sup>c</sup>		Sweep 2 (3 years old) <sup>d</sup>		Sweep 3 (5 years old) <sup>e</sup>		Sweep 4 (7 years old) <sup>f</sup>	
	depressive symptoms		depressive symptoms		depressive symptoms		depressive symptoms	
	Low	High	Low	High	Low	High	Low	High
<b>Family context factors</b>								
Maternal depressive symptoms: Mean(SD)	3.96 (4.3)	6.18 (5.6)	2.82 (3.2)	4.98 (4.6)	2.62 (3.2)	4.23 (4.6)	2.57 (3.2)	4.69 (4.4) <sup>b</sup>
Marital conflict: Mean (SD)	-0.04 (1.0)	0.97 (1.3)	-0.00 (1.0)	1.38 (1.3)	-0.01 (1.0)	1.13 (1.5)	-0.02 (1.0)	1.02 (1.5) <sup>b</sup>
Child temperament: Mean(SD)	57.44 (6.1)	55.26 (6.8)	57.49 (6.0)	56.88 (7.1) <sup>b</sup>	57.52 (6.0)	56.44 (6.8)	57.41 (6.0)	55.45 (6.7) <sup>b</sup>
Child gender (%)								
1. Boy	52	50	50	51	51	57	51	51
2. Girl	48	50	50	49	49	43	49	49
<b>Socio-demographic factors</b>								
Paternal education (%)								
1. No qualifications	14	31	12	29	12	37	12	27
2. School level, Degree or higher	86	69	88	71	88	63	88	73
Fathers ethnic background (%)								
1. White	91	88	92	88	93	89	92	86
2. Indian, Pakistani & Bangladeshi	5	7	5	7	4	7	4	9
3. Afro-Caribbean & British afro-Caribbean	2	2	2	3	1	0	2	1
4. Mixed, other ethnic	2	3	2	2	2	4	2	4
Fathers' employment (%)								
1. Employed	92	74	94	74	95	63	95	61
2. Unemployed	8	26	6	26	5	37	5	39
Housing (%)								
1. Council or private rent	22	43	17	40	15	46	16	46
2. Home owner	78	57	83	60	85	54	84	54
Family income: Mean (£ per week)	370.15 (205.00)	290.92 (197.10)	413.88 (227.14)	291.21 (192.93) <sup>b</sup>	439.95 (222.63)	272.53 (150.63)	474.08 (229.37)	309.37 (200.71) <sup>b</sup>
Paternal age (years): Mean (SD)	33.2 (6.0)	32.7 (6.6)	35.7 (5.9)	34.7 (6.5)	37.8 (5.9)	37.6 (6.2)	39.7 (5.9)	38.7 (6.3) <sup>b</sup>

<sup>a</sup> Sample size ranged from 5,491 to 12,396 due to missing data in the variables

<sup>b</sup> SD were taken from data out of survey, as survey set in stata was giving inaccurate result of 0 SD's

<sup>c</sup> Sample size was 12,396 (high depressive symptoms= 1,133, low depressive symptoms=11,263)

<sup>d</sup> Sample size was 8,768 (high depressive symptoms= 129, low depressive symptoms= 8,768)

<sup>e</sup> Sample size was 8,312 (high depressive symptoms= 165, low depressive symptoms=8,147)

<sup>f</sup> Sample size was 7,382 (high depressive symptoms= 179, low depressive symptoms=7,203)

**Table 3** The associations between predictors and paternal depressive symptoms in the Millennium Cohort Study

Predictors at each sweep	Unadjusted <sup>a</sup>		Adjusted <sup>b</sup>	
	Coefficient (95% CI)	p	Coefficient (95% CI)	p
<b>Predictors (Sweep 1 when child 9-months old)</b>				
<i>Family context factors</i>				
Maternal depressive symptoms	0.17 (0.15-0.19)	<0.001	0.11 (0.08 - 0.13)	<0.001
Marital conflict	1.18 (1.18-1.38)	<0.001	1.12 (1.01 – 1.23)	<0.001
Child temperament	-0.05 (-0.07- 0.03)	<0.001	-0.01 (-0.03- -0.00)	0.097
Child gender	-0.01 (0.13 – 0.04)	0.133		
<i>Socioeconomic factors</i>				
Paternal education		<0.001		0.011
No qualifications	reference group			
School level, Degree or higher	-0.17 (-1.42- -0.92)		-0.45 (-0.79- -0.10)	
Ethnic background		0.028		
White	reference group			
Indian, Pakistani, & Bangladeshi	0.23 (-0.10- 0.56)			
Afro-Caribbean & British afro-Caribbean	-0.80 (-1.46- -0.14)			
Mixed, other	0.14 (-0.42- 0.71)			
Fathers work status				
Employed	reference group			
Unemployed	1.94 (1.56-2.32)	<0.001	0.94 (0.41 -1.46)	<0.001
Housing tenure		<0.001		<0.004
Council and private renting, %	Reference group			
home owner, %	-1.40 (-1.62- -1.18)		-0.41 (-0.69- -0.13)	
Family income (per £1000 p.a.)	-2.53 (-2.98- -2.08)	<0.001	-0.35 (-0.90-0.21)	0.219
Paternal age	-0.40 (-0.55- -0.25)	<0.001	-0.08 (-0.25-0.10)	0.395
<b>Predictors (Sweep 2 when child 3 years old)</b>				
<i>Family context factors</i>				
Maternal depressive symptoms	0.17 (0.14-0.20)	<0.001	0.09 (0.05 -0.12)	<0.001
Marital conflict	1.14 (1.05-1.23)	<0.001	1.06 (0.95-1.17)	<0.001
Child temperament	-0.03 (-0.04- -0.01)	<0.001	-0.01 (-0.02-0.01)	0.321
Child gender	-0.08 (-0.21- 0.06)	0.273		
<i>Socioeconomic factors</i>				
Paternal education		0.013		
No qualifications	reference group			
School level, Degree or higher	-0.30 (-0.53- -0.06)			
Ethnic background		<0.001		0.017
White	reference group			
Indian, Pakistani, & Bangladeshi	0.80 (0.45-1.15)		0.60 (0.03-1.18)	
Afro-Caribbean & British afro-Caribbean	-0.26 (-0.89-0.36)		-0.50 (-1.71-0.70)	
Mixed, other	0.99 (0.34-1.64)		0.99 (0.10-1.88)	
Fathers employment				
Employed	reference group			
Unemployed	1.81 (1.43-2.19)	<0.001	0.97 (0.48-1.45)	<0.001
Housing tenure		<0.001		

Council and private renting, %	reference group			0.128
home owner, %	-1.03 (-1.28- -0.78)		-0.25 (-0.57- -0.07)	
Family income (per £1000 p.a.)	-1.20 (-1.51- -0.88)	<0.001	-0.25 (-0.13-0.62)	0.195
Paternal age	-0.18 (-0.31- -0.04)	0.010		
<b>Predictors (Sweep 3 when child 5 years old)</b>				
<i>Family context factors</i>				
Maternal depressive symptoms	0.17 (0.14-0.20)	<0.001	0.08 (0.04-0.11)	<0.001
Marital conflict	1.20 (1.10-1.30)	<0.001	1.09 (0.96-1.22)	<0.001
Child temperament	-0.02 (-0.04- -0.01)	0.008	-0.00 (-0.02-0.02)	0.987
Child gender	-0.12 (-0.28-0.04)	0.140		
<i>Socioeconomic factors</i>				
Paternal education		<0.001		0.878
No qualifications	reference group			
School level, Degree or higher	-0.99 (-1.34- -0.65)		0.03 (-0.37-0.43)	
Ethnic background		<0.001		0.001
White	reference group			
Indian, Pakistani, & Bangladeshi	1.01 (0.53-1.49)		1.09 (0.45-1.72)	
Afro-Caribbean & British afro-Caribbean	-0.59 (-0.95- -0.23)		-0.36 (-1.12-0.40)	
Mixed, other	1.62 (0.76-2.47)		0.73 (-0.13-1.60)	
Fathers employment				
Employed	reference group			
Unemployed	3.01 (2.47-3.56)	<0.001	2.44 (1.66 -3.22)	<0.001
Housing tenure		<0.001		0.366
Council and private renting, %	reference group			
home owner, %	-1.41 (-1.65- -1.17)		-0.18 (-0.57- 0.21)	
Family income (per £1000 p.a.)	-2.08 (-2.48- -1.69)	<0.001	-0.68 (-1.12 - -0.24)	0.002
Paternal age	-0.11 (-0.25 - 0.02)	0.088		
<b>Predictors (Sweep 4 when child 7 years old)</b>				
<i>Family context factors</i>				
Maternal depressive symptoms	0.18 (0.14-0.22)	<0.001	0.09 (0.04-0.15)	0.001
Marital conflict	1.08 (0.97-1.19)	<0.001	1.00 (0.84-1.15)	<0.001
Child temperament	-0.02 (-0.04- -0.00)	<0.001	-0.00 (-0.02-0.01)	0.713
Child gender	-0.14 (-0.31-0.04)	0.129		
<i>Socioeconomic factors</i>				
Paternal education		0.019		
No qualifications	reference group			
School level, Degree or higher	-0.66 (-1.04 - -0.28)			
Ethnic background		0.001		0.589
White	reference group			
Indian, Pakistani, & Bangladeshi	1.20 (0.59-1.81)		0.32 (-0.37-1.01)	
Afro-Caribbean & British afro-Caribbean	-0.01 (-0.68-0.67)		-0.19 (-1.20-0.83)	
Mixed, other	1.35 (0.15-2.55)		0.87 (-0.68-2.43)	
Fathers employment				
Employed	reference group			

Unemployed	2.78 (2.20-3.37)	<0.001	2.40 (1.44-3.37)	<0.001
Housing tenure		<0.001		0.066
Council and private renting, %	reference group			
home owner, %	-1.28 (-1.59- -0.97)		-0.40 (-0.83 - -0.03)	
Family income (per £1000 p.a.)	-2.01 (-2.43- -1.58)	<0.001	-0.61 (-1.10- -0.13)	0.014
Paternal age	-0.10 (-0.26-0.06)	0.229		

<sup>a</sup> Sample size ranged from 4,612 to 12,396 due to missing data in the variables

<sup>b</sup> Sample size range was 3,833 to 6,831

**Table 4** Longitudinal repeated measures mixed effects model showing the associations between predictors and paternal depressive symptoms in the Millennium Cohort Study across all time points <sup>a</sup>

Predictors from all sweeps	Coefficient (95% CI) <sup>b</sup>	p
<i>MCS wave</i>		
Wave 1	reference group	
Wave 2	-0.49 (-0.61 - -0.37)	<0.001
Wave 3	-0.44 (-0.56 - -0.31)	<0.001
Wave 4	-0.38 (-0.49 - -0.22)	<0.001
<i>Family context factors</i>		
Maternal depressive symptoms	0.08 (0.06 - 0.10)	<0.001
Marital conflict	0.84 (0.77 - 0.91)	<0.001
<i>Socioeconomic factors</i>		
Paternal education		0.522
No qualifications	reference group	
School level, Degree or higher	-0.10 (-0.40 - 0.20)	
Ethnic background		
White	reference group	
Indian, Pakistani, & Bangladeshi	0.56 (0.05 - 1.07)	0.031
Afro-Caribbean & British afro-Caribbean	-0.74 (-1.23 - 0.25)	0.003
Mixed, other	0.76 (-0.01 - 1.53)	0.053
Fathers employment		
Employed	reference group	
Unemployed	1.13 (0.70 - 1.56)	<0.001
Housing tenure		0.001
Council and private renting, %	reference group	
home owner, %	-0.41 (-0.66 - -0.17)	
Family income (per £1000 p.a.)	-0.31 (-0.58 - -0.06)	0.022

<sup>a</sup> Finite population correction factor could not be fitted onto model, but all other required weights (accounting for clustering, attrition/non-response and oversampling for ethnic minorities/disadvantaged participants) were incorporated.

<sup>b</sup> Sample size 4766