Does Postpartum Depression Affect Employment?

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Non-Technical Summary

Postpartum depression (PPD) is a relatively common psychological disorder following childbirth which, if left untreated, may have long-term adverse effects on women's mental health. It is estimated that postpartum depression affects around 10% to 15% of women in developed countries. In the United Kingdom, it is estimated that 8%-15% of women suffer from the condition with long-term consequences for maternal mood and child development. Research not only shows that postpartum depression has high prevalence rates, but can also lead to long-term disability and incapacity for work. However, empirical evidence regarding the effects of postpartum depression is very limited and despite its potential implications for the individual and society the effect of postpartum depression on women's employment outcomes remains unaddressed.

The present paper explores the possible effects of postpartum depression on maternal employment in the UK using data from the Millennium Cohort Study (MCS) and a timespan covering several years (3 to 11 years after the birth of the child). We consider both direct and indirect effects of PPD on maternal employment, testing the importance of a range of factors - including marital status, physical longstanding health problems, mental health problems, children's outcomes - as potential mediators.

The findings indicate that PPD has mainly a direct effect on maternal employment 5 years after birth. After 7 and 11 years the effects are mainly indirect and emerge through the impact of PPD on subsequent maternal mental and physical health problems.

These results are of policy relevance, as they show that PPD can have long-lasting impacts on maternal outcomes even when its direct effects are no longer present. Our analysis is based on a representative sample of the UK population and are therefore generalizable.

Does postpartum depression affect employment?[i]

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Abstract

This paper examines the effect of postpartum depression (PPD) on maternal employment in the UK and assesses the extent of the direct and indirect link between PPD and maternal employment up to eleven years after the birth of the child. The study tests a range of factors (marital status, physical longstanding health problems, mental health problems, children's outcomes) as mediators in order to assess the indirect effect of PPD on maternal employment, utilising several waves of data from the Millennium Cohort Study. The findings are of significance to policy makers as they indicate that PPD has a direct effect on maternal employment 5 years after the birth of the child and an indirect effect after 7 and 11 years. The indirect effects are mediated primarily through subsequent maternal mental and physical health problems.

Keywords: postpartum depression; maternal employment; health inequalities; KHB decomposition

JEL codes: J21, J13, J16, I14.

1. Introduction

Depression in the postpartum period (PPD) is considered a major public health problem (Stewart et al., 2003; Hay et al., 2008; Chew-Graham et al., 2009). It is a relatively common psychological disorder following childbirth which, if left untreated, may have long-term adverse effects on women's mental health. It is estimated that postpartum depression affects around 10% to 15% of women in developed countries (O'Hara and Swain, 1996; O'Hara, 1997; Prince et al., 2007). In the United Kingdom, 8%-15%[1] of women suffer from the condition with long-term consequences for maternal mood and child development (Chew-Graham et al., 2009). Research not only shows that postpartum depression has high prevalence rates (NHS Choices, 2013), but can also lead to long-term disability and incapacity for work.

However, empirical evidence regarding the effects of postpartum depression on a variety of maternal outcomes is very limited and despite its potential implications for the individual and society the effect of postpartum depression on women's employment outcomes remains unaddressed. The high participation of women in the labour market and the growing number of young mothers who choose to return to employment after childbirth (Fagan and Norman, 2012), indicate the important role that work plays in women's lives and how vital mental health is for personal and professional development (McDaid et al., 2008).

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[1] Reviewing prior studies, Forman et al. (2000) observe that depression in the postpartum period varies between 8% and 15% according to the different diagnostic criteria used. Citing Gaynes et al. (2005), Wisner et al. (2006) note that one in seven new mothers (14.5%) in the USA experience depressive episodes that impair maternal role function.

The present study explores the possible effects of postpartum depression on maternal employment in the UK, using data from the Millennium Cohort Study (MCS) and a timespan covering several years (3 to 11 years after the birth). The findings of this study are of significance to policy makers as they indicate that PPD has a direct effect on maternal employment 5 years after the birth of the child and an indirect effect after 7 and 11 years. We show that these indirect effects are mediated primarily through subsequent maternal mental and physical health problems. These results are broadly in agreement with prior literature observations that mental health problems have far-reaching consequences and postpartum depression can make women more vulnerable to subsequent mental health problems, suggesting the need for greater awareness of the effects of the condition on women's long-term employability trajectories.

2. Relevant Literature

As the interplay between postpartum depression and maternal employment outcomes has received limited research attention, we built a wider backdrop considering observations and findings of previous studies. Specifically, we discuss issues related to women's presence in the labour force, maternal employment trajectories after childbirth, mental disability, and the economic burden of depression on national economies, as well as the difficulties in diagnosing the condition, mainly due to multiple causal factors associated with PPD.

Women's growing presence in the labour force is a topic of worldwide research interest. In the UK the number of mothers who choose to be in employment after giving birth has increased rapidly over the past few decades (Fagan and Norman,

2012). Estimates show that employment among mothers with dependent children rose from 67% in 1996 to 72% in 2013.[2] As Crosby and Hawkes (2008) observed, women's presence within the labour market has generated a large amount of research aimed at understanding its implications, particularly regarding employment in the first year or two following the birth of a child. The topic has mainly been examined from two distinct standpoints: the first focuses on the effects of childbearing on women's employment trajectories; and the second focuses on the effects of maternal employment on children's developmental trajectories. Two recent studies – one by Fagan and Norman (2012) in the UK context and the other by Chatterji et al. (2013) in the USA context – highlight the problems mothers face after childbirth. However, concerning the transition back to employment, neither study explored the possible impact of PPD on women's employment trajectories despite evidence for the high prevalence of the condition and its negative consequences on the mother's ability to function in her different roles – at home and at work.

2.1. Mental disability

Another aspect that has been in the focus of research is the relationship between employment and mental disability, especially in terms of incapacity to work due to poor mental health. Examining labour market experiences of people with disabilities in the UK, Smith and Twomey (2002) observe that work provides networks of friends and colleagues, a sense of participation or social inclusion, as well as opportunities for both personal and professional development, adding that

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[2] Office for National Statistics: employment rates for men and women aged 16-64, April to June 2013. Available at: http://www.ons.gov.uk/ons/dcp171776_328352.pdf

nearly one in five people of working age in the UK had a long-term disability. The percentage of disabled people reporting as their main problem, mental illness including depression and phobias was 9%, with women presenting higher rates than men (Smith and Twomey, 2002). Research findings reveal that women show a greater prevalence of depressive disorders than men, especially during the childbearing years (Burke, 2003). As pointed out by McDaid et al. (2008), mental health is subject to discrimination and stigma and despite legislation and human rights instruments, people with mental health problems still face difficulties in terms of employment. The employment rate for adults with mental health problems is very low – only 43% of people with mental health problems are in employment compared to 65% of people with other health conditions (Mental Health Taskforce, 2016). Furthermore, the World Health Organization (2001) estimates that globally depression will emerge as one of the leading causes of disability by the year 2020, second only to heart disease.

2.2. PPD determinants

Postpartum mood disturbances are traditionally viewed in terms of three categories: postpartum blues; postpartum (nonpsychotic) depression; and depression with psychotic features.[3] Each category differs in its prevalence, clinical presentation, and management (Robertson et al., 2003). Postpartum depression is the most common complication of childbearing. It tends to be recurrent and follows a chronic course (Burke, 2003). Research studies (Fisch et al., 1997; Cooper and Murray, 1998;

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[3] According to Miller (2002, p.762) postpartum blues "are a transient state of heightened emotional reactivity" that affects nearly 50% of women who have recently given birth, 3 to 5 days after delivery, often coinciding with the start of lactation. Postpartum nonpsychotic depression is mostly due to a history of major depression, psychosocial stress, and inadequate social support. Postpartum psychotic depression is a psychosis characterised by delusions, hallucinations, or both, appearing within 3 weeks of birth, either for the first time or as part of a recurrent illness, due largely to depression or bipolar disorder with mixed "manic and depressive" features (Miller, 2002, p.763).

Forman et al., 2000; Brockington, 2004; Wisner et al., 2006; Prince et al., 2007; Musters et al., 2008; O'Hara, 2009 and Yelland et al., 2010) show that there are multiple causal factors, both biological and non-biological, associated with the development of postpartum depression. Robertson et al. (2003) reviewing a large number of studies, evaluated antepartum depression, anxiety during pregnancy, stressful recent life events, lack of social support and previous history of depression as strong to moderate predictors of PPD, whereas ethnicity, maternal age, level of education, parity, and gender of the child (within Western societies) have no effect. Earlier meta-analyses showing the relationship between significant risk factors and PPD were conducted by O'Hara and Swain (1996) and by Beck (1998 and 2001).

Some studies (O'Hara, 2009; Oppo et al., 2009) emphasise risk factors during pregnancy, while hormonal changes at birth are also considered to influence depression (Bloch et al., 2000). Other studies have found no major differences in the hormonal physiology of women who develop postpartum depression (Musters et al., 2008). It is also argued that the probability of developing postpartum blues is not related to psychiatric history, environmental stressors, cultural context, breastfeeding or parity. Nevertheless, those factors may have an influence on whether the blues develop into major depression (Miller, 2002). Unemployment has specifically been associated with PPD whereas the results of studies on the impacts of other social variables such as income and the mother's level of education appear controversial (Miyake et al., 2011; Vilella et al., 2012). Women who experience difficulties in their marital relationship (Beck, 2001; O'Hara, 2009) or have a poor marital relationship during pregnancy show an increased risk of developing postpartum depression. Mann et al. (2008) found a positive association between

religiosity/spirituality and postpartum depression, and that organised religious participation was significantly protective from PPD symptoms. Other studies underline the importance of husbands and partners playing a positive role and stress the valuable support they can offer to the mother. However, Mitchell et al. (2011) and Musters et al. (2008) suggest that some women are genetically more reactive to the environment. The former study pointed to the interaction between a mother's genes and the environment in postpartum depression, while the latter suggested that "women who become depressed immediately postpartum may have an abnormal sensitivity to the normal physiological changes of childbirth" (Musters et al., 2008, p.400).

Although emphasis is placed on detection and prevention, the condition often remains undiagnosed with devastating consequences for the mother.

3. Methods

In order to address the possible effect of PPD on employment the following equation (reduced model) is used:

$$Y_{it} = a_R + \beta_R PPD_{i,t=0} + \delta_R X_{i,t=0} + \varepsilon_{it} \ (1)$$

where Y_{it} is the outcome variable (employment) measured at ages t=3, 5, 7, and 11 of the child, PPD is postpartum depression measured at 9 months, $t = 0$, i is the individual, t is age of the child at each MCS sweep, and $X_{it=}$ is a vector of background variables measured at 9 months (for example child gender, ethnicity) and the subscript R denotes the reduced model.

A probit regression (eq.1) was applied to assess the possible association between PPD and employment (probability of being employed) as a base model without any controls and then adjusted (with the background variables) for longstanding physical health and health attitudes (to alcohol and smoking), depression related variables (antepartum depression and religiousness), relationship and social support variables (father present at birth, partner completed the questionnaire, and whether mother lived with both parents at age 15).[4] This subsequent application of the models facilitates a broader evaluation of the importance of each set of the above predictors regarding the unadjusted association between PPD and maternal employment.

3.1. Direct and indirect effect of PPD on employment

Given the potential negative effect of a mental health episode (in this case PPD) on marital status, future mental and physical health and children's development, as described in the literature (Cogill et al., 1986; Reichman et al., 2013), it would be interesting to understand whether the potential detrimental effect of PPD on employment is a direct result of the illness itself, or if it is an indirect result through mediating factors (e.g. through future mental health episodes which in turn have a negative impact on maternal employment). In order to examine whether the effect of PPD on maternal employment is potentially mediated through (i) marital status, (ii) fertility, (iii) maternal mental health, (iv) maternal physical health and (v) child outcomes, a two-stage approach is used.

Firstly, we examine whether an association exists between PPD and each of the mediating variables using the following equation (eq.2):

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[4] Income was not included due to the association with employment.

$$Z_{i,t-1} = a + bPPD_{i,t=0} + cX_{i,t=0} + u_{i,t-1} \quad (2)$$

where $Z_{i,t-1}$ is one of the mediating variables (marital status, maternal mental health, maternal physical health, fertility, and children's outcomes) measured at the previous sweep, $t-1$ at ages 3, 5, and 7 of the child, $PPD_{i,t=0}$ is postpartum depression, i is the individual, t is age of the child at MCS sweep, and $X_{i,t=0}$ is a vector of background variables. PPD and all background variables were measured at 9 months, $t = 0$.

Probit regressions were estimated in order to assess the effect of PPD on marital relationship, fertility, maternal physical health and maternal mental health, except for child outcome measures where linear regression was applied. In order to better disentangle the indirect effect of PPD on employment, temporality is assumed (equation 3).[5]

$$Y_{it} = \alpha_F + \beta_F PPD_{i,t=0} + \gamma_F Z_{i,t-1} + \delta_F X_{i,t=0} + \epsilon_{it} \quad (3)$$

For example, to examine the indirect effect of marital status on employment at age 5 (t), we use marital status at age 3 ($t-1$) as a mediator. Hence, the outcome variable – employment - is estimated until age 11 (MCS5) and the mediating variables until age 7 (MCS4). Where no association was found between PPD and one of the variables, it was not used as a mediator. The regressions in equations 1 and 2 were subsequently estimated using PPD as a continuous indicator, as a robustness check.

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[5] Temporality refers to an assumption that there is a lag in the effect of PPD and other mediators on the outcome variable.

Secondly a method proposed by Breen et al. (2013), and Karlson et al. (2010; 2013), known as the KHB decomposition method, is used.[6] This method disentangles the total effect of a variable on the outcome - in this case PPD on maternal employment - into a direct effect (the effect of PPD on maternal employment adjusting for a mediating variable, e.g. marital status) and an indirect effect (the difference between the total and direct effect) for nested non-linear models. This method is necessary to facilitate the estimation of the direct and indirect effect in probit models. For example, if this was a linear model then we could calculate the direct and indirect effect of PPD by firstly estimating equation 1 above and then re-estimating the equation with the inclusion of a mediator (e.g. maternal physical problems), as in equation 3 above. The coefficient of PPD in the second step is equal to the direct effect, while the difference of the two coefficients of PPD (β_R and β_F) is equal to the indirect effect. However, in probit models the indirect effect cannot be calculated in this way due to the rescaling of the model. The rescaling of the probit model occurs because the estimator of PPD depends on the error variance of the model. Hence, when a mediating (or controlled) variable is added, this will change the coefficient of PPD whether or not the mediator is correlated with PPD. This is because, if the mediating variable is correlated with maternal employment, its inclusion will reduce the error variance of the probit model.

Following Kohler et al. (2011), we can rewrite the model as follows, ignoring the time subscript for ease of exposition:

$$Y^* = \alpha_F + \beta_F PPD + \gamma_F Z + \delta_F X + \epsilon \ (4)$$

$$Y^* = \alpha_R + \beta_R PPD + \delta_R X + \varepsilon \ (5)$$

where Y^* is the latent outcome variable, PPD is the variable whose effect we want to decompose, Z is the mediating variable, X are the control variables, β_F is the direct effect, β_R is the total effect, and ϵ, ε are the error terms. Equation 4 denotes the full model (F) and equation 5 is the reduced model (R). The only difference between these models is the effect of Z, the indirect effect, which can also be expressed as $\beta_R - \beta_F$.

Because Y* is a latent variable that is not observed, the outcome Y is measured using a threshold τ as follows:

$$Y \begin{cases} = 0 \ if \ Y^* < \tau \\ = 1 \ if \ Y^* \geq \tau \end{cases}$$

Given that the model is non-linear, the estimated coefficients for the direct and total effect are $b_F = \frac{\beta_F}{\sigma_F}$ and $b_R = \frac{\beta_R}{\sigma_R}$ respectively, where σ_F and σ_R are their respective scale parameters (which are a function of the residual standard deviation of the linear equations in (4) and (5)). Hence, it is clear that the indirect effect $(b_R - b_F)$ will be affected not only by the differences in coefficient effects, but also by the differences in scale parameters.

A direct way to achieve estimates for the indirect effect that are not affected by the rescaling of the model, is to calculate the residuals (R) of a linear regression of Z (mediating variable) on PPD (variable whose effect we want to decompose)

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(equation 6) and then use them in the main equation instead of Z (eq.7). The indirect effect is then the difference between $\widetilde{b}_R$ and b_F.

$$R = Z - (a + bPPD) \quad (6)$$

$$Y^* = \tilde{a}_R + \tilde{\beta}_R PPD + \tilde{\gamma}_R R + \tilde{\delta}_R X + \zeta \quad (7)$$

$$\tilde{b}_R - b_F = \frac{\tilde{\beta}_R}{\tilde{\sigma}_R} - \frac{\beta_F}{\sigma_F} = \frac{\beta_R - \beta_F}{\sigma_F} \quad (8)$$

The indirect effect in eq. 8 equates to the differences in effects (total effect – modified reduced model) minus the direct effect (full model)), as in the linear case, divided by a common scale.

4. Data and Descriptive Statistics

The Millennium Cohort Study (MCS) began as a longitudinal study of approximately 18,000 children born in the UK in 2000. The MCS is a large-scale survey of children born in the four constituent countries of the United Kingdom. The first sweep (MCS1) was carried out during the period 2001-2002 and contained information on 18,819 children in 18,533 families, collected from the parents when they were 9-11 months old. The sample design allows for over-representation of families living in areas of England with high rates of child poverty or high proportions of ethnic minorities, and the three smaller countries of the UK. Detailed information on the sampling strategy and response rates for the survey can be found in Plewis et al. (2004) and Plewis (2007).

Full details about the survey, its origins, objectives, sampling and content of the sweeps are provided in the documentation attached to the data.[7] For the present analysis, the chosen sample consisted of the main respondents who were the natural mothers and who also responded to all five sweeps. Observations with missing values were excluded. This left us with 9,669 observations for the main sample. Given the sampling design (clustering), the non-response rates and the sampling attrition from subsequent sweeps of the MCS survey, all results are weighted and the svy Stata commands are used to account for the MCS survey complex sampling design, unless otherwise indicated.

4.1. Variables

Mental health variables: Postpartum depression mood / maternal psychological distress

The two measures of maternal mental health in the MCS are the Malaise Inventory and the Kessler K6 scale. The first measure, the Malaise Inventory (Rutter et al., 1970 cited in Johnson, 2012) is a psychometrically valid measure of psychological distress (Rodgers et al., 1999 cited in Flouri et al., 2010). In the MCS study it was included only at the first sweep (MCS 1) when the baby was 9 months old and was derived from the answers to 9 questions designed to assess maternal psychosocial distress: *whether the respondents felt tired, miserable or depressed, worried, often get into a violent rage, become scared, easily upset or irritated, keyed up and jittery, every little thing get on their nerves and wear them out, and heart often race like mad*. Its items, coded as 0=no and 1=yes, measure physical and psychological symptoms of anxiety and depression. A score of at least 4 indicates psychosocial distress and, given its timing (9 months after birth), is used as an indicator of

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

maternal depressed mood postpartum. The Malaise Inventory is widely used to measure maternal depression (Malmberg and Flouri, 2011; Flouri et al., 2010). According to this measure, 15.5% of mothers (Appendix I, Table1) had experienced depressed mood 9 months after the birth of their child (scoring 4 and above in the Malaise Inventory), in accordance with the literature (Musters et al., 2008).[8]

The Kessler scale has been evaluated as a screen for the prevalence of serious mental illness within a community population of US adults for the purpose of discriminating between cases and non-cases of SMI (National Comorbidity Survey, 2013). The scale is in the process of being clinically validated in a number of countries. No clinical validation of the K6 scale has been carried out on a UK population to my knowledge, hence the proposed scoring (>13) is used with the caveat that the scale has been clinically validated for the US population. Using this evaluation, a score of 13 or more was taken as an appropriate reference level to estimate the prevalence of serious mental illness in the population. This scale is used to measure psychological distress from the respondents' report *of how often over the last 30 days they had felt depressed, hopeless, restless or fidgety, that everything they did was an effort, worthless and nervous*. For each question, the respondents indicate whether they have felt this way: none; a little; some; most or all of the time; and these categories are scored from 0 to 4, respectively. The questions form a 24-point scale. The scores for this study were grouped as 0-12 and 13-24, the latter indicating serious levels of mental health issues. In this study (Appendix I, Table 2) 11.3% of mothers suffered serious mental health problems (score of 13 or above) at

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[8] The variable indicating whether the mother was ever diagnosed by a doctor with depression was asked at age 9 months (MCS1), which is the same sweep in which the variable used for deriving antepartum depression was asked, and the other psychological questions used to construct PPD (Malaise Index) were answered; however, the time when the diagnosis was made is not indicated. As a result, this variable is not used as a background variable as it is not clear whether it captures previous history of depression, antepartum depression or current (postpartum) depression.

age 3 (MCS2), falling to 6.11% at age 5 (MCS3) and rising slightly to 6.26% at age 7 (MCS4). In relation to postpartum depression it is interesting that, when the child is aged 3, the percentage of mothers who suffered serious mental health problems after having postpartum depression is 25.1% and at age 5 the percentage of mothers who suffered serious mental health problems after having postpartum depression is 17%, while at age 7, 17.7% mothers suffered serious mental health problems following postpartum depression. The recurrent episodes of maternal mental health problems after PPD are in accordance with Wisner et al. (2006).

Employment

Employment measured as a binary variable was derived from the main respondent Economic Activity Status and was constructed to indicate *whether the natural mother was in employment or not* after 9 months, and after 3, 5, 7 and 11 years respectively, since the birth of the cohort child. Observations labelled 'waiting to start employment' were thus coded as 'not in employment'. As expected, at age 3, 53.8% of mothers were in employment 3 years after the birth, and 58.9% of mothers were in employment 5 years after the birth (in MCS3), 85.2% of mothers were in employment at age 7 (MCS4), and 70% of mothers were in employment at age 11 (MCS5).[9] The overall trend is for mothers to return to employment, but as is shown in Appendix I, Table 3, the pattern is not the same for mothers who experienced postpartum depression relative to mothers who did not. Out of the 84.5% of mothers who did not experience depression, 56% were in employment in MCS2, 61.5% in MCS3, 87% in MCS4 and 61.2% in MCS5.

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[9] Maternity leave ended at 29 weeks after childbirth at the time. (The Maternity and Parental Leave Regulations 1999. Available at: http://www.legislation.gov.uk/uksi/1999/3312/contents/made).

Family structure – Marital status

The family structure variable is measured *using the natural mother's current legal marital status*. The categories include: legally separated; married (first and only marriage); remarried (second or later marriage); single - never married; divorced; and widowed. It appears that cohabiting parents fall in the single-never married category. Hence, we cannot estimate differences in those who are in a cohabiting relationship from those who are not in a partnership - either over time or due to the potential effect of PPD. [10] In Table 4, at age 9 months (MCS1), 56.4% of mothers were married, 32.2% were single - never married, 4.42% were divorced, 4.54% were remarried, 2.32% were legally separated, and 0.15% were widowed. Accordingly, mothers who suffered postpartum depressed mood had the highest percentage in the married category (58.1%) while the lowest percentage was found in the widowed category (0.093%). The same marital status rankings for both the total sample and for mothers who experienced postpartum depressed mood apply at age 3 (MCS2), age 5 (MCS3), and age 7 (MCS4).

Child outcomes–Cognitive (BAS) scores

The child outcome in this study (cognitive scores) is measured using the British Ability Scales (Early Years version) Vocabulary Test at age 3 (MCS2), age 5 (MCS3), and age 7 (MCS4). The BAS test measures *children's capacity to verbally name what they see in a picture.* It is also one of the best predictors of children's all-round intelligence and, like IQ it is not easy to drive up or down as it contains a strong genetic component (Dearden et al., 2011). In this study, the variable utilised

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[10] At age 3, 60% of the respondents in the single-never married category were cohabiting parents, at age 5 around 58% were cohabiting parents and at age 7 only 48% of respondents in the single-never married category were cohabiting parents.

is the BAS ability scores. This was chosen because the scores have been adjusted for both item difficulty and age, so as to facilitate the performance comparison of younger and older cohort members (Connelly, 2013).[11] The variable was divided into quintiles for ease of comparison. From Appendix I, Table 5 at age 3 (MCS2), it can be observed that the highest percentage of children's BAS score for mothers who have not suffered from postpartum depression is in the fourth quintile, followed by the first quintile (25.3% and 18.7% respectively), while most of the children of mothers who have suffered from postpartum depression scored in the first quintile followed by the fourth. At age 5 (MCS3) the pattern is again less clear regarding the children's BAS scores. The highest percentage is located in the fifth quintile, followed by the third quintile. The BAS scores of children (in percentages) whose mothers had suffered from postpartum depression are concentrated in the first and second quintile. At age 7 (MCS4), the BAS scores of children whose mothers had not suffered from PPD are concentrated in the fifth quintile, followed by the third quintile, while the BAS scores of children whose mothers had suffered from postpartum depression remain concentrated in the first two quintiles, as at age 5.

Longstanding physical health problems

Longstanding physical health problems are measured using a binary variable available in the MCS, indicating *whether the respondent had a longstanding (defined as something that has troubled you over a period of time or that is likely to affect you over a period of time) illness, disability or infirmity*. In Table 6, 32.9% of mothers who had experienced PPD had longstanding physical problems at age 3, while at age 5 the figure was 37.1%, and at age 7 was 35.9%. In the case of mothers

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

who had not experienced PPD, 19.7% had longstanding physical problems at age 3, while at age 5 the figure was 22.5%, and at age 7 was 22.7%.

Fertility

The binary variables measuring fertility were derived by combining information on *whether there is a natural sibling in the household and the change in the number of siblings in the household*. In Table 7, the percentage of women who chose to have another child after the cohort member was born drops from 21.4% at age 3, to 7.24% at age 7. The rate of this maternal choice (of a subsequent birth) remains relatively similar for PPD mothers and non-PPD mothers across all sweeps. Specifically, 21.9% of PPD mothers and 18.6% of non-PPD mothers have had another child by age 3, 12.2% of PPD mothers and 12.7% of non-PPD mothers have had another child by age 5, and 7.01% of PPD mothers and 8.47% of non-PPD mothers have had another child by age 7.

Background variables

The social and demographic characteristics used in this analysis broadly fall into five categories: maternal socio-demographic; maternal longstanding physical health and health attitudes; relationship and social support variables; child characteristics; and depression related variables. The following maternal socio-demographic characteristics control for social vulnerability (for example, nativity) and risks to socio-economic status: maternal age at birth; whether the mother was born in the UK (omitted variable foreign born); maternal highest educational qualification achieved (Higher degree, First degree, Diplomas in higher education, A / AS / S levels, O level / GCSE grades A-C, GCSE grades D-G, Other academic

qualifications (incl. overseas), (omitted variable no qualifications)); worked during pregnancy; maternal ethnic identity, utilising the categories corresponding to those in the UK census (White, Indian, Pakistani and Bangladeshi, Mixed Ethnicity, Black, (omitted variable 'other ethnicity')); and OECD median poverty rate. Maternal longstanding physical health and health attitudes control for: physical health that often coincides with mental health problems; maternal longstanding illness; whether the mother smoked in pregnancy; and whether the mother consumed alcohol before pregnancy. Relationship and social support variables control for: relationship capital and support at birth; whether the mother lived with both parents when she was 15; whether the father completed the questionnaire/interview; and whether the father was present at the birth. Child characteristics control for the following risk factors regarding the child's health: baby's age in months in MCS1; baby's sex, male (omitted variable 'female'); baby's weight at birth; whether the baby was very early pre-term; whether the baby was very late post-term; whether the mother tried to breastfeed; and whether the baby has other siblings. The depression related variables control for: whether the mother was depressed in pregnancy (antepartum depression); and whether the mother attends religious services.[12] Descriptive statistics for the control variables as well as the missing values are presented in Appendix I, Tables 8 and 9. All background variables were taken from the MCS1.

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[12] Due to high numbers of missing cases, the variable that indicates whether the baby was in ICU was not included but the variables, whether the baby was very early pre-term, and whether the baby was very late post-term, are used as proxies. For the same reason, the date when the mother stopped employment is not used.

5. Results

Before presenting the results, the two steps of the analysis are explained. The first step consists of probit regressions to examine whether mothers who had experienced postpartum depression were more or less likely to be in employment, to be married, to experience physical or mental health problems. Linear regression analysis was utilised to evaluate whether children whose mothers had experienced postpartum depression have lower BAS scores. The association between the outcome variable (employment) and PPD, and the potential mediating variables (marital status, mental health problems, physical problems, fertility and child cognitive outcomes) and PPD were first estimated with no controls (Model 1), then adjusted for socio-economic characteristics and child characteristics (control variables) (Model 2), background longstanding physical health and health attitudes (Model 3), depression related variables (Model 4), relationship and social support variables (Model 5) – fully adjusted. The unadjusted and adjusted models described earlier were estimated firstly using the Malaise Inventory score as a binary indicator (Table 1) and then as a continuous indicator for PPD as a robustness check (not shown here). The second step evaluated whether the relationship between PPD has a direct or indirect effect on maternal employment utilising the KHB decomposition (Tables 3-5).

Table 1: Marginal effects (Probit) using binary indicator of PPD: unadjusted and adjusted models

	Age 3 (MCS2)					Age 5 (MCS3)				
	Outcome variable									
	Model 1[+]	Model 2[++]	Model 3[+++]	Model 4[++++]	Model 5[+++++]	Model 1[+]	Model 2[++]	Model 3[+++]	Model 4[++++]	Model 5[+++++]
Employed	-0.142**	-0.049**	-0.041*	-0.041*	-0.041*	-0.161**	-0.075**	-0.066**	-0.066**	-0.066**
	(0.018)	(0.019)	(0.019)	(0.019)	(0.019)	(0.017)	(0.017)	(0.018)	(0.018)	(0.018)
	Mediating variables									
	Model 1[+]	Model 2[++]	Model 3[+++]	Model 4[++++]	Model 5[+++++]	Model 1[+]	Model 2[++]	Model 3[+++]	Model 4[++++]	Model 5[+++++]
Married	-0.116**	-0.070**	-0.055**	-0.052**	-0.045**	-0.118**	-0.076**	-0.063**	-0.060**	-0.053**
	(0.017)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)	(0.017)	(0.017)	(0.017)
Mental Health	0.125**	0.083**	0.080**	0.080**	0.080**	0.084**	0.041**	0.038**	0.038**	0.038**
	(0.011)	(0.008)	(0.008)	(0.008)	(0.008)	(0.006)	(0.004)	(0.004)	(0.004)	(0.004)
Child BAS Scores	-2.931**	-0.420	-0.442	-0.443	-0.362	-3.331**	-0.730*	-0.771*	-0.761*	-0.667*
	(0.484)	(0.379)	(0.386)	(0.386)	(0.382)	(0.456)	(0.329)	(0.326)	(0.328)	(0.326)
Physical problems	0.120**	0.118**	0.065**	0.064**	0.063**	0.134**	0.134**	0.083**	0.083**	0.082**
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)
Fertility	-0.034*	-0.012	-0.007	-0.007	-0.003	0.005	0.002	0.006	0.007	0.008
	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)

Note: Marginal effects at means. Standard errors in parentheses. * $p<0.05$ ** $p<0.01$. Full tables available upon request. Main dependent (outcome) variable: employed age 3: mean 0.538, standard error 0.008; age 5: mean 0.589, standard error 0.008; age 7: mean 0.852, standard error 0.006; age 11: mean 0.700, standard error 0.008; Main independent variable PPD measured at MCS1. First column indicates the dependent variables measured at MCS2-5 for the outcome variable and MCS2-4 for the mediating variables. Observations main dependent variable (employed), age 3: 9669; age 5: 9659; age 7: 9669; age 11: 9600. Observations mediating variables: married, age 3: 9669; age 5: 9665; age 7: 9669. Mental Health, age 3: 9669; age 5: 9669; age 7: 9669. Child BAS Scores, age 3: 9209; age 5: 9569; age 7: 9669. Physical problems, age 3: 9669; age 5: 9662; age 7: 9660. Fertility, age 3: 9073; age 5: 8994; age 7: 9089.

[+] unadjusted Model

[++] Adjusted for socio-economic characteristics and child characteristics (control variables) at MCS1

[+++] Adjusted for characteristics in Model 2 and for longstanding physical health problems and health attitudes at MCS1

[++++] Adjusted for characteristics in Model 3 and for depression related variables at MCS1

[+++++] Adjusted for characteristics in Model 4 and for relationship and social support variables at MCS1

Table 1 (cont'd): Marginal effects (Probit) using binary indicator of PPD: unadjusted and adjusted models

	Age 7 (MCS4)					Age 11 (MCS5)				
					Outcome variable					
	Model 1[+]	Model 2[++]	Model 3[+++]	Model 4[++++]	Model 5[+++++]	Model 1[+]	Model 2[++]	Model 3[+++]	Model 4[++++]	Model 5[+++++]
Employed	-0.100**	-0.038**	-0.032**	-0.032**	-0.031**	-0.147**	-0.063**	-0.053**	-0.053**	-0.051**
	(0.012)	(0.009)	(0.009)	(0.009)	(0.010)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
					Mediating variables					
	Model 1[+]	Model 2[++]	Model 3[+++]	Model 4[++++]	Model 5[+++++]	Model 1[+]	Model 2[++]	Model 3[+++]	Model 4[++++]	Model 5[+++++]
Married	-0.105**	-0.056**	-0.045**	-0.043**	-0.038*	n/a	n/a	n/a	n/a	n/a
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)					
Mental Health	0.088**	0.053**	0.050**	0.050**	0.049**	n/a	n/a	n/a	n/a	n/a
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)					
Child BAS Scores	-2.985**	-0.455	-0.384	-0.337	-0.246	n/a	n/a	n/a	n/a	n/a
	(0.877)	(0.902)	(0.897)	(0.903)	(0.907)					
Physical problems	0.123**	0.126**	0.078**	0.078**	0.076**	n/a	n/a	n/a	n/a	n/a
	(0.014)	(0.013)	(0.014)	(0.014)	(0.014)					
Fertility	0.014	-0.006	-0.006	-0.006	-0.008	n/a	n/a	n/a	n/a	n/a
	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)					

Note: Marginal effects at means. Standard errors in parentheses. * $p<0.05$ ** $p<0.01$. Full tables available upon request. Main dependent (outcome) variable: employed age 3: mean 0.538, standard error 0.008; age 5: mean 0.589, standard error 0.008; age 7: mean 0.852, standard error 0.006; age 11: mean 0.700, standard error 0.008; Main independent variable PPD measured at MCS1. First column indicates the dependent variables measured at MCS2-5 for the outcome variable and MCS2-4 for the mediating variables. Observations main dependent variable (employed), age 3: 9669; age 5: 9659; age 7: 9669; age 11: 9600. Observations mediating variables: married, age 3: 9669; age 5: 9665; age 7: 9669. Mental Health, age 3: 9669; age 5: 9669; age 7: 9669. Child BAS Scores, age 3: 9209; age 5: 9569; age 7: 9669. Physical problems, age 3: 9669; age 5: 9662; age 7: 9660. Fertility, age 3: 9073; age 5: 8994; age 7: 9089.

[+] unadjusted Model

[++] Adjusted for socio-economic characteristics and child characteristics (control variables) at MCS1

[+++] Adjusted for characteristics in Model 2 and for longstanding physical health problems and health attitudes at MCS1

[++++] Adjusted for characteristics in Model 3 and for depression related variables at MCS1

[+++++] Adjusted for characteristics in Model 4 and for relationship and social support variables at MCS1

The estimates in Table 1 show that postpartum depression in relation to employment results in a reduced probability of PPD mothers being employed (4.1%), relative to non-PPD mothers, when adjusted for all confounders. As regards marital status, the estimates in Table 1 show that mothers who have experienced PPD have a reduced probability (4.5%) of being married 3 years after the birth of the child relative to mothers who have not experienced PPD. Mothers who have experienced PPD have an increased probability of facing subsequent mental health problems relative to mothers who have not experienced PPD. This effect remains the same (both in magnitude and in strength) across all models – after adjusting for controls – with the probability of subsequent mental health problems for mothers who have experienced PPD 3 years after the birth of the child being higher (8%). Regarding children's BAS scores at age 3, the association between BAS scores and PPD is diminished after adjusting for control variables (Model 2). Experiencing PPD after birth has a strong association with an increase in maternal longstanding physical health problems in later years compared to non-PPD mothers and, like mental health problems, is consistent across all sweeps. This effect remains the same (both in magnitude and in strength) across all models, after adjusting for physical health problems at baseline (Model 3). At age 3 there is a 6.3% increase in the probability of experiencing physical health problems for PPD mothers. There is no association between PPD and subsequent fertility at age 3.

In MCS3, 5 years after the birth, mothers who have experienced PPD have a lower probability of being employed (6.6%) than non-PPD mothers when all available confounders in the sample are controlled. The effect of PPD on maternal marital status 5 years after the birth of the child is reduced in each model, resulting in a

5.3% reduction in the probability of being married at age 5 for PPD mothers. PPD has a strong effect on subsequent mental health problems at age 5 (MCS3), resulting in a higher probability (3.8%) that PPD mothers, relative to non-PPD mothers, to face subsequent mental health problems. However, at age 5, the association between BAS scores and PPD remains after adjusting for all confounders (Model 5), suggesting that children whose mothers had experienced PPD performed worse at BAS relative to children whose mothers had not experienced postpartum depression. Regarding the association between PPD and longstanding physical health problems, it increases – from age 3 – to 8.2% for PPD mothers relative to non-PPD mothers at age 5 (MCS3). As was the case for age 3 (MCS2), there is no association between PPD and subsequent fertility.

Regarding the negative effect of PPD on maternal employment at age 7 (MCS4), it can be observed that adjusting for all available confounders, mothers who have suffered from PPD are 3.1% less likely to be employed 7 years after the birth of the child (Model 5). At age 7 (MCS4), PPD appears to have a negative effect on maternal marital status when adjusting for all confounders controls, resulting in a reduced probability (3.8%) that PPD mothers, relative to non-PPD affected mothers, to be married 7 years after the birth. Mothers who have experienced PPD have an increased probability of facing subsequent mental health problems (4.9%), relative to mothers who have not experienced PPD. There is no relationship between PPD and children's BAS scores – after adjusting for control variables – at age 7. Experiencing PPD after the birth of a child has a strong association with an increase in maternal longstanding physical health problems in later years compared to non-PPD mothers and, like mental health problems, is consistent across all sweeps. This

effect remains the same (both in magnitude and in strength) across all models, after adjusting for physical health problems at baseline (Model 3). At age 7 there is a 7.6% increase in the probability of PPD mothers experiencing physical health problems. There is no association between PPD and subsequent fertility in any adjustments at any age; hence this variable was dropped as a potential mediator.

In MCS5, 11 years after the birth of the child, the negative effect of PPD on maternal employment remains. The probability of mothers who have experienced PPD being employed 11 years after the birth is 5.1% less than for non-PPD mothers.

5.1. Direct and Indirect effect–the KHB decomposition

Table 2: Evaluating potential mediators

	Probit equations (1)	KHB method (2)
Age 3 (MCS2)		
Married	Yes	No
Mental Health	Yes	Yes
Child BAS Scores	No	Not considered
Physical problems	Yes	No
Fertility	No	Not considered
Age 5 (MCS3)		
Married	Yes	Yes
Mental Health	Yes	Yes
Child BAS Scores	Yes	No
Physical problems	Yes	Yes
Fertility	No	Not considered
Age 7 (MCS4)		
Married	Yes	No
Mental Health	Yes	Yes
Child BAS Scores	No	Not considered
Physical problems	Yes	Yes
Fertility	No	Not considered

Table 2 presents a summary of the relationship between PPD and the potential mediators examined in Table 1 above, and re-evaluated using the KHB method. Potential mediators that showed no statistical significance with PPD are not

considered for evaluation using the KHB method. The first column of Table 2 indicates the potential mediators which were examined in Table 1, in order to establish whether there is an association with PPD, using probit equations. However, in probit models this association cannot only be attributed to including the potential mediating variable but is also due to the rescaling of the model. Hence, all the potential mediators (which showed an association with PPD in probit models) are re-evaluated using the KHB method (the results are presented in Appendix II). This is to ensure that the association with PPD is not attributed to the rescaling of the probit models. For example, in Appendix II, Table 2, controlling for physical health problems at age 3, it can be observed that this variable has no impact as a mediator (indirect effect of physical health problems is statistically insignificant) on PPD and maternal employment at age 5, and hence it is excluded as a mediator. The mediators used in the KHB decomposition are shown in the second column of Table 2.[14]

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[14] Due to concerns whether the maternal limiting longstanding illness (used as a mediator to capture physical health problems) actually captures physical health problems and/or mental health problems we performed robustness checks using the only available alternative measures, which could indicate maternal physical problems, in the MCS. However, there are different measures used in each sweep as discussed below.

At age 3 we used the limiting longstanding illness ICD-10 variable which indicates each mother's longstanding illness according to the international classification of diseases, ICD-10. According to this around 12% have mental disorders (including dementia /brain injury) in our sample, the rest have physical illnesses. Observations that had mental disorders were dropped. However, the ICD-10 is only available at age 3. The SF-8 health index is available only at age 5 as a full indicator (Johnson 2012). At age 7, only 4 out of 8 items are asked in the MCS (Johnson 2012). Since the physical health component in the SF-8 requires all 8 scales, we chose the bodily pain scale which is present at ages 5 and 7 as an indicator of maternal physical health problems. The bodily pain scale consists of one item.

The results obtained using these different indicators of the physical illness variable are presented in Appendix IIA. These results do not change the main (qualitative) results of using maternal limiting longstanding illness as a mediator.

Table 3: KHB decomposition of the effect of PPD on employment -at age 5 (MCS3)

Mediator: Maternal Mental Health Problems Age3	Average Partial Effects	Coefficient	Robust Standard Errors
Postpartum depression			
Total	-0.054	-0.175**	0.046
Direct	-0.043	-0.141**	0.047
Indirect	-0.010	-0.033**	0.008
N	9659		
Pseudo R2	0.20		

Note: * p<0.05 ** p<0.01. Standard errors of difference not known for APE method; robust standard errors presented for coefficients

Table 4: KHB decomposition of the effect of PPD on employment -at age 7 (MCS4)

Mediators: Maternal Mental Health Problems Age 3 Age 5, Physical Health Problems and Marital Status Age 5	Average Partial Effects	Coefficient	Robust Standard Errors
Postpartum depression			
Total	-0.029	-0.172**	0.063
Direct	-0.014	-0.085	0.063
Indirect	-0.014	-0.087**	0.015
N	9660		
Pseudo R^2	0.28		

Note: * p<0.05 ** p<0.01. Standard errors of difference not known for APE method; robust standard errors presented for coefficients

Table 5: KHB decomposition of the effect of PPD on employment - at age 11 (MCS5)

Mediators: Maternal Mental Health Problems Age 3 Age 5 Age 7 and Physical Health Problems Age 5 Age 7	Average Partial Effects	Coefficient	Robust Standard Errors
Postpartum depression			
Total	-0.042	-0.152**	0.050
Direct	-0.016	-0.058	0.051
Indirect	-0.026	-0.094**	0.013
N	9584		
Pseudo R2	0.19		

Note: * p<0.05 ** p<0.01. Standard errors of difference not known for APE method; robust standard errors presented for coefficients

Table 3 presents the total effect of PPD on maternal employment at age 5, the direct effect, and their difference (the indirect effect) expressed in average partial effects using the KHB decomposition method. The results indicate that postpartum depression has a strong direct effect. As observed, mothers who have experienced PPD have a reduced probability of being employed 5 years after the birth of the child by 0.054 or 5.4 percentage points relative to non-depressed mothers. When controlling for future maternal mental health at age 3 (Table 4), it was observed that the indirect effect is statistically significant. This indicates that PPD indirectly affects maternal employment at age 5 through maternal mental health problems at age 3. Furthermore, PPD has a direct effect of 0.054 and an indirect effect of 0.010, indicating that 19.20% of the total effect of PPD on maternal employment at age 5 is mediated through the mother's mental health at age 3.[15]

In Table 4, it is shown that mothers who have experienced PPD have a reduced probability of being employed 7 years after the birth of the child, relative to non-depressed mothers. When adjusting for maternal mental health problems (at ages 3 and 5), physical health problems, and marital status at age 5 as mediators, the direct effect of PPD becomes insignificant. This indicates that the effect of PPD on maternal employment at age 7 is mainly indirect; as it is mediated through mental health problems at ages 3 and 5, physical health problems, and marital status at age 5.

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[15] The percentage is calculated by the KHB package as $100 \times \frac{\tilde{b}_R - b_F}{\tilde{b}_R}$. Small differences are due to rounding errors.

Table 5 displays the results of the KHB decomposition of the total effect of PPD on maternal employment at age 11, the direct effect and their difference (the indirect effect mediated through maternal mental health problems at ages 3, 5, and 7 and physical health problems at ages 5 and 7). However, only the indirect effect (reduced probability of employment for PPD experienced mothers at age 11 of 0.026) is strongly significant, indicating that PPD has an effect on maternal employment at age 11 only through maternal mental health problems at ages 3-7 and physical health problems at ages 5-7.

In order to understand the impact of subsequent mental and physical health problems on the total effect of PPD on maternal employment at age 11 at all MCS sweeps following the birth, the KHB decomposition was repeated using maternal mental health problems at age 3, age 5, and age 7 and maternal physical health problems at age 5 and age 7 as mediators (Table 17 in Appendix II).[16] It was observed that, when using the mediators individually, they explain the indirect effect of PPD on maternal employment to a lesser extent. For example, using maternal mental health problems at age 3 as a mediator, around 19% of the total effect of PPD on maternal employment at age 11 is mediated. Maternal mental health problems at age 5 account for around 21% and maternal mental health problems at age 7 explain around 39% of the total effect of PPD on maternal employment at age 11. Regarding maternal physical health problems, at age 5 explain approximately 8%, while maternal physical health problems at age 7 account for around 8% of the total effect of PPD on maternal employment at age 11. When maternal mental and physical health problems at age 3, age 5, and age 7 are used together as mediators, it was

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[16] Examining marital status at age 5 as a potential mediator of the effect of PPD on maternal employment at age 11, using the KHB method, it was observed that it has no impact as a mediator

observed that they explain around 62% of the unconditional (total) effect of PPD on maternal employment at age 11 and render the direct effect of PPD on maternal employment insignificant.

As a robustness check, the KHB decomposition results of Tables 3-5 were repeated with persistence in employment as a mediator, for example using employment at age 3 as a mediator of the effect of PPD on employment at age 5. These results are presented in Appendix III. These robustness checks do not change the main results (qualitative results) of this study.

6. Discussion

This study examined the role of postpartum depression, the most common psychiatric disorder experienced by women after childbirth, on maternal employment outcomes. The analysis indicates that PPD has an effect on maternal employment at ages 5, 7 and 11. What is significant is the way PPD affects maternal employment. The analysis demonstrated the effect of PPD on maternal employment at age 5 is mediated by 19.20%. However, in later years the direct effect of PPD on maternal employment is diminished and the effect of PPD is mainly indirect. Specifically, the effect of PPD and maternal employment at age 7 and at age 11 is indirect and is mediated primarily through maternal mental health and physical health problems.

Viewed broadly, the findings of the study can contribute to the ongoing debate on two relevant areas of research: a) women's growing presence within the formal labour market and its implications, particularly as regards employment in the first

year or two following the birth of a child (Crosby and Hawkes, 2008); and b) the impact of depression in the general population, particularly the consequences of mental disorders on the economy and the workplace (Thomas and Morris, 2003; Almond and Healey, 2003; McDaid et al., 2008). As mentioned earlier in this study, these areas (women's presence in the formal labour market and the prevalence of depression) are of concern to national governments, the European Union and the World Health Organization. The prevalence of postpartum depression, its recurrent nature and long-term damaging effects should be taken into account by economists and employers' organizations and not only by medical professionals.

The present study has several strengths. It specifically examines the possible effect of PPD on maternal employment in the UK and assesses the extent of the direct and indirect link between PPD and maternal employment eleven years after the birth. The study tests a range of factors (marital status, physical longstanding health problems, mental health problems, children's outcomes) as mediators in order to assess the indirect effect of PPD on maternal employment, utilising all available sweeps from the MCS. The study uses a wealth of data from the MCS relating to the gestation and birth, from antepartum maternal depression to the gestation age of the baby (early preterm/ late post-term). Due to the nature of the MCS, the results can be used to make assumptions about the population of the UK. Additionally, this study benefits from utilising non-maternal reporting measures on child outcomes to study the link between PPD and child outcomes in the MCS.

The limitations of the study are the lack of the Edinburgh Postnatal Depression Scale (EPDS) measure for postpartum mental health in a clinical setting from the

MCS, as well as the measures of previous history of maternal psychological characteristics (prior to pregnancy), in addition to maternal family psychological characteristics that are not included in the MCS. The Malaise Index used to measure PPD and the Kessler scale used to assess mental health problems, differ in that the first measures psychosocial distress and the second measures the prevalence of serious mental illness in the population. This could potentially affect the mediating effect of PPD through subsequent mental health problems to a small extent. Replication of the study using medical data to account for hormonal/medical influences on PPD is needed as these are not included in the MCS. The study would therefore have benefited from their inclusion.

7. Conclusion and policy implications

Despite the limitations of the study, the findings suggest the need for greater awareness of the effects of PPD on women's long-term employability trajectories and the potential implications for society and the national economy, given the greater number of women participating in the formal labour market and the female propensity for depressive disorders. It is therefore imperative to conduct more research into the issue and specifically the potential consequences for young women's employment trajectories. The results do highlight the importance of maternal mental health as a determinant of employment outcomes and economic growth and the need for regular evaluations of maternal health – particularly for those women who were diagnosed with the condition or underwent treatment for PPD, given the illness' long-term influence. This might entail drastic changes as regards current mental health policies and to the healthcare provision system.

Furthermore, it would entail an innovative approach and a comprehensive strategy that involves co-operation between government departments, healthcare professionals, and certainly employers' organizations or unions (Dewa and McDaid, 2011).

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Appendix I Descriptive statistics

Table 1: Postpartum Depression

Postpartum Depression	Percentage %	Observations
No	84.5	8168
Yes	15.5	1501
Total	100	9669

Note: Postpartum depression measured at MCS1, using Malaise Inventory

Table 2: Postpartum Depression and Subsequent Mental Health Issues

Mental Health	Age 3 (MCS2)			Age 5 (MCS3)			Age 7 (MCS4)		
	Postpartum depression			Postpartum depression			Postpartum depression		
	No	Yes	**Total**	No	Yes	**Total**	No	Yes	**Total**
No %	91.3	74.9	**88.7**	95.9	83	**93.9**	95.8	82.3	**93.7**
Observations	7420	1125	**8545**	7824	1243	**9067**	7848	1252	**9100**
Yes %	8.71	25.1	**11.3**	4.13	17	**6.11**	4.16	17.7	**6.26**
Observations	748	376	**1124**	344	258	**602**	320	249	**569**
Total %	84.5	15.5	**100**	84.5	15.5	**100**	84.5	15.5	**100**
Observations	8168	1501	**9669**	8168	1501	**9669**	8168	1501	**9669**

Note: Column percentages. Postpartum depression measured at MCS1. Subsequent mental health issues (using the Kessler Scale) were measured at MCS2-4.

Table 3: Postpartum Depression and Employment

Employment	Age 9 months (MCS1)			Age 3 (MCS2)			Age 5 (MCS3)		
	Postpartum depression			Postpartum depression			Postpartum depression		
	No	Yes	**Total**	No	Yes	**Total**	No	Yes	**Total**
No %	46.9	58.6	**48.7**	44	58.2	**46.2**	38.5	54.9	**41.1**
Observations	3553	839	**4392**	3320	842	**4162**	2889	771	**3660**
Yes %	53.1	41.4	**51.3**	56	41.8	**53.8**	61.5	45.1	**58.9**
Observations	4610	661	**5271**	4848	659	**5507**	5272	727	**5999**
Total %	100	100	**100**	100	100	**100**	100	100	**100**
Observations	8163	1500	**9663**	8168	1501	**9669**	8161	1498	**9659**

Note: Column percentages. Postpartum depression measured at MCS1. Employment measured at MCS1-5.

Table 3 (cont'd): Postpartum Depression and Employment

Employment	Age 7 (MCS4)			Age 11 (MCS5)		
	Postpartum depression			Postpartum depression		
	No	Yes	Total	No	Yes	**Total**
No %	13	24.5	14.8	23.4	6.67	**30**
Observations	936	339	1275	2093	608	**2701**
Yes %	87	75.5	85.2	61.2	8.74	**70**
Observations	7232	1162	8394	6024	875	**6899**
Total %	84.5	15.5	100	84.6	15.4	**100**
Observations	8168	1501	9669	8117	1483	**9600**

Note: Column percentages. Postpartum depression measured at MCS1. Employment measured at MCS1-5.

Table 4: Postpartum Depression and Marital Status (percentages)

Current Legal Marital Status	Age 9 months (MCS1)			Age 3 (MCS2)			Age 5 (MCS3)			Age 7 (MCS4)		
	Postpartum depression			Postpartum depression			Postpartum depression			Postpartum depression		
	No	Yes	Total	No	Yes	Total	No	Yes	Total	No	Yes	Total
Legally Separated	2.09	3.54	**2.32**	2.5	4.74	**2.84**	3.35	4.7	**3.56**	3.97	5.13	**4.15**
Married	58.1	46.9	**56.4**	62	50.6	**60.2**	61.3	50.3	**59.6**	61.1	52.3	**59.7**
Remarried	4.57	4.4	**4.54**	5.62	4.99	**5.52**	6.04	4.86	**5.86**	6.2	4.15	**5.88**
Single	30.8	39.7	**32.2**	25.8	33.5	**27**	23.3	32.3	**24.7**	21.5	29.2	**22.7**
Divorced	4.33	4.92	**4.42**	4.05	5.52	**4.28**	5.79	7.25	**6.02**	6.95	8.44	**7.18**
Widowed	0.0926	0.469	**0.151**	0.108	0.61	**0.186**	0.196	0.673	**0.27**	0.315	0.763	**0.384**
Total	84.5	15.5	**100**	84.5	15.5	**100**	84.5	15.5	**100**	84.5	15.5	**100**

Note: Column percentages. Postpartum depression measured at MCS1. Marital Status measured at MCS1-4.

Table 5: Postpartum Depression and BAS Scores (quintiles)

BAS Scores	Age 3 (MCS2)			Age 5 (MCS3)			Age 7 (MCS4)		
	Postpartum depression			Postpartum depression			Postpartum depression		
	No	Yes	Total	No	Yes	Total	No	Yes	Total
1st quintile	22	32.8	**23.7**	15.4	27.6	**17.2**	18.6	21.9	**19.1**
2nd quintile	18	18.1	**18**	19.1	19.5	**19.1**	19.1	23.3	**19.8**
3rd quintile	15.9	14.5	**15.7**	21.4	19.1	**21.1**	21.2	19.1	**20.9**
4th quintile	25.3	19.8	**24.5**	21.1	18	**20.6**	19.6	19	**19.5**
5th quintile	18.7	14.7	**18.1**	23	15.8	**21.9**	21.5	16.7	**20.8**
Total	84.2	15.8	**100**	84.6	15.4	**100**	84.5	15.5	**100**

Note: Column percentages. Postpartum depression measured at MCS1. BAS Scores measured at MCS2-4.

Table 6: Postpartum Depression and Longstanding Physical Health Problems

Physical problems	Age 3 (MCS2)			Age 5 (MCS3)			Age 7 (MCS4)		
	Postpartum depression			Postpartum depression			Postpartum depression		
	No	Yes	Total	No	Yes	Total	No	Yes	Total
No %	80.3	67.1	**78.3**	77.5	62.9	**75.2**	77.3	64.1	**75.3**
Yes %	19.7	32.9	**21.7**	22.5	37.1	**24.8**	22.7	35.9	**24.7**
Total %	84.5	15.5	**100**	84.5	15.5	**100**	84.5	15.5	**100**

Note: Column percentages. Postpartum depression measured at MCS1. Longstanding physical health problems measured at MCS2-4.

Table 7: Postpartum Depression and Fertility

Fertility	Age 3 (MCS2)			Age 5 (MCS3)			Age 7 (MCS4)		
	Postpartum depression			Postpartum depression			Postpartum depression		
	No	Yes	Total	No	Yes	Total	No	Yes	Total
No %	78.1	81.4	**78.6**	87.8	87.3	**87.7**	93	91.5	**92.8**
Yes %	21.9	18.6	**21.4**	12.2	12.7	**12.3**	7.01	8.47	**7.24**
Total %	84.5	15.5	**100**	84.5	15.5	**100**	84.6	15.4	**100**

Note: Column percentages. Postpartum depression measured at MCS1. Fertility measured at MCS2-4.

Table 8: Descriptives of control variables

Variables	Mean sample	Standard errors	Variables	Mean sample	Standard Errors
Maternal age at birth of CM	28.87	(0.129)	Baby pre term	0.075	(0.004)
Paid work during pregnancy	0.683	(0.008)	Other sibling	0.583	(0.007)
Mother born in UK	0.905	(0.006)	Birth weight in kilos	3.369	(0.007)
Maternal ethnic group – White	0.901	(0.010)	Baby's age in months	9.187	(0.009)
Maternal ethnic group – Mixed	0.009	(0.002)	Ever tried to breastfeed	0.692	(0.010)
Maternal ethnic group – Indian	0.017	(0.003)	Cohort Member Sex	0.505	(0.007)
Maternal ethnic group – Pakistani	0.035	(0.007)	Highest academic qualification – Higher Degree	0.032	(0.003)
Maternal ethnic group – Black	0.026	(0.005)	Highest academic qualification – First Degree	0.144	(0.008)
Interview government office region - North East	0.036	(0.011)	Highest academic qualification – Diploma in Higher Education	0.093	(0.004)
Interview government office region – Humber	0.085	(0.025)	Highest academic qualification – A-Level	0.099	(0.003)
Interview government office region – East Midlands	0.071	(0.017)	Highest academic qualification – O-Level GCSE Grades A-C	0.359	(0.009)
Interview government office region – West Midlands	0.078	(0.020)	Highest academic qualification – O-Level GCSE Grades D-G	0.108	(0.005)
Interview government office region – East of England	0.094	(0.020)	Highest academic qualification – Other Qualification	0.019	(0.002)
Interview government office region – London	0.123	(0.026)	Smoke during pregnancy	0.365	(0.008)
Interview government office region – South East	0.149	(0.026)	Alcohol	0.332	(0.008)
Interview government office region – South West	0.079	(0.019)	Longstanding Illness	0.219	(0.006)
Interview government office region – Welsh	0.052	(0.005)	Antepartum depression	0.004	(0.001)
Interview government office region – Scotland	0.091	(0.006)	Attend religious services	0.159	(0.007)
Interview government office region – N. Ireland	0.042	(0.003)	Dad present at birth	0.852	(0.006)
OECD below 60% median poverty indicator	0.287	(0.010)	Lived with both parents at 15	0.776	(0.006)
Baby post term	0.009	(0.001)	Partner not complete interview	0.015	(0.002)
Observations	9669		Observations	9669	

Note: Standard errors in parentheses; Variables measured at age 9 months (MCS1). Abbreviations: CM, cohort member, child

Table 9: Item non-response

Variables	Values Missing
Worked pregnant	4
Mother born in UK	1
Ethnic group	14
OECD below 60% median poverty indicator	13
Baby pre term	74
Baby post term	74
Birth weight in kilos	6
Ever tried to breastfeed	1
Highest academic qualification	9
Smoking	9
Longstanding illness	3

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

Appendix II Decomposing the direct and indirect effect of postpartum depression on employment using the KHB decomposition

Table 1: KHB decomposition of the effect of PPD on employment using mental health problems in MCS2 as mediator

MCS3 Employed	Coefficient	Robust Std. Error	z
Postpartum depression			
Total	-0.175	0.046	-3.75
Direct	-0.141	0.047	-2.99
Indirect	-0.033	0.008	-4.34
N	9659		
Pseudo R2	0.20		

Table 2: KHB decomposition of the effect of PPD on employment using physical health problems in MCS2 as mediator

MCS3 Employed	Coefficient	Robust Std. Error	Z
Postpartum depression			
Total	-0.171	0.046	-3.68
Direct	-0.168	0.046	-3.60
Indirect	-0.003	0.003	-0.89
N	9659		
Pseudo R2	0.19		

Table 3: KHB decomposition of the effect of PPD on employment using marital status in MCS2 as mediator

MCS3 Employed	Coefficient	Robust Std. Error	Z
Postpartum depression			
Total	-0.171	0.000	-3.69
Direct	-0.172	0.000	-3.71
Indirect	0.001	0.641	0.47
N	9659		
Pseudo R2	0.19		

Table 4: KHB decomposition of the effect of PPD on employment using mental health problems in MCS3 as mediator

MCS4 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.181	0.061	-2.95
Direct	-0.155	0.062	-2.50
Indirect	-0.026	0.008	-3.06
N	9669		
Pseudo R2	0.26		

Table 5: KHB decomposition of the effect of PPD on employment using physical health problems in MCS3 as mediator

MCS4 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.185	0.060	-3.06
Direct	-0.166	0.060	-2.77
Indirect	-0.018	0.006	-3.23
N	9662		
Pseudo R2	0.26		

Table 6: KHB decomposition of the effect of PPD on employment using marital status in MCS3 as mediator

MCS4 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.184	0.061	-3.00
Direct	-0.161	0.061	-2.63
Indirect	-0.023	0.007	-3.00
N	9665		
Pseudo R2	0.27		

Table 7: KHB decomposition of the effect of PPD on employment using BAS Scores in MCS3 as mediator

MCS4 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.190	0.061	-3.13
Direct	-0.185	0.060	-3.06
Indirect	-0.005	0.003	-1.66
N	9569		
Pseudo R2	0.26		

Table 8: KHB decomposition of the effect of PPD on employment using mental health problems in MCS2 as mediator

MCS4 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.184	0.060	-3.03
Direct	-0.151	0.060	-2.50
Indirect	-0.033	0.009	-3.45
N	9669		
Pseudo R2	0.26		

Table 9: KHB decomposition of the effect of PPD on employment using, mental health problems in MCS2 MCS3, marital status and physical health problems in MCS3 as mediators

MCS4 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.172	0.063	-2.75
Direct	-0.085	0.063	-1.35
Indirect	-0.087	0.015	-5.87
N	9660		
Pseudo R2	0.28		

Table 10: KHB decomposition of the effect of PPD on employment using mental health problems in MCS4 as mediator

MCS5 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.150	0.050	-3.00
Direct	-0.092	0.051	-1.80
Indirect	-0.058	0.010	-5.60
N	9600		
Pseudo R2	0.19		

Table 11: KHB decomposition of the effect of PPD on employment using mental health problems in MCS3 as mediator

MCS5 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.152	0.049	-3.06
Direct	-0.119	0.049	-2.42
Indirect	-0.032	0.0073	-4.30
N	9600		
Pseudo R2	0.18		

Table 12: KHB decomposition of the effect of PPD on employment using mental health problems in MCS2 as mediator

MCS5 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.155	0.050	-3.09
Direct	-0.125	0.050	-2.48
Indirect	-0.029	0.007	-4.04
N	9600		
Pseudo R2	0.18		

Table 13: KHB decomposition of the effect of PPD on employment using physical health problems in MCS3 as mediator

MCS5 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.156	0.049	-3.14
Direct	-0.143	0.050	-2.88
Indirect	-0.012	0.004	-2.98
N	9593		
Pseudo R2	0.18		

Table 14: KHB decomposition of the effect of PPD on employment using physical health problems in MCS4 as mediator

MCS5 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.154	0.054	-3.10
Direct	-0.142	0.053	-2.86
Indirect	-0.012	0.005	-3.04
N	9591		
Pseudo R2	0.18		

Table 15: KHB decomposition of the effect of PPD on employment using marital status in MCS3 as mediator

MCS5 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.153	0.049	-3.09
Direct	-0.154	0.049	-3.13
Indirect	0.001	0.002	0.47
N	9596		
Pseudo R2	0.18		

Table 16: KHB decomposition of the effect of PPD on employment using marital status in MCS4 as mediator

MCS5 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.154	0.049	-3.10
Direct	-0.155	0.049	-3.14
Indirect	0.001	0.001	0.89
N	9600		
Pseudo R2	0.18		

Table 17: KHB decomposition using of the effect of PPD on employment physical and mental health problems in MCS2 MCS3 and MCS4 as mediators

MCS5 Employed	Coefficient	Robust Std. Error.	Z
Postpartum depression			
Total	-0.152	0.050	-3.04
Direct	-0.058	0.051	-1.14
Indirect	-0.094	0.013	-7.01
N	9584		
Pseudo R2	0.19		

Appendix IIA Decomposing the direct and indirect effect of postpartum depression on employment using the KHB decomposition-Robustness checks for longstanding physical health as a mediator using different measures at age 3, age 5, and age 7.

Table 1: KHB decomposition of the effect of PPD on employment using physical health problems (ICD-10 coded) in MCS2 as mediator

MCS3 Employed	Coefficient	Robust Std. Error	Z
Postpartum depression			
Total	-0.141	0.047	-3.04
Direct	-0.140	0.047	-3.01
Indirect	-0.001	0.002	-0.29
N	9445		
Pseudo R2	0.19		

Table 2: KHB decomposition of the effect of PPD on employment using physical health problems (SF-8 amount of bodily pain) in MCS3 as mediator

MCS4 Employed	Coefficient	Robust Std. Error	Z
Postpartum depression			
Total	-0.185	0.060	-3.08
Direct	-0.164	0.060	-2.72
Indirect	-0.021	0.008	-2.73
N	9661		
Pseudo R2	0.26		

Table 3: KHB decomposition of the effect of PPD on employment using physical health problems (SF-8 amount of bodily pain) in MCS4 as mediator

MCS5 Employed	Coefficient	Robust Std. Error	Z
Postpartum depression			
Total	-0.148	0.049	-3.00
Direct	-0.121	0.049	-2.45
Indirect	-0.027	0.007	-4.17
N	9662		
Pseudo R2	0.18		

Appendix III Decomposing the direct and indirect effect of postpartum depression on employment using the KHB decomposition: Using persistence in employment as a robustness check

Table 1: KHB decomposition of the effect of PPD on employment - at age 5 (MCS3)

Mediators: Mental Health Problems, Employment Age 3				
	Average Partial Effects	Coefficient	Robust Standard Errors	Z
Postpartum depression				
Reduced	-0.047	-0.199	0.055	-3.59
Full	-0.030	-0.127	0.056	-2.25
Difference	-0.017	-0.072	0.023	-3.09
N	9659			
Pseudo R2	0.37			

Note: Standard errors of difference not known for APE method; robust standard errors presented for coefficients

Table 2: KHB decomposition of the effect of PPD on employment - at age 7 (MCS4)

Mediators: Maternal Mental Health Problems Age 3 Age 5, Marital Status, Physical Health Problems Age 5 and Employment Age 3 Age 5				
	Average Partial Effects	Coefficient	Robust Standard Errors	Z
Postpartum depression				
Reduced	-0.028	-0.176	0.062	-2.85
Full	-0.010	-0.064	0.062	-1.02
Difference	-0.018	-0.112	0.017	-6.40
N	9656			
Pseudo R2	0.31			

Note: Standard errors of difference not known for APE method; robust standard errors presented for coefficients

Table 3: KHB decomposition of the effect of PPD on employment - at age 11 (MCS5)

Mediators: Maternal Mental Health Problems, Employment Age 3 Age 5 Age 7 and Physical Health Problems Age 5 Age 7				
	Average Partial Effects	Coefficient	Robust Standard Errors	Z
Postpartum depression				
Reduced	-0.037	-0.159	0.053	-3.01
Full	0.000	0.001	0.054	0.02
Difference	-0.037	-0.160	0.024	-6.65
N	9580			
Pseudo R^2	0.30			

Note: Standard errors of difference not known for APE method; robust standard errors presented for coefficients