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Predictors and protective factors in relation to maternal postpartum fatigue: findings from a national survey

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Abstract

Background **-** Postpartum fatigue is commonly perceived as an unavoidable, temporary and relatively trivial symptom following childbirth. Different study methods and timing have resulted in wide-ranging prevalence estimates. Suggested predictors include clinical factors, depression and breastfeeding. This study aimed to assess prevalence, women's characteristics, risk factors, associations with infant characteristics and partner and health professional support.

Methods - Used data from the cross-sectional 2014 National Maternity Survey conducted in England. A random sample of 10,000 women aged 16 years and over was selected by the Office for National Statistics, using birth registration. Questionnaires were sent three months postpartum asking about clinical events, care during pregnancy, labour and birth and the postnatal period. Specifically, women were asked whether they experienced fatigue/severe tiredness at 10 days, one month or three months postpartum.

Results – Responses were received from 4578 women (47% response rate). Decreasing, but significant proportions of women, 38.8%, 27.1% and 11.4%, experienced fatigue/severe tiredness at 10 days, one month and three months. These figures varied significantly by maternal age, level of deprivation, education and parity. Women reporting depression, anxiety, sleep problems and those breastfeeding were at significantly increased risk (e.g. OR for depression in women with fatigue at 3 months 2.99 (95% CI 2.13, 4.21)). Significantly more negative language was used by these women to describe their babies and they perceived their baby as more difficult than average (e.g. two or more negative adjectives used by women with fatigue at three months OR 1.86 (95% CI 1.36, 2.54)). Women with postpartum fatigue had greater partner support but were significantly less likely to report seeing the midwife as much as they wanted.

Conclusions - Postpartum fatigue affects a substantial proportion of women. Predictors include age and parity but practical help and support from partners and health professionals may be protective factors.

Keywords: Postpartum fatigue; Childbirth; Postnatal; Survey; Prevalence; Predictors

Strengths and limitations of this study

- Maternal fatigue after childbirth is common, but infrequently the subject of research.
- The study used a large population-based random sample based on birth registration.
- The response rate was 47% and in common with other surveys there was under-representation of hard-to-reach groups.
- The study was a cross-sectional survey conducted at three months postpartum and women may not have accurately remembered everything.
- Studies comparing women's reports of events around childbirth with medical records or other recorded data have demonstrated good recall

Predictors and protective factors in relation to maternal postpartum fatigue: findings from a national survey

Background

Postpartum fatigue (PPF) has been defined in various ways but generally includes a decreased capacity for physical and mental activity, a persistent lack of energy, impairments in concentration and attention not easily relieved by rest or sleep (1-7). The prevalence of postpartum fatigue has not been studied extensively as it has been perceived as an unavoidable, temporary and relatively trivial symptom commonly experienced in early parenthood. It is typically marked by disrupted sleep due to night-waking infants, difficulties settling the baby, and night time feeding.

Such evidence as does exist on the prevalence of PPF varies according to how it is measured and timing of measurement after birth. Apart from simple self-report symptom checklists which ask about fatigue, tiredness, exhaustion, and vitality, there are a number of scales relating to fatigue including the Lee Fatigue Scale (8), the Fatigue Assessment Scale (9) and Vitality sub-scale of the Psychological General Well-being Index (10). However, these measures were not developed specifically for PPF where different issues, such as interrupted sleep, may be more salient. Use of a simple self-report symptom question as part of a checklists have suggested the proportion of women with PPF to be 42% in the first few days after birth (11), 37-64% at five to six weeks (12, 13), 25-67% at 12-24 weeks (12, 14), and 18-66% at 1-2 years (12, 14). These wide variations in prevalence may, to some extent, be due to severity: in one study (15) 83% of women were fatigued at 4-6 weeks but none considered it a major problem. Different groups of women in the population may also differ in their experience of PPF. For example, in a study of low income American women 63% reported being severely fatigued at both one and three months (16), whereas only 25% of recent mothers reported PPF in a relatively affluent Dutch population (12).

Factors reported to be associated with higher rates of PPF include clinical issues associated with the birth such as longer duration of labour and instrumental or operative delivery, clinical problems such

as anaemia, infection and haemorrhage, situational factors such as low socioeconomic status, unemployment, difficult infant temperament, primiparity, and higher maternal age (12, 17-20) although these were not found to be significant in all studies (21). Arising from a qualitative interview based study with use of a fatigue symptoms checklist (7) it has been argued that social and practical support from a woman's partner or family is the strongest factor in protection against postnatal fatigue (16).

Sleep disruption in the early postpartum period is normal due to nocturnal infant caregiving. Sleep efficiency, the proportion of time spent asleep relative to time spent in bed, is lowest immediately after birth and thereafter improves as the baby's sleep pattern shifts to nocturnal hours (22). However, in exhausted mothers melatonin is transmitted to the infant in breast milk which can delay the establishment of mature sleep cycles (18). PPF has been shown to be related to fragmented sleep (23) but not sleep more generally (24).

The association between PPF and breastfeeding is unclear. Some studies have reported an association (12, 25), others not (21, 26). Women who worried more about insufficient milk and those who had breastfeeding problems tended to have higher levels of fatigue (25) possibly due to spending more time involved in breastfeeding.

Several studies examined the relationship between PPF and depression (3, 4, 15, 16, 19, 27, 28). PPF may have a role in contributing to depression, but is thought to be a separate although related theoretical construct. While the two are correlated, it is unclear to what degree depression leads to fatigue, or fatigue to depression; they do not necessarily occur contemporaneously. In one study, fatigue at one week predicted depression at four weeks (19).

The purpose of the present study was to address the following research questions:

- What is the prevalence of PPF at 10 days, one month and three months?

- What are the characteristics of women who have PPF at 10 days, one month and three months after childbirth?
- Is there an association between maternal PPF and infant characteristics?
- Is there an association between partner and health professional support in the postnatal period and PPF at this time?

Methods

This study used data from the cross-sectional National Maternity Survey conducted in England 2014 (29). A random sample of 10,000 women who gave birth in two weeks in 2014 in England, excluding those aged less than 16 years and those whose baby had died, were sent a questionnaire 12 weeks after the birth asking about clinical events and care during pregnancy, labour and birth, and in the postnatal period. Questionnaires could be returned by Freepost, completed online, or completed by telephone with the aid of an interpreter if necessary. Up to three reminders were sent to non-respondents using a tailored reminder system (30).

Women were asked questions about postnatal health including 'Did you experience any of the following 10 days, one month, and three months after the birth of your baby?' with answer options including 'Fatigue/severe tiredness', and other postnatal symptoms. Women were asked whether they had mental health problems, and asked to complete the Edinburgh Postnatal Depression Scale (EPDS). Questions were also asked about sociodemographic variables, pre-pregnancy and antenatal health and well-being, variables related to labour and birth, multiple birth, postnatal maternal and infant health, situational variables such as employment, perceptions of their baby at three months and indicators of maternal-infant attachment, partner support and health professional support. The full list of variables included in the analysis is given in Appendix 1.

The data were analysed descriptively using proportions and means as appropriate. A cut-off of 13 or more was used for the EPDS. Variables which were significant in univariate analyses were entered into binary logistic regression to determine the key predictors of PPF from the sociodemographic, antenatal and intrapartum variables, and then for the indicators of infant attachment and partner and health professional support adjusted for sociodemographic variables. Due to the large number of comparisons in the univariate analysis, only those which were significant at $p<0.001$ were entered into binary logistic regression.

Ethical approval for the survey was obtained from the NRES committee for Yorkshire and The Humber – Humber Bridge (REC reference 14/YH/0065).

Results

In total 4578 women completed and returned questionnaires (47% response rate after exclusion of undeliverable questionnaires). Response was such that women born outside the UK, younger women and those resident in more deprived areas were significantly less likely to respond (29).

According to the symptom checklist, 38.8%, 27.1% and 11.4% of women experienced fatigue/severe tiredness at 10 days, one month and three months respectively. Of those women who reported PFF at 10 days, 46% also reported it at one month; however, of those who reported PFF at one month, only 30% also reported it at three months. These figures varied significantly by maternal age, Index of Multiple Deprivation (an area based measure of deprivation), whether the woman had left full-time education before age 16, and parity, such that PPF was more common in women who were older, primiparous, more highly educated, and resident in *less* deprived areas. There were marginal differences by ethnicity (Table 1).

Sociodemographic and predictive variables that were significantly associated with PPF ($p<0.001$) in univariate analyses were entered into binary logistic regressions separately for PFF at 10 days, one month and three months; the results are shown in Table 2. Different variables were important at

different times with the exception of maternal age which was significant throughout. Women aged 20-24 years were significantly less at risk of PPF at each time point compared to those aged 30-34, with Odds ratios of 0.60, 0.45 and 0.40 respectively at 10 days, one month and three months. At one month women aged 25-29 years were also at significantly reduced risk (OR = 0.58), and at three months women aged 40 or over were at significantly increased risk (OR = 2.00) compared to those aged 30-34 years. Multiparous women were at significantly reduced risk of PPF at one month and, to a lesser extent, at 10 days compared to primiparous women. Leaving full-time education aged 16 years or less was significantly protective at 10 days but not subsequently. Reported postnatal health problems, particularly depression and anxiety, were significantly associated with PPF at each time point with Odds ratios for depression of 2.04, 2.41 and 3.34 respectively at 10 days, one month and three months. Similarly for anxiety, Odds ratios were 2.63, 3.37 and 3.70 respectively. In addition, at 10 days and one month post-traumatic stress disorder (PTSD) symptoms were significantly raised and, at three months sleep problems not associated with the baby were higher in women who had PPF. Women who were still breastfeeding at three months, either exclusively or partially, were also at increased risk of PPF. Raised EPDS, although statistically significant in the univariate analysis, dropped out in the multivariate logistic regression.

Table 3 shows indicators of maternal-infant attachment in women with and without PPF at 10 days, one month and three months adjusted for sociodemographic variables. Women who had PPF at all time points were at significantly increased risk of using more negative adjectives to describe their baby and perceived their baby as more difficult than average. Women who had PPF, especially at three months, experienced significant delay in feeling that their baby belonged to them in addition to having more negative feelings about their baby, although it was relatively uncommon for women to describe their baby as belonging to them 'not quite yet' belonging to them (n= 29).

We postulated that women who had less support from their partner may be at greater risk of PPF. However, this was not borne out in the results (Table 4). On the contrary, after adjustment for

sociodemographic variables, women whose partner was more involved in practical postnatal care (changing nappies, supporting feeding, helping when the baby cried, bathing and playing with the baby) were *more* likely to be experiencing PPF at three months and, to a lesser degree, at one month. Similarly, number of days of paternity leave was positively associated with PPF at one month although this was of only marginal significance.

Women with PPF at three months were significantly more likely to be seen for longer by their midwife in the postnatal period, however these women were also significantly less likely to report that they saw the midwife as much as they wanted. Women with PPF were also more likely to report not receiving enough help and advice about the baby's feeding (at 10 days), crying (at one month), and sleeping (at three months). Women with PPF also tended to use more peer, online and web support, with Odds ratios (95% confidence interval) of 1.45 (1.26, 1.67), 1.25 (1.08, 1.45), and 1.35 (1.17, 1.55) respectively for women with PPF at 10 days, and slightly lower Odds ratios at one and three months (data not shown).

Women were asked about physical well-being in the first few days and at three months after giving birth with answer options 'very well', 'quite well', 'tired and uncomfortable', 'exhausted', and 'very ill'. In the first few days and at three months 13% and 5% respectively reported feeling 'Exhausted', but of these women only 68% and 55% respectively also reported feeling 'Fatigue/severe tiredness'. Women who reported feeling 'exhausted' or 'very ill' were also significantly more likely to report feeling that their baby belonged to them 'only recently' or 'not quite yet' (15.6% of 'exhausted', 14.3% of 'very ill' women reported 'only recently/not quite yet' compared to 4.8% overall).

Discussion

The prevalence findings for PPF were 38.8%, 27.1% and 11.4% at 10 days, one month and three months after giving birth in this large scale population-based study. These figures are somewhat

lower than estimates from other studies (11-14) which may reflect the manner in which the questions were asked. For example, in a US study using a 30 item checklist (3), 44% of women were 'severely fatigued' at 12 weeks whereas the current survey used self-report of 'Fatigue/severe tiredness'. Women were asked about general physical well-being in the first few days and at three months after giving birth: 13% and 5% respectively reported feeling 'exhausted' but of these women, only two thirds or less also reported having 'Fatigue/severe tiredness'. This indicates that framing effects and how the question is asked may affect response.

Sociodemographic factors were significantly associated with PPF. The importance of older maternal age and primiparity as risk factors for PPF has been previously recognised (7, 25, 31), however low education and low socioeconomic status were previously thought to be as risk factors (17, 32) whereas in this population based study they were protective against PPF. Even when assessed in binary logistic regression, women aged less than 30 and those who had left full-time education aged less than 16 years were consistently at lower risk of PPF. Residence in the most deprived quintile was also protective against PFF at three months but this was of only marginal significance. It has been postulated that there are several different types of fatigue: normal, pathophysiological, situational and psychological (32) and it is possible that risk factors differ between these groups.

Clinical factors such as operative or instrumental delivery were associated with PPF in univariate analyses, but only duration of labour was positively associated with fatigue at each time point in the multivariate analyses, consistent with the literature (17). As has been reported elsewhere (3, 4, 19), poorer maternal mental health, as indicated by postnatal depression and anxiety were strongly associated with PPF, especially at three months. Women may have felt that it was normal to be tired and experiencing a low mood in the first month after childbirth, but significant fatigue at three months begins to be perceived as a problem.

The association between breastfeeding and PPF was strongest at three months especially for women who combined breast and bottle feeding. Although this makes sense intuitively, previous research has not reported on associations between mixed feeding and PPF; findings from other studies relating to breastfeeding and PPF generally are mixed (21, 25, 26).

Maternal-infant attachment appears to be negatively affected by PPF, such women being more likely to report that they felt their baby belonged to them only relatively recently, using more negative terms to describe their baby, and they considered their baby more difficult than average. It is possible that these babies were actually more difficult: slightly more of them were premature and more had health problems at three months, suggesting that poor infant health is a contributor to PPF. Other research has also found that, after adjusting for maternal depression and anxiety, positive infant behaviour, as indicated by smile count, is associated with positive maternal attachment (33). This hints at the complexity of the relationship between PPF, attachment and infant health and behaviour.

Previous research has also reported associations between PPF and maternal-infant attachment (3, 12, 16, 22, 34). Other reported associations include poorer mental and physical health, difficulties with relationships and employment, and early weaning (2, 4, 14, 18, 21, 25). Personal and social development and eye-hand coordination aspects of infant development, as measured using the Griffiths Scales, were also significantly affected in infants of chronically fatigued mothers (34). In one qualitative interview study (16), chronically fatigued women used more negative language in describing their baby or themselves, such as “Angry,” “Body shut down,” “Resent baby,” “Beat/Exhausted,” “Overwhelmed,” and “Can’t think straight.”

An important finding of this study is that support from partners was greatest in women who were suffering from PPF, suggesting reverse causality, that partners were taking more paternity leave and were more involved in baby care because it was needed. This would parallel the

'compensation/buffering' model (35) in which partners of women with depression became more involved in baby care to compensate for poorer maternal wellbeing and fatigue.

Longer postnatal contact with the midwife was greatest for women with PPF, again perhaps suggesting that help was being targeted where it was needed. Even so, women with PPF were significantly less likely to report that they saw a midwife as much as they would have liked or that they received enough help and advice about baby care from healthcare professionals. It may be that even though these women received more support than average, they would have liked more. It may also be the case that the type of support was unhelpful, particularly lacking continuity. Barriers to continuity of postnatal carer include shift patterns, part-time work, staff shortages and travel time (36). However, individualised, women-centred care can still be achieved with good communication and antenatal care planning (37).

This study was based on a large population based random sample of recent mothers, with considerable diversity among respondents. However, the response rate was 47% and, in common with many other surveys (38-40), there was significant under-representation of hard-to-reach groups. PPF was as reported by women using a single item as part of a symptom checklist rather than one of the many scales. The cross-sectional survey was conducted at three months postpartum and thus causality cannot be inferred from associations found and women may not have accurately remembered all the details reported. However, studies comparing women's reports of events around childbirth with medical records or other recorded data have demonstrated good recall (41, 42).

Implications for healthcare professionals

These finding highlight that for some women PPF can be severe and long lasting and may require intervention. Several interventions to reduce PPF have been evaluated in good quality randomised controlled studies (14, 22, 43-45). These were a mixture of self-management, telephone support, exercise, and education and all were reported to be beneficial except for the purely self-directed

intervention which used the Tiredness Management Guide to help women to self-manage their fatigue (45). Supportive interventions and availability of additional advice and support targeted to those women with the greatest need is to be encouraged. The nature of the additional advice and support should be tailored to the needs of individual women. However, there is also a need for antenatal preparation for women and their partners in approaching the transition to parenthood so that they have realistic expectations, can enlist practical help and emotional support when required postnatally, and enhance their own coping skills.

Implications for research

The cross-sectional nature of this study has precluded teasing out of the interaction between PPF and postnatal depression. Although the two are clearly linked, the nature of the relationship is unclear. Further exploration of the impact of PPF on the developing mother-child and partner relationships, and the influence of method of infant feeding, in prospective longitudinal studies is also likely to better elucidate the way in which individual differences may contribute. There is a wide range of estimates of prevalence of PPF in the literature which requires further elucidation.

Conclusions

Postpartum fatigue is not inevitable or universal, although early in the postnatal period it affects a substantial proportion of women. Predictors of postpartum fatigue include age and parity; possible protective factors include practical help and support from partners, as well as input from health professionals.

List of abbreviations

CS Caesarean section; EPDS Edinburgh Postnatal Depression Scale; MW midwife; OR Odds ratio; PN postnatal; PPF Postpartum fatigue; PTSD post-traumatic stress disorder; SVD Spontaneous vaginal delivery

Declarations

Ethics approval and consent to participate

Ethical approval for the survey was obtained from the NRES committee for Yorkshire and The Humber – Humber Bridge (REC reference 14/YH/0065). Completion and return of the questionnaire was taken as implicit consent to participate.

Consent for publication – N/A

Availability of data and materials – Further analyses of these data are planned. The data will be made available by the NPEU when these are complete.

Competing interests – The authors declare that they have no competing interests.

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Authors' contributions – MR designed the National Maternity Survey; MR, JH and JH were responsible for the research questions; JH analysed the data; MR, FA, and JH wrote the manuscript.

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Table 1 – Description of sample sociodemographic characteristics

	Fatigue at 10 days					Fatigue at 1 month					Fatigue at 3 months				
	Yes		No		*p*	Yes		No		*p*	Yes		No		*p*
	n	%	n	%		n	%	n	%		n	%	n	%	
Maternal age (years)															
16-19	40	2.3	60	2.2		24	2.0	76	2.3		10	1.9	90	2.2	
20-24	164	9.3	366	13.2		99	8.1	431	13.1		28	5.4	502	12.5	
25-29	475	27.0	742	26.8		263	21.4	954	28.9		120	23.2	1097	27.3	
30-34	634	36.1	939	33.9		477	38.8	1096	33.2		192	37.1	1381	34.4	
35-39	347	19.7	522	18.8		279	22.7	590	17.9		114	22.0	755	18.8	
40+	98	5.6	143	5.2		87	7.1	154	4.7		54	10.4	187	4.7	
Total	1758	100.0	2772	100.0	**	1229	100.0	3301	100.0	***	518	100.0	4012	100.0	***
Index of Multiple Deprivation															
1	373	21.2	524	18.9		285	23.2	612	18.5		129	25.0	768	19.1	
2	334	19.0	525	18.9		273	22.2	586	17.7		97	18.8	762	19.0	
3	377	21.4	550	19.8		244	19.9	683	20.7		113	21.9	814	20.3	
4	366	20.8	602	21.7		234	19.1	734	22.2		109	21.1	859	21.4	
5 (most deprived)	308	17.5	572	20.6		192	15.6	688	20.8		69	13.3	811	20.2	
Total	1758	100.0	2773	100.0	*	1228	100.0	3303	100.0	***	517	100.0	4014	100.0	**
Ethnicity															
White	1443	83.3	2270	84.4		1041	85.9	2672	83.2		434	84.8	3279	83.8	
Mixed	35	2.0	52	1.9		28	2.3	59	1.8		12	2.3	75	1.9	
Asian	194	11.2	248	9.2		106	8.7	336	10.5		43	8.4	399	10.2	
Black	48	2.8	110	4.1		29	2.4	129	4.0		18	3.5	140	3.6	
Other	12	0.7	11	0.4		8	0.7	15	0.5		5	1.0	18	0.5	
Total	1732	100.0	2691	100.0	*	1212	100.0	3211	100.0	*	512	100.0	3911	100.0	

Left full-time education aged <16 years																
No	1525	87.4	2198	80.4		1068	87.8	2655	81.4		450	87.5	3273	82.5		
Yes	220	12.6	537	19.6		149	12.2	608	18.6		64	12.5	693	17.5		
Total	1745	100.0	2735	100.0	***	1217	100.0	3263	100.0	***	514	100.0	3966	100.0	**	
Parity																
Primiparous	973	56.4	1232	45.6		672	55.9	1533	47.5		247	48.4	1958	50.0		
Multiparous	752	43.6	1470	54.4		531	44.1	1691	52.5		263	51.6	1959	50.0		
Total	1725	100.0	2702	100.0	***	1203	100.0	3224	100.0	***	510	100.0	3917	100.0		

* p<0.05 ** p<0.01 *** p<0.001

Table 2 – Predictors of PPF – Binary logistic regression

		Fatigue at 10 days	**Fatigue at 1 month**	**Fatigue at 3 months**
		Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Maternal age (years)	16-19	0.91 (0.55, 1.51)	0.64 (0.36, 1.15)	1.01 (0.45, 2.24)
	20-24	0.62 (0.48, 0.79)***	0.54 (0.40, 0.71)***	0.44 (0.28, 0.70)**
	25-29	0.91 (0.76, 1.09)	0.63 (0.52, 0.77)***	0.87 (0.66, 1.14)
	30-34	1.00 (ref)		
	35-39	1.00 (0.83, 1.22)	1.13 (0.92, 1.39)	1.04 (0.79, 1.38)
	40+	1.20 (0.86, 1.66)	1.39 (0.99, 2.95)	2.00 (1.34, 2.98)**
Parity	Primiparous	1.00 (ref)		
	Multiparous	0.83 (0.71, 0.97)*	0.81 (0.68, 0.97)*	1.21 (0.95, 1.54)
Left full-time education	aged16 or more years	1.00 (ref)		
	aged <16 yrs	0.64 (0.52, 0.78)***	0.74 (0.59, 0.93)*	0.82 (0.60, 1.13)
Mode of delivery	SVD	1.00 (ref)		
	Instrumental	1.23 (1.00, 1.52)	0.99 (0.79, 1.25)	0.87 (0.63, 1.21)
	Planned CS	1.03 (0.83, 1.27)	1.21 (0.96, 1.52)	1.30 (0.96, 1.76)
	CS due to unforeseen problem	1.06 (0.84, 1.34)	1.09 (0.85, 1.41)	1.06 (0.75, 1.51)
Labour duration (mins)[1]		1.00 (1.00, 1.00)*	1.00 (1.00, 0.00)*	1.00 (1.00, 1.00)**
Postnatal depression	10 days	2.08 (1.79, 2.42)***	1.65 (1.40, 1.95)***	1.24 (0.98, 1.56)
	1 month	1.27 (1.03, 1.56)*	2.13 (1.72, 2.63)***	1.28 (0.96, 1.71)
	3 months	1.17 (0.86, 1.60)	1.62 (1.18, 2.23)**	2.99 (2.13, 4.21)***
Postnatal anxiety	10 days	2.49 (2.04, 3.04)***	1.36 (1.10, 1.67)**	1.13 (0.84, 1.52)
	1 month	1.28 (0.98, 1.67)	2.77 (2.13, 3.61)***	1.54 (1.09, 2.18)*
	3 months	0.87 (0.61, 1.25)	1.08 (0.76, 2.55)	2.42 (1.65, 3.56)***
Postnatal sleep	10 days	1.05 (0.72, 1.54)	0.95 (0.64, 1.41)	0.80 (0.46, 1.38)
	1 month	1.39 (0.92, 2.08)	0.90 (0.58, 2.38)	0.95 (0.55, 1.65)
	3 months	1.04 (0.67, 1.59)	2.20 (1.43, 4.38)***	2.87 (1.80, 4.60)***
PTSD	10 days	4.31 (2.88, 6.45)***	1.02 (0.70, 1.48)	0.79 (0.48, 1.32)

	1 month	0.78	(0.48, 1.27)	3.67	(2.27, 9.92)***	1.40	(0.79, 2.48)
	3 months	0.88	(0.48, 1.61)	0.61	(0.33, 1.12)	1.84	(1.00, 3.38)*
Postnatal mental health problems		0.93	(0.72, 1.21)	0.59	(0.44, 0.79)***	0.76	(0.53, 1.09)
Infant feeding at 3 months	Formula only	1.00 (ref)					
	Breast only	1.06	(0.91, 1.24)	1.19	(1.00, 1.42)	1.38	(1.08, 1.76)*
	Combined	1.17	(0.95, 1.45)	1.33	(1.06, 1.67)*	1.73	(1.29, 2.33)***
	Other	0.30	(0.06, 1.45)	0.97	(0.21, 7.50)	0.59	(0.06, 5.68)
Infant health poor at 3 months		1.22	(1.00, 1.49)	1.14	(0.91, 1.41)	1.52	(1.15, 2.00)*

1 Duration of labour in minutes marginally positively associated with PPF

* p<0.05 ** p<0.01 *** p<0.001 PTSD Post-traumatic stress disorder PN Postnatal SVD Spontaneous vaginal delivery CS Caesarean section

NB –Only variables significant in earlier iterations of logistic regression included (see Appendix for full list of variables)

Table 3 – Indicators of maternal-infant attachment associated with PPF – Binary logistic regression adjusted for sociodemographic factors[1]

	Fatigue at 10 days		Fatigue at 1 month		Fatigue at 3 months	
	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)
When woman first felt baby belonged						
During pregnancy	1 (ref)		1 (ref)		1 (ref)	
Immediately after birth	0.96	(0.81, 1.13)	0.90	(0.75, 1.09)	0.96	(0.74, 1.26)
First few days	1.27	(1.02, 1.57)*	1.28	(1.02, 1.62)*	1.77	(1.31, 2.39)***
First few weeks	1.60	(1.27, 2.00)***	1.61	(1.27, 2.05)***	1.39	(0.99, 1.95)
Only recently	2.12	(1.52, 2.94)***	2.23	(1.60, 3.10)***	2.52	(1.68, 3.77)***
Not quite yet	2.48	(1.14, 5.43)*	2.90	(1.34, 6.27)**	4.13	(1.77, 9.64)**
Number of negative adjectives used about baby						
0	1 (ref)		1 (ref)		1 (ref)	
1	1.20	(1.01, 1.43)*	1.21	(0.99, 1.48)	1.27	(0.94, 1.70)
2 or more	1.64	(1.35, 2.00)***	1.52	(1.22, 1.89)***	1.86	(1.36, 2.54)***
Baby considered more or less difficult than average						
Difficult	1 (ref)		1 (ref)		1 (ref)	
Average	0.52	(0.37, 0.73)***	0.60	(0.43, 0.84)**	0.36	(0.25, 0.52)***
Easier	0.42	(0.30, 0.60)***	0.44	(0.31, 0.63)***	0.30	(0.20, 0.45)***

* p<0.05 ** p<0.01 *** p<0.001

1 Adjusted for maternal age, parity, Index of Multiple Deprivation, ethnicity, age left full-time education

Table 4 –Protective factors associated with PPF – Binary logistic regression adjusted for sociodemographic factors[1]

	Fatigue at 10 days		Fatigue at 1 month		Fatigue at 3 months	
	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)
Single mother	1.19	(0.87, 1.62)	1.22	(0.86, 1.71)	0.82	(0.50, 1.33)
Score for partner help PN [2]	1.00	(0.98, 1.03)	1.05	(1.02, 1.08)**	1.12	(1.08, 1.16)***
Days of paternity leave	1.01	(1.00, 1.02)	1.02	(1.00, 1.03)*	1.01	(1.00, 1.03)
Number of times saw a MW at home	1.03	(1.00, 1.07)	1.02	(0.98, 1.06)	1.00	(0.95, 1.06)
Age of baby at last visit (per additional day)	1.00	(1.00, 1.00)	1.00	(1.00, 1.00)	1.01	(1.00, 1.01)***
Would have liked to see a MW…						
more often	1 (ref)					
less often	0.73	(0.49, 1.09)	0.87	(0.57, 1.35)	0.68	(0.37, 1.23)
saw MW as much as wanted	0.81	(0.67, 0.97)*	0.76	(0.62, 0.92)**	0.68	(0.52, 0.88)**
Received enough help and advice about baby's…						
crying	0.79	(0.60, 1.04)	0.69	(0.51, 0.93)*	0.99	(0.65, 1.50)
sleeping	0.82	(0.62, 1.10)	0.81	(0.59, 1.10)	0.50	(0.33, 0.76)**
feeding	0.77	(0.63, 0.95)*	0.86	(0.69, 1.07)	0.92	(0.68, 1.23)

* p<0.05 ** p<0.01 *** p<0.001

[1] Adjusted for maternal age, parity, Index of Multiple Deprivation, ethnicity, age left full-time education

[2] Score for partner help = Changing baby's nappy, Supporting feeding, Helping when the baby cries, Bathing the baby, Playing with the baby; each scored 1-4 and summed (high score = more support)

MW midwife; PN postnatally

Appendix 1 – Variables included in analysis

Sociodemographic variables
Maternal age
Index of Multiple Deprivation (quintile)
Ethnicity (5 categories)
Left full-time education aged <16 years
Parity

Pre-pregnancy health
Long-standing physical health problem or disability
Long-standing mental health problem or learning disability

Antenatal health and well-being
Anxiety
Depression
Mental health problem

Long-term health problem complicating pregnancy
Pregnancy-specific problem

Labour and birth
Duration of labour
Mode of delivery
Multiple birth
Gestation at birth
Baby admitted to neonatal unit
Baby born <37 weeks' gestation
Baby <2500g at birth

Postnatal variables
Infant feeding in first few days and at 3 months
Depression at 10 days, 1 and 3 months
Anxiety at 10 days, 1 and 3 months
Sleep problems (not related to the baby) at 10 days, 1 and 3 months
PTSD symptoms at 10 days, 1 and 3 months
EPDS >12 at 3 months
Infant health at 3 months

Situational variables in PN period
Employment/maternity leave

Indicators of infant attachment
Woman's sense of when the baby belonged (6 categories: pregnancy-not quite yet)
Positive and negative adjectives used about baby (8 of each)
Baby considered more or less difficult than average

Partner support
Single mother
Amount of paternity leave taken (days)
Score of help with baby care (0-20)

Health professional support
No. home visits by MW
Age of baby at last visit (days)
Would have liked to see MW more/less
Support with baby's crying, sleeping, feeding
Attended baby clinic, drop-in clinic, Children's centre, parents' group, peer support, PN classes, baby café, used online support, parenting website

MW midwife; PN postnatal; EPDS Edinburgh Postnatal Depression Scale; PTSD post-traumatic stress disorder

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Reported on page…
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1/4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4/5
Objectives	3	State specific objectives, including any prespecified hypotheses	4/5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2, 6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6/7, Appendix
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	-
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6/7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6/7
		(*b*) Describe any methods used to examine subgroups and interactions	6/7
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Tables 2, 3 & 4
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted	Tables 2, 3

		estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	&4
		(*b*) Report category boundaries when continuous variables were categorized	Tables
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Funding statement

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Factors associated with maternal postpartum fatigue: an observational study

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Factors associated with maternal postpartum fatigue: an observational study

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Abstract

***Objectives*:** To assess the prevalence of postpartum fatigue, characteristics of women with fatigue, risk factors, associations with infant characteristics, partner and midwifery support for women with fatigue.

Setting: Maternity care in England. Secondary analysis of 2014 National Maternity Survey.

Participants: A random sample of 10,000 women selected by the Office for National Statistics, using birth registration. Women were excluded if they were aged less than 16 years or if their baby had died. Questionnaires were sent to these women three months postpartum and asked about clinical events (such as mode of delivery), care during pregnancy, labour, birth and the postnatal period. Specifically, women were asked whether they experienced fatigue/severe tiredness at 10 days, one month or three months postpartum. Responses were received from 4578 women (47% response rate).

Results: Decreasing, but substantial proportions of women, 38.8%, 27.1% and 11.4%, experienced fatigue/severe tiredness at 10 days, one month and three months respectively. These figures varied significantly by maternal age, level of deprivation, education and parity. Women reporting depression, anxiety, sleep problems and those breastfeeding were at significantly increased risk (e.g. OR for depression in women with fatigue at 3 months 2.99 (95% CI 2.13, 4.21)). Significantly more negative language was used by these women to describe their babies and they perceived their baby as more difficult than average (e.g. two or more negative adjectives used by women with fatigue at three months OR 1.86 (95% CI 1.36, 2.54)). Women with postpartum fatigue had greater partner support but were significantly less likely to report seeing the midwife as much as they wanted.

Conclusions: Postpartum fatigue affects a substantial proportion of women. Predictors include age and parity but practical help and support from partners and midwives may be protective factors.

Keywords: Postpartum fatigue; Childbirth; Postnatal; Survey; Prevalence; Predictors

Strengths and limitations of this study

- Maternal fatigue after childbirth is often seen as a trivial health issue common to women with young children, is but infrequently the subject of research.
- The study used a large population-based random sample based on birth registration.
- The response rate was 47% and in common with other surveys there was under-representation of hard-to-reach groups.
- The study was a cross-sectional survey conducted at three months postpartum and women may not have accurately remembered all the details reported.

Factors associated with maternal postpartum fatigue: an observational study

Background

Postpartum fatigue (PPF) has been defined in various ways but generally includes a decreased capacity for physical and mental activity, a persistent lack of energy, impairments in concentration and attention not easily relieved by rest or sleep (1-7). The prevalence of postpartum fatigue has not been studied extensively as it has been perceived as an unavoidable, temporary and relatively trivial symptom commonly experienced in early parenthood. It is typically marked by disrupted sleep due to night-waking infants, difficulties settling the baby, and night time feeding.

Such evidence as does exist on the prevalence of PPF varies according to how it is measured and timing of measurement after birth. Apart from simple self-report symptom checklists which ask about fatigue, tiredness, exhaustion, and vitality, there are a number of scales relating to fatigue including the Lee Fatigue Scale (8), the Fatigue Assessment Scale (9) and Vitality sub-scale of the Psychological General Well-being Index (10). However, these measures were not developed specifically for PPF where different issues, such as interrupted sleep, may be more salient. Use of a simple self-report symptom question as part of a checklists have suggested the proportion of women with PPF to be 42% in the first few days after birth (11), 37-64% at five to six weeks (12, 13), 25-67% at 12-24 weeks (12, 14), and 18-66% at 1-2 years (12, 14). These wide variations in prevalence may, to some extent, be due to severity: in one study (15) 83% of women were fatigued at 4-6 weeks but none considered it a major problem. Different groups of women in the population may also differ in their experience of PPF. For example, in a study of low income American women 63% reported being severely fatigued at both one and three months (16), whereas only 25% of recent mothers reported PPF in a relatively affluent Dutch population (12).

Factors reported to be associated with higher rates of PPF include clinical issues associated with the birth such as longer duration of labour and instrumental or operative delivery, clinical problems such

as anaemia, infection and haemorrhage, situational factors such as low socioeconomic status, unemployment, primiparity, and higher maternal age (12, 17-20) although these were not found to be significant in all studies (21). For example, some studies reported that socioeconomic disadvantage was associated with poorer sleep and higher rates of PPF(22, 23), but a review of PPF commented that middle income women appeared to be at highest risk(17).

Sleep disruption in the early postpartum period is normal due to nocturnal infant caregiving. Sleep efficiency, the proportion of time spent asleep relative to time spent in bed, is lowest immediately after birth and thereafter improves as the baby's sleep pattern shifts to nocturnal hours (22). However, in exhausted mothers melatonin is transmitted to the infant in breast milk which can delay the establishment of mature sleep cycles (18). PPF has been shown to be related to fragmented sleep (24) but not sleep more generally (25).

The association between PPF and breastfeeding is unclear. Some studies have reported an association (12, 26), others not (21, 27). Women who worried more about insufficient milk and those who had breastfeeding problems tended to have higher levels of fatigue (26) possibly due to spending more time involved in breastfeeding.

Several studies examined the relationship between PPF and depression (3, 4, 15, 16, 19, 28, 29). PPF may have a role in contributing to depression, but is thought to be a separate although related theoretical construct. While the two are correlated, it is unclear to what degree depression leads to fatigue, or fatigue to depression; they do not necessarily occur contemporaneously. In one study, fatigue at one week predicted depression at four weeks (19).

The association between maternal fatigue and infant attachment has not been extensively studied. However, infant characteristics, such as preterm birth, have been found to be associated with both maternal fatigue and delayed infant attachment (30). Similarly, a study which examined maternal fatigue and maternal-infant attachment following different modes of delivery and different rooming-

in policies, found that the mother-infant relationship was adversely affected when women were experiencing particular fatigue following caesarean delivery (18).

A qualitative interview-based study which used a fatigue symptoms checklist (7) reported that social and practical support from a woman's partner or family was the strongest factor in protection against postnatal fatigue (16). Similarly, it is assumed, but not proven, that more support from midwives is likely to have a beneficial effect(31). In the UK, postnatal care is provided in the community by midwives for the first few weeks, and thereafter by health visitors. Women normally see their general/family practitioner (GP) about six weeks after birth for a postnatal check.

The purpose of the present study was to address the following research questions:

- What is the prevalence of PPF at 10 days, one month and three months?
- What are the sociodemographic characteristics of women who experience PPF at 10 days, one month and three months after childbirth?
- Is there an association between maternal PPF and the mother-infant relationship at three months?
- Is there an association between partner and midwifery support in the postnatal period and PPF?

Methods

National Maternity Survey 2014

This study used data from the cross-sectional National Maternity Survey conducted in England in 2014 (32). A random sample of 10,000 women who gave birth during a two week period, excluding those aged less than 16 years and those whose baby had died, were selected by the Office for National Statistics from birth registrations. They were sent a questionnaire 12 weeks after the birth asking about clinical events and care during pregnancy, labour and birth, and in the postnatal period.

Questionnaires could be returned by Freepost, completed online, or completed by telephone with the aid of an interpreter if necessary. Up to three reminders were sent to non-respondents using a tailored reminder system (33).

Exposure and outcome measures

Women were asked questions about postnatal health including 'Did you experience any of the following 10 days, one month, and three months after the birth of your baby?' as used in previous national maternity surveys with answer options including 'Fatigue/severe tiredness' among various other postnatal symptoms. The time points of 10 days, one month and three months had been selected pragmatically to reflect the range of experience up to the time of the survey. Women were asked whether they had mental health problems, and asked to complete the Edinburgh Postnatal Depression Scale (EPDS). Questions were also asked about sociodemographic variables, including age, parity, Index of Multiple Deprivation (an area based measure representing the level of socioeconomic deprivation of the neighbourhoods in which respondents lived), ethnicity and age on completing full-time education; pre-pregnancy and antenatal health and well-being, variables related to labour and birth, including duration of labour and mode of delivery; multiple birth, a checklist relating to postnatal maternal health and symptoms; infant health and feeding at three months; perceptions of their baby at three months indicated by number of positive and negative adjectives circled from a list of 16, and indicators of maternal-infant relationship reflected in women's sense of when their baby belonged to them on a six point scale ranging from 'during pregnancy' to 'not quite yet', and whether she considered her baby more or less difficult than average. Postnatal partner support was estimated by summing scores for five activities: changing baby's nappy, supporting feeding, helping when the baby cries, bathing the baby, and playing with the baby; each scored 1-4 and summed (high score = more support). Midwifery support was estimated by women responding that they had/had not received enough help and advice about the baby's crying, sleeping and feeding, also whether the woman would have liked to see the midwife

more or less often in the postnatal period. The full list of variables included in the analysis is given Supplementary data.

Analyses

The data were analysed descriptively using proportions and means as appropriate. A cut-off of 13 or more was used for the EPDS. Associations with PPF were tested using the Chi-square test. Variables which were statistically significant at $p<0.001$ (due to the large number of comparisons) were entered into binary logistic regression to determine the key predictors of PPF. Variables were entered in four groups: i) sociodemographic variables; ii) antenatal and intrapartum variables; iii) indicators of infant the mother-infants relationship; iv) partner and midwife support. Analyses were carried out separately for PPF at 10 days, one month and three months as it was anticipated that different variables may be important at different time points.

Patient and public involvement

Patients were not directly involved in this particular study. Women were selected at random for the survey by the Office for National Statistics from birth registrations. The survey questions, including those relating to postnatal health, were developed in consultation with a Research Advisory Group with representatives from user groups, maternity services liaison committees and members of national charities associated with maternity care. The reports from the National Maternity Surveys are available on the NPEU website.

Ethical approval for the survey was obtained from the NRES committee for Yorkshire and The Humber – Humber Bridge (REC reference 14/YH/0065).

Results

In total 4578 women completed and returned questionnaires (47% response rate after exclusion of undeliverable questionnaires). Response was such that women born outside the UK, younger women and those resident in more deprived areas were significantly less likely to respond (32).

Prevalence of PPF

According to the symptom checklist, 38.8%, 27.1% and 11.4% of women experienced fatigue/severe tiredness at 10 days, one month and three months respectively. Of those women who reported PFF at 10 days, 46% also reported it at one month; however, of those who reported PFF at one month, only 30% also reported it at three months. These figures varied significantly by maternal age, Index of Multiple Deprivation (an area based measure of deprivation), whether the woman had left full-time education before age 16, and parity, such that PPF was more common in women who were older, primiparous, more highly educated, and resident in *less* deprived areas. There were marginal differences by ethnicity (Table 1).

Associations between risk factors and PPF

Sociodemographic and predictive variables that were significantly associated with PPF ($p<0.001$) in univariate analyses were entered into binary logistic regressions separately for PFF at 10 days, one month and three months; the results are shown in Table 2. Different variables were important at different times with the exception of maternal age which was significant throughout. Women aged 20-24 years were significantly less at risk of PPF at each time point compared to those aged 30-34, with Odds ratios of 0.60, 0.45 and 0.40 respectively at 10 days, one month and three months. At one month women aged 25-29 years were also at significantly reduced risk (OR = 0.58), and at three months women aged 40 or over were at significantly increased risk (OR = 2.00) compared to those aged 30-34 years. Multiparous women were at significantly reduced risk of PPF at one month and, to a lesser extent, at 10 days compared to primiparous women. Leaving full-time education aged 16 years or less was significantly protective at 10 days but not subsequently. Reported postnatal health problems, particularly depression and anxiety, were significantly associated with PPF at each time

point with Odds ratios for depression of 2.04, 2.41 and 3.34 respectively at 10 days, one month and three months. Similarly for anxiety, Odds ratios were 2.63, 3.37 and 3.70 respectively. In addition, at 10 days and one month post-traumatic stress disorder (PTSD) symptoms were significantly raised and, at three months sleep problems not associated with the baby were higher in women who had PPF. Women who were still breastfeeding at three months, either exclusively or partially, were also at increased risk of PPF. Raised EPDS, although statistically significant in the univariate analysis, dropped out in the multivariate logistic regression.

The mother-infant relationship

Table 3 shows the indicators of maternal-infant attachment in women with and without PPF at 10 days, one month and three months adjusted for sociodemographic variables. At each time point, women who had PPF used significantly more negative adjectives to describe their baby and perceived their baby as more difficult than average. Women who had PPF, especially at three months, experienced significant delay in feeling that their baby belonged to them in addition to having more negative feelings about their baby, although it was relatively uncommon for women to describe their baby as belonging to them 'not quite yet' (n= 29).

Partner and midwife support

We postulated that women who had less support from their partner may be at greater risk of PPF. However, this was not borne out in the results (Table 4). On the contrary, after adjustment for sociodemographic variables, women whose partner was more involved in practical postnatal care (changing nappies, supporting feeding, helping when the baby cried, bathing and playing with the baby) were *more* likely to be experiencing PPF at three months and, to a lesser degree, at one month. Similarly, number of days of paternity leave was positively associated with PPF at one month although this was of only marginal significance.

Women with PPF at three months were significantly more likely to be seen for longer by their midwife in the postnatal period, however these women were also significantly less likely to report that they saw the midwife as much as they wanted. Women with PPF were also more likely to report not receiving enough help and advice about the baby's feeding (at 10 days), crying (at one month), and sleeping (at three months). Women with PPF also tended to use more peer, online and web support, with Odds ratios (95% confidence interval) of 1.45 (1.26, 1.67), 1.25 (1.08, 1.45), and 1.35 (1.17, 1.55) respectively for women with PPF at 10 days, and slightly lower Odds ratios at one and three months (data not shown).

Women were asked about physical well-being in the first few days and at three months after giving birth with answer options 'very well', 'quite well', 'tired and uncomfortable', 'exhausted', and 'very ill'. In the first few days and at three months 13% and 5% respectively reported feeling 'Exhausted', but of these women only 68% and 55% respectively also reported feeling 'Fatigue/severe tiredness'. Women who reported feeling 'exhausted' or 'very ill' were also significantly more likely to report feeling that their baby belonged to them 'only recently' or 'not quite yet' (15.6% of 'exhausted', 14.3% of 'very ill' women reported 'only recently/not quite yet' compared to 4.8% overall).

Discussion

The prevalence findings for PPF were 38.8%, 27.1% and 11.4% at 10 days, one month and three months after giving birth in this large scale population-based study. These figures are somewhat lower than estimates from other studies (11-14) which may reflect the manner in which the questions were asked. For example, in a US study using a 30 item checklist (3), 44% of women were 'severely fatigued' at 12 weeks whereas the current survey used self-report of 'Fatigue/severe tiredness'. Women were asked about general physical well-being in the first few days and at three months after giving birth: 13% and 5% respectively reported feeling 'exhausted' but of these

women, only two thirds or less also reported having 'Fatigue/severe tiredness'. This indicates that framing effects and how the question is asked may affect response.

Sociodemographic factors were significantly associated with PPF. The importance of older maternal age and primiparity as risk factors for PPF has been previously recognised (7, 26, 34), however low education and low socioeconomic status were previously thought to be risk factors (17, 23) whereas in this population based study they were protective against PPF. Even when assessed in binary logistic regression, women aged less than 30 and those who had left full-time education aged less than 16 years were consistently at lower risk of PPF. Residence in the most deprived quintile was also protective against PFF at three months but this was of only marginal significance. It has been postulated that there are several different types of fatigue: normal, pathophysiological, situational and psychological (23) and it is possible that risk factors differ between these groups.

Clinical factors such as operative or instrumental delivery were associated with PPF in univariate analyses, but only duration of labour was positively associated with fatigue at each time point in the multivariate analyses, consistent with the literature (17). As has been reported elsewhere (3, 4, 19), poorer maternal mental health, as indicated by postnatal depression and anxiety, were strongly associated with PPF, especially at three months. Women may have felt that it was normal to be tired and experiencing a low mood in the first month after childbirth, but significant fatigue at three months begins to be perceived as a problem.

The association between breastfeeding and PPF was strongest at three months especially for women who combined breast and bottle feeding. Although this makes sense intuitively, previous research has not reported on associations between mixed feeding and PPF; findings from other studies relating to breastfeeding and PPF are generally mixed (21, 26, 27).

Maternal-infant attachment appears to be negatively affected by PPF, such women being more likely to report that they felt their baby belonged to them only relatively recently, using more negative terms to describe their baby, and they considered their baby more difficult than average. It is

possible that these babies were actually more difficult: slightly more of them were premature and more had health problems at three months, suggesting that poor infant health is a contributor to PPF. Other research has also found that, after adjusting for maternal depression and anxiety, positive infant behaviour, as indicated by smile count, is associated with positive maternal attachment (35). This hints at the complexity of the relationship between PPF, attachment and infant health and behaviour.

Previous research has also reported associations between PPF and maternal-infant attachment (3, 12, 16, 22, 36). Other reported associations include poorer mental and physical health, difficulties with relationships and employment, and early weaning (2, 4, 14, 18, 21, 26). Personal and social development and eye-hand coordination aspects of infant development, as measured using the Griffiths Scales, were also significantly affected in infants of chronically fatigued mothers (36). In one qualitative interview study (16), chronically fatigued women used more negative language in describing their baby or themselves, such as “Angry,” “Body shut down,” “Resent baby,” “Beat/Exhausted,” “Overwhelmed,” and “Can’t think straight.”

An important finding of this study is that support from partners was greatest in women who were suffering from PPF, suggesting reverse causality, that partners were taking more paternity leave and were more involved in baby care because it was needed. This would parallel the ‘compensation/buffering’ model (37) in which partners of women with depression became more involved in baby care to compensate for poorer maternal wellbeing and fatigue.

Longer postnatal contact with the midwife was greatest for women with PPF, again suggesting that help was being targeted where it was needed. Even so, women with PPF were significantly less likely to report that they saw a midwife as much as they would have liked or that they received enough help and advice about baby care from midwives. It may be that, even though these women received more support than average, they would have liked more. It may also be the case that the type of support was unhelpful, particularly lacking continuity. Barriers to continuity of postnatal carer

include shift patterns, part-time work, staff shortages and travel time (38). However, individualised, women-centred care can still be achieved with good communication and antenatal care planning (39).

Strengths and limitations

This study was based on a large population based random sample of recent mothers, with considerable diversity among respondents. However, the response rate was 47% and, in common with many other surveys (40-42), there was significant under-representation of hard-to-reach groups. PPF was as reported by women using a single item as part of a symptom checklist rather than one of the many scales. The cross-sectional survey was conducted at three months postpartum and thus causality cannot be inferred from associations found and women may not have accurately remembered all the details reported. In particular, while fatigue at the time of the survey is likely to be accurately reported, recall of fatigue at 10 days and one month may be inaccurate and subject to recall bias. However, studies comparing women's reports of events around childbirth with medical records or other recorded data have demonstrated good recall (43, 44).

Implications for healthcare professionals

These finding highlight that, for some women, PPF can be severe and long lasting and may require intervention. Several interventions to reduce PPF have been evaluated in good quality randomised controlled studies (14, 22, 31, 45, 46). These were a mixture of self-management, telephone support, exercise, and education and all were reported to be beneficial except for the purely self-directed intervention which used the Tiredness Management Guide to help women to self-manage their fatigue (46). Supportive interventions and availability of additional advice and support targeted to those women with the greatest need is to be encouraged. The nature of the additional advice and support should be tailored to the needs of individual women. However, there is also a need for antenatal preparation for women and their partners in approaching the transition to parenthood so

that they have realistic expectations, can enlist practical help and emotional support when required postnatally, and enhance their own coping skills.

Implications for research

The cross-sectional nature of this study has precluded teasing out of the interaction between PPF and postnatal depression. Although the two are clearly linked, the nature of the relationship is unclear. Further exploration of the impact of PPF on the developing mother-child and partner relationships, and the influence of method of infant feeding, in prospective longitudinal studies is also likely to better elucidate the way in which individual differences may contribute. There is a wide range of estimates of prevalence of PPF in the literature which requires further elucidation.

Conclusions

Postpartum fatigue is not inevitable or universal, although early in the postnatal period it affects a substantial proportion of women. Predictors of postpartum fatigue include age and parity; possible protective factors include practical help and support from partners, as well as input from midwives.

List of abbreviations

CS Caesarean section; EPDS Edinburgh Postnatal Depression Scale; MW midwife; OR Odds ratio; PN postnatal; PPF Postpartum fatigue; PTSD post-traumatic stress disorder; SVD Spontaneous vaginal delivery

Declarations

Ethics approval and consent to participate

Ethical approval for the survey was obtained from the NRES committee for Yorkshire and The Humber – Humber Bridge (REC reference 14/YH/0065). Completion and return of the questionnaire was taken as implicit consent to participate.

Consent for publication – N/A

Availability of data and materials – Further analyses of these data are planned. The data will be made available by the NPEU when these are complete.

Competing interests – The authors declare that they have no competing interests.

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Authors' contributions

MR designed the National Maternity Survey; MR, JH and JH were responsible for the research questions; JH analysed the data; MR, FA, and JH wrote the manuscript.

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Table 1 – Description of sample sociodemographic characteristics

	Fatigue at 10 days					Fatigue at 1 month					Fatigue at 3 months				
	Yes		No		*p*	Yes		No		*p*	Yes		No		*p*
	n	%	n	%		n	%	n	%		n	%	n	%	
Maternal age (years)															
16-19	40	2.3	60	2.2		24	2.0	76	2.3		10	1.9	90	2.2	
20-24	164	9.3	366	13.2		99	8.1	431	13.1		28	5.4	502	12.5	
25-29	475	27.0	742	26.8		263	21.4	954	28.9		120	23.2	1097	27.3	
30-34	634	36.1	939	33.9		477	38.8	1096	33.2		192	37.1	1381	34.4	
35-39	347	19.7	522	18.8		279	22.7	590	17.9		114	22.0	755	18.8	
40+	98	5.6	143	5.2		87	7.1	154	4.7		54	10.4	187	4.7	
Total	1758	100.0	2772	100.0	**	1229	100.0	3301	100.0	***	518	100.0	4012	100.0	***
Index of Multiple Deprivation															
1	373	21.2	524	18.9		285	23.2	612	18.5		129	25.0	768	19.1	
2	334	19.0	525	18.9		273	22.2	586	17.7		97	18.8	762	19.0	
3	377	21.4	550	19.8		244	19.9	683	20.7		113	21.9	814	20.3	
4	366	20.8	602	21.7		234	19.1	734	22.2		109	21.1	859	21.4	
5 (most deprived)	308	17.5	572	20.6		192	15.6	688	20.8		69	13.3	811	20.2	
Total	1758	100.0	2773	100.0	*	1228	100.0	3303	100.0	***	517	100.0	4014	100.0	**
Ethnicity															
White	1443	83.3	2270	84.4		1041	85.9	2672	83.2		434	84.8	3279	83.8	
Mixed	35	2.0	52	1.9		28	2.3	59	1.8		12	2.3	75	1.9	
Asian	194	11.2	248	9.2		106	8.7	336	10.5		43	8.4	399	10.2	
Black	48	2.8	110	4.1		29	2.4	129	4.0		18	3.5	140	3.6	
Other	12	0.7	11	0.4		8	0.7	15	0.5		5	1.0	18	0.5	
Total	1732	100.0	2691	100.0	*	1212	100.0	3211	100.0	*	512	100.0	3911	100.0	

Left full-time education aged <16 years															
No	1525	87.4	2198	80.4		1068	87.8	2655	81.4		450	87.5	3273	82.5	
Yes	220	12.6	537	19.6		149	12.2	608	18.6		64	12.5	693	17.5	
Total	1745	100.0	2735	100.0	***	1217	100.0	3263	100.0	***	514	100.0	3966	100.0	**
Parity															
Primiparous	973	56.4	1232	45.6		672	55.9	1533	47.5		247	48.4	1958	50.0	
Multiparous	752	43.6	1470	54.4		531	44.1	1691	52.5		263	51.6	1959	50.0	
Total	1725	100.0	2702	100.0	***	1203	100.0	3224	100.0	***	510	100.0	3917	100.0	

* p<0.05 ** p<0.01 *** p<0.001

Table 2 – Predictors of PPF – Binary logistic regression

		Fatigue at 10 days		**Fatigue at 1 month**		**Fatigue at 3 months**	
		Odds Ratio (95% CI)		Odds Ratio (95% CI)		Odds Ratio (95% CI)	
Maternal age (years)	16-19	0.91	(0.55, 1.51)	0.64	(0.36, 1.15)	1.01	(0.45, 2.24)
	20-24	0.62	(0.48, 0.79)***	0.54	(0.40, 0.71)***	0.44	(0.28, 0.70)**
	25-29	0.91	(0.76, 1.09)	0.63	(0.52, 0.77)***	0.87	(0.66, 1.14)
	30-34	1.00 (ref)					
	35-39	1.00	(0.83, 1.22)	1.13	(0.92, 1.39)	1.04	(0.79, 1.38)
	40+	1.20	(0.86, 1.66)	1.39	(0.99, 2.95)	2.00	(1.34, 2.98)**
Parity	Primiparous	1.00 (ref)					
	Multiparous	0.83	(0.71, 0.97)*	0.81	(0.68, 0.97)*	1.21	(0.95, 1.54)
Left full-time education	aged16 or more years	1.00 (ref)					
	aged <16 yrs	0.64	(0.52, 0.78)***	0.74	(0.59, 0.93)*	0.82	(0.60, 1.13)
Mode of delivery	SVD	1.00 (ref)					
	Instrumental	1.23	(1.00, 1.52)	0.99	(0.79, 1.25)	0.87	(0.63, 1.21)
	Planned CS	1.03	(0.83, 1.27)	1.21	(0.96, 1.52)	1.30	(0.96, 1.76)
	CS due to unforeseen problem	1.06	(0.84, 1.34)	1.09	(0.85, 1.41)	1.06	(0.75, 1.51)
Labour duration (mins)[1]		1.00	(1.00, 1.00)*	1.00	(1.00, 0.00)*	1.00	(1.00, 1.00)**
Postnatal depression	10 days	2.08	(1.79, 2.42)***	1.65	(1.40, 1.95)***	1.24	(0.98, 1.56)
	1 month	1.27	(1.03, 1.56)*	2.13	(1.72, 2.63)***	1.28	(0.96, 1.71)
	3 months	1.17	(0.86, 1.60)	1.62	(1.18, 2.23)**	2.99	(2.13, 4.21)***
Postnatal anxiety	10 days	2.49	(2.04, 3.04)***	1.36	(1.10, 1.67)**	1.13	(0.84, 1.52)
	1 month	1.28	(0.98, 1.67)	2.77	(2.13, 3.61)***	1.54	(1.09, 2.18)*
	3 months	0.87	(0.61, 1.25)	1.08	(0.76, 2.55)	2.42	(1.65, 3.56)***
Postnatal sleep	10 days	1.05	(0.72, 1.54)	0.95	(0.64, 1.41)	0.80	(0.46, 1.38)
	1 month	1.39	(0.92, 2.08)	0.90	(0.58, 2.38)	0.95	(0.55, 1.65)
	3 months	1.04	(0.67, 1.59)	2.20	(1.43, 4.38)***	2.87	(1.80, 4.60)***
PTSD	10 days	4.31	(2.88, 6.45)***	1.02	(0.70, 1.48)	0.79	(0.48, 1.32)

	1 month	0.78	(0.48, 1.27)	3.67	(2.27, 9.92)***	1.40	(0.79, 2.48)
	3 months	0.88	(0.48, 1.61)	0.61	(0.33, 1.12)	1.84	(1.00, 3.38)*
Postnatal mental health problems		0.93	(0.72, 1.21)	0.59	(0.44, 0.79)***	0.76	(0.53, 1.09)
Infant feeding at 3 months	Formula only	1.00 (ref)					
	Breast only	1.06	(0.91, 1.24)	1.19	(1.00, 1.42)	1.38	(1.08, 1.76)*
	Combined	1.17	(0.95, 1.45)	1.33	(1.06, 1.67)*	1.73	(1.29, 2.33)***
	Other	0.30	(0.06, 1.45)	0.97	(0.21, 7.50)	0.59	(0.06, 5.68)
Infant health poor at 3 months		1.22	(1.00, 1.49)	1.14	(0.91, 1.41)	1.52	(1.15, 2.00)*

1 Duration of labour in minutes marginally positively associated with PPF

* p<0.05 ** p<0.01 *** p<0.001 PTSD Post-traumatic stress disorder PN Postnatal SVD Spontaneous vaginal delivery CS Caesarean section

NB –Only variables significant in earlier iterations of logistic regression included (see Appendix for full list of variables)

Table 3 – Indicators of maternal-infant attachment associated with PPF – Binary logistic regression adjusted for sociodemographic factors[1]

	Fatigue at 10 days		Fatigue at 1 month		Fatigue at 3 months	
	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)
When woman first felt baby belonged						
During pregnancy	1 (ref)		1 (ref)		1 (ref)	
Immediately after birth	0.96	(0.81, 1.13)	0.90	(0.75, 1.09)	0.96	(0.74, 1.26)
First few days	1.27	(1.02, 1.57)*	1.28	(1.02, 1.62)*	1.77	(1.31, 2.39)***
First few weeks	1.60	(1.27, 2.00)***	1.61	(1.27, 2.05)***	1.39	(0.99, 1.95)
Only recently	2.12	(1.52, 2.94)***	2.23	(1.60, 3.10)***	2.52	(1.68, 3.77)***
Not quite yet	2.48	(1.14, 5.43)*	2.90	(1.34, 6.27)**	4.13	(1.77, 9.64)**
Number of negative adjectives used about baby						
0	1 (ref)		1 (ref)		1 (ref)	
1	1.20	(1.01, 1.43)*	1.21	(0.99, 1.48)	1.27	(0.94, 1.70)
2 or more	1.64	(1.35, 2.00)***	1.52	(1.22, 1.89)***	1.86	(1.36, 2.54)***
Baby considered more or less difficult than average						
Difficult	1 (ref)		1 (ref)		1 (ref)	
Average	0.52	(0.37, 0.73)***	0.60	(0.43, 0.84)**	0.36	(0.25, 0.52)***
Easier	0.42	(0.30, 0.60)***	0.44	(0.31, 0.63)***	0.30	(0.20, 0.45)***

* p<0.05 ** p<0.01 *** p<0.001

1 Adjusted for maternal age, parity, Index of Multiple Deprivation, ethnicity, age left full-time education

Table 4 –Protective factors associated with PPF – Binary logistic regression adjusted for sociodemographic factors[1]

	Fatigue at 10 days		Fatigue at 1 month		Fatigue at 3 months	
	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)
Single mother	1.19	(0.87, 1.62)	1.22	(0.86, 1.71)	0.82	(0.50, 1.33)
Score for partner help PN [2]	1.00	(0.98, 1.03)	1.05	(1.02, 1.08)**	1.12	(1.08, 1.16)***
Days of paternity leave	1.01	(1.00, 1.02)	1.02	(1.00, 1.03)*	1.01	(1.00, 1.03)
Number of times saw a MW at home	1.03	(1.00, 1.07)	1.02	(0.98, 1.06)	1.00	(0.95, 1.06)
Age of baby at last visit (per additional day)	1.00	(1.00, 1.00)	1.00	(1.00, 1.00)	1.01	(1.00, 1.01)***
Would have liked to see a MW…						
more often	1 (ref)					
less often	0.73	(0.49, 1.09)	0.87	(0.57, 1.35)	0.68	(0.37, 1.23)
saw MW as much as wanted	0.81	(0.67, 0.97)*	0.76	(0.62, 0.92)**	0.68	(0.52, 0.88)**
Received enough help and advice about baby's…						
crying	0.79	(0.60, 1.04)	0.69	(0.51, 0.93)*	0.99	(0.65, 1.50)
sleeping	0.82	(0.62, 1.10)	0.81	(0.59, 1.10)	0.50	(0.33, 0.76)**
feeding	0.77	(0.63, 0.95)*	0.86	(0.69, 1.07)	0.92	(0.68, 1.23)

* p<0.05 ** p<0.01 *** p<0.001

[1] Adjusted for maternal age, parity, Index of Multiple Deprivation, ethnicity, age left full-time education

[2] Score for partner help = Changing baby's nappy, Supporting feeding, Helping when the baby cries, Bathing the baby, Playing with the baby; each scored 1-4 and summed (high score = more support)

MW midwife; PN postnatally

Appendix 1 – Variables included in analysis

Sociodemographic variables
Maternal age
Index of Multiple Deprivation (quintile)
Ethnicity (5 categories)
Left full-time education aged <16 yrs
Parity

Pre-pregnancy health
Long-standing physical health problem or disability
Long-standing mental health problem or learning disability

Antenatal health and well-being
Anxiety
Depression
Mental health problem

Long-term health problem complicating pregnancy
Pregnancy-specific problem

Labour and birth
Duration of labour
Mode of delivery
Multiple birth
Gestation at birth
Baby admitted to neonatal unit
Baby born <37 weeks' gestation
Baby <2500g at birth

Postnatal variables
Infant feeding in first few days and at 3 mths
Depression at 10 days, 1 mth, 3 mths
Anxiety at 10 days, 1 mth, 3 mths
Sleep problems (not related to the baby) at 10 days, 1 mth, 3 mths
PTSD symptoms at 10 days, 1 mth, 3 mths
EPDS >12 at 3 mths
Infant health at 3 mths

Situational variables in PN period
Employment/maternity leave

Indicators of infant attachment
Woman's sense of when the baby belonged (6 categories: pregnancy-not quite yet)
Positive and negative adjectives used about baby (8 of each)
Baby considered more or less difficult than average

Partner support
Single mother
Amount of paternity leave taken (days)
Score of help with baby care (0-20)

Health professional support
No. home visits by MW
Age of baby at last visit (days)
Would have liked to see MW more/less
Support with baby's crying, sleeping, feeding
Attended baby clinic, drop-in clinic, Children's centre, parents' group, peer support, PN classes, baby café, used online support, parenting website

MW midwife; PN postnatal; EPDS Edinburgh Postnatal Depression Scale; PTSD post-traumatic stress disorder

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Reported on page…
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1/4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4/6
Objectives	3	State specific objectives, including any prespecified hypotheses	4/6
Methods			
Study design	4	Present key elements of study design early in the paper	6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2, 6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6/7, Appendix
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	-
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6/7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6/8
		(*b*) Describe any methods used to examine subgroups and interactions	6/7
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8-9
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Tables 2, 3 & 4

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Tables 2, 3 &4
		(*b*) Report category boundaries when continuous variables were categorized	Tables
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Funding statement Page 16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Factors associated with maternal postpartum fatigue: an observational study

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Factors associated with maternal postpartum fatigue: an observational study

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Abstract

***Objectives*:** To assess the prevalence of postpartum fatigue at 10 days, one month and three months; describe sociodemographic and clinical characteristics of women with fatigue and associations of fatigue with infant characteristics and partner and midwifery support.

Setting: Maternity care in England. Secondary analysis of 2014 National Maternity Survey.

Participants: A random sample of 10,000 women selected by the Office for National Statistics, using birth registration records. Women aged less than 16 years or if their baby had died were excluded. Questionnaires were sent to women at three months postpartum and asked about wellbeing and care during pregnancy, labour, birth and postpartum. Specifically, women were asked whether they experienced fatigue/severe tiredness at 10 days, one month or three months postpartum. Responses were received from 4578 women (47% response rate).

Results: Decreasing, but substantial proportions of women, 38.8%, 27.1% and 11.4%, experienced fatigue/severe tiredness at 10 days, one month and three months respectively. These figures varied significantly by maternal age, level of deprivation, education and parity. Women reporting depression, anxiety, sleep problems and those breastfeeding were at significantly increased risk (e.g. OR for depression in women with fatigue at 3 months 2.99 (95% CI 2.13, 4.21)). Significantly more negative language was used by these women to describe their babies and they perceived their baby as more difficult than average (e.g. two or more negative adjectives used by women with fatigue at three months OR 1.86 (95% CI 1.36, 2.54)). Women with postpartum fatigue had greater partner support but were significantly less likely to report seeing the midwife as much as they wanted.

Conclusions: Postpartum fatigue is not inevitable or universal, although early in the postnatal period it affects a substantial proportion of women. Predictors include age and parity but practical help and support from partners and midwives may be protective factors.

Keywords: Postpartum fatigue; Childbirth; Postnatal; Survey; Prevalence; Predictor

Strengths and limitations of this study

- Maternal fatigue after childbirth is often seen as a trivial health issue common to women with young children, but is infrequently the subject of research.
- The study used a large population-based random sample based on birth registration.
- The response rate was 47% and in common with other surveys there was under-representation of hard-to-reach groups.
- The study was a cross-sectional survey conducted at three months postpartum and women may not have accurately remembered some of the details reported.

Factors associated with maternal postpartum fatigue: an observational study

Background

Postpartum fatigue (PPF) has been defined rather variably and generally includes a decreased capacity for physical and mental activity after childbirth, a persistent lack of energy, impairments in concentration and attention not easily relieved by rest or sleep (1-7). It occurs within a context of situational factors, with a range of demographic, individual, antenatal and postnatal clinical factors that may influence the experience of women and their families.

The prevalence of postpartum fatigue has not been studied extensively as it has been perceived as an unavoidable, temporary and relatively trivial symptom commonly experienced in early parenthood. It is typically marked by disrupted sleep due to night-waking infants, difficulties settling the baby, and night time feeding.

Literature findings relating to the prevalence of PPF vary according to measurement methods and timing of measurement after birth. Apart from simple self-report symptom checklists which ask about fatigue, tiredness, exhaustion, and vitality, there are a number of scales relating to fatigue including the Lee Fatigue Scale (8), the Fatigue Assessment Scale (9) and Vitality sub-scale of the Psychological General Well-being Index (10). However, these measures were not developed specifically for PPF where different issues, such as interrupted sleep, may be more salient. Use of a simple self-report symptom question has suggested the proportion of women with PPF to be 42% in the first few days after birth (11), 37-64% at five to six weeks (12, 13), 25-67% at 12-24 weeks (12, 14), and 18-66% at 1-2 years (12, 14). These wide variations in prevalence may, to some extent, be due to severity: in one study (15) 83% of women were fatigued at 4-6 weeks but none considered it a major problem.

Different groups of women in the population may also differ in the prevalence of PPF. For example, in a study of low income American women 63% reported being severely fatigued at both one and

three months (16), whereas only 25% of recent mothers reported PPF in a relatively affluent Dutch population (12). Clinical issues reported to be associated with higher rates of PPF include aspects of the pregnancy and birth such as antenatal fatigue, longer duration of labour and instrumental or operative delivery, and clinical problems in the postpartum period such as anaemia, infection and haemorrhage (12, 17-20). At the same time demographic and situational factors such as low socioeconomic status, unemployment, primiparity, and higher maternal age were associated, although not found to be significant in all studies (21). For example, some reported that socioeconomic disadvantage was associated with poorer sleep and higher rates of PPF(22, 23), but a review of PPF commented that middle income women appeared to be at highest risk(17).

Due to the parental nocturnal infant caregiving that is needed sleep disruption in the early postpartum period is normal. Sleep efficiency, the proportion of time spent asleep relative to time spent in bed, is lowest immediately after birth and thereafter improves as the baby's sleep pattern shifts to nocturnal hours (22). However, in exhausted mothers melatonin is transmitted to the infant in breast milk which can delay the establishment of mature sleep cycles (18). PPF has been shown to be related to fragmented sleep (24) but not sleep more generally (25). It also seems that women who worry more about insufficient milk and those with breastfeeding problems tend to have higher levels of fatigue (26) possibly due to spending more time involved in breastfeeding. However, overall the relationship between PPF and breastfeeding is unclear with some studies reporting an association (12, 26), others not (21, 27).

Maternal wellbeing is of concern postnatally and several studies have examined the relationship between PPF and depression (3, 4, 15, 16, 19, 28, 29). While PPF may have a role in contributing to depression, it is thought to be a separate although related theoretical construct. While the two are correlated, it is unclear to what degree depression leads to fatigue, or fatigue to depression; they do not necessarily occur contemporaneously. In one study, fatigue at one week predicted depression at four weeks (19).

Few studies have been carried out on the association between maternal fatigue and attachment to the baby. However, infant characteristics, such as preterm birth, have been found to be associated with both maternal fatigue and delayed infant attachment (30). Similarly, a study which examined maternal fatigue and maternal-infant attachment following different modes of delivery and different rooming-in policies, found that the mother-infant relationship was adversely affected when women were experiencing particular fatigue following caesarean delivery (18).

A qualitative interview-based study which used a fatigue symptoms checklist (7) reported that social and practical support from a woman's partner or family was the strongest factor in protection against postnatal fatigue (16). Similarly, it is assumed, but not proven, that more support from midwives is likely to have a beneficial effect(31). In the UK, postnatal care is provided in the community by midwives for the first few weeks, and thereafter by health visitors. Women normally see their general/family practitioner (GP) about six weeks after birth for a postnatal check.

The time points chosen in this study reflect the different situations of very recent mothers (10 days after giving birth) ((11), physical recovery and adjustment in the relatively short term to the presence of a new baby (one month)(12) and to changing infant behaviour and the developing relationship over a slightly longer period (three months)(32, 33) as well as those used in other studies (12, 13, 16).

The purpose of the present study was to address the following research questions:

- What is the prevalence of PPF at 10 days, one month and three months?
- What are the sociodemographic and clinical characteristics of women who experience PPF at 10 days, one month and three months after childbirth?
- Is there an association between maternal PPF and the mother-infant relationship at three months?
- Is there an association between partner and midwifery support in the postnatal period and PPF?

Methods

National Maternity Survey 2014

This study used data from the cross-sectional National Maternity Survey conducted in England in 2014 (34). A random sample of 10,000 women who gave birth during a two week period, excluding those aged less than 16 years and those whose baby had died, were selected by the Office for National Statistics from birth registrations. They were sent a questionnaire 12 weeks after the birth asking about clinical events and care during pregnancy, labour and birth, and in the postnatal period. Questionnaires could be returned by Freepost, completed online, or completed by telephone with the aid of an interpreter if necessary. Up to three reminders were sent to non-respondents using a tailored reminder system (35).

Exposure and outcome measures

Women were asked questions about postnatal health including 'Did you experience any of the following 10 days, one month, and three months after the birth of your baby?' as used in previous national maternity surveys with answer options including 'Fatigue/severe tiredness' among various other postnatal symptoms. The time points of 10 days, one month and three months had been selected pragmatically to reflect the range of experience up to the time of the survey. Women were asked whether they had mental health problems, and asked to complete the Edinburgh Postnatal Depression Scale (EPDS). Questions were also asked about sociodemographic variables, including age, parity, Index of Multiple Deprivation (an area based measure representing the level of socioeconomic deprivation of the neighbourhoods in which respondents lived comprising elements related to income, employment, education, health, crime, barriers to housing and services, and living environment), ethnicity and age on completing full-time education; pre-pregnancy and antenatal health and well-being, variables related to labour and birth, including duration of labour and mode

of delivery; multiple birth, a checklist relating to postnatal maternal health and symptoms; infant health and feeding at three months; perceptions of their baby at three months indicated by number of positive and negative adjectives circled from a list of 16, and indicators of maternal-infant relationship reflected in women's sense of when their baby belonged to them on a six point scale ranging from 'during pregnancy' to 'not quite yet', and whether she considered her baby more or less difficult than average. Postnatal partner support was estimated by summing scores for five activities: changing baby's nappy, supporting feeding, helping when the baby cries, bathing the baby, and playing with the baby; each scored 1-4 and summed (high score = more support). Midwifery support was estimated by women responding that they had/had not received enough help and advice about the baby's crying, sleeping and feeding, also whether the woman would have liked to see the midwife more or less often in the postnatal period. The full list of variables included in the analysis is given Supplementary data.

Analyses

The data were analysed descriptively using proportions and means as appropriate. A cut-off of 13 or more was used for the EPDS. Associations with PPF were tested using the Chi-square test. Variables which were statistically significant at $p<0.001$ (due to the large number of comparisons) were entered into binary logistic regression to determine the key predictors of PPF. Variables were entered in four groups: i) sociodemographic variables; ii) antenatal and intrapartum variables; iii) indicators of the mother-infants relationship; iv) partner and midwife support. Analyses were carried out separately for PPF at 10 days, one month and three months as it was anticipated that different variables may be important at different time points. All logistic regression analyses were adjusted for maternal age, parity, Index of Multiple Deprivation, ethnicity, and age left full-time education as these were potential confounding factors. A full case analysis was carried out as missing data were generally less than five per cent.

Patient and public involvement

Patients were not directly involved in the conceptualisation or design of this study. Women were selected at random for the survey by the Office for National Statistics from birth registrations. The survey questions, including those relating to postnatal health, were developed in consultation with a Research Advisory Group with representatives from user groups, maternity services liaison committees and members of national charities associated with maternity care. The reports from the National Maternity Surveys are available on the NPEU website.

Ethical approval for the survey was obtained from the NRES committee for Yorkshire and The Humber – Humber Bridge (REC reference 14/YH/0065).

Results

In total 4578 women completed and returned questionnaires (47% response rate after exclusion of undeliverable questionnaires). Response was such that women born outside the UK, younger women and those resident in more deprived areas were significantly less likely to respond (34).

Prevalence of PPF

According to the symptom checklist, 38.8%, 27.1% and 11.4% of women experienced fatigue/severe tiredness at 10 days, one month and three months respectively. Of those women who reported PFF at 10 days, 46% also reported it at one month; however, of those who reported PFF at one month, only 30% also reported it at three months. These figures varied significantly by maternal age, Index of Multiple Deprivation (an area based measure of deprivation), whether the woman had left full-time education before age 16, and parity, such that PPF was more common in women who were older, primiparous, more highly educated, and resident in *less* deprived areas. There were marginal differences by ethnicity (Table 1).

Associations between risk factors and PPF

Sociodemographic and predictive variables that were significantly associated with PPF ($p<0.001$) in univariate analyses were entered into binary logistic regressions separately for PFF at 10 days, one month and three months; the results are shown in Table 2. Different variables were important at different times with the exception of maternal age which was significant throughout. Women aged 20-24 years were significantly less at risk of PPF at each time point compared to those aged 30-34, with Odds ratios of 0.60, 0.45 and 0.40 respectively at 10 days, one month and three months. At one month women aged 25-29 years were also at significantly reduced risk (OR = 0.58), and at three months women aged 40 or over were at significantly increased risk (OR = 2.00) compared to those aged 30-34 years. Multiparous women were at significantly reduced risk of PPF at one month and, to a lesser extent, at 10 days compared to primiparous women. Leaving full-time education aged 16 years or less was significantly protective at 10 days but not subsequently. Reported postnatal health problems, particularly depression and anxiety, were significantly associated with PPF at each time point. In addition, at 10 days and one month post-traumatic stress disorder (PTSD) symptoms were significantly raised and, at three months sleep problems not associated with the baby were higher in women who had PPF. Women who were still breastfeeding at three months, either exclusively or partially, were also at increased risk of PPF. Raised EPDS, although statistically significant in the univariate analysis, dropped out in the multivariate logistic regression.

The mother-infant relationship

Table 3 shows the indicators of maternal-infant attachment in women with and without PPF at 10 days, one month and three months adjusted for sociodemographic variables. At each time point, women who had PPF used significantly more negative adjectives to describe their baby and perceived their baby as more difficult than average. Women who had PPF, especially at three months, experienced significant delay in feeling that their baby belonged to them in addition to having more negative feelings about their baby, although it was relatively uncommon for women to describe their baby as belonging to them 'not quite yet' (n= 29).

Partner and midwife support

We postulated that women who had less support from their partner may be at greater risk of PPF. However, this was not borne out in the results (Table 4). On the contrary, after adjustment for sociodemographic variables, women whose partner was more involved in practical postnatal care (changing nappies, supporting feeding, helping when the baby cried, bathing and playing with the baby) were *more* likely to be experiencing PPF at three months and, to a lesser degree, at one month. Similarly, number of days of paternity leave was positively associated with PPF at one month although this was of only marginal significance.

Women with PPF at three months were significantly more likely to be seen for longer by their midwife in the postnatal period, however these women were also significantly less likely to report that they saw the midwife as much as they wanted. Women with PPF were also more likely to report not receiving enough help and advice about the baby's feeding (at 10 days), crying (at one month), and sleeping (at three months). Women with PPF also tended to use more peer, online and web support, with Odds ratios (95% confidence interval) of 1.45 (1.26, 1.67), 1.25 (1.08, 1.45), and 1.35 (1.17, 1.55) respectively for women with PPF at 10 days, and slightly lower Odds ratios at one and three months (data not shown).

Women were asked about physical well-being in the first few days and at three months after giving birth with answer options 'very well', 'quite well', 'tired and uncomfortable', 'exhausted', and 'very ill'. In the first few days and at three months 13% and 5% respectively reported feeling 'Exhausted', but of these women only 68% and 55% respectively also reported feeling 'Fatigue/severe tiredness'. Women who reported feeling 'exhausted' or 'very ill' were also significantly more likely to report feeling that their baby belonged to them 'only recently' or 'not quite yet' (15.6% of 'exhausted', 14.3% of 'very ill' women reported 'only recently/not quite yet' compared to 4.8% overall).

Discussion

This study provides new data on the prevalence of PPF at 10 days, one month and three months based on women's own report. It clarifies the role of demographic, clinical and care factors in relation to PPF and, importantly, describes the associations with mother-infant relationship and partner and midwife support. The prevalence findings for PPF after giving birth were 38.8%, 27.1% and 11.4% at 10 days, one month and three months respectively in this large scale population-based study. These figures are somewhat lower than estimates from other studies (11-14) which may reflect the manner in which the questions were asked. For example, in a US study using a 30 item checklist (3), 44% of women were 'severely fatigued' at 12 weeks whereas the current survey used self-report of 'Fatigue/severe tiredness'. Women were asked about general physical well-being in the first few days and at three months after giving birth: 13% and 5% respectively reported feeling 'exhausted' but of these women, only two thirds or less also reported having 'Fatigue/severe tiredness'. This indicates that framing effects and how the question is asked may affect response.

The importance of older maternal age and primiparity as risk factors for PPF has been previously recognised (7, 26, 36), however low education and low socioeconomic status were previously thought to be risk factors (17, 23) whereas in this population based study they were protective against PPF. Even when assessed in binary logistic regression, women aged less than 30 and those who had left full-time education aged less than 16 years were consistently at lower risk of PPF. Residence in the most deprived quintile was also protective against PFF at three months but this was of only marginal significance. It has been postulated that there are several different types of fatigue: normal, pathophysiological, situational and psychological (23) and it is possible that risk factors differ between these groups.

Clinical factors such as operative or instrumental delivery were associated with PPF in univariate analyses, but only duration of labour was positively associated with fatigue at each time point in the multivariate analyses, consistent with the literature (17). As has been reported elsewhere (3, 4, 19),

poorer maternal mental health, as indicated by postnatal depression and anxiety, were strongly associated with PPF, especially at three months. Women may have felt that it was normal to be tired, to experience low mood in the early weeks after childbirth, but significant fatigue at three months begins to be perceived as a problem.

The association between breastfeeding and PPF was strongest at three months especially for women who combined breast and bottle feeding. Although this makes sense intuitively, previous research has not reported on associations between mixed feeding and PPF; findings from other studies relating to breastfeeding and PPF vary (21, 26, 27).

Maternal-infant attachment appears to be negatively affected by PPF, such women being more likely to report that they felt their baby belonged to them only relatively recently, using more negative terms to describe their baby, and they considered their baby more difficult than average. It is possible that these babies were actually more difficult: slightly more of them were premature and more had health problems at three months, suggesting that poor infant health is a contributor to PPF. Other research has also found that, after adjusting for maternal depression and anxiety, positive infant behaviour, as indicated by smile count, is associated with positive maternal attachment (37). These findings reflect the complexity of the relationship between PPF, maternal attachment and infant health and behaviour.

Some previous research has also reported associations between PPF and maternal-infant attachment (3, 12, 16, 22, 38). Other reported associations include poorer mental and physical health, difficulties with relationships and employment, and early weaning (2, 4, 14, 18, 21, 26). Personal and social development and eye-hand coordination aspects of infant development, as measured using the Griffiths Scales, were also significantly affected in infants of chronically fatigued mothers (38). In one qualitative interview study (16), chronically fatigued women used more negative language in describing their baby or themselves, such as “Angry,” “Body shut down,” “Resent baby,” “Beat/Exhausted,” “Overwhelmed,” and “Can’t think straight.”

An important finding of this study is that support from partners was greatest in women who were suffering from PPF, suggesting reverse causality, that partners were taking more paternity leave and were more involved in baby care because it was needed. This would parallel the 'compensation/buffering' model (39) in which partners of women with depression became more involved in baby care, to compensate for poorer maternal wellbeing and fatigue.

Longer postnatal contact with the midwife was greatest for women with PPF, again suggesting that help was being targeted where it was needed. Even so, women with PPF were significantly less likely to report that they saw a midwife as much as they would have liked or that they received enough help and advice about baby care from midwives. It may be that, even though these women received more support than average, they would have liked more. It may also be the case that the type of support was unhelpful, particularly lacking continuity. Barriers to continuity of postnatal carer include shift patterns, part-time work, staff shortages and travel time (40). However, individualised, women-centred care can still be achieved with good communication and antenatal care planning (41).

Strengths and limitations

This study was based on a large population based random sample of recent mothers, with considerable diversity among respondents. The importance of some specific risk, care and individual factors was identified. However, the response rate was 47% and, in common with many other surveys (42-44), there was significant under-representation of hard-to-reach groups. PPF was as reported by women using a single item as part of a symptom checklist rather than one of the many scales. The cross-sectional survey was conducted at three months postpartum and thus causality cannot be inferred from associations found and women may not have accurately remembered some of the details reported. In particular, while fatigue at the time of the survey is likely to be accurately reported, fatigue at 10 days and one month may be less accurately recollected and subject to recall

bias. However, studies comparing women's reports of events around childbirth with medical records or other recorded data have demonstrated good recall (45, 46).

Implications for healthcare professionals

These finding highlight that, for some women, PPF can be severe and long lasting and may require intervention. Several interventions to reduce PPF have been evaluated in good quality randomised controlled studies (14, 22, 31, 47, 48). These were a mixture of self-management, telephone support, exercise, and education and all were reported to be beneficial except for the purely self-directed intervention which used the Tiredness Management Guide to help women to self-manage their fatigue (48). Supportive interventions and availability of additional advice and support targeted to those women with the greatest need is to be encouraged. The nature of the additional advice and support should be tailored to the needs of individual women. The association with more negative perceptions of their infant and of infants who may have been ill or born preterm may be a key point for health professionals working in postnatal care to consider. There is also a need for antenatal preparation for women and their partners in approaching the transition to parenthood so that they have realistic expectations, can enlist practical help and emotional support when required postnatally, and enhance their own coping skills.

Implications for research

The cross-sectional nature of this study has precluded teasing out of the interaction between PPF and postnatal depression. Although the two are clearly linked, the nature of the relationship is unclear. Further exploration of the impact of PPF on the developing mother-child and partner relationships, and the influence of method of infant feeding, in prospective longitudinal studies is also likely to better elucidate the way in which individual differences may contribute. There is a wide range of estimates of point and period prevalence of PPF in the literature which requires further elucidation.

Conclusions

Postpartum fatigue is not inevitable or universal, although early in the postnatal period it affects a substantial proportion of women. Associations with infant characteristics and maternal attachment are described which may affect families. Predictors of postpartum fatigue include age and parity; possible protective factors include practical help and support from partners, as well as input from midwives.

List of abbreviations

CS Caesarean section; EPDS Edinburgh Postnatal Depression Scale; MW midwife; OR Odds ratio; PN postnatal; PPF Postpartum fatigue; PTSD post-traumatic stress disorder; SVD Spontaneous vaginal delivery

Declarations

Ethics approval and consent to participate

Ethical approval for the survey was obtained from the NRES committee for Yorkshire and The Humber – Humber Bridge (REC reference 14/YH/0065). Completion and return of the questionnaire was taken as implicit consent to participate.

Consent for publication – N/A

Availability of data and materials – Further analyses of these data are planned. The data will be made available by the NPEU when these are complete.

Competing interests – The authors declare that they have no competing interests.

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Authors' contributions

MR designed the National Maternity Survey; MR, FA and JH were responsible for the research questions; JH analysed the data; MR, FA, and JH wrote the manuscript.

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Table 1 – Description of sample sociodemographic characteristics

	Fatigue at 10 days					Fatigue at 1 month					Fatigue at 3 months				
	Yes		No		*p*	Yes		No		*p*	Yes		No		*p*
	n	%	n	%		n	%	n	%		n	%	n	%	
Maternal age (years)															
16-19	40	2.3	60	2.2		24	2.0	76	2.3		10	1.9	90	2.2	
20-24	164	9.3	366	13.2		99	8.1	431	13.1		28	5.4	502	12.5	
25-29	475	27.0	742	26.8		263	21.4	954	28.9		120	23.2	1097	27.3	
30-34	634	36.1	939	33.9		477	38.8	1096	33.2		192	37.1	1381	34.4	
35-39	347	19.7	522	18.8		279	22.7	590	17.9		114	22.0	755	18.8	
40+	98	5.6	143	5.2		87	7.1	154	4.7		54	10.4	187	4.7	
Total	1758	100.0	2772	100.0	**	1229	100.0	3301	100.0	***	518	100.0	4012	100.0	***
Index of Multiple Deprivation															
1	373	21.2	524	18.9		285	23.2	612	18.5		129	25.0	768	19.1	
2	334	19.0	525	18.9		273	22.2	586	17.7		97	18.8	762	19.0	
3	377	21.4	550	19.8		244	19.9	683	20.7		113	21.9	814	20.3	
4	366	20.8	602	21.7		234	19.1	734	22.2		109	21.1	859	21.4	
5 (most deprived)	308	17.5	572	20.6		192	15.6	688	20.8		69	13.3	811	20.2	
Total	1758	100.0	2773	100.0	*	1228	100.0	3303	100.0	***	517	100.0	4014	100.0	**
Ethnicity															
White	1443	83.3	2270	84.4		1041	85.9	2672	83.2		434	84.8	3279	83.8	
Mixed	35	2.0	52	1.9		28	2.3	59	1.8		12	2.3	75	1.9	
Asian	194	11.2	248	9.2		106	8.7	336	10.5		43	8.4	399	10.2	
Black	48	2.8	110	4.1		29	2.4	129	4.0		18	3.5	140	3.6	
Other	12	0.7	11	0.4		8	0.7	15	0.5		5	1.0	18	0.5	
Total	1732	100.0	2691	100.0	*	1212	100.0	3211	100.0	*	512	100.0	3911	100.0	

Left full-time education aged <16 years															
No	1525	87.4	2198	80.4		1068	87.8	2655	81.4		450	87.5	3273	82.5	
Yes	220	12.6	537	19.6		149	12.2	608	18.6		64	12.5	693	17.5	
Total	1745	100.0	2735	100.0	***	1217	100.0	3263	100.0	***	514	100.0	3966	100.0	**
Parity															
Primiparous	973	56.4	1232	45.6		672	55.9	1533	47.5		247	48.4	1958	50.0	
Multiparous	752	43.6	1470	54.4		531	44.1	1691	52.5		263	51.6	1959	50.0	
Total	1725	100.0	2702	100.0	***	1203	100.0	3224	100.0	***	510	100.0	3917	100.0	

* p<0.05 ** p<0.01 *** p<0.001

Table 2 – Predictors of PPF – Binary logistic regression

		Fatigue at 10 days	Fatigue at 1 month	Fatigue at 3 months
		Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Maternal age (years)	16-19	0.91 (0.55, 1.51)	0.64 (0.36, 1.15)	1.01 (0.45, 2.24)
	20-24	0.62 (0.48, 0.79)***	0.54 (0.40, 0.71)***	0.44 (0.28, 0.70)**
	25-29	0.91 (0.76, 1.09)	0.63 (0.52, 0.77)***	0.87 (0.66, 1.14)
	30-34	1.00 (ref)		
	35-39	1.00 (0.83, 1.22)	1.13 (0.92, 1.39)	1.04 (0.79, 1.38)
	40+	1.20 (0.86, 1.66)	1.39 (0.99, 2.95)	2.00 (1.34, 2.98)**
Parity	Primiparous	1.00 (ref)		
	Multiparous	0.83 (0.71, 0.97)*	0.81 (0.68, 0.97)*	1.21 (0.95, 1.54)
Left full-time education	aged16 or more years	1.00 (ref)		
	aged <16 yrs	0.64 (0.52, 0.78)***	0.74 (0.59, 0.93)*	0.82 (0.60, 1.13)
Mode of delivery	SVD	1.00 (ref)		
	Instrumental	1.23 (1.00, 1.52)	0.99 (0.79, 1.25)	0.87 (0.63, 1.21)
	Planned CS	1.03 (0.83, 1.27)	1.21 (0.96, 1.52)	1.30 (0.96, 1.76)
	CS due to unforeseen problem	1.06 (0.84, 1.34)	1.09 (0.85, 1.41)	1.06 (0.75, 1.51)
Labour duration (mins)[1]		1.00 (1.00, 1.00)*	1.00 (1.00, 0.00)*	1.00 (1.00, 1.00)**
Postnatal depression	10 days	2.08 (1.79, 2.42)***	1.65 (1.40, 1.95)***	1.24 (0.98, 1.56)
	1 month	1.27 (1.03, 1.56)*	2.13 (1.72, 2.63)***	1.28 (0.96, 1.71)
	3 months	1.17 (0.86, 1.60)	1.62 (1.18, 2.23)**	2.99 (2.13, 4.21)***
Postnatal anxiety	10 days	2.49 (2.04, 3.04)***	1.36 (1.10, 1.67)**	1.13 (0.84, 1.52)
	1 month	1.28 (0.98, 1.67)	2.77 (2.13, 3.61)***	1.54 (1.09, 2.18)*
	3 months	0.87 (0.61, 1.25)	1.08 (0.76, 2.55)	2.42 (1.65, 3.56)***
Postnatal sleep	10 days	1.05 (0.72, 1.54)	0.95 (0.64, 1.41)	0.80 (0.46, 1.38)
	1 month	1.39 (0.92, 2.08)	0.90 (0.58, 2.38)	0.95 (0.55, 1.65)
	3 months	1.04 (0.67, 1.59)	2.20 (1.43, 4.38)***	2.87 (1.80, 4.60)***
PTSD	10 days	4.31 (2.88, 6.45)***	1.02 (0.70, 1.48)	0.79 (0.48, 1.32)

	1 month	0.78	(0.48, 1.27)	3.67	(2.27, 9.92)***	1.40	(0.79, 2.48)
	3 months	0.88	(0.48, 1.61)	0.61	(0.33, 1.12)	1.84	(1.00, 3.38)*
Postnatal mental health problems		0.93	(0.72, 1.21)	0.59	(0.44, 0.79)***	0.76	(0.53, 1.09)
Infant feeding at 3 months	Formula only	1.00 (ref)					
	Breast only	1.06	(0.91, 1.24)	1.19	(1.00, 1.42)	1.38	(1.08, 1.76)*
	Combined	1.17	(0.95, 1.45)	1.33	(1.06, 1.67)*	1.73	(1.29, 2.33)***
	Other	0.30	(0.06, 1.45)	0.97	(0.21, 7.50)	0.59	(0.06, 5.68)
Infant health poor at 3 months		1.22	(1.00, 1.49)	1.14	(0.91, 1.41)	1.52	(1.15, 2.00)*

1 Duration of labour in minutes marginally positively associated with PPF

* p<0.05 ** p<0.01 *** p<0.001 PTSD Post-traumatic stress disorder PN Postnatal SVD Spontaneous vaginal delivery CS Caesarean section

NB –Only variables significant in earlier iterations of logistic regression included (see Appendix for full list of variables)

Table 3 – Indicators of maternal-infant attachment associated with PPF – Binary logistic regression adjusted for sociodemographic factors[1]

	Fatigue at 10 days		Fatigue at 1 month		Fatigue at 3 months	
	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)
When woman first felt baby belonged						
During pregnancy	1 (ref)		1 (ref)		1 (ref)	
Immediately after birth	0.96	(0.81, 1.13)	0.90	(0.75, 1.09)	0.96	(0.74, 1.26)
First few days	1.27	(1.02, 1.57)*	1.28	(1.02, 1.62)*	1.77	(1.31, 2.39)***
First few weeks	1.60	(1.27, 2.00)***	1.61	(1.27, 2.05)***	1.39	(0.99, 1.95)
Only recently	2.12	(1.52, 2.94)***	2.23	(1.60, 3.10)***	2.52	(1.68, 3.77)***
Not quite yet	2.48	(1.14, 5.43)*	2.90	(1.34, 6.27)**	4.13	(1.77, 9.64)**
Number of negative adjectives used about baby						
0	1 (ref)		1 (ref)		1 (ref)	
1	1.20	(1.01, 1.43)*	1.21	(0.99, 1.48)	1.27	(0.94, 1.70)
2 or more	1.64	(1.35, 2.00)***	1.52	(1.22, 1.89)***	1.86	(1.36, 2.54)***
Baby considered more or less difficult than average						
Difficult	1 (ref)		1 (ref)		1 (ref)	
Average	0.52	(0.37, 0.73)***	0.60	(0.43, 0.84)**	0.36	(0.25, 0.52)***
Easier	0.42	(0.30, 0.60)***	0.44	(0.31, 0.63)***	0.30	(0.20, 0.45)***

* p<0.05 ** p<0.01 *** p<0.001

1 Adjusted for maternal age, parity, Index of Multiple Deprivation, ethnicity, age left full-time education

Table 4 –Protective factors associated with PPF – Binary logistic regression adjusted for sociodemographic factors[1]

	Fatigue at 10 days		Fatigue at 1 month		Fatigue at 3 months	
	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)
Single mother	1.19	(0.87, 1.62)	1.22	(0.86, 1.71)	0.82	(0.50, 1.33)
Score for partner help PN [2]	1.00	(0.98, 1.03)	1.05	(1.02, 1.08)**	1.12	(1.08, 1.16)***
Days of paternity leave	1.01	(1.00, 1.02)	1.02	(1.00, 1.03)*	1.01	(1.00, 1.03)
Number of times saw a MW at home	1.03	(1.00, 1.07)	1.02	(0.98, 1.06)	1.00	(0.95, 1.06)
Age of baby at last visit (per additional day)	1.00	(1.00, 1.00)	1.00	(1.00, 1.00)	1.01	(1.00, 1.01)***
Would have liked to see a MW…						
more often	1 (ref)					
less often	0.73	(0.49, 1.09)	0.87	(0.57, 1.35)	0.68	(0.37, 1.23)
saw MW as much as wanted	0.81	(0.67, 0.97)*	0.76	(0.62, 0.92)**	0.68	(0.52, 0.88)**
Received enough help and advice about baby's…						
crying	0.79	(0.60, 1.04)	0.69	(0.51, 0.93)*	0.99	(0.65, 1.50)
sleeping	0.82	(0.62, 1.10)	0.81	(0.59, 1.10)	0.50	(0.33, 0.76)**
feeding	0.77	(0.63, 0.95)*	0.86	(0.69, 1.07)	0.92	(0.68, 1.23)

* p<0.05 ** p<0.01 *** p<0.001

[1] Adjusted for maternal age, parity, Index of Multiple Deprivation, ethnicity, age left full-time education

[2] Score for partner help = Changing baby's nappy, Supporting feeding, Helping when the baby cries, Bathing the baby, Playing with the baby; each scored 1-4 and summed (high score = more support)

MW midwife; PN postnatally

Appendix 1 – Variables included in analysis

Sociodemographic variables
Maternal age
Index of Multiple Deprivation (quintile)
Ethnicity (5 categories)
Left full-time education aged <16 yrs
Parity

Pre-pregnancy health
Long-standing physical health problem or disability
Long-standing mental health problem or learning disability

Antenatal health and well-being
Anxiety
Depression
Mental health problem

Long-term health problem complicating pregnancy
Pregnancy-specific problem

Labour and birth
Duration of labour
Mode of delivery
Multiple birth
Gestation at birth
Baby admitted to neonatal unit
Baby born <37 weeks' gestation
Baby <2500g at birth

Postnatal variables
Infant feeding in first few days and at 3 mths
Depression at 10 days, 1 mth, 3 mths
Anxiety at 10 days, 1 mth, 3 mths
Sleep problems (not related to the baby) at 10 days, 1 mth, 3 mths
PTSD symptoms at 10 days, 1 mth, 3 mths
EPDS >12 at 3 mths
Infant health at 3 mths

Situational variables in PN period
Employment/maternity leave

Indicators of infant attachment
Woman's sense of when the baby belonged (6 categories: pregnancy-not quite yet)
Positive and negative adjectives used about baby (8 of each)
Baby considered more or less difficult than average

Partner support
Single mother
Amount of paternity leave taken (days)
Score of help with baby care (0-20)

Health professional support
No. home visits by MW
Age of baby at last visit (days)
Would have liked to see MW more/less
Support with baby's crying, sleeping, feeding
Attended baby clinic, drop-in clinic, Children's centre, parents' group, peer support, PN classes, baby café, used online support, parenting website

MW midwife; PN postnatal; EPDS Edinburgh Postnatal Depression Scale; PTSD post-traumatic stress disorder

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Reported on page…
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1/4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4/6
Objectives	3	State specific objectives, including any prespecified hypotheses	4/6
Methods			
Study design	4	Present key elements of study design early in the paper	6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2, 6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6/7, Appendix
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	-
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6/7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6/8
		(*b*) Describe any methods used to examine subgroups and interactions	6/7
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8-9
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Tables 2, 3 & 4

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Tables 2, 3 &4
		(*b*) Report category boundaries when continuous variables were categorized	Tables
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Funding statement Page 16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Factors associated with maternal postpartum fatigue: an observational study

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Factors associated with maternal postpartum fatigue: an observational study

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Abstract

***Objectives*:** To assess the prevalence of postpartum fatigue at 10 days, one month and three months; describe sociodemographic and clinical characteristics of women with fatigue and associations with infant characteristics, maternal-infant attachment and partner and midwifery support.

Setting: Maternity care in England. Secondary analysis of 2014 National Maternity Survey.

Participants: A random sample of 10,000 women selected by the Office for National Statistics, using birth registration records. Women aged less than 16 years or if their baby had died were excluded. Questionnaires were sent to women at three months postpartum and asked about wellbeing and care during pregnancy, labour, birth and postpartum. Specifically, women were asked whether they experienced fatigue/severe tiredness at 10 days, one month or three months postpartum. Responses were received from 4578 women (47% response rate).

Results: Decreasing, but substantial proportions of women, 38.8%, 27.1% and 11.4%, experienced fatigue/severe tiredness at 10 days, one month and three months respectively. These figures varied significantly by maternal age, level of deprivation, education and parity. Women reporting depression, anxiety, sleep problems and those breastfeeding were at significantly increased risk (e.g. OR for depression in women with fatigue at 3 months 2.99 (95% CI 2.13, 4.21)). Significantly more negative language was used by these women to describe their babies and they perceived their baby as more difficult than average (e.g. two or more negative adjectives used by women with fatigue at three months OR 1.86 (95% CI 1.36, 2.54)). Women with postpartum fatigue had greater partner support but were significantly less likely to report seeing the midwife as much as they wanted.

Conclusions: Postpartum fatigue is not inevitable or universal, although early in the postnatal period it affects a substantial proportion of women. Predictors include age and parity but practical help and support from partners and midwives may be protective factors.

Keywords: Postpartum fatigue; Childbirth; Postnatal; Survey; Prevalence; Predictor

Strengths and limitations of this study

- Maternal fatigue after childbirth is often seen as a trivial health issue common to women with young children, but is infrequently the subject of research.
- The study used a large population-based random sample based on birth registration.
- The response rate was 47% and in common with other surveys there was under-representation of hard-to-reach groups.
- The study was a cross-sectional survey conducted at three months postpartum and women may not have accurately remembered some of the details reported.

Factors associated with maternal postpartum fatigue: an observational study

Background

Postpartum fatigue (PPF) has been defined rather variably and generally includes a decreased capacity for physical and mental activity after childbirth, a persistent lack of energy, impairments in concentration and attention not easily relieved by rest or sleep (1-7). It occurs within a context of situational factors, with a range of demographic, individual, antenatal and postnatal clinical factors that may influence the experience of women and their families. The prevalence of postpartum fatigue has not been studied extensively as it has been perceived as an unavoidable, temporary and relatively trivial symptom commonly experienced in early parenthood. It is typically marked by disrupted sleep due to night-waking infants, difficulties settling the baby, and night time feeding.

Literature findings relating to the prevalence of PPF vary according to measurement methods and timing of measurement after birth. Apart from simple self-report symptom checklists which ask about fatigue, tiredness, exhaustion, and vitality, there are a number of scales relating to fatigue including the Lee Fatigue Scale (8), the Fatigue Assessment Scale (9) and Vitality sub-scale of the Psychological General Well-being Index (10). However, these measures were not developed specifically for PPF where different issues, such as interrupted sleep, may be more salient. Use of a simple self-report symptom question has suggested the proportion of women with PPF to be 42% in the first few days after birth (11), 37-64% at five to six weeks (12, 13), 25-67% at 12-24 weeks (12, 14), and 18-66% at 1-2 years (12, 14). These wide variations in prevalence may, to some extent, be due to severity: in one study (15) 83% of women were fatigued at 4-6 weeks but none considered it a major problem.

Different groups of women in the population may also differ in the prevalence of PPF. For example, in a study of low income American women 63% reported being severely fatigued at both one and three months (16), whereas only 25% of recent mothers reported PPF in a relatively affluent Dutch

population (12). Clinical issues reported to be associated with higher rates of PPF include aspects of the pregnancy and birth such as antenatal fatigue, longer duration of labour and instrumental or operative delivery, and clinical problems in the postpartum period such as anaemia, infection and haemorrhage (12, 17-20). At the same time demographic and situational factors such as low socioeconomic status, unemployment, primiparity, and higher maternal age were associated, although not found to be significant in all studies (21). For example, some reported that socioeconomic disadvantage was associated with poorer sleep and higher rates of PPF(22, 23), but a review of PPF commented that middle income women appeared to be at highest risk(17).

Due to the parental nocturnal infant caregiving that is needed, sleep disruption in the early postpartum period is normal. Sleep efficiency, the proportion of time spent asleep relative to time spent in bed, is lowest immediately after birth and thereafter improves as the baby's sleep pattern shifts to nocturnal hours (22). However, in exhausted mothers melatonin is transmitted to the infant in breast milk which can delay the establishment of mature sleep cycles (18). PPF has been shown to be related to fragmented sleep (24) but not sleep more generally (25). It also seems that women who worry more about insufficient milk and those with breastfeeding problems tend to have higher levels of fatigue (26) possibly due to spending more time involved in breastfeeding. However, overall the relationship between PPF and breastfeeding is unclear with some studies reporting an association (12, 26), others not (21, 27).

Maternal wellbeing is of concern postnatally and several studies have examined the relationship between PPF and depression (3, 4, 15, 16, 19, 28, 29). While PPF may have a role in contributing to depression, it is thought to be a separate although related theoretical construct. While the two are correlated, it is unclear to what degree depression leads to fatigue, or fatigue to depression; they do not necessarily occur contemporaneously. In one study, fatigue at one week predicted depression at four weeks (19).

Few studies have been conducted to explore the association between maternal fatigue and attachment to the baby. However, infant characteristics, such as preterm birth, have been found to be associated with both maternal fatigue and delayed infant attachment (30). Similarly, a study which examined maternal fatigue and maternal-infant attachment following different modes of delivery and different rooming-in policies, found that the mother-infant relationship was adversely affected when women were experiencing fatigue following caesarean delivery (18).

A qualitative interview-based study which used a fatigue symptoms checklist (7) reported that social and practical support from a woman's partner or family was the strongest factor in protection against postnatal fatigue (16). Similarly, it is assumed, but not proven, that more support from midwives is likely to have a beneficial effect(31). In the UK, postnatal care is provided in the community by midwives for the first few weeks, and thereafter by health visitors. Women normally see their general/family practitioner (GP) about six weeks after birth for a postnatal check.

The time points chosen in this study reflect the different situations of very recent mothers (10 days after giving birth) ((11), physical recovery and adjustment in the relatively short term to the presence of a new baby (one month)(12) and to changing infant behaviour and the developing relationship over a slightly longer period (three months)(32, 33) as well as those used in other studies (12, 13, 16).

This study aimed to focus on individual characteristics and experiences in a large population of women who had recently given birth, addressing the knowledge gaps and variation in prevalence of postnatal fatigue that have been described. Thus the specific purpose of the present study was to address the following research questions:

- What is the prevalence of PPF at 10 days, one month and three months?
- What are the sociodemographic and clinical characteristics of women who experience PPF at 10 days, one month and three months after childbirth?

- Is there an association between maternal PPF and the mother-infant relationship at three months?
- Is there an association between partner and midwifery support in the postnatal period and PPF?

Methods

National Maternity Survey 2014

This study used data from the cross-sectional National Maternity Survey conducted in England in 2014 (34). A random sample of 10,000 women who gave birth during a two week period, excluding those aged less than 16 years and those whose baby had died, were selected by the Office for National Statistics from birth registrations. They were sent a questionnaire 12 weeks after the birth asking about clinical events and care during pregnancy, labour and birth, and in the postnatal period. Questionnaires could be returned by Freepost, completed online, or completed by telephone with the aid of an interpreter if necessary. Up to three reminders were sent to non-respondents using a tailored reminder system (35).

Exposure and outcome measures

Women were asked questions about postnatal health including 'Did you experience any of the following 10 days, one month, and three months after the birth of your baby?' as used in previous national maternity surveys with answer options including 'Fatigue/severe tiredness' among various other postnatal symptoms. The time points of 10 days, one month and three months had been selected pragmatically to reflect the range of experience up to the time of the survey. Women were asked whether they had mental health problems, and asked to complete the Edinburgh Postnatal Depression Scale (EPDS). Questions were also asked about sociodemographic variables, including age, parity, Index of Multiple Deprivation (an area based measure representing the level of

socioeconomic deprivation of the neighbourhoods in which respondents lived comprising elements related to income, employment, education, health, crime, barriers to housing and services, and living environment), ethnicity and age on completing full-time education; pre-pregnancy and antenatal health and well-being, variables related to labour and birth, including duration of labour and mode of delivery; multiple birth, a checklist relating to postnatal maternal health and symptoms; infant health and feeding at three months; perceptions of their baby at three months indicated by number of positive and negative adjectives circled from a list of 16, and indicators of maternal-infant relationship reflected in women's sense of when their baby belonged to them on a six point scale ranging from 'during pregnancy' to 'not quite yet', and whether she considered her baby more or less difficult than average. Postnatal partner support was estimated by summing scores for five activities: changing baby's nappy, supporting feeding, helping when the baby cries, bathing the baby, and playing with the baby; each scored 1-4 and summed (high score = more support). Midwifery support was estimated by women responding that they had/had not received enough help and advice about the baby's crying, sleeping and feeding, also whether the woman would have liked to see the midwife more or less often in the postnatal period. The full list of variables included in the analysis is given Supplementary data.

Analyses

Descriptive statistics were used to describe the prevalence of fatigue at 10 days, one month and three months, with proportions and means as appropriate. Associations with PPF were tested using the Chi-square test. A cut-off of 13 or more was used for the EPDS. To assess the sociodemographic and clinical characteristics of women who experience PPF separate logistic regression models were estimated for each time point. Analyses were thus carried out separately for PPF at 10 days, one month and three months as it was anticipated that different variables may be important at different time points. Four groups were entered: i) sociodemographic variables; ii) antenatal and intrapartum variables; iii) indicators of the mother-infants relationship; iv) partner and midwife support. Due to

the large number of comparisons made in determining the key predictors of PPF, only variables which were statistically significant at p<0.001 were entered into binary logistic regression. All logistic regression analyses were adjusted for maternal age, parity, Index of Multiple Deprivation, ethnicity, and age left full-time education as these were potential confounding factors. A full case analysis was carried out as missing data were generally less than five per cent.

Patient and public involvement

Patients were not directly involved in the conceptualisation or design of this study. Women were selected at random for the survey by the Office for National Statistics from birth registrations. The survey questions, including those relating to postnatal health, were developed in consultation with a Research Advisory Group with representatives from user groups, maternity services liaison committees and members of national charities associated with maternity care. The reports from the National Maternity Surveys are available on the NPEU website.

Ethical approval for the survey was obtained from the NRES committee for Yorkshire and The Humber – Humber Bridge (REC reference 14/YH/0065).

Results

In total 4578 women completed and returned questionnaires (47% response rate after exclusion of undeliverable questionnaires). Response was such that women born outside the UK, younger women and those resident in more deprived areas were significantly less likely to respond (34).

Prevalence of PPF

According to the symptom checklist, 38.8%, 27.1% and 11.4% of women experienced fatigue/severe tiredness at 10 days, one month and three months respectively. Of those women who reported PFF

at 10 days, 46% also reported it at one month; however, of those who reported PFF at one month, only 30% also reported it at three months. These figures varied significantly by maternal age, Index of Multiple Deprivation (an area based measure of deprivation), whether the woman had left full-time education before age 16, and parity, such that PPF was more common in women who were older, primiparous, more highly educated, and resident in *less* deprived areas. There were marginal differences by ethnicity (Table 1).

Associations between risk factors and PPF

Sociodemographic and predictive variables that were significantly associated with PPF ($p<0.001$) in univariate analyses were entered into binary logistic regressions separately for PFF at 10 days, one month and three months; the results are shown in Table 2. Different variables were important at different times with the exception of maternal age which was significant throughout. Women aged 20-24 years were significantly less at risk of PPF at each time point compared to those aged 30-34, with Odds ratios of 0.60, 0.45 and 0.40 respectively at 10 days, one month and three months. At one month women aged 25-29 years were also at significantly reduced risk (OR = 0.58), and at three months women aged 40 or over were at significantly increased risk (OR = 2.00) compared to those aged 30-34 years. Multiparous women were at significantly reduced risk of PPF at one month and, to a lesser extent, at 10 days compared to primiparous women. Leaving full-time education aged 16 years or less was significantly protective at 10 days but not subsequently. Reported postnatal health problems, particularly depression and anxiety, were significantly associated with PPF at each time point. In addition, at 10 days and one month post-traumatic stress disorder (PTSD) symptoms were significantly raised and, at three months sleep problems not associated with the baby were higher in women who had PPF. Women who were still breastfeeding at three months, either exclusively or partially, were also at increased risk of PPF. Raised EPDS, although statistically significant in the univariate analysis, dropped out in the multivariate logistic regression.

The mother-infant relationship

Table 3 shows the indicators of maternal-infant attachment in women with and without PPF at 10 days, one month and three months, adjusted for sociodemographic variables. At each time point, women who had PPF used significantly more negative adjectives to describe their baby and perceived their baby as more difficult than average. Women who had PPF, especially at three months, experienced significant delay in feeling that their baby belonged to them in addition to having more negative feelings about their baby, although it was relatively uncommon for women to describe their baby as belonging to them 'not quite yet' (n= 29).

Women were also asked about physical well-being in the first few days and at three months after giving birth with answer options 'very well', 'quite well', 'tired and uncomfortable', 'exhausted', and 'very ill'. In the first few days and at three months 13% and 5% respectively reported feeling 'Exhausted', but of these women only 68% and 55% respectively also reported feeling 'Fatigue/severe tiredness'. Those who reported feeling 'exhausted' or 'very ill' were also significantly more likely to report feeling that their baby belonged to them 'only recently' or 'not quite yet' (15.6% of 'exhausted', 14.3% of 'very ill' women reported 'only recently/not quite yet' compared to 4.8% overall).

Partner and midwife support

We postulated that women who had less support from their partner may be at greater risk of PPF. However, this was not borne out in the results (Table 4). On the contrary, after adjustment for sociodemographic variables, women whose partner was more involved in practical postnatal care (changing nappies, supporting feeding, helping when the baby cried, bathing and playing with the baby) were *more* likely to be experiencing PPF at three months and, to a lesser degree, at one month. Similarly, number of days of paternity leave was positively associated with PPF at one month although this was of only marginal significance.

Women with PPF at three months were significantly more likely to be seen for longer by their midwife in the postnatal period, however these women were also significantly less likely to report that they saw the midwife as much as they wanted. Women with PPF were also more likely to report not receiving enough help and advice about the baby's feeding (at 10 days), crying (at one month), and sleeping (at three months). Women with PPF also tended to use more peer, online and web support, with Odds ratios (95% confidence interval) of 1.45 (1.26, 1.67), 1.25 (1.08, 1.45), and 1.35 (1.17, 1.55) respectively for women with PPF at 10 days, and slightly lower Odds ratios at one and three months (data not shown).

Discussion

This study provides new data on the prevalence of PPF at 10 days, one month and three months based on women's own report. It clarifies the role of demographic, clinical and care factors in relation to PPF and, importantly, describes the associations with mother-infant relationship and partner and midwife support. The prevalence findings for PPF after giving birth were 38.8%, 27.1% and 11.4% at 10 days, one month and three months respectively in this large scale population-based study. These figures are somewhat lower than estimates from other studies (11-14) which may reflect the manner in which the questions were asked. For example, in a US study using a 30 item checklist (3), 44% of women were 'severely fatigued' at 12 weeks whereas the current survey used self-report of 'Fatigue/severe tiredness'. Women were asked about general physical well-being in the first few days and at three months after giving birth: 13% and 5% respectively reported feeling 'exhausted' but of these women, only two thirds or less also reported having 'Fatigue/severe tiredness'. This indicates that framing effects and how the question is asked may affect response.

The importance of older maternal age and primiparity as risk factors for PPF has been previously recognised (7, 26, 36), however low education and low socioeconomic status were previously thought to be risk factors (17, 23) whereas in this large population based study they were protective

against PPF. Even when assessed in binary logistic regression, women aged less than 30 and those who had left full-time education aged less than 16 years were consistently at lower risk of PPF. Residence in the most deprived quintile was also protective against PFF at three months but this was of only marginal significance. It has been postulated that there are several different types of fatigue: normal, pathophysiological, situational and psychological (23) and it is possible that risk factors differ between these groups.

Clinical factors such as operative or instrumental delivery were associated with PPF in univariate analyses, but only duration of labour was positively associated with fatigue at each time point in the multivariate analyses, consistent with the literature (17). As has been reported elsewhere (3, 4, 19), poorer maternal mental health, as indicated by postnatal depression and anxiety, were strongly associated with PPF, especially at three months. Women may have felt that it was normal to be tired, to experience low mood in the early weeks after childbirth, but significant fatigue at three months begins to be perceived as a problem.

The association between breastfeeding and PPF was strongest at three months especially for women who combined breast and bottle feeding. Although this makes sense intuitively, previous research has not reported on associations between mixed feeding and PPF; findings from other studies relating to breastfeeding and PPF vary (21, 26, 27).

Maternal-infant attachment appears to be negatively affected by PPF, such women being more likely to report that they felt their baby belonged to them only relatively recently, using more negative terms to describe their baby, and they considered their baby more difficult than average. It is possible that these babies were actually more difficult: slightly more of them were premature and more had health problems at three months, suggesting that poor infant health is a contributor to PPF. Other research has also found that, after adjusting for maternal depression and anxiety, positive infant behaviour, as indicated by smile count, is associated with positive maternal

attachment (37). These findings reflect the complexity of the relationship between PPF, maternal attachment and infant health and behaviour.

Some previous research has also reported associations between PPF and maternal-infant attachment (3, 12, 16, 22, 38). Other reported associations include poorer mental and physical health, difficulties with relationships and employment, and early weaning (2, 4, 14, 18, 21, 26). Personal and social development and eye-hand coordination aspects of infant development, as measured using the Griffiths Scales, were also significantly affected in infants of chronically fatigued mothers (38). In one qualitative interview study (16), chronically fatigued women used more negative language in describing their baby or themselves, such as “Angry,” “Body shut down,” “Resent baby,” “Beat/Exhausted,” “Overwhelmed,” and “Can’t think straight.”

An important finding of this study is that support from partners was greatest in women who were suffering from PPF, suggesting reverse causality, that partners were taking more paternity leave and were more involved in baby care because it was needed. This would parallel the ‘compensation/buffering’ model (39) in which partners of women with depression became more involved in baby care, to compensate for poorer maternal wellbeing and fatigue.

Longer postnatal contact with the midwife was greatest for women with PPF, again suggesting that help was being targeted where it was needed. Even so, women with PPF were significantly less likely to report that they saw a midwife as much as they would have liked or that they received enough help and advice about baby care from midwives. It may be that, even though these women received more support than average, they would have liked more. It may also be the case that the type of support was unhelpful, particularly lacking continuity. Barriers to continuity of postnatal carer include shift patterns, part-time work, staff shortages and travel time (40). However, individualised, women-centred care can still be achieved with good communication and antenatal care planning (41).

Strengths and limitations

This study was based on a large population based random sample of recent mothers, with considerable diversity among respondents. The importance of some specific risk, care and individual factors was identified. However, the response rate was 47% and, in common with many other surveys (42-44), there was significant under-representation of hard-to-reach groups. PPF was as reported by women using a single item as part of a symptom checklist rather than one of the many scales. The cross-sectional survey was conducted at three months postpartum and thus causality cannot be inferred from associations found and women may not have accurately remembered some of the details reported. In particular, while fatigue at the time of the survey is likely to be accurately reported, fatigue at 10 days and one month may be less well recollected and subject to recall bias. However, studies comparing women's reports of events around childbirth with medical records or other recorded data have demonstrated good recall (45, 46).

Implications for healthcare professionals

These finding highlight that, for some women, PPF can be severe and long lasting and may require intervention. Several interventions to reduce PPF have been evaluated in good quality randomised controlled studies (14, 22, 31, 47, 48). These were a mixture of self-management, telephone support, exercise, and education and all were reported to be beneficial except for the purely self-directed intervention which used the Tiredness Management Guide to help women to self-manage their fatigue (48). Supportive interventions and availability of additional advice and support targeted to those women with the greatest need is to be encouraged. The nature of the additional advice and support should be tailored to the needs of individual women. The association with more negative perceptions of their infant and of infants who may have been ill or born preterm may be a key point for health professionals working in postnatal care to consider. There is also a need for antenatal preparation for women and their partners in approaching the transition to parenthood so that they have realistic expectations, can enlist practical help and emotional support when required postnatally, and enhance their own coping skills.

Implications for research

The cross-sectional nature of this study has precluded teasing out of the interaction between PPF and postnatal depression. Although the two are clearly linked, the nature of the relationship is unclear. Further exploration of the impact of PPF on the developing mother-child and partner relationships, and the influence of method of infant feeding, in prospective longitudinal studies is also likely to better illuminate the way in which individual differences may contribute. There is a wide range of estimates of point and period prevalence of PPF in the literature which requires further elucidation.

Conclusions

Postpartum fatigue is not inevitable or universal, although early in the postnatal period it affects a substantial proportion of women. Associations with infant characteristics and maternal attachment are described which may affect families. Predictors of postpartum fatigue include age and parity; possible protective factors include practical help and support from partners, as well as input from midwives.

List of abbreviations

CS Caesarean section; EPDS Edinburgh Postnatal Depression Scale; MW midwife; OR Odds ratio; PN postnatal; PPF Postpartum fatigue; PTSD post-traumatic stress disorder; SVD Spontaneous vaginal delivery

Declarations

Ethics approval and consent to participate

Ethical approval for the survey was obtained from the NRES committee for Yorkshire and The Humber – Humber Bridge (REC reference 14/YH/0065). Completion and return of the questionnaire was taken as implicit consent to participate.

Consent for publication – N/A

Availability of data and materials – Further analyses of these data are planned. The data will be made available by the NPEU when these are complete.

Competing interests – The authors declare that they have no competing interests.

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Authors' contributions

MR designed the National Maternity Survey; MR, FA and JH were responsible for the research questions; JH analysed the data; MR, FA, and JH wrote the manuscript.

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Table 1 – Description of sample sociodemographic characteristics

	Fatigue at 10 days					Fatigue at 1 month					Fatigue at 3 months				
	Yes		No		*p*	Yes		No		*p*	Yes		No		*p*
	n	%	n	%		n	%	n	%		n	%	n	%	
Maternal age (years)															
16-19	40	2.3	60	2.2		24	2.0	76	2.3		10	1.9	90	2.2	
20-24	164	9.3	366	13.2		99	8.1	431	13.1		28	5.4	502	12.5	
25-29	475	27.0	742	26.8		263	21.4	954	28.9		120	23.2	1097	27.3	
30-34	634	36.1	939	33.9		477	38.8	1096	33.2		192	37.1	1381	34.4	
35-39	347	19.7	522	18.8		279	22.7	590	17.9		114	22.0	755	18.8	
40+	98	5.6	143	5.2		87	7.1	154	4.7		54	10.4	187	4.7	
Total	1758	100.0	2772	100.0	**	1229	100.0	3301	100.0	***	518	100.0	4012	100.0	***
Index of Multiple Deprivation															
1	373	21.2	524	18.9		285	23.2	612	18.5		129	25.0	768	19.1	
2	334	19.0	525	18.9		273	22.2	586	17.7		97	18.8	762	19.0	
3	377	21.4	550	19.8		244	19.9	683	20.7		113	21.9	814	20.3	
4	366	20.8	602	21.7		234	19.1	734	22.2		109	21.1	859	21.4	
5 (most deprived)	308	17.5	572	20.6		192	15.6	688	20.8		69	13.3	811	20.2	
Total	1758	100.0	2773	100.0	*	1228	100.0	3303	100.0	***	517	100.0	4014	100.0	**
Ethnicity															
White	1443	83.3	2270	84.4		1041	85.9	2672	83.2		434	84.8	3279	83.8	
Mixed	35	2.0	52	1.9		28	2.3	59	1.8		12	2.3	75	1.9	
Asian	194	11.2	248	9.2		106	8.7	336	10.5		43	8.4	399	10.2	
Black	48	2.8	110	4.1		29	2.4	129	4.0		18	3.5	140	3.6	
Other	12	0.7	11	0.4		8	0.7	15	0.5		5	1.0	18	0.5	
Total	1732	100.0	2691	100.0	*	1212	100.0	3211	100.0	*	512	100.0	3911	100.0	

Left full-time education aged <16 years															
No	1525	87.4	2198	80.4		1068	87.8	2655	81.4		450	87.5	3273	82.5	
Yes	220	12.6	537	19.6		149	12.2	608	18.6		64	12.5	693	17.5	
Total	1745	100.0	2735	100.0	***	1217	100.0	3263	100.0	***	514	100.0	3966	100.0	**
Parity															
Primiparous	973	56.4	1232	45.6		672	55.9	1533	47.5		247	48.4	1958	50.0	
Multiparous	752	43.6	1470	54.4		531	44.1	1691	52.5		263	51.6	1959	50.0	
Total	1725	100.0	2702	100.0	***	1203	100.0	3224	100.0	***	510	100.0	3917	100.0	

* p<0.05 ** p<0.01 *** p<0.001

Table 2 – Predictors of PPF – Binary logistic regression

		Fatigue at 10 days	Fatigue at 1 month	Fatigue at 3 months
		Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Maternal age (years)	16-19	0.91 (0.55, 1.51)	0.64 (0.36, 1.15)	1.01 (0.45, 2.24)
	20-24	0.62 (0.48, 0.79)***	0.54 (0.40, 0.71)***	0.44 (0.28, 0.70)**
	25-29	0.91 (0.76, 1.09)	0.63 (0.52, 0.77)***	0.87 (0.66, 1.14)
	30-34	1.00 (ref)		
	35-39	1.00 (0.83, 1.22)	1.13 (0.92, 1.39)	1.04 (0.79, 1.38)
	40+	1.20 (0.86, 1.66)	1.39 (0.99, 2.95)	2.00 (1.34, 2.98)**
Parity	Primiparous	1.00 (ref)		
	Multiparous	0.83 (0.71, 0.97)*	0.81 (0.68, 0.97)*	1.21 (0.95, 1.54)
Left full-time education	aged16 or more years	1.00 (ref)		
	aged <16 yrs	0.64 (0.52, 0.78)***	0.74 (0.59, 0.93)*	0.82 (0.60, 1.13)
Mode of delivery	SVD	1.00 (ref)		
	Instrumental	1.23 (1.00, 1.52)	0.99 (0.79, 1.25)	0.87 (0.63, 1.21)
	Planned CS	1.03 (0.83, 1.27)	1.21 (0.96, 1.52)	1.30 (0.96, 1.76)
	CS due to unforeseen problem	1.06 (0.84, 1.34)	1.09 (0.85, 1.41)	1.06 (0.75, 1.51)
Labour duration (mins)[1]		1.00 (1.00, 1.00)*	1.00 (1.00, 0.00)*	1.00 (1.00, 1.00)**
Postnatal depression	10 days	2.08 (1.79, 2.42)***	1.65 (1.40, 1.95)***	1.24 (0.98, 1.56)
	1 month	1.27 (1.03, 1.56)*	2.13 (1.72, 2.63)***	1.28 (0.96, 1.71)
	3 months	1.17 (0.86, 1.60)	1.62 (1.18, 2.23)**	2.99 (2.13, 4.21)***
Postnatal anxiety	10 days	2.49 (2.04, 3.04)***	1.36 (1.10, 1.67)**	1.13 (0.84, 1.52)
	1 month	1.28 (0.98, 1.67)	2.77 (2.13, 3.61)***	1.54 (1.09, 2.18)*
	3 months	0.87 (0.61, 1.25)	1.08 (0.76, 2.55)	2.42 (1.65, 3.56)***
Postnatal sleep	10 days	1.05 (0.72, 1.54)	0.95 (0.64, 1.41)	0.80 (0.46, 1.38)
	1 month	1.39 (0.92, 2.08)	0.90 (0.58, 2.38)	0.95 (0.55, 1.65)
	3 months	1.04 (0.67, 1.59)	2.20 (1.43, 4.38)***	2.87 (1.80, 4.60)***
PTSD	10 days	4.31 (2.88, 6.45)***	1.02 (0.70, 1.48)	0.79 (0.48, 1.32)

	1 month	0.78	(0.48, 1.27)	3.67	(2.27, 9.92)***	1.40	(0.79, 2.48)
	3 months	0.88	(0.48, 1.61)	0.61	(0.33, 1.12)	1.84	(1.00, 3.38)*
Postnatal mental health problems		0.93	(0.72, 1.21)	0.59	(0.44, 0.79)***	0.76	(0.53, 1.09)
Infant feeding at 3 months	Formula only	1.00 (ref)					
	Breast only	1.06	(0.91, 1.24)	1.19	(1.00, 1.42)	1.38	(1.08, 1.76)*
	Combined	1.17	(0.95, 1.45)	1.33	(1.06, 1.67)*	1.73	(1.29, 2.33)***
	Other	0.30	(0.06, 1.45)	0.97	(0.21, 7.50)	0.59	(0.06, 5.68)
Infant health poor at 3 months		1.22	(1.00, 1.49)	1.14	(0.91, 1.41)	1.52	(1.15, 2.00)*

1 Duration of labour in minutes marginally positively associated with PPF

* p<0.05 ** p<0.01 *** p<0.001 PTSD Post-traumatic stress disorder PN Postnatal SVD Spontaneous vaginal delivery CS Caesarean section

NB –Only variables significant in earlier iterations of logistic regression included (see Appendix for full list of variables)

Table 3 – Indicators of maternal-infant attachment associated with PPF – Binary logistic regression adjusted for sociodemographic factors[1]

	Fatigue at 10 days		Fatigue at 1 month		Fatigue at 3 months	
	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)
When woman first felt baby belonged						
During pregnancy	1 (ref)		1 (ref)		1 (ref)	
Immediately after birth	0.96	(0.81, 1.13)	0.90	(0.75, 1.09)	0.96	(0.74, 1.26)
First few days	1.27	(1.02, 1.57)*	1.28	(1.02, 1.62)*	1.77	(1.31, 2.39)***
First few weeks	1.60	(1.27, 2.00)***	1.61	(1.27, 2.05)***	1.39	(0.99, 1.95)
Only recently	2.12	(1.52, 2.94)***	2.23	(1.60, 3.10)***	2.52	(1.68, 3.77)***
Not quite yet	2.48	(1.14, 5.43)*	2.90	(1.34, 6.27)**	4.13	(1.77, 9.64)**
Number of negative adjectives used about baby						
0	1 (ref)		1 (ref)		1 (ref)	
1	1.20	(1.01, 1.43)*	1.21	(0.99, 1.48)	1.27	(0.94, 1.70)
2 or more	1.64	(1.35, 2.00)***	1.52	(1.22, 1.89)***	1.86	(1.36, 2.54)***
Baby considered more or less difficult than average						
Difficult	1 (ref)		1 (ref)		1 (ref)	
Average	0.52	(0.37, 0.73)***	0.60	(0.43, 0.84)**	0.36	(0.25, 0.52)***
Easier	0.42	(0.30, 0.60)***	0.44	(0.31, 0.63)***	0.30	(0.20, 0.45)***

* p<0.05 ** p<0.01 *** p<0.001

1 Adjusted for maternal age, parity, Index of Multiple Deprivation, ethnicity, age left full-time education

Table 4 –Protective factors associated with PPF – Binary logistic regression adjusted for sociodemographic factors[1]

	Fatigue at 10 days		Fatigue at 1 month		Fatigue at 3 months	
	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)
Single mother	1.19	(0.87, 1.62)	1.22	(0.86, 1.71)	0.82	(0.50, 1.33)
Score for partner help PN [2]	1.00	(0.98, 1.03)	1.05	(1.02, 1.08)**	1.12	(1.08, 1.16)***
Days of paternity leave	1.01	(1.00, 1.02)	1.02	(1.00, 1.03)*	1.01	(1.00, 1.03)
Number of times saw a MW at home	1.03	(1.00, 1.07)	1.02	(0.98, 1.06)	1.00	(0.95, 1.06)
Age of baby at last visit (per additional day)	1.00	(1.00, 1.00)	1.00	(1.00, 1.00)	1.01	(1.00, 1.01)***
Would have liked to see a MW…						
more often	1 (ref)					
less often	0.73	(0.49, 1.09)	0.87	(0.57, 1.35)	0.68	(0.37, 1.23)
saw MW as much as wanted	0.81	(0.67, 0.97)*	0.76	(0.62, 0.92)**	0.68	(0.52, 0.88)**
Received enough help and advice about baby's…						
crying	0.79	(0.60, 1.04)	0.69	(0.51, 0.93)*	0.99	(0.65, 1.50)
sleeping	0.82	(0.62, 1.10)	0.81	(0.59, 1.10)	0.50	(0.33, 0.76)**
feeding	0.77	(0.63, 0.95)*	0.86	(0.69, 1.07)	0.92	(0.68, 1.23)

* p<0.05 ** p<0.01 *** p<0.001

[1] Adjusted for maternal age, parity, Index of Multiple Deprivation, ethnicity, age left full-time education

[2] Score for partner help = Changing baby's nappy, Supporting feeding, Helping when the baby cries, Bathing the baby, Playing with the baby; each scored 1-4 and summed (high score = more support)

MW midwife; PN postnatally

Appendix 1 – Variables included in analysis

Sociodemographic variables
Maternal age
Index of Multiple Deprivation (quintile)
Ethnicity (5 categories)
Left full-time education aged <16 yrs
Parity

Pre-pregnancy health
Long-standing physical health problem or disability
Long-standing mental health problem or learning disability

Antenatal health and well-being
Anxiety
Depression
Mental health problem

Long-term health problem complicating pregnancy
Pregnancy-specific problem

Labour and birth
Duration of labour
Mode of delivery
Multiple birth
Gestation at birth
Baby admitted to neonatal unit
Baby born <37 weeks' gestation
Baby <2500g at birth

Postnatal variables
Infant feeding in first few days and at 3 mths
Depression at 10 days, 1 mth, 3 mths
Anxiety at 10 days, 1 mth, 3 mths
Sleep problems (not related to the baby) at 10 days, 1 mth, 3 mths
PTSD symptoms at 10 days, 1 mth, 3 mths
EPDS >12 at 3 mths
Infant health at 3 mths

Situational variables in PN period
Employment/maternity leave

Indicators of infant attachment
Woman's sense of when the baby belonged (6 categories: pregnancy-not quite yet)
Positive and negative adjectives used about baby (8 of each)
Baby considered more or less difficult than average

Partner support
Single mother
Amount of paternity leave taken (days)
Score of help with baby care (0-20)

Health professional support
No. home visits by MW
Age of baby at last visit (days)
Would have liked to see MW more/less
Support with baby's crying, sleeping, feeding
Attended baby clinic, drop-in clinic, Children's centre, parents' group, peer support, PN classes, baby café, used online support, parenting website

MW midwife; PN postnatal; EPDS Edinburgh Postnatal Depression Scale; PTSD post-traumatic stress disorder

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Reported on page…
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1/4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4/6
Objectives	3	State specific objectives, including any prespecified hypotheses	4/6
Methods			
Study design	4	Present key elements of study design early in the paper	6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2, 6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6/7, Appendix
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	-
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6/7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6/8
		(*b*) Describe any methods used to examine subgroups and interactions	6/7
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8-9
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Tables 2, 3 & 4

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Tables 2, 3 &4
		(*b*) Report category boundaries when continuous variables were categorized	Tables
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Funding statement Page 16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.