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Incidence of postpartum depression among women with postpartum haemorrhage in Kano, northern Nigeria

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The burden of postpartum depression (PPD), an important but largely neglected cause of maternal morbidity, is often increased by the presence of common co-morbidities, such as postpartum haemorrhage (PPH). Additionally, stress and the absence of social support can amplify PPD risk. Understanding the relationship between these conditions will help identify at-risk women and allow prompt intervention. Using a prospective cohort design, we recruited 72 women who had experienced PPH and another 72 women who had not within 24 h of delivery to assess the risk of PPD among them. The cumulative incidence of PPD among all participants was 15.3% (19/124). There was insufficient evidence to suggest that women with PPH have a higher risk of PPH than women without PPH (OR: 1.32; 95% CI: 0.55–3.13). Poor social support and high perceived stress increased the risk of PPD. We recommend screening for PPD among women with high perceived stress and low social support.

Postpartum depression (PPD) is a mood disorder that manifests as a feeling of melancholy and disinterest, which occurs within the first four weeks of delivery and may last up to a year after childbirth[1,2]. PPD affects approximately 1 in 7 new mothers globally, with an estimated prevalence of 17.7% in the first year following delivery[1,3]. The frequency of PPD varies between African countries, albeit higher than values found in high-income settings. In Nigeria, rates ranging from 10.7% to 44.39% have been documented in various sub-geographical regions[2]. PPD has been linked to suicide in the mother, impaired mother-infant bonding, as well as a negative influence on the child's emotional and cognitive development[4,5]. Akin to PPD, postpartum haemorrhage (PPH) is a worldwide public health priority, resulting in over 70,000 annual maternal deaths globally[6,7]. Globally, about 14 million people experience PPH annually[6], and it is the leading preventable cause of maternal mortality and morbidity, globally. In sub-Saharan Africa, PPH is responsible for between 30% and 50% of maternal deaths[8], and in Nigeria, PPH is estimated to account for nearly a quarter (23%) of maternal deaths[9].

In addition to the potentially fatal outcomes, PPH has also been linked with increased maternal morbidity, particularly due to improved survival associated with improving maternal health services. Notably among these PPH-related consequences are mental illnesses, including anxiety, post-traumatic stress disorder and postpartum depression (PPD)[10]. A recent review and metanalysis involving nine studies reported that PPH was strongly linked to a higher risk of developing postpartum depression. More specifically, compared to women without PPH, the risk of PPD was raised by 27% in women with PPH[5]. Similarly, a population-based longitudinal study from the United Kingdom found a substantial correlation between PPH and a higher incidence of postnatal depression and posttraumatic stress disorder (PTSD) in the first year after delivery. The prevalence of PND was 5.34%, and that of PTSD was 0.20% among women who had PPH[11]. Several other studies have documented a similar relationship between PPH and PPD[12–16].

The development of PPD is linked to the physiological changes of the postpartum period, characterised by profound changes in placental and maternal hypothalamic hormones, a decline in circulating blood volume, and alterations in metabolism[17,18]. PPH is a pathologically stressful event that can in addition to reducing blood volume, also lead to endocrine imbalance, a documented aetiologic factor for PPD[18]. The most common consequences of PPH are anaemia and trauma. Furthermore, clinical symptoms of PPH, such as fatigue, reduced cognitive abilities, and

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emotional instability, can lead to increased stress levels that alter the hypothalamic–pituitary–adrenal (HPA) axis function, leading to increased vulnerability to mood disorders[18]. Consistent with a role for HPA axis dysfunction in PPD, levels of the stress hormones are altered in patients with PPD.

Postpartum haemorrhage and postpartum depression are common and serious public health problems associated with maternal and child distress[5]. Although PPD is the most common psychiatric disorder during the 5 years after delivery[19], the relationship between this disorder and the traumatic experience of postpartum haemorrhage is under-studied, in developing countries like Nigeria. Most studies exploring the relationship between PPH and PPD are from high-income settings. Given the prevalence of PPH and over 7 million births occurring in Nigeria annually[20], over a million women will experience PPH, and many will suffer its health sequelae. Therefore, there is a need to investigate this relationship further. This study aimed to recruit women with and without PPH within 24 h of delivery and follow them up to estimate the incidence of PPD at 6, 10 and 14 weeks postpartum and to evaluate the effect of social support and perceived stress on the risk of PPD.

Results

At the end of the study period, complete data on 124 women was analysed, giving a response rate of 82.7%. Eleven women from the PPH group and thirteen from the comparative group were excluded because they either did not fulfil the inclusion criteria or had incomplete data. There were 63 women who had PPH and 61 women without PPH, the majority of whom were from Gwale LGA (26.2% non-PPH and 28.6% PPH respondents). The respondent's ages ranged from 18 to 44 years, with a mean and standard deviation (SD) of 27 ± 5 years. All but two women (98.39%, $n = 122$) were married, 76.61% ($n = 95$) were from a monogamous setting, and 30.65% ($n = 38$) had post-secondary education. The husbands' mean age ± SD was 39 ± 7 years, and 52.83% ($n = 65$) were educated up to tertiary level.

Among respondents who had PPH, the quantity of blood loss ranged from 500 to 1500 mls (IQR 500,1000 mls). Approximately a third of the respondents (31.75% < $n = 20$) were transfused after PPH, and only one woman (1.59% < $n = 1$) had a hysterectomy secondary to PPH. Among all respondents, a sizeable number had strong social support (62.90%, $n = 78$), and the majority of the respondents reported experiencing moderate levels of perceived stress (59.68%, $n = 74$). Baseline characteristics are presented in Table 1

At the conclusion of follow-up, the overall cumulative incidence of postpartum depression among all respondents was 15.32% ($n = 19$); 17.46% ($n = 11$) among women who had PPH and 13.11% ($n = 8$) among women who did not have PPH. The incidence was highest in both groups on the first visit, despite insufficient evidence to support a difference between the groups (Table 2).

The distribution of PPD by baseline characteristics and risk factors for PPD is presented in Table 3. Among all respondents, the incidence of PPD was higher among respondents who were less than 25 years (84.21%) and from monogamous households (78.95%). There was insufficient evidence of a difference in the incidence of PPD between women who had PPH and those who did not, and this relationship was maintained even after adjusting for the effects of age, parity, perceived stress and social support. Nonetheless, perceived stress and social support were found to be independent risk factors for PPD after adjusting for these variables. Compared to women who had low perceived stress, the odds of PPD were approximately three times in those who had moderate stress [AOR: 2.60, 95% CI: 1.10–13.20] and 4 times among those with high perceived stress [AOR: 4.20, 95% CI: 1.04–18.55]. Similarly, respondents with strong [AOR: 11.68, 95% CI: 4.03–18.74] and moderate social support [AOR: 6.20, 95% CI: 1.22–13.60] had higher odds of PPD compared to those with poor support.

On stratified analysis, we did not observe evidence of effect modification of both perceived stress (P = 0.266) and social support (0.601) on the relationship between PPH and PPD (Table 4)

Discussion

This is a prospective cohort study of women with and without PPH who were followed up until 14 weeks postpartum in order to evaluate the incidence of PPD. The findings of our study show that the overall cumulative 14-week incidence of PPD for all respondents was 15.32%(17.46%, and 13.11% for women with PPH and without PPH respectively).

The incidence of PPD was not significantly different between women who had PPH and those who didn't, and this lack of association persisted even after controlling for age, parity, perceived stress and social support. After controlling for these confounders, the only independent risk factors for PPD were perceived stress and social support. Social support and perceived stress, however, did not modify the relationship between PPH and PPD.

Our findings reveal that approximately 1 in 5 women who had postpartum haemorrhage in Kano develop PPD, a value higher than the 13.11% risk of PPD obtained from women who did not have PPH. The risk of PPD among both groups of women obtained in this study is akin to findings from China, where puerperal women with PPH were more likely to screen positive for postpartum depressive symptoms than those without PPH (16.4% vs 11.7%)[13]. Values from around the world, however differing from ours, also showed higher rates of PPD among women who had PPH as opposed to those who did not; from France (35% vs 15%)[21], from Sweden (2.0% vs 1.9%)[14]. and from the UK (5.34% as opposed to 4.75%).[11]. Even though these results were consistent, the variances seen could have been caused by different inclusion criteria and methodological variations. For instance, one study defined PPD as having a value of EDPS score of 11 or above[21], another defined PPH as losing >1000 mls[13], while the third study limited its study group to term births with a non-anomalous pregnancy[14]. Two recent metanalyses revealed pooled evidence which showed that women with PPH are at increased risk of PPD compared with women without PPH[5,22].

Over a third of the women who experienced PPH in this study reported high perceived stress relative to those who did not. Additionally, having high perceived stress was associated with increased odds of PPD. Epidemiological data has linked the occurrence of traumatic birth events, including PPH to higher stress levels[10,23–25]. Our results are in keeping with a review which reported a pooled incidence of PTSD after traumatic childbirth of 19.4% (95% CI 11.9–26.5%)[26]. Postpartum haemorrhage can have a profound psychological impact on mothers leading to feelings of fear, anxiety, helplessness, and loss of control. Witnessing or experiencing a life-threatening event during childbirth can trigger symptoms of post-traumatic stress disorder (PTSD) or contribute to general feelings of distress[12]. These psychological factors are closely linked to the development of postpartum depression. Thus, it is unsurprising that more than half of the PPD cases among women who experienced PPH were those with high perceived stress. The physical consequences of PPH, such as fatigue, weakness, anaemia, and the need for medical interventions like blood transfusions or surgery, can contribute to postpartum physical recovery challenges. This physical trauma and stress can exacerbate feelings of emotional distress and increase the risk of developing postpartum depression, pre-term deliveries and a pre-existing medical condition prior to pregnancy.

Our findings revealed an inverse relationship between social support and PPD. A significant number of our study participants among both groups had strong social support, however, there were more women with poor social support among those who had PPD. In line with our discovery, strong social support has been seen to positively influence the occurrence of PPD in African communities[2,27,28]. Social support plays a crucial role in promoting individual well-being, resilience, and community cohesion. In Africa, social support encompasses a rich tapestry of familial, communal, religious, and cultural practices that contribute to individual and collective well-being. African communities often exhibit strong bonds of solidarity and reciprocity, where neighbours, friends, and community members come together to support one another. In addition, family is central to social support in Africa, with strong kinship ties serving as the primary source of support. Extended family networks provide emotional, financial, and practical assistance to mothers after childbirth. This may further explain why women from monogamous homes in this study had a higher risk of PPD.

Table 1 | Baseline characteristics of 124 women with and without postpartum haemorrhage who delivered at the study facilities

Characteristic	Total	PPH *n* = 63	Non-PPH *n* = 61	*P*-value
Age (years)				
<25	41 (33.06%)	21 (33.33%)	20 (32.79%)	0.751
≥25	83 (66.94%)	42 (66.67%)	41 (67.21%)	
Family structure				
Monogamous	95 (76.61%)	48 (76.19)	48 (77.05%)	0.910
Polygamous	29 (23.39%)	15 (23.81%)	14 (22.95%)	
Highest educational level				
Post-secondary	38 (30.65%)	17 (26.98%)	21 (34.43%)	0.760
Secondary	71 (57.26%)	39 (61.90%)	32 (52.46%)	
Primary	11 (8.87%)	5 (7.94%)	6 (9.84%)	
Non-formal	4 (3.23%)	2 (3.17%)	2 (3.28%)	
Husband's highest education				
Tertiary	65 (52.83%)	34 (55.74%)	31 (39.21)	0.379
Secondary	45 (36.29%)	27 (42.86%)	18 (29.51%)	
Primary	4 (3.23%)	2 (3.17%)	2 (3.28%)	
Non-formal	10 (8.06%)	3 (4.76%)	5 (11.48%)	
Parity				
1	14 (11.29%)	7 (11.11%)	7 (11.48%)	0.455
2–3	71 (68.85%)	33 (52.38%)	38 (62.30%)	
≥5	39 (31.45%)	23 (36.41%)	16 (26.23%)	
Had unplanned pregnancy				
No	27 (21.77%)	15 (23.81%)	12 (19.67%)	0.577
Yes	97(78.13%)	48 (76.19%)	49 (80.33%)	
Have pre-existing medical conditions				
Yes	14 (11.29%)	6 (9.52%)	8 (13.11%)	0.528
No	110(88.71%)	57 (90.48%)	53 (86.89%)	
Gestational age at delivery				
Pre-term	15 (12.20%)	8 (12.7%)	7 (11.67%)	0.835
Term	108 (87.80%)	55 (87.30%)	53 (88.33%)	
Perceived stress				
Low	14 (11.29%)	4 (6.35%)	10 (16.39%)	0.034
Moderate	74 (59.68%)	35 (59.68%)	39(63.93%)	
High	36 (29.03%)	36 (29.03%)	24 (38.10%)	
Social support				
Poor	12 (9.68%)	8 (12.70%)	4 (6.56%)	0.402
Moderate	34 (27.42%)	15 (23.81%)	19(31.15%)	
Strong	78 (62.90%)	40 (63.49%)	38 (62.30%)	

Table 2 | Incidence of PPD among 124 women who had PPH and those who didn't

Time of diagnosis	Total	Postpartum depression		
	Frequency (proportion)	PPH frequency (proportion)	NON-PPH frequency (proportion)	*P*-value
At 6 weeks	12 (9.7%)	8 (12.7%)	4 (6.56%)	0.248
At 10 weeks	4 (3.3%)	2 (3.57%)	2 (3.51%)	0.986
At 14 weeks	3 (2.8%)	1 (1.85%)	2 (3.63%)	0.517
Cumulative total	19 (15.3%)	11 (17.46%)	8 (13.11%)	0.467

A major strength of this study is its prospective design. The prospective design allowed us to correctly estimate blood loss during delivery, a major flaw identified from previous studies, disentangle the temporal direction of association between PPH and PPD and assess the risk of PPD over time at three follow-up periods postpartum. Our study had some limitations, and the results must therefore be interpreted with caution. While all measures were put in place to reduce bias due to loss of follow-up, a negligible number of respondents could not be located after assessing the baseline information. A major source of potential bias in cohort studies arises from the degree of accuracy with which subjects have been classified with the outcome status. To avoid this, all staff collecting information underwent rigorous training with continuous supportive supervision. We also measured both PPH and PPD objectively using standardised tools.

We investigated the risk of PPD among women with and without PPH. Our findings showed insufficient evidence to suggest that women with PPH have a higher risk of PPH than women without PPH. However, perceived stress and social support were significantly associated with the development of PPD. We recommend the provision of holistic postpartum care that addresses both physical and emotional recovery needs as well as integrating mental health screening and support services into routine postpartum visits, alongside medical assessments.

Methods

This study is a multicenter prospective cohort study carried out in two tertiary hospitals (Aminu Kano Teaching Hospital and Murtala Muhammad Specialist Hospital) and one secondary hospital (Sabo Bakin Zuwo Maternity Hospital) within Kano, northern Nigeria. Kano state is one of the most populous states in Nigeria, with an estimated population of >14 million in 2022. Kano State is also among the states with poor maternal and child health indices, with a maternal mortality ratio of 1025 deaths per 100,000 live births (compared to the National figure of 576 per 100,000)[29], and a high total fertility rate of over 6.5 births per woman[30].

Aminu Kano Teaching Hospital (AKTH) and Murtala Muhammad Specialist Hospital (MMSH) serve as referral centres serving people from Kano and neighbouring states, while Sabo Bakin Zuwo Maternity Hospital (SBZMH) mainly serves people from within the Kano metropolis. The average number of annual births is 3800, 14,000 and 4000 in AKTH, MMSH and SBZMH, respectively.

The study population included women who gave birth in the three designated hospitals between April 13th 2023, and July 30th 2023, irrespective of parity and age. The study only comprised eligible women who were Kano residents, had a live birth, and received prenatal care in these facilities. In addition, women who had undergone a caesarean section, had a severe illness or had a history of mood disorders were excluded.

Prior data indicate that the incidence of PPD is 16% in Kano[2]. We hypothesise an absolute difference of 20% between our two study groups, based on observed difference of 20% found in a similar study[21]. Thus, a sample size of 75 for each group (total sample of 150), will achieve a power of 80% to observe a difference in incidence risk of 20% between women with and without PPH at 5% level of significance.

Baseline sociodemographic data, medical and obstetric history were obtained using a structured interviewer-administered questionnaire and other clinical data were obtained from the hospital records.

A Hausa-translated version of the Edinburgh postnatal depression scale (EDPS) was used to screen for PPD[31]. The EDPS is a 10-item, widely used, efficient and easy-to-use scale for identifying women at risk of postpartum depression[32]. Responses are scored between 0 and 3 based on the severity of the symptom, and the sum of the points for the 10 elements determines the final score, which can reach a maximum of 30. The EPDS is not a diagnostic tool but rather a means to identify the presence of a depressive symptom. The validity of EDPS has been tested in different settings, including Nigeria[33,34], and has also been translated into several languages, including the Hausa Language[31,33,35].

This study employed the Mini International Neuropsychiatric Interview (MINI) version 7.0.2 for DSM-5 to diagnose depressive disorders among the

Table 3 | Multivariable logistic regression model for risk factors of PPD among 124 women with and without postpartum haemorrhage who delivered at the study facilities

Characteristic	Total *n* = 124	PPD *n* = 19	Non-PPD	Crude OR 95% CI	Adjusted OR*
PPH status					
Non-PPH	61 (49.19%)	8 (42.11%)	53 (50.48%)	Reference	Reference
PPH	63 (50.81%)	11 (57.89%)	52 (49.52%)	1.40 (0.52–3.78)	1.32 (0.55–3.13)
Age (years)					
<25	41 (33.06%)	16 (84.21%)	25 (23.81%)	Reference	
≥25	83 (66.94%)	3 (15.79%%)	80 (76.19%)	0.49 (0.18–1.31)	0.77 (0.22–1.91)
Family structure					
Monogamous	95 (76.61%)	15 (78.95%)	80 (76.19%)	Reference	
Polygamous	29 (23.39%)	4 (21.05%)	25 (23.89%)	0.32 (0.10–1.49)	
Parity					
1	14 (11.29%)	1 (5.26%)	13 (12.38%)	Reference	
2–4	71 (68.85%)	13 (68.42%)	58 (55.24%)	1.34 (0.27–6.75)	1.60 (0.19–4.89)
≥5	39 (31.45%)	5 (26.32%)	34 (32.38%)	0.69 (0.11–4.23)	0.90 (0.45–5.11)
Had unplanned pregnancy					
Yes	27 (21.77%)	5 (26.32%)	22 (20.94%)	Reference	
No	97(78.13%)	14 (73.68%)	83 (79.05%)	1.00 (0.30–3.34)	
Have pre-existing medical conditions					
Yes	14 (11.29%)	3 (15.79%)	11(10.48%)	Reference	
No	110(88.71%)	16 (84.21%)	94 (89.52%)	2.53 (0.70–9.12)	
Gestational age at delivery					
Pre-term	15 (12.10%)	1 (5.26%)	14 (13.33%)	Reference	
Term	109 (87.80%)	18 (94.74%)	91 (86.67%)	2.78 (0.34–22.41)	
Perceived stress					
Low	14 (11.29%)	2 (10.53%)	12 (11.43%)	Reference	Reference
Moderate	74 (59.68%)	5 (26.32%)	69 (65.71%)	1.8 (0.21–15.45)	2.60 (1.10–13.20)
High	36 (29.03%)	12 (63.16%)	24 (22.86%)	4.33 (0.50–37.92)	4.20 (1.04–18.55)
Social Support					
Strong	78 (62.90%)	3 (15.79%)	75 (71.43%)	Reference	Reference
Moderate	34 (27.42%)	6 (31.58%)	28 (26.67%)	6.48 (1.56–14.87)	6.20 (1.22–13.60)
Poor	12 (9.68%)	10 (52.63%)	2 (1.90%)	12.00 (4.13–18.70)	11.68 (4.03–18.74)

*Adjusted for age, parity, perceived stress and social support.

Table 4 | Interaction effects of social support and perceived stress on the relationship between PPH and PPD

Variable	OR (95% CI)	*P*-value	Mantel–Haenszel OR (95% CI)	*P*-value
Social support				
Poor	–			
Moderate	0.93 (0.35–10.86)	0.442	0.15 (0.34–3.89)	0.266
Strong	0.95 (0.17–12.87)	0.589		
Perceived stress				
Low	–			
Moderate	1.88 (0.21–3.60)	0.855	1.14 (0.39–3.31)	0.601
High	2.05 (0.34–12.41)	0.420		

participants[36]. MINI is a short, standardised, structured instrument of choice often used for quick psychiatric evaluation in clinical and research settings. It covers a range of psychiatric disorders, including mood disorders, anxiety disorders, psychotic disorders, substance use disorders, and more. Studies have confirmed the validity and reliability of MINI[37]. Adopted by mental health practitioners and health organisations in over 100 countries, the MINI is the most extensively used psychiatric structured diagnostic interview instrument globally and has been verified and translated into more than 70 languages[36]. The scoring of the MINI entails determining whether or not specific criteria for a range of psychiatric disorders are present. Usually, responses are categorised as "Yes", denoting the presence of symptoms or "No", denoting their absence.

Social support was evaluated using the Oslo Social Support Scale (OSSS-3). The OSSS-3 is a brief measure designed to assess perceived social support, especially in population-based surveys and clinical contexts and has been recommended as a tool to assess social support in Nigeria[38,39]. Respondents score each of the three items on a Likert scale, which captures various facets of social support. The scores for each item are typically summed, with higher scores indicating greater perceived social support.

Perceived stress was measured using the Perceived Stress Scale. The Perceived Stress Scale (PSS-10) is a 10-item widely used psychological instrument for measuring the perception of stress in individuals over the past month. The PSS-10 covers various aspects of stress, including unpredictability, lack of control, and coping ability. Respondents rate their answers on a Likert scale, typically ranging from 0 (never) to 4 (very often). The PSS can be self-administered, making it appropriate for surveys. The

total score can range from 0 to 4, with higher scores on the PSS indicating a higher level of perceived stress[40].

The primary outcome, postnatal depression, was evaluated at 6, 10 and 14 weeks using the Edinburgh postnatal depression scale and the Mini International Neuropsychiatric Interview version 7.0.2 for DSM-5. Initial screening was conducted using the EDPS, and as recommended, a score of 9 or higher on the EDPS was the threshold for administering the MINI to establish the diagnosis of postpartum depression[31]. Confirmation of a major depressive disorder, as well as categorisation into current, past or recurrent, was made using the elements A1 to A6 on the A module of the MINI version 7.0.2.

The primary exposure, primary postpartum haemorrhage, was defined using the WHO description i.e. excess bleeding from the uterine cavity associated with childbirth in the quantity of 500 mls or more within 24 h of delivery[41].

Other exposures included were social support classified as poor social support (score of 3–8), moderate social support (9–11) and strong social support (12–14) and perceived stress defined as low perceived stress (scores from 0 to 13), moderate stress (14 to 26), and high stress (scores from 27 to 40).

Explanatory variables were sociodemographic characteristics of the respondents, past medical history, obstetric history, and information regarding the most recent birth, including clinical findings, were also included as explanatory variables.

Selection of exposed group began with midwives in the delivery rooms of the three facilities being trained on how to quantify the volume of blood loss within 24 h of delivery. Under-buttock plastic calibrated drapes were used immediately after a woman delivered to collect blood around delivery time. Subsequently, sanitary towels were collected and weighed and specially formulated charts were used to calculate blood loss based on weight. Two nurses (research assistants) visited the delivery unit daily to identify women who had lost more than 500 mls within 24 h using the blood loss chart. Any woman who met the inclusion criteria was then enrolled as a participant in the exposed group. For each woman recruited into the exposed group, one woman who fulfilled the inclusion criteria but had not lost up to 500 mls of blood within 24 h was selected using a random sampling technique for recruitment into the unexposed group. This was done using randomly generated numbers from a tablet form within the list of the women without PPH who delivered that day.

Upon recruitment, baseline information was collected from participants of both groups. Clinical data and information on perceived stress and social support were also obtained.

All respondents were followed up for 14 weeks and the time for data collection was made to coincide with the second, third and fourth immunisation visits, which are at 6, 10 and 14 weeks. Index date of follow up was the date of the delivery. For participants who did not show up, phone calls were made, and they were visited in their homes.

Two nurses at the well-child clinic where women come for routine childhood immunisation collected data on the outcome (PPD). The EPDS was administered to each participant during the first visit, and those with a score of 9 and above were further evaluated using the MINI. Participants with scores less than 9 had the EPDS re-administered during the next visit, and the procedure was repeated until the last visit (at 14 weeks).

We utilised STATA version 15.0 (StataCorp LLC, College Station, TX, USA) for data analysis. Background characteristics were presented using frequencies and proportions as well as means and their corresponding standard deviations (SD) or median and interquartile range as appropriate. We estimated the cumulative incidence of PPD as the total number of PPD cases at the end of follow-up divided by the number of respondents followed up from the beginning of the study. We fitted logistic regression models to report the crude odds ratio (OR) and 95% confidence interval (CI) for the factors associated with PPD among all respondents and then employed a multivariable logistic regression modelling to report the adjusted odds ratio (aOR) and CI for the independent risk factors for PPD. We adopted a backward selection approach to modelling, beginning with a complete model that included all relevant variables and sequentially removing variables with a p-value > 0.20 and no established theoretical relevance. The likelihood ratio test was used to identify better models. The final model included our primary exposure to PPH status, age, parity, perceived stress and social support. We employed Mantel Haenszel (MH) odds to stratify the effect of PPH on PPD by perceived stress and social support and presented the ORs and CIs for each category.

Ethical approval for this study was obtained from the Health Research Ethics Committees of the Kano State Ministry of Health (SHREC/2022/3366) and Aminu Kano Teaching Hospital (NHREC/28/01/2020/AKTH/EC/3355). Permission to conduct the study was sought from the management of the three hospitals. Every respondent provided signed informed consent, and the provisions of the Helsinki declarations were adhered to.

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Author contributions

F.I.T., U.M.U., A.T.G., Z.D.A. and H.S.G. conceived and designed the study. F.I.T., S.M.A., S.M.S., N.T.A. and H.K.S. collected data. R.I.J., A.A.K., S.M.A. and S.K.S. performed a literature search. F.I.T., A.L.A. and R.I.J. performed the statistical analysis. F.I.T., U.M.I., A.T.G. and A.L.A. drafted the paper. Z.D.A., U.M.U. and S.K.S. assisted with data interpretation and critically reviewed the paper for intellectual content. A.A.K., S.M.S. and N.T.A. revised the paper. All authors contributed to and approved the paper.

Competing interests

The authors declare no competing interests.

Additional information

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