ความชุกและปัจจัยทำนายของโรคโลหิตจางหลังคลอดในมารดาหลังคลอด ที่โรงพยาบาล Nyangabwe เมืองฟรานซิสทาวน์ ประเทศบอตสวานา
Prevalence and Predicting Factors of Postpartum Anemia Among Postpartum Mothers at Nyangabwe Referral Hospital, Francistown, Botswana

นิพนธ์ต้นฉบับ **Original Article**

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บทคัดย่อ

วัตถุประสงค์: เพื่อสำรวจความชุกและปัจจัยทำนายภาวะโลหิตจางของมารดาหลังคลอด โรงพยาบาลส่งต่อแนงแกบวี ฟรานซีสทาวน์ บอสวาน่า ปัจจัยทางชีววิทยา (การติดเชื้อเอชไอวี) ปัจจัยทางจิตใจ (ความเครียด) และปัจจัยทางสังคม (การรับประทานอาหารที่มีธาตุเหล็ก ผลิตภัณฑ์เสริมธาตุเหล็กและโฟลิก อาหารต้องห้าม (Food Taboo) และสิ่งที่ไม่ใช่อาหาร (Pica) **วิธีการศึกษา:** การศึกษาแบบภาคตัดขวางในมารดาหลังคลอดจำนวน 385 ราย ด้วยวิธีการคัดเลือกกลุ่มตัวอย่างแบบสะดวกในเดือนกุมภาพันธ์ถึงมีนาคม พ.ศ. 2567 เครื่องมือที่ใช้ในการวิจัยนี้ประกอบด้วย แบบสอบถามที่ผู้วิจัยสร้างขึ้น และแบบวัดการรับรู้ความเครียด วิเคราะห์ข้อมูลโดยใช้ค่าเฉลี่ย ความถี่ และสัดส่วน หาความสัมพันธ์ระหว่างตัวแปรต้นและตัวแปรตามด้วยค่าไคว์สแคว์ และหาปัจจัยทำนายด้วยการวิเคราะห์ถดถอยโลจิสติค **ผลการศึกษา:** ความชุกของภาวะโลหิตจางในมารดาหลังคลอดเท่ากับ ร้อยละ 51.4 (95% CI: 46.5% - 56.4%) ปัจจัยทำนายภาวะโลหิตจางของมารดาหลังคลอดอย่างมีนัยสำคัญทางสถิติประกอบด้วย การติดเชื้อเอชไอวี (AOR=4.57, 95% CI: 2.41 - 8.67) การรับประทานผลิตภัณฑ์เสริมธาตุเหล็กและโฟลิกไม่สม่ำเสมอ (AOR=2.18, 95% CI: 1.29 - 3.68) และการรับประทานสิ่งที่ไม่ใช่อาหาร (Pica) ในระหว่างตั้งครรภ์ (AOR=4.39, 95% CI: 2.67 - 7.23) สรุป: ความชุกของภาวะโลหิตจางในมารดาหลังคลอดพบประมาณครึ่งหนึ่งของกลุ่มตัวอย่าง โดยปัจจัยทำนายภาวะโลหิตจางในระยะหลังคลอดประกอบด้วยการติดเชื้อเอชไอวี การรับประทานผลิตภัณฑ์เสริมธาตุเหล็กและโฟลิกไม่สม่ำเสมอ และการรับประทานสิ่งที่ไม่ใช่อาหาร ดังนั้นการลดการติดเชื้อเอชไอวี การประทานผลิตภัณฑ์เสริมธาตุเหล็กและโฟลิกอย่างสม่ำเสมอ และการป้องกันการรับประทานสิ่งที่ไม่ใช่อาหาร ในขณะตั้งครรภ์ สามารถป้องกันผลกระทบจากภาวะโลหิตจางของมารดาหลังคลอดได้

คำสำคัญ: ภาวะโลหิตจางในระยะหลังคลอด; การติดเชื้อเอชไอวี; ผลิตภัณฑ์เสริมธาตุเหล็กและโฟลิก; สิ่งที่ไม่ใช่อาหาร; บอสวาน่า

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Abstract

Objective: This study aims to explore the prevalence and the predicting factors of PPA in postpartum mothers from Nyangabwe Referral Hospital, Francistown, Botswana. The predicting factors of interest include biological factors (HIV positive status), psychological factors (stress) and social factors (Dietary intake of food rich in iron, adherence to Iron Folic Acid (IFA) supplements, food taboos and pica). **Method:** A cross-sectional study was conducted on 385 postpartum mothers with a convenience sampling technique during February to March 2024. The instruments were a pre-tested researcher designed structured questionnaire and the Perceived Stress Scale (PSS). Descriptive analysis was done using means, frequency, and proportions. Chi-square test was used to determine the relationship between independent and dependent variables. Multivariable logistic regression analysis was performed to identify predictors of PPA. **Results:** The overall prevalence of PPA was estimated at 51.4% (95% CI: 46.5% - 56.4%). HIV-positive status (AOR=4.57, 95% CI: 2.41 - 8.67), poor adherence to IFA supplements (AOR=2.18, 95% CI: 1.29 - 3.68), and practiced PICA during pregnancy (AOR= 4.39, 95% CI: 2.67 - 7.23) could statistically predict PPA. **Conclusion:** The prevalence of PPA was about a half the samples and HIV positive, poor adherence to IFA, and practice pica were significant predicting factors of PPA among women in Botswana. Suggesting the need for interventions to reduce HIV infection in childbearing women, encouraging the importance of adhering to IFA supplements and promoting nutritional health education to prevent pica practices during pregnancy and postpartum periods hence prevent consequences of PPA.

Keywords: Postpartum anemia; HIV; IFA supplements; Pica; Botswana.

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Introduction

Anemia affects 500 million reproductive-age women in low- and middle-income countries[1]. Anemia occurs when red blood cells (RBCs) or hemoglobin (Hb) levels fall below the normal range[1]. It is defined by the World Health Organization (WHO) as levels below 12 g/dl in women, 11g/dl in pregnant women, 10 g/dl in postpartum mothers, and 13 g/dl in men of Hb concentrations[2,3]. No universal definition of Postpartum Anemia (PPA) exists, but researchers define it as anemia with Hb values <10g/dl at 48 hours, <11 gm/dl at 1 week, and <12 different cut off points and different timelines have been used in different studies[4,5]. In this study, the definition that was adopted is PPA of <10g/dl checked within 48 hours postpartum.

PPA is linked to obstetric difficulties, poor economic status and dietary deficits. It can lead to various symptoms, including palpitations, dyspnea, fatigue, and decreased functional capacity[1]. Low iron levels during and after labor can cause impaired cognition, postpartum depression and altering the mother's emotional and cognitive changes. PPA can negatively impact both the mother and child's wellbeing, therefore this necessitates immediate diagnosis and treatment to prevent severe consequences[1]. In addition, PPA can also lead to decreased quality of life, severe hemorrhage, maternal shock, increased admission to the maternal intensive care unit, hysterectomy, postnatal maternal sepsis, blood transfusion, poor wound healing, cardiac failure, and maternal death (OR 2.36; 95% CI 1.60–3.48), in a US study[6]. It can also negatively impact mother-baby relationships, reduces breastfeeding milk supply, the optimal development and growth of infants exclusively breastfed and increases morbidity and mortality rates among reproductive-age women[1]. PPA significantly impacts both the mother and infant, necessitating a robust family support system. This can include additional funds for formula, if milk production is insufficient, or lifestyle changes to accommodate postpartum anxiety-related quality of life, cognitive impairment, and emotional instability. If iron stores are not supplemented soon after childbirth, anemia may linger throughout the reproductive cycle, especially in areas with high anemia rates and low-iron diets[7].

PPA is a global issue with a prevalence of 50.0% to 80.0% in impoverished countries and less than 30.0% in affluent ones[8]. PPA can be classified based on its impact on public health, with normal rates below 4.9%, mild rates between 5.0% and 19.9%, moderate rates (20.0-39.0%), and severe rates 40% and higher[9]. In Botswana, PPA can be classified as a severe public health problem as it was responsible for 53.0% and 49.1% of all maternal complications in 2020 and 2021, respectively[10]. From the studies, other countries found with severe rates of PPA were India 76.2%[11], Ghana 46.7%[12] and Ethiopia with 47.2%[1]. Francistown, the second most populous city in Botswana, accounts for 17.2% of all PPA cases, while Nyangabwe Referral Hospital (NRH) has the highest percentage (14,4%) of the total cases[10]. However, there is no previous research on PPA in Botswana, including Francistown, and no information suggests predictors of high PPA cases.

This study uses the biopsychosocial (BPS) model, developed by Engel in 1970, to understand the predicting factors of PPA. According to George Engel[13], it is not simply biological factors that are needed to understand a person's medical condition but psychological and social factors are also important factors that need to be considered[14]. Taukeni, defines BPS model as an interdisciplinary framework that examines the relationships of biological, psychological, and social components in relation to health phenomena[13]. In addition, individual's perception of their symptoms and how they and their families respond to those symptoms is what the BPS model is focusing on[13]. The BPS model emphasizes the importance of psychological, social, and biological factors in understanding a person's medical condition[14]. It suggests that none of these factors alone can definitively cause health or illness, but the profound interaction between all three factors determines a certain result[13]. The BPS model may be key to addressing health inequities in maternal morbidity and mortality, as it emphasizes individual needs, the social context of health and healthcare, and the connections between a person's biological processes and the social and cultural systems in which they are embedded[15]. Duberstein and others suggest that identifying the causes and reducing their prevalence is a key clinical and public health goal[15]. Based on this fact, in this study biological (HIV status), psychological (stress), and social (dietary intake of food rich in iron, adherence to IFA supplements, food taboos, and pica) factors will be followed to identify their association with PPA.

The biological aspect of the BPS model elucidates the physiological response of the body to illness[13]. This study examines the influence of an individual's biological composition on PPA. Various biological variables, including prepartum anemia, comorbidities such as HIV, and postpartum hemorrhage, can heighten the probability of PPA in postpartum mothers[16,17]. A study in India found that HIV infection affects the cytokine environment in the bone marrow, impacting hematopoietic progenitor cells[18]. Another study done in Ethiopia also supported this, stating that HIV infection increases the likelihood of anemia due to its effects on the bone marrow and subsequent decrease in hemoglobin levels in the blood[19].This study specifically examined if HIV status among postpartum women in Botswana can predict PPA. In 2019, the prevalence rate of HIV positive status among pregnant mothers in Botswana was 22.7%[20]. Studies show HIV is a significant risk factor for anemia during pregnancy,

especially among African women. Anemia was found to be significantly correlated with HIV positive women ($p<0.001$)[21]. The presence of HIV infection is an independent factor highly associated with anemia, with an AOR = 2.11; 95%, CI 1.59 - 2.79[19].

Psychological refers to the elements of mental and emotional well-being that influence conduct[22]. The objective of the BPS model's psychological composition is to identify the underlying psychological factors contributing to a particular illness[13]. During pregnancy, a woman has physiological and psychological changes[23], which include stress. Stress has been identified as a risk factor for anemia in some studies, with limited and inconsistent influence on iron concentrations in human populations[24]. Navy Seal trainees experienced a 44.0% decline in iron concentrations after 5 days of physical and psychological stress[24]. Stress is also a common condition during postpartum periods, which can be exacerbated by events like pregnancy, labor, and delivery[25]. According to some research, stress can result in low levels of vitamins B12, C, magnesium, folate, and other nutrients[26]. This occurs when stress lowers the level of stomach acid in the body, which might result in inadequate food absorption[26]. Some of these nutrients are essential for iron absorption, which can affect the level of red blood cells[26]. Literature suggests that psychological stress have an association with iron availability, in addition maternal stress was found to cause iron deficiency[27]. Despite some studies linking stress to anemia, there is limited evidence about the relationship between stress and PPA in Botswana, hence necessitating further research to investigate if stress may be a predictor of PPA.

The BPS model recognizes that social elements, like interpersonal connections and communal activities, have a substantial influence on the overall well-being of both individuals and society[22]. Approximately 40.0% of the elements that influence general health can be attributed to social variables, including living conditions, social relationships, socioeconomic status and lifestyle choices[28]. The study investigated social determinants that are in relation to eating practices, such as dietary intake of food rich in iron, adherence to IFA supplements, food taboos and pica, to ascertain whether these factors can predict PPA. Prior studies have established a notable correlation between these factors and PPA[29-32]. According to a study done in Chicago on black pregnant women food choices during pregnancy can be influenced by social factors[33]. Research shows that developing nations like Botswana experience a triple burden of malnutrition, including undernutrition and micronutrient deficiencies among pregnant and lactating women due to dietary practices like food taboos and pica[34]. These practices, influenced by cultural and religious beliefs, contribute to inadequate dietary diversity during pregnancy, increasing the risk of PPA[35]. Women who do not follow recommended guidelines on minimum dietary diversity were three times more likely to experience anemia, the Adjusted Odds Ratio (AOR) was found to be 2.96, with a 95.0% Coefficient (CI) ranging from 1.67 to 5.25, $p<0.001$[12]. Furthermore, according to Adjei-Banuah and others, pregnant women in impoverished nations often begin their pregnancies with a preexisting iron deficiency, which worsens due to the heightened iron requirement of the developing fetus[36]. This condition persists throughout the postpartum phase and can lead to PPA[36].

Iron folic acid (IFA) supplements can prevent anemia during pregnancy and postpartum, but 57.4% of postpartum mothers show inadequate adherence to the prescribed regimen. Suboptimal adherence increases the likelihood of developing PPA[29]. In Botswana, 94.0% of women attend antenatal care services, and many are given IFA supplement for prophylaxis or treatment[37]. Studying IFA supplement adherence could help identify the gap between IFA supplement and PPA.

Food taboos are specific foods and beverages that individuals avoid due to religious, cultural or hygienic reasons[38]. These dietary prohibitions limit the intake of essential nutrients, and pregnant women who adhere to these practices are more likely to experience unfavorable pregnancy outcomes[39]. Amare and others, study results showed that women with knowledge of food taboos are more likely to adhere to these practices, AOR: 3.58, 95%, CI: 1.89 - 6.8339. However, there is a lack of studies in Botswana that specifically examine predictors of PPA, hence this study investigates the association between social and cultural food taboos and PPA.

Pica, a condition involving repetitive non-nutritive eating, insatiable hunger, and obsessive behavior, is linked to PPA[40]. It is characterized by consuming non-nutritive substances for a minimum of one month, which is not culturally acceptable[40]. Non-food substances may hinder iron absorption by binding to iron within the gastrointestinal system, worsening iron insufficiency. The linkage between pica and vitamin insufficiency is unclear, but certain pica items may exacerbate

iron shortages[41]. The prevalence of pica ranges from 1.6% to 76.0%, with an estimated 34.0% with a 95%, CI ranging from 28.0 to 41.0 during pregnancy[42]. This study investigated the relationship between pica and PPA in Francistown, a region with high anemia rates among postpartum mothers.

Despite the high rate of PPA and the profound impact of PPA on the mother, infant and family health and the availability of many studies on factors predicting PPA in other countries, studies on PPA in Botswana are limited or inexistence. This is a gap that has been identified given that Botswana is characterized by high maternal mortality rates in the year 2020, with a ratio of 130.5 maternal deaths per 100,000 live births which could be associated with high prevalence of PPA[43]. It was identified that there is statistical significancy between HIV, stress, poor dietary intake of food rich in iron, non-adherence to IFA supplements, food taboo and pica to PPA, but no studies on these factors done in Botswana were accessible, hence there is need for a study to explore on their association with PPA. Moreover, based on the literature analysis, it has been determined that PPA is a result of biological variables, including prepartum anemia and postpartum hemorrhage[4,29]. To explore other factors not mostly researched on, emphasis was placed on studying social factors that reflect dietary issues for pregnant women which can lead to PPA. Understanding these variables association with PPA will contribute to baseline scientific knowledge and help identify women at higher risk for PPA. This knowledge can be utilized to mitigate or avert PPA through the dissemination of health education and active involvement of families.

The research questions for this study were: 1. What is the prevalence of PPA among postpartum mothers admitted in postpartum unit in NRH, Francistown, Botswana? 2. Do biological (HIV status), psychological (stress), and social (dietary intake of food rich in iron, adherence to Iron Folic Acid (IFA) supplements, food taboos, and pica) factors predict PPA among postpartum mothers admitted in postpartum unit in NRH, Francistown, Botswana? This study aimed to estimate the prevalence of PPA and examine which factors among HIV status, stress, dietary intake of food rich in iron, adherence to IFA supplements, food taboos and pica can predict PPA among postpartum mothers. It was hypothesized that HIV status, stress, and dietary intake of food rich in iron, adherence to Iron Folic Acid (IFA) supplements, food taboos and pica factors can predict PPA among postpartum mothers.

Methods

A cross sectional study design was used in this study, all postnatal mothers who gave birth in NRH and mothers who gave birth somewhere else and were referred and admitted at the hospital within 48 hours of the postpartum period were considered as the target population. The participants were selected from the postpartum mothers who were admitted in NRH postpartum ward during February 2024 to March 2024. To be eligible, they had to be aged 18 years and above, able to communicate in Setswana, agree to participate in this study and sign a consent form, have no history of sickle cell anemia, aplastic anemia, and hemolytic anemia. Participants who were critically ill that is bed ridden and unable to communicate and rape victims were excluded. The calculation of the sample size was determined using the method for a single population proportion[44], taking into consideration the following assumptions: The proportion of 50% was determined based on the absence of accessible documents pertaining to prior investigations. A confidence level of 95% and a margin of error of 5% were employed in the calculation. Consequently, the resulting sample size was determined to be 385. Convenience sampling technique was used, this involves interviewing all available postpartum mothers who met the inclusion criteria on the day of data collection and were willing to participate in the study. On each data collection day, the researcher approached all mothers on day 2 (48 hours) post-delivery, brief them on the purpose, and objectives of the study, and then request for consent to participate in the study and permission to go through her medical records. Obstetric records of those who gave consent and agreed to take part in the study was screened for inclusion criteria and those who meet the criteria were requested to sign an informed consent. The interview was started when the mother was comfortable and ready.

Research instruments

The data were collected using a pre-tested structured and interviewer-administered questionnaire adapted and customized from different kinds of literature. Socio-demographic questionnaire had three parts. The socio-demographic data made the first part and included age, marital status, education level, family income and maternal residence. The second part was made up of questions assessing the obstetric and comorbidity characteristics

including postpartum hemoglobin level, mode of delivery, postpartum blood loss, gestation at initial ANC visit, gestation at delivery, weight of the baby at birth, prepartum hemoglobin level, number of ANC visits, gravidity, parity, number of abortions, number of living children, gravidity interval, and HIV status.

Postpartum anemia was defined as a mother's hemoglobin level of < 10 g/dL, within 48 hours of postpartum period. The value was recorded from the mother's Hb results of blood samples collected within 48 hours after delivery. Categorized as <10 g/dl and >10 g/dl in a socio-demographic questionnaire under the second part.

Human Immunodeficiency Virus (HIV) status was defined as a record of positive or negative to HIV test results extracted from the women's obstetric card. The measurement was HIV positive or negative and it was assessed using a socio-demographic questionnaire.

The third part assessed the dietary practices characteristics which included dietary intake of food rich in iron, adherence to IFA supplements, food taboo and pica.

Dietary intake of food rich in iron was defined as a 2-week recall of the meals consumed that are rich in iron, from 9 groups of food rich in iron. For each food group, the women ate from, they got a score of "1" (irrespective of the number of foods eaten), otherwise a score of "0". The scores were added up to give the dietary diversity score (range 0 – 9) for each woman. The score of ≤ 5 was recorded as inadequate and the score of > 5 was recorded as adequate, the dietary diversity scale (DDS) by Macías & Glasauer[45] was used for this variable. The items used to measure this variable were derived from the manual titled "Assessing Nutrition-Related Knowledge, Attitudes, and Practices" published by the Food and Agriculture Organization (FAO) of the United Nations[45]. The tool's reliability was confirmed with a Kuder–Richardson 20 =.75 from a sample of 385.

Adherence of IFA supplements was defined as good adherence if the mother took IFA supplementation for ≥90 days, it was assessed through number of days the woman took IFA supplement during pregnancy question in the socio-demographic questionnaire, adapted from a study by Abebe and others[29]. The measurement was good adherence for number of days equal or more than 90 and poor adherence for days less than 90.

Food taboo was yes for those with a history of avoiding food rich in iron during this pregnancy. It was assessed through a yes and no answer to a question of history of avoiding food rich in iron during pregnancy through a socio-demographic questionnaire. The question was adapted from a study by Gibore and others[30].

Pica which was defined as yes to history of eating things which are not usually considered as food, for example clay soil, chalk, and termitaria mounds. It was measured by yes to a report of practicing pica for a month or more and no to those who have practiced pica for less than 1 month or never. The question was incorporated in a socio-demographic questionnaire, having been adapted from the study be Gibore and others[30].

Stress was defined as a score of 14-40 in a Perceived Stress Scale (PSS) developed by Cohen and others[46]. The scale comprises of 10 items. The response was a 5-point Likert scale ranging from 0-never, 1- almost never, 2-sometimes, 3- fairly often, and 4- very often. With the possible total score of 0 to 40 points[47]. In this study, stress was categorized into no stress 0-13 points and stress 14-40 points. The Cronbach's alpha value from a sample of 30 was 0.77.

Research instruments quality assurance

Questionnaires were tested prior main data collection among 30 participants from the same health facility of study. To ensure validity of the research instruments, the panel of three experts were asked to evaluate the content validity, language suitability and criteria for scoring of the entire questionnaire. The item- level content validity index score (CVI) of three experts for DDS and PSS was .80 and 0.83 respectively. Modifications were done based on the result of the pretest before the final task of data collection.

Participant ethical protection

The proposal and the instruments were submitted to the Institutional Review Board (IRB), (G-HS113/2566), Burapha University, and Botswana, Ministry of Health, Health Policy Research and Development department (HPRDD), Health Research Division (HPRD:6/14/1) for approval of this study. Permission to conduct the study in the facility was also sourced from the hospital management through the hospital research team including the postnatal unit manager. After that, the eligible participants were invited to take part in the study. The researcher clearly explained the purpose and procedures

of the study to the participants. Also, the researcher informed them about their confidentiality, anonymity, and freedom to withdraw from the study at any time.

Data collection procedures

The researcher and the research assistant introduced themselves to the manager and staff of postpartum ward, by presenting identity cards and permission letter from the hospital management. They then asked for two working areas in the unit. After been granted permission to see participants, participants were approached individually by the either the research or the assistant, who introduced the purpose of the study, its objective and confidentiality issues using a participants information sheet. Rapport was created and those willing to participate signed the consent form and they were taken to a private room and were interviewed. Two interviews would run concurrently in two different rooms. Questionnaires were used to collect data from respondents. All the data that was collected was later stored in a sealed envelope by the researcher for data protection purposes. The questionnaires took 30 to 45 minutes of the respondent's time and all interviews were conducted from 10.30 hours to 16.30 hours. The number of participants interviewed per day was around 12 cases and these continued every day until the sample size of 385 postpartum women was reached. The researcher then entered the data collected by paper-based tools into a software computer program for subsequent data analysis.

Data analysis

The collected data were coded, cleaned, and entered into Statistical Package for Social Sciences (SPSS) version 26 software, license number 001483 (Faculty of Nursing, Burapha University) for further analysis. Descriptive statistics including mean with standard deviation and frequency with percentage were used to summarize socio demographic and obstetric characteristics of the participants and study factors. To compare prevalence of PPA according to respondents' biological, psychological and social characteristics, bivariable analyses (i.e., chi-square test for independence) was conducted. Thereafter, multivariable logistic regression analyses with a 95% Confidence Interval (CI) was used to explain the predicted odds of PPA. The statistical significance was declared at a p-value less than 0.05.

Results

A total of 385 postpartum women were recruited in this study. Their mean age was 28.1 years with a standard deviation (SD) of ±7.1 years. Two-thirds (68.3%) of the participants aged between 20 and 35 years. One-third (37.4%) of women had secondary education. In terms of occupation, one-third (33.3%) of them were housewives and only 2.6% were still attending school. About half (53.0%) of the women resided in rural areas. Concerning family monthly income, 88.6% of the participants had family monthly income of less than BWP6, 000 (Table 1).

Table 1 Demographic characteristics (N = 385).

Characteristics	N	%
Age (years), (Mean = 28.1, SD = 7.1, Min =18, Max = 46)		
18-19 years	40	10.4
20 – 35 years	263	68.3
36 years and above	83	21.3
Marital Status		
Single	348	90.4
Married	36	9.3
Divorced	1	0.3
Education attained		
No formal education	5	1.3
Primary	20	5.2
Junior Secondary	128	33.2
Senior Secondary	144	37.4
Tertiary	88	22.9
Occupation		
Housewife	128	33.3
Self-employed	110	28.6
Private	77	20.0
Government	60	15.5
Student	10	2.6
Residence		
Rural	204	53.0
Urban	181	47.0
Family monthly income (in BWP), (Mean = 2805.5, SD = 3767.8, Min =200, Max = 30,000)		
0-6000	341	88.6
>6000	44	11.4

SD=standard deviation, Min = Minimum and Max = Maximum

Regarding the obstetrical history on the women, a half (56.4%) had completed ≥8 antenatal care (ANC) visits during their pregnancy and about 3 quarters of them (71.7%) had spontaneous vaginal delivery, half (52.7%) of the women were multigravida, and 50.1% were multiparous. Of the multigravida (multigravida and grand multigravida), 58.4% had an inter-pregnancy interval of two years or more. Nearly half (51.1%) of the women had prepartum anemia (Table 2).

Prevalence of postpartum anemia (PPA)

The prevalence of PPA of admitted women. The overall prevalence of PPA was estimated at 51.4%, 95% CI: (46.5% - 56.4%).

practice food taboos (39.5%), and women who reported practicing pica (73.2%) (Table 3).

Table 2 Obstetric characteristics of the sample (N = 385)

Variables	n	(%)
Method of delivery		
Cesarean Section	109	28.3
Spontaneous Vaginal Delivery	276	71.7
Postpartum hemorrhage		
Yes	9	2.3
No	376	96.7
Pregnancy interval		
First pregnancy	132	34.3
< 2 years	28	7.3
≥ 2 years	225	58.4
ANC visits during last pregnancy		
No visits	7	1.8
< 8 visits	161	41.8
8 or more visits	217	56.4
Gravity		
Primigravida	132	34.3
Multigravida	203	52.7
Grand Multigravida	50	13.0
Parity		
Primiparous	152	39.5
Multiparous	193	50.1
Grand Multipara	40	10.4
Prepartum anemia*		
Yes	179	51.1
No	171	48.9

**Missing data of Hb. First pregnancy: pregnant for the first time in her life time;*

< 2 years:Years between the last pregnancy and the current pregnancy was less than 2 years and;

≥ 2 years: years between the last pregnancy and the current pregnancy was more than 2 years.

Bivariable analysis

The chi-square test for independent variables was conducted to assess the prevalence of PPA according to biological, psychological and social characteristics of the mothers. With respect to social characteristics, the results show that prevalence of PPA was statistically significant by adherence of IFA supplements during pregnancy, food taboo practice and pica practice. The prevalence of PPA was not statistically significant statistical association by dietary intake of food rich in iron during pregnancy ($p > 0.05$). About biological and psychological characteristics, prevalence of anemia was also statistically significant by HIV status, and stress perceived during pregnancy.

The prevalence of anemia was statistically significantly higher among HIV-positive women (79.0%) and women who reported high/moderate stress during pregnancy (54.1%). About the adherence of IFA supplements during pregnancy, prevalence of anemia was higher among respondents who had poor IFA adherence (71.3%). Furthermore, the prevalence of anemia was higher among respondents who

Table 3 Relationship between PPA and biological, psychological and social characteristics (N = 385).

Variables		Non-PPA[#] (n = 187), n (%)	PPA[$] (n = 198), n (%)	P-value[†]
HIV status				0.000***
	Negative	171 (55.3)	138 (44.7)	
	Positive	16 (21.0)	60 (79.0)	
Adherence of IFA supplements				0.000***
	Poor adherence	33 (28.7)	82 (71.3)	
	Good adherence	154 (57.0)	116 (43.0)	
Stress				0.025*
	No stress	43 (60.6)	28 (39.4)	
	Stress	144 (45.9)	170 (54.1)	
Dietary intake of food rich in iron				0.056
	Inadequate	108 (44.8)	133 (55.2)	
	Adequate	79 (54.9)	65 (45.1)	
Food taboos				0.000***
	Yes	65 (38.5)	104 (61.5)	
	No	122 (56.5)	94 (43.5)	
Pica				0.000***
	Yes	48 (26.8)	131 (73.2)	
	No	139 (67.5)	67 (32.5)	

[†] Chi-square test.

***p < 0.001, **p < 0.01 and *p < 0.05. [#] Non PPA ≥10g/dl, [$] PPA < 10g/dl, IFA: iron and folic acid.

Multivariable logistic regression

Multivariable logistic regression was conducted for all variables with p-value of ≤ 0.05 at the chi-square test to identify factors independently associated with anemia. Dietary intake of food rich in iron sufficiency during pregnancy was not good predictors of PPA hence this factor was omitted when conducting the multivariable logistic regression.

In multivariable logistic regression, adherence of IFA supplements during pregnancy, woman's HIV status and pica practice were significantly associated with PPA. The odds of PPA were 4.57 times higher among HIV-positive women (AOR=4.57, 95% CI: (2.41 - 8.67) compared with HIV-negative women. PPA was more common among women who did practice PICA during pregnancy (AOR=4.39, 95% CI: (2.67 - 7.23) compared with their counterparts. Moreover, women who had poor adherence to iron and folic acid supplements during pregnancy were more likely to have PPA (AOR=2.18, 95% CI: (1.29 - 3.68) compared to those who had good IFA adherence (Table 4).

Table 4 Predictors of PPA among delivered women (N = 385).

Variables		B	p-value	Exp (B)	95% CI
HIV status					
	Negative	1.00			
	Positive	1.52	0.000	4.57	2.41-8.67
Adherence of IFA supplements					

	Good adherence	1.00			
	Poor adherence	0.78	0.004	2.18	1.29-3.68
Stress					
	No stress	1.00			
	Stress	0.31	0.318	1.36	0.74-2.51
Food taboo					
	No	1.00			
	Yes	0.15	0.544	1.16	0.71-1.90
PICA					
	No	1.00			
	Yes	1.48	0.000	4.39	2.67-7.23

Discussions and Conclusion

This study assessed the prevalence of PPA, and examine which factors among biological (HIV status), psychological (stress), and social (dietary intake of food rich in iron, adherence to IFA supplements, food taboos, and pica) can predict PPA among delivered women admitted at NRH postpartum unit in Francistown, Botswana. The overall prevalence of PPA among women admitted at NRH in Francistown, was estimated at 51.4%. This study highlighted that PPA is a significant public health problem in Botswana. PPA is a common problem throughout the world, with a high prevalence rate ranging from 50.0% to 80% in developing countries and this include Botswana[8]. The current finding is comparable to other studies conducted in African countries such as Senegal at 55.2%[49] and more than the studies conducted in Ethiopia at 47.2%[1] and in Ghana at 46.7%[12]. However, the current prevalence is less than what was reported from a study conducted in Saudi Arabia (59.3%)3 and India (65%)[11]. Possible explanations for this difference might be attributed to differences in study populations and definitions of anemia used between the current study and the previous studies. Unlike the current study, the former studies were conducted among postpartum mothers using hemoglobin cut-off points and different timeline, Selvaraj used HB level of <12 g/dl at 6 weeks postpartum[11] and Bambo used <11 g/dl at 24 hours postpartum[1], to define PPA. Despite, the differences in prevalence observed this can also be attributed to the fact that the current study population was relatively at higher risk of anemia compared to that of the former studies.

The high prevalence of PPA observed in this study might be linked with the low socio-economic classes of the participants which might had an impact on their nutritional status. In the current study, two-thirds (88.6%) of the participants had family monthly income of less than BWP 6,000.00 which is less than recommended average national household income of BWP 6, 027.00 to live a decent life in Botswana[50]. Women in low socio-economic classes are likely to be poorly educated and often have financial constraints. As a result, they likely encounter food insecurity and which can then prevent pregnant women from consuming adequate, good-quality, and nutritious food, which predisposes them to the risk of developing anemia.

The study found that HIV-positive women had 4.57 times higher odds of PPA compared to HIV-negative women, it was statistically significate p<.001 with and a prevalence of 79.0%. This supports previous research suggesting anemia is prevalent among all HIV-positive populations[18,50]. A study done in Ethiopia state that HIV's effect on the bone marrow and the decrease in hemoglobin levels in the blood may increase the risk of anemia AOR = 2·11; 95 % CI 1·59 - 2·79[19]. The current finding aligns with the theoretical aspects of BPS that indicate, HIV as a biological factor significantly increases the risk of anemia during pregnancy due to its impact on red blood cell production, susceptibility to opportunistic infections, nutritional deficiencies, and potential side effects from antiretroviral therapy. These biological challenges, compounded by the increased nutritional demands of pregnancy, make anemia a common and serious concern for pregnant women living with HIV.

The odds of PPA were 2.18 high among postpartum mothers who had poor adherence to IFA supplementation. The study found out that prevalence of PPA was higher among respondents who had poor IFA adherence (71.3%). This finding was in agreement with the studies carried out in Ethiopia by Abebe at 57.4%, AOR: 3.27; 95% CI: (1.31-8.15)[29] and Abebaw at 72.7%, AOR = 2.52; 95% CI (1.06 - 6.04)[16]. The depletion of stored maternal iron during pregnancy and childbirth may be a possible explanation, as the physiological demands for iron are substantial. Failing to follow the correct sequence of taking Iron and Folic Acid supplements could lead to anemia, even with modest blood loss. Research indicates that consuming a minimum of 90 iron and folic acid (IFA) supplements, in the form of one tablet per day, can reduce the occurrence of maternal anemia by up to 70.0% during pregnancy[29]. The BPS model suggest that poor adherence to taking IFA during pregnancy which could be associated with cultural attitudes towards pregnancy for example a woman preferring to take traditional remedies over taking IFA supplements or lack of awareness on the importance of IFA during pregnancy. These social factors can

influence the decision or the ability of pregnant women to take iron supplements, which in turn can result with PPA.

In this study, pica in pregnant women was associated with anemia, the proportion of women who reported this eating habit was high (46.5%) and same with a study done in Ghana, which found (47.5%) of pregnant women reported such non-food cravings[42]. PPA was found to be common in women who practiced pica 73.2 %, with odds of 4.39 times high compared to their counter parts in this study. It is important that pregnant women are educated on the dangers of eating non-food substances such as termiteria mounds, soil, and charcoal, which can predispose them to intestinal worms and other infections that can contribute to development of anemia or other unwanted outcomes. According to BPS model lack of education or low health literacy which is a social factor in the model, can lead to misunderstandings about the dangers of pica. If a pregnant woman is unaware of the risk associated with consuming non-food substances, she may continue the practice, especially if it is common in her community which is same as reported in this study.

Stress was statistically significantly associated with anemia during postpartum in the bivariate test ($p<0.05$), and half of those who reported stress (54.1%) had PPA. This finding was expected as stress is a commonly seen phenomenon during the postpartum period, intensified by stressful events, such as the process of labor and delivery[25]. Meldawati and others asserts the journey of having a baby can be associated with mixed feelings and psychological adjustments[23]. This could exacerbate the preexisting physiological stress experienced during pregnancy, potentially leading to the inhibition of erythropoiesis in the bone marrow[24]. In the BPS model stress can lead to elevated levels of cortisol and other stress hormones, which may interfere with the body's ability to absorb and utilize nutrients, including iron. This disruption can exacerbate or contribute to anemia during pregnancy which was the results of this study. However, despite this significant association found in this study, stress did not predict PPA. While stress can influence factors like diet and absorption mechanism, it does not directly cause anemia. For stress to lead to anemia, it would need to trigger a series of specific behavior or physiological changes, which do not occur universally across all individuals experiencing stress.

The current study noted that prevalence of PPA was statistically higher (61.5%) among mothers who practiced food taboo. This could be explained by the fact that in Botswana, many pregnant women tend to avoid meat, salty foods and bread which are high in protein are also excellent sources of calcium, iron, vitamin, and B-complex. In support, the current study found out that of women who practiced food taboo during pregnancy, two-thirds (60.1%) avoided eggs while 8.3% avoided liver and it was mainly due to cultural beliefs (98.8%). This finding is line with study done in Ethiopia[51], which revealed that pregnant women who adhered to cultural beliefs and experienced food taboo during pregnancy were 3.9 times more prone to developing anemia compared to pregnant women who did not restrict their food intake. Research has shown that women from various regions worldwide face dietary restrictions during pregnancy and the postpartum period due to cultural customs and beliefs38. In the BPS model, food taboo as a social factor can significantly influence the risk of PPA. Even when pregnant women are educated about the importance of certain food e.g., food rich in iron, they may be reluctant to break taboos due to fear of social judgment or cultural consequences, this was reflected by this study. Although, food taboo was significantly associated with PPA, in this study it did not predict PPA. Reasons could be because of the potential for nutrient compensation, health interventions, and individual differences in adherence to these taboos. These factors can mitigate the risk of anemia, making food taboo an inconsistent predictor of PPA.

The study found out that two-thirds (62.6%) of mothers had inadequate dietary intake of food rich in iron during pregnancy. The inadequate dietary intake of food rich in iron could be explained by low socio-economic status observed in this study leading to poor eating practice/diet. 55.2% of mothers who had inadequate dietary intake of food rich in iron had PPA. Despite this finding inadequate dietary intake of food rich in iron was not statistically significant to PPA unlike in a study by Gibore and others which showed that pregnant women who exhibited inadequate dietary variety scores were shown to have a higher likelihood of experiencing anemia in comparison to their counterparts AOR = 1.16; 95% CI: 0.57 - 2.36; $P < 0.05$[30]. The possible explanation for this insignificant finding could be linked to methodological issues such as sample size and variability in dietary habits might not be large enough to detect a statistically significant relationship.

Overall, the findings of this study align with the biopsychosocial model, which posits that biological,

psychological, and social factors interact to influence health outcomes. The association between biological (HIV status), psychological (stress), social (adherence to IFA supplements, food taboos, and pica) and postpartum anemia in our study highlights the relevance of the biopsychosocial model in understanding maternal health outcomes. By recognizing the interconnectedness of biological, psychological, and social factors, healthcare professionals can create more comprehensive strategies to prevent and manage PPA, ultimately enhancing the health and well-being of postpartum women.

The study results will help nurses and other health care providers to understand the factors that are strongly related to PPA. Thus, nurses and nurse- midwives can apply this knowledge to create educational programs for pregnant women in Botswana to prevent occurrence of PPA. Moreover, midwives and health care providers can apply the study findings to improve care during prenatal period by providing counseling on how to prevent HIV infection, nutritional education on how to avoid practicing pica and encourage good adherence to IFA. Interventions directed at prevention of PPA will also enhance the quality of care for pregnant and postpartum mothers and reduce maternal and child morbidity and mortality in Botswana. It is necessary to teach nursing and midwifery students about PPA and its prevalence and risk factors as well as intervention strategies geared towards prevention of PPA. Therefore, knowledge gained from this study can be incorporated in teaching nursing students to understand factors predicting PPA. The results of this study will give guide to the hospital management standard of procedure (SOP) makers to formulate appropriate SOPs that might be a guideline for the hospital and other facilities to incorporate early screening of PPA to detect and treat PPA early including preventive measure for PPA. Given the inadequate intake of food rich in iron and IFA supplements, it is crucial to strengthen the implementation of WHO guideline, which recommends the continuation of daily supplementation of oral iron and folic acid for 3 months during the postpartum period. This would reduce the rate of PPA and its consequences, and improve maternal and child health.

More researches to provide evidences that will help in planning cost-effective interventions to this problem are vital. Moreover, a study involving more than one facility should be conducted to detect other risk factors associated with PPA so that the result can be generalize. This would aid in planning health care services, reducing maternal morbidity and mortality and help improve the wellbeing of mothers in general.

One of the key limitations of this research arises from its cross-sectional survey design, which restricts causal inferences and instead permits only the establishment of associations between dependent and independent variables. An additional limitation is that the study was facility based which restrict the ability to generalize the findings to all women in Botswana. Furthermore, the socio-demographic variables and other factors evaluated in the study were based on self-reported data provided by the participants, which could potentially introduce information bias.

In conclusion, this study indicated that the prevalence of PPA is a severe public health problem per the WHO cut-off value for the public health significance of anemia. About half of mothers admitted for postpartum care had anemia within 48 hours of giving birth. Finding of this study demonstrated that positive HIV status, pica practice, and poor adherence to IFA are significant factors determining high level of PPA among postpartum mothers in Francistown, Botswana. Standard postnatal guideline is important to help healthcare provider give adequate care and monitoring of postpartum mothers.

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