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Variation of hematological parameters in anemic pregnant women with or without periodontitis in Gharyan city

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الإهداء

إلى من غاب جسده وبقي أثره لا يُنسى

إلى روح والدي الغالي **البهلول أحمد البكاي**
الذي غمرني بحبّه في حياته ولا زالت دعواته ترافقني حتى بعد وفاته
الذي علّمني الصبر وغرس في قلبي الإيمان
أهدي إليه ثمرة هذا الجهد عسى أن يكون في ميزان حسناته ونورًا في قبره ورحمة تحفّه إلى يوم الدين

وإلى **والدتي العزيزة** نبع الحنان والدعم الدائم التي حملتني بحبها ورعايتها ووقفت إلى جانبي دائمًا
وإلى إخوتي الغاليين الذين كانوا سندي وعزوتي في كل المحطات
الذين تشاركت معهم الفرح والحزن والنجاح والتحديات ولم يبخلوا عليّ بدعمهم وحبهم الدائم

وإلى ابني الحبيب زهرة حياتي ونور قلبي الذي منحني القوة للاستمرار رغم كل الصعوبات والذي كانت ابتسامته مصدر إلهامي في كل لحظة تعب

والى اصدقائي الأعزاء وكل من كان لي داعماً او مشجعاً
لكم جميعًا أهدي هذا العمل بكل فخر وامتنان

الشكر والتقدير

بسم الله الرحمن الرحيم

الحمد لله رب العالمين أولاً وأخيراً الذي بفضله وكرمه تيسرت لي هذه الرحلة العلمية

أتوجه بخالص الشكر وعظيم الامتنان إلى كل من ساندني في رحلتي العلمية وكان له أثر في وصولي إلى هذه المرحلة

وأبدأ بتقديم الشكر والتقدير لنفسي على ما بذلته من جهدٍ متواصل وصبرٍ طويل ومثابرةٍ لم تعرف الاستسلام وعلى قدرتي على تحمّل المسؤولية ومواجهة التحديات العلمية والعملية والإصرار على الاستمرار والسعي حتى اكتمال هذا العمل سائلًا الله أن يجعله خالصًا لوجهه الكريم

كل التقدير والعرفان للمشرف الأستاذ الفاضل جبريل مسعود جبريل الذي كان مثالًا في الدعم العلمي والتوجيه الرصين والمتابعة الدقيقة فلم يبخل بعلمه ولا بنصحه ورافقتني إرشاداته حتى اكتمال هذا العمل فله مني كل فيه التقدير والاحترام

كما أتقدّم بخالص الشكر والتقدير إلى إدارة الأكاديمية وأعضاء هيئة التدريس وايضاً العيادة المجمعة غريان على دعمهم مما أسهم بشكل فعّال في إنجاز هذا العمل.

ولا يفوتني أن أتوجه بالشكر العميق إلى أسرتي الحبيبة التي كانت حافزًا لي في مواصلة الطريق وتحقيق هذا الإنجاز

كما لا أنسى أن أشكر كل من وقف بجانبي ولو بكلمة فلكم مني الدعاء الصادق والعرفان العميق

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List of Abbreviations

Terms	Full name
WHO	World health organization
PD	Periodontal disease
TNF	Tumor necrosis factor
CRP	C-Reactive protein
CAL	Clinical Attachment Loss
MCV	Mean corpuscular volume
MCHC	Mean cell hemoglobin concentration
MCH	Mean corpuscular hemoglobin
CBC	Complete blood count
HCT	Hematocrit
SI	Serum iron
ACD	Anemia caused by chronic infection
Hb	Hemoglobin
RBC	Red blood cell count
WBC	White blood cell
PTB	Preterm birth
LBW	Low birth weight
PDI	Periodontal index
PPD	probing pocket depth
GBI	Gingival bleeding index
ANOVA	Analysis of variance
SD	Standard deviation
GI	Gingival Index
PI	Plaque Index
BOP	prevalence of bleeding on probing

Abstract

Introduction: Anemia during pregnancy is a significant public health concern that adversely affects maternal and fetal outcomes. Periodontitis, a chronic inflammatory oral disease, has been suggested to exacerbate systemic inflammation and hematological imbalances. This study aims to investigate the variations in hematological parameters among anemic pregnant women with and without periodontitis in Gharyan City, exploring the potential impact of periodontal disease on systemic inflammation and anemia severity during pregnancy.

Methodology: A cross-sectional study was conducted involving 112 anemic pregnant women attending antenatal clinics in Gharyan City. Participants were divided into two groups: anemic pregnant women without periodontitis (n=50) and anemic pregnant women with clinically diagnosed periodontitis (n=62). Comprehensive periodontal examinations, including plaque index, gingival index, probing pocket depth, bleeding on probing, and gum discoloration assessments, were performed. Hematological parameters, including hemoglobin (Hb), red blood cell count (RBC), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), platelet count (PLT), white blood cell count (WBC), and serum ferritin, were measured. Statistical analyses included descriptive statistics, Pearson correlation, and ANOVA tests to compare and correlate variables within and between groups.

Results: Both groups were similar in age and gestational distribution. The periodontitis group exhibited significantly higher plaque accumulation, gingival inflammation, bleeding on probing, and gum redness. Hematological analysis showed that the periodontitis group had slightly lower Hb and HCT levels, higher PLT and WBC counts, and lower ferritin levels compared to the anemic-only group. Significant correlations between Hb and hematological indices, including a negative correlation with PLT, were observed predominantly in the periodontitis group. ANOVA results indicated more uniform hematological parameters within the periodontitis group, whereas the anemic-only group showed greater variability in Hb and HCT.

Discussion: The findings suggest that periodontitis contributes to a systemic inflammatory state that exacerbates anemia severity and alters hematological parameters in pregnant women. The increased platelet and white blood cell counts reflect an inflammatory response, while lower ferritin levels may indicate impaired iron metabolism due to chronic inflammation. The more consistent hematological profile in the periodontitis group points to periodontal disease as a systemic equalizer, intensifying the inflammatory burden in anemia during pregnancy.

Conclusion: Periodontitis significantly impacts the hematological health of anemic pregnant women by worsening anemia and inducing systemic inflammation. Integrating periodontal screening and treatment into prenatal care is recommended to mitigate these effects and improve maternal and fetal health outcomes.

Keywords: Anemia, Pregnancy; Periodontitis; Hematological parameters; Systemic inflammation; Oral health; Maternal health.

Chapter One

Introduction and literature Review

1.1. Introduction

Pregnancy causes several changes in women that affect every body system. Significant alterations also occur in hematological parameters. Reduced blood ability to carry oxygen is known as anemia, and it can be brought on by a drop in hemoglobin or a drop in red blood cell count. Iron, folate, and vitamin B12 deficiencies, as well as chronic inflammation, genetic abnormalities, parasite infections, and other conditions, can all contribute to anemia. Fatigue, weakness, lightheadedness, and drowsiness are all symptoms of anemia. Iron deficiency anemia is the most frequent cause of anemia, affecting two billion people worldwide, according to the world health organization (WHO) Pregnant women are deemed anemic by the WHO if their hemoglobin level is less than 11 gm/dl.[1]

An infection of all the tissues surrounding the teeth, including the gingiva (gum tissue), cementum (outer layer), and others, is the hallmark of periodontal disease (PD), the most prevalent public health issue in the world, which can impact up to 90% [2,3] of populations. Periodontal ligaments (connective tissue fibers that connect the cementum and the alveolar bone), alveolar bone (sockets into which the teeth are fastened), and the roots of teeth) [4].

It is a prevalent dental ailment that includes periodontitis and gingivitis [5]. Gum inflammation, or gingivitis, is a mild, early stage of periodontitis, or gum disease, which is brought on by plaque and bacteria accumulation in the mouth that causes infection. Additionally, it is characterized by discomfort, swollen gums, and bleeding; if these symptoms persist and lead to the loss of supporting bone and periodontal attachment, it is referred to as periodontitis [6].

Almost 3.5 billion people worldwide suffer from oral illnesses [7]. The most prevalent of them is untreated dental caries, or tooth decay, in permanent teeth. Severe periodontal (gum) disease will develop if dental caries is not treated right away. Severe periodontal disease, which ranged in prevalence from 20% to 50% worldwide [8], was the eleventh most common ailment in the world [9]. Dental care typically accounts for 5% of overall health spending in the majority of high-income nations [10].

Periodontal diseases are highly common during pregnancy and lactation [11] due to hormonal factors (high concentration of estrogen and progesterone) and the subsequent impact on the gingival arteries compared with non-pregnant and non-lactating women [12]. Periodontal disease is more prevalent at eight months of pregnancy and its rate begins to return to normal during two months postpartum [13,14].

Poor pregnancy outcomes, including preeclampsia [15], gestational diabetes [16], vulvovaginitis, preterm labor (gestational age <37 weeks), fetal growth restriction [17], low birth weight (<2500 g) [18], perinatal mortality [19], early abortion, and an increased risk of early neonatal infection [20], are more likely to occur in pregnant women with periodontal disease.

Thus, scaling and root planning in the second trimester of pregnancy may lower the risk of problems from periodontal disease, according to many research [21, 22, 23]. Therefore, it is hypothesized that low-grade systemic inflammation brought on by periodontitis may result in fewer erythrocytes and, as a result, decreased hemoglobin (Hb) concentrations (6–7 g/dl).

With the potential to enhance maternal health outcomes and lessen the burden of pregnancy-related problems, this study will provide crucial evidence regarding the significance of periodontal care as part of standard prenatal care for pregnant women with anemia and other variations in hematological parameters. A comprehensive strategy for treating anemia and enhancing the general health of expectant mothers may be provided by healthcare professionals integrating oral health management into routine prenatal examinations if a strong correlation between periodontitis and anemia is discovered.

1.2. Periodontal Disease in Pregnancy

The whole-body inflammatory pre-activation associated with untreated periodontitis is a significant risk factor for several systemic diseases, such as atherosclerosis, acute coronary events, strokes, diabetes, obesity, asthma, and erectile dysfunction, in addition to low birth weight and preterm births [24, 25, 26].

Bacteremia is the term for the transient or persistent presence of living bacteria in the bloodstream. Because the pathogenic subgingival microflora in periodontitis is located adjacent to the damaged internal epithelium of the periodontal pockets, pathogenic bacteria can reach the bloodstream. Chronic low-level bacteremia is believed to be the direct mechanism underlying the association between periodontitis and an adverse pregnancy outcome [27, 28, 29].

Additionally, any infection that develops during pregnancy is serious. It showed that low birth weight and preterm labor are more common in pregnant women with periodontitis [30]. The probability of preexisting periodontal problems getting worse during pregnancy increases. Because of the significant increase in hormones, particularly estrogen and progesterone, during the second or third trimesters of pregnancy, gums may react differently to dental plaque bacteria [31]. This may cause bleeding, discomfort, edema, or redness of the gums. Therefore, doctors should recommend a periodontal checkup and prophylactic care for women who are considering pregnancy [32].

The biological activity of perio-pathogens during pregnancy is closely related to the cavity bacteria and their metabolites (endo and exotoxins), which enter the bloodstream and go to the fetoplacental unit. By regulating inflammatory mediators that are produced locally in periodontal tissues and that also travel through the bloodstream to the liver and fetal-placental unit, the indirect route raises systemic inflammation through the action of the acute phase protein C-reactive [33].

The most compelling evidence suggesting a direct pathway for the hematological spread of oral cavity microorganisms and their metabolites, which in turn cause an immunological and inflammatory reaction in the feto-placental unit, was discovered in 2012. The presence and amount of microorganisms and their products in the amniotic fluid, placental umbilical cord blood, neonatal respiratory aspirates, fetal membranes, or fetal tissues, as well as the levels of antibodies to oral microbes, have also been proposed as the best indicators for assessing exposure to oral bacterial infections in the oral cavity fetal placental unit.

Porphyromonas gingivalis, *Bergeyella sp.*, *Campylobacter rectus*, and *Fusobacterium nucleatum* were the bacterial species most closely associated with pregnancy issues.

The best indicators for a potential assessment of the fetoplacental unit's exposure to inflammation, however, were believed to be the levels of inflammatory biomarkers in maternal serum, umbilical cord blood, and amniotic fluid (including IL-1, IL-6, prostaglandin-E2, TNF-, CRP, 8-isoprostane, soluble intercellular adhesion molecule-1, matrix metalloproteinases, fibronectin, and fetoprotein) in these fluids [34].

1.3. The Relation between Periodontitis and variations in hematological parameters

Periodontitis, an anti-inflammatory disease of the tissues supporting teeth, leads to a progressive degradation of the alveolar bone and PDL, which can induce gingival recession, pocket formation, or both [35]. Chronic periodontitis, which is more common in adults [36], is classified as mild (1-2 mm), moderate (3-4 mm), or severe (5 mm or greater) [37] according to the severity of Clinical Attachment Loss (CAL).

A clinically accepted laboratory evaluation of hematological parameters is as follows: Complete blood count (CBC), hematocrit (HCT), erythrocyte indices, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) are all discussed. To evaluate the reticulocyte count and iron stores, measurements are made of serum iron (SI), total iron binding capacity (TIBC), ferritin, and other essential markers. A malfunction distinguishes three types of anemia [38, 39, 40].

Anemia caused by chronic infection; Anemia of Chronic Disease (ACD), which is present in inflammatory diseases, infections, and malignancies, is one of the most prevalent forms of anemia seen in hospitalized patients. Despite having sufficient iron stores and no bone marrow malfunction, this kind of anemia can nonetheless arise [41].

1.4. The link between poor pregnancy outcomes and periodontal disease

Offenbacher et al. [42] first recognized periodontal disease as a risk factor for premature low birth weight in 1996 through a case-control study of 124 pregnant women. Numerous relevant investigations to examine the connection between periodontal disease and adverse pregnancy outcomes were spurred by this discovery. The majority of the 232 relevant clinical research investigations that were carried out between 1996 and April 2020 found a clear connection between periodontal disease and several adverse pregnancy outcomes [43].

Interestingly, most research done in the last two years has also shown a high correlation between poor pregnancy outcomes and periodontal disease. Premature babies are more likely to be born to mothers who have periodontal disease during pregnancy, according to several studies. As the mother's periodontal inflammation develops, this association becomes much more apparent [44, 45, 46]. Both a meta-analysis and cohort studies found that pregnant women with periodontitis had a twofold increased risk of preterm birth compared to those without the condition [47, 48].

According to a retrospective case-control research that included 555 postpartum women, pregnant women with periodontitis were also six times more likely to give birth to premature babies than women without the condition [49]. A hospital-based cross-sectional case-control study also found that the presence and severity of postpartum maternal periodontitis remained independent risk factors for preterm birth in the setting of antepartum smoking habits and delivery routes [50].

Moreover, periodontal infections and their metabolites are known to affect progressive and inflammatory lesions of tooth-supporting tissues by regulating the release of inflammatory mediators. Furthermore, it is commonly known that these infections and inflammatory mediators can transfer to the placenta and cause a variety of adverse pregnancy outcomes [51].

1.5. Importance of the current study

The study titled *"Variation of Hematological Parameters in Anemic Pregnant Women with or without Periodontitis in Gharyan City"* is of significant importance as it explores the interplay between maternal anemia and periodontal disease—two prevalent health conditions that can impact both maternal and fetal well-being. Preterm birth, low birth weight, and elevated maternal morbidity are among the consequences that can result from anemia during pregnancy, which is a serious public health issue.

Similarly, periodontitis, a chronic inflammatory disease affecting the supporting structures of the teeth, has been linked to systemic conditions, including adverse pregnancy outcomes. Investigating the hematological variations in anemic pregnant women with or without periodontitis can provide valuable insights into the potential role of periodontal health in exacerbating or influencing anemia.

Moreover, anemia during pregnancy is a major global health concern, often associated with increased risks of preterm birth, low birth weight, and maternal complications. Periodontitis, a chronic inflammatory condition of the gums, has been identified as a potential contributing factor to systemic inflammation, which may further influence hematological parameters such as hemoglobin (Hb), red blood cell count (RBC), white blood cell count (WBC), and inflammatory markers like C-reactive protein (CRP).

In pregnant women, the presence of periodontitis may exacerbate anemia by increasing systemic inflammatory mediators, potentially leading to a reduction in iron absorption and erythropoiesis. Additionally, elevated WBC counts and inflammatory cytokines associated with periodontal infections could contribute to chronic immune activation, further impacting the hematological profile. This study aims to explore these variations and determine whether periodontal disease aggravates anemia-related hematological imbalances. Understanding these interactions is essential for developing integrated prenatal care strategies that emphasize both oral and systemic health, ultimately improving maternal and fetal outcomes.

Understanding these associations can help in developing integrated healthcare strategies that emphasize both maternal oral and systemic health, ultimately improving pregnancy

outcomes and overall well-being in affected populations, particularly in Gharyan City, where such data may be limited

1.6. Study hypothesis

This study hypothesizes that anemic pregnant women with periodontitis exhibit significant variations in hematological parameters compared to anemic pregnant women without periodontitis. Specifically, we propose that the presence of periodontitis contributes to an increase in systemic inflammation, which may exacerbate the hematological imbalances associated with anemia. More precisely, it is expected that anemic pregnant women with periodontitis will have:

1. **Lower Hb levels and RBC counts** due to the potential impact of chronic inflammation on iron metabolism and erythropoiesis. Inflammatory mediators released in response to periodontal infection may interfere with iron absorption and utilization, further worsening anemia.
2. **Elevated WBC counts**, indicating a heightened systemic inflammatory response. The chronic bacterial infection in periodontitis may stimulate immune activation, leading to an increase in circulating leukocytes and pro-inflammatory cytokines.
3. **Altered platelet counts and coagulation markers**, as systemic inflammation may influence thrombopoiesis and clotting mechanisms, potentially increasing the risk of pregnancy-related complications.

By investigating these variations, this study aims to determine whether periodontal disease is a contributing factor to hematological disturbances in anemic pregnant women. If confirmed, this hypothesis would support the need for integrating periodontal health assessments into antenatal care programs to mitigate anemia-related risks and improve maternal and fetal health outcomes, particularly in Gharyan City.

1.7. Aims and specific objectives

The following structured general aim and objectives will help ensure a clear research focus while addressing key aspects of the relationship between anemia and periodontitis in pregnancy:

1.8. General Aim

This study aims to evaluate the effect of periodontitis on hematological parameters in anemic pregnant women in Gharyan City by comparing these parameters between a group of pregnant women suffering from anemia and periodontitis and another group suffering from anemia only.

1.8.1. Specific Objectives

1. To assess and compare hematological parameters (such as hemoglobin levels, RBC, WBC, and platelet count) between anemic pregnant women with and without periodontitis.
2. To evaluate the inflammatory markers (e.g., total leukocyte count) in both groups to determine the extent of systemic inflammation associated with periodontitis.
3. To analyze the correlation between the severity of periodontitis and hematological variations in anemic pregnant women.
4. To identify potential risk factors contributing to both anemia and periodontitis in pregnant women within Gharyan City.
5. To highlight the importance of periodontal health management in antenatal care as a potential strategy to reduce anemia-related complications during pregnancy.

1.9. Literature Review

The connection between periodontal disease and poor pregnancy outcomes is still up for dispute. This may be due to variations in sample sizes, racial and age distributions, lifestyle choices, and socioeconomic situations, as well as the fact that different research have employed varied definitions of periodontal disease and adverse pregnancy outcomes.

Two serious pregnancy issues that can impact the unborn child's health and survival are preterm birth (PTB) and low birth weight (LBW). Regardless of gestational age, LBW is defined as a birth weight of less than 2,500 g. A birth that takes place before 37 weeks of pregnancy is the hallmark of PTB. Both PTB and LBW are associated with long-term

developmental problems and a higher risk of neonatal morbidity and mortality [52, 53, 54]. Numerous research have discovered a link between periodontitis and LBW and PTB, while the exact data is still unknown.

This link has been explained in two plausible ways. Inflammation results from th
e direct channel, which involves bacteria from the tooth biofilm or its byproducts entering the bloodstream, moving to the placenta, and infecting it. Inflamed periodontal tissues produce proinflammatory cytokines throughout the body, which can disrupt the feto-placental unit, impede intrauterine growth, and result in preterm birth [53, 54, 55].

According to a study by Nair Sk et al. [56], periodontitis is a chronic condition that can lower hemoglobin percentage and is consistent with a study by Hutter et al. [57]. The MCV and MCH values, or hemoglobin per erythrocyte, are similar across the three groups, despite the fact that periodontitis patients had lower hemoglobin levels. Since, the MCV values are unaffected, it is crucial to remember that lower Hb% in periodontitis is not caused by iron or vitamin deficits [58]. Numerous chronic illnesses, infections, and cancers have been linked to mild to moderate anemia.

This led to the creation of the term ACD, which is defined as anemia that occurs in inflammatory conditions, neoplastic disorders, or chronic infections and is not brought on by marrow deficiencies or other illnesses, even when there are sufficient iron stores and vitamins present [59, 60]. This kind of anemia is known as microcytic anemia [59]. There are several contributing factors to ACD. According to Cartwright [61], ACD is caused by at least three pathologic processes: 1) decreased erythrocyte survival, 2) the bone marrow's inability to produce more red blood cells to meet this increasing demand, and 3) a compromised ability of the reticuloendothelial system to release iron.

In comparison to healthy controls, several observational studies also found that patients with chronic periodontitis had lower Hb%, RBC, and other hematocrit values [62,63]. Following periodontal therapy, a slight rise in MCV, MCH, and MCHC levels indicates normocytic and normochromic anemia that is not brought on by an iron or vitamin shortage [64]. The current study concludes that anemia from chronic periodontitis is

moderate because it demonstrates a statistically significant change in Hb and RBC levels, although these changes are not as great as those shown in anemia from other systemic inflammatory disorders including multiple myeloma [65] and rheumatoid arthritis [66].

Pregnancy may be associated with an increased risk of periodontal disease. The prevalence of periodontitis in various pregnant women groups has been found to be exceptionally high, possibly reaching 66.7% in some ethnic groups, even in highly developed nations [67, 68]. Pregnant women know very little about periodontal disease and its potential effects on pregnancy, according to numerous research. Only 12% of Saudi Arabian respondents knew about the connection, according to the Asa'ad et al. study [69].

This information may be influenced by variables like age, education, or even marital status [70]. Just 10.5% to 18% of pregnant women in France sought advice from medical specialists regarding dental health issues. Dental consultations before to pregnancy were positively correlated with not having a dental examination during that time [71, 72]. Even though some women are aware of the connection between Periodontal Disease (PD) and poor pregnancy outcomes, only 47% of women received an oral health diagnosis or the necessary treatment [71].

All of these findings suggest that pregnant women need to be educated about periodontal disease (PD) and its consequences because of a lack of knowledge [73]. According to the Centers for Disease Control and Prevention, 47.2% of people in the United States who are 30 years of age or older have PD. Males are more likely than females to smoke (male vs. female: 56.4% vs. 38.4%), be older, be poor, be male, and have less than a high school degree [74].

Given this, there is still a significant possibility that many expectant mothers may experience the negative effects of PD. Additionally, González-Jaranay demonstrated that all PD-descriptive metrics, including gingival index, plaque index, and probing death, rise during pregnancy [75].

However, other studies on the impact of periodontitis on other physiological processes in pregnant women have indicated that pregnant women with the condition had a doubled risk of preterm birth when compared to those without the illness, according to a meta-analysis and a cohort study [76, 77]. According to a retrospective case-control research that included 555 postpartum women, pregnant women with periodontitis were also six times more likely to give birth to premature babies than women without the condition [78].

A hospital-based cross-sectional case-control study also found that the presence and severity of postpartum maternal periodontitis remained independent risk factors for preterm birth in the setting of antepartum smoking habits and delivery routes [79]. A cross-sectional study measuring clinical periodontal parameters and blood C-reactive protein levels indicated that worse maternal periodontal status, higher oral inflammatory load, and increased systemic inflammation had a deleterious effect on infant birth weight [80].

Additionally, it was suggested that a periodontal infection could exacerbate the progression of pre-eclampsia, and that periodontal disease was one of the risk factors for pre-eclampsia [81, 82]. Apart from that, few studies have found a direct correlation between periodontal disease and poor pregnancy outcomes. A case-control study that obtained subgingival biofilm samples of pregnant women from four locations up to 48 hours postpartum and processed them using a polymerase chain reaction to check for the presence of periodontal pathogens found that most oral cavity periodontal pathogens were not clearly associated with the development of preterm birth or low birth weight [83].

Although the data is still unclear, a number of studies have found a connection between periodontitis and LBW and PTB. This link has been explained in two plausible ways. Inflammation results from the direct channel, which involves bacteria from the tooth biofilm or its byproducts entering the bloodstream, moving to the placenta, and infecting it. The indirect route entails the systemic synthesis of proinflammatory cytokines from

inflammatory periodontal tissues, which might disrupt the feto-placental unit and result in premature delivery and intrauterine growth restriction [84, 85, 86].

A study by Castaño Suárez et al. [87] evaluated the control group and women with pregnancy difficulties for variations in periodontal attachment level and probing depth; however, due to the lack of data, no meta-analysis of periodontal variables was carried out. The results showed no discernible differences.

Additionally, after controlling for maternal education, ethnicity, age, smoking, alcohol use, infections, and hypertension during pregnancy, Davenport et al. [88] conducted a case-control analysis and found no evidence of a relationship between probing depth and the risk of preterm low birth weight.

On the other hand, a recent study [89] discovered that the groups' probing depths varied by nearly 2 mm. Additionally, the methods used to assess periodontal health varied throughout studies, which may account for the absence of a discernible and meaningful difference between the groups. However, a moderate correlation between periodontitis and low birth weight was discovered in the meta-analysis of periodontitis prevalence, which is consistent with a prior comprehensive review [90]. Therefore, Preterm delivery was found to have a weak but significant correlation with periodontitis, which is also consistent with a previous systematic study.

In another study conducted in Mali by Hess et al. [91] found that the periodontal index (PDI) has a mean score of 2.58 (1.8), with scores ranging from 0 to 6. The CPI mean was 2.00 (1.5), with scores ranging from 0 to 4. The PDI and community periodontal index (CPI) scores have a substantial, positive, and statistically significant association (Pearson $r=0.94$; $P<0.001$). 73% of the women had PD, according to the PDI; 24% had gingivitis and 48.6% had periodontitis. Of these pregnant women, 42% (31/74) had plaque on at least 50% of their tooth surfaces. Nearly half (36/74) exhibited a lot of subgingival and supragingival calculus. According to the CPI score, 47% of people had gum disease pockets.

Additionally, this sample of pregnant women in the same study had HCT levels ranging from 16 to 39%, with a mean of 31.96% (4.95). There were no statistically significant relationships between the HCT and CPI scores and the HCT and PDI scores (P=0.74 and 0.77, respectively). The proportion of deep periodontal pockets was larger in non-anemic women than in anemic women (63.6% versus 34.3%, respectively).

However, a study by Nair et al. [56] found that periodontitis is a chronic condition that can diminish hemoglobin %, which is consistent with a study by Hutter et al. [57] The MCV and MCH values, or hemoglobin per erythrocyte, are similar across the three groups, despite the fact that periodontitis patients had lower hemaglobin levels. Additionally, this study has demonstrated a negative association between gingival index (GI) and both RBC and Hb%.

Furthermore, the positive link between GI and MCHC% may be due to the fact that the former is more reliant on the body's iron stores. The pro-inflammatory cytokines generated in periodontitis can be regarded as downregulating erythropoesis, as evidenced by the negative connection seen in the periodontitis group between clinical attachment level (CAL) vs. Hb% and CAL vs. MCHC% [92].

According to a different study by Pulluru et al. [93], pregnancy gingivitis is more common in the first trimester (55%) and the second trimester (45%). These findings are consistent with a study by Mills LW et al. [94] that emphasized the possible connection between periodontal disease and pregnancy, and a study by Renata et al. [95] that examined the subgingival flora and serum levels of progesterone and estradiol in various gestational trimesters and non-pregnant women. They discovered a correlation between the total bacterial count and gestation. Gingivitis was linked to a higher bacterial count in the first trimester, whereas progesterone levels during this time accelerated the development of gingivitis into periodontitis.

Therefore, according to the literature currently available, there is a significant correlation between periodontitis and changed hematological parameters in pregnant women who are anemic. Through systemic inflammatory reactions and abnormalities in iron metabolism, chronic periodontal inflammation may make anemia worse. To clarify the underlying

mechanisms and create focused therapies that can enhance the hematological and periodontal health outcomes in this susceptible group, more research is necessary.

Chapter Two

Materials and Methods

2. Materials and Methods

2.1. Study design

This comparative cross-sectional study was conducted in Gharyan City during the period from January 2025 to May 2025. The study aimed to investigate the variations in hematological parameters among anemic pregnant women with and without periodontitis. Data collection and clinical examinations were performed at selected antenatal care clinics and dental centers within the city.

2.2. Study population

The study population consisted of pregnant women who were clinically diagnosed with anemia and attended antenatal care services in Gharyan City. Eligible participants were selected using specific inclusion and exclusion criteria.

2.3. Inclusion Criteria

1. Pregnant women between the ages of 18-40 years.
2. Diagnosis of anemia, defined as a hemoglobin level less than 11 g/dL.
3. Consent to participate in the study.

2.4.Exclusion Criteria

1. Pregnant women with pre-existing chronic diseases (e.g., diabetes, kidney disease) that could independently affect hematological parameters.
2. Women with active infections or other conditions that could interfere with periodontal health.

2.5.Sample Size:

The study aims to record 112 pregnant women, with approximately 62 women with periodontitis and anemia, and 50 with only anemia (without periodontitis).

2.6. Sampling and Grouping: A total of 50 anemic pregnant women and 62 anemic pregnant women with periodontitis were recruited and categorized into two groups:

Group I: Anemic pregnant women diagnosed with periodontitis.

Group II: Anemic pregnant women without periodontitis.

Periodontal status was assessed using standard clinical periodontal examination, which included measurement of probing pocket depth (PPD), CAL, and gingival bleeding index (GBI). Diagnosis and severity of periodontitis were determined according to established criteria by the American Academy of Periodontology.

2.7.Data Collection

In addition to clinical examinations and laboratory investigations, data were collected through a structured, pre-tested questionnaire specifically designed for this study. The questionnaire was developed to obtain comprehensive information relevant to the research objectives and to identify potential risk factors associated with anemia and periodontitis among pregnant women.

The questionnaire consisted of multiple sections, including demographic information (such as age, marital status, educational level, and socioeconomic status), obstetric history (gestational age, number of pregnancies, and history of anemia), oral hygiene practices (frequency of tooth brushing, use of dental services, and previous periodontal treatment), and general health-related behaviors (dietary habits and use of supplements).

Trained interviewers administered the questionnaire to all participants through face-to-face interviews during their visits to antenatal clinics. Participants were informed about the purpose of the questionnaire, and confidentiality was ensured. The collected data complemented the clinical and laboratory findings and helped identify possible contributing factors to anemia and periodontal disease during pregnancy. Periodontal Assessment: The severity of periodontitis was assessed using the CAL and PD as indicators of gum health.

Figure 2.1. Clinical investigation for study participants.

2.8. Laboratory Investigation

Blood samples were collected from all participants under aseptic conditions. Hematological parameters, including Hb level, RBC, WBC, platelet count, RBC indices and ferritin levels, were measured using an automated hematology and biochemical analyzer at the designated laboratory. Standard procedures were followed to ensure accuracy and reliability of results.

Serum ferritin measurement and the CBC were among the hematological studies carried out in this investigation. Red-top tubes, which are appropriate for serum-based immunoassay assays, were used to collect samples for ferritin testing, whereas EDTA tubes were used to collect blood samples for CBC. The laboratories of the Gharian Polyclinic, Al-Hekma Laboratory, Al-Yusr Laboratory, and Al-Deqqa Laboratory conducted these tests.

Al-Yusr Laboratory handled the majority of the patients and performed the majority of laboratory analyses. The Dymind DF50 Hematology Analyzers for CBC and the COBAS INTEGRA 400 plus analyzers for ferritin levels were among the instruments utilized.

Finally, a standardized Williams periodontal probe was used for the periodontal examination in order to measure clinical parameters such clinical attachment loss and probing pocket depth.

2.8.1. Materials, biomedical machines and laboratory analyzers used for investigations

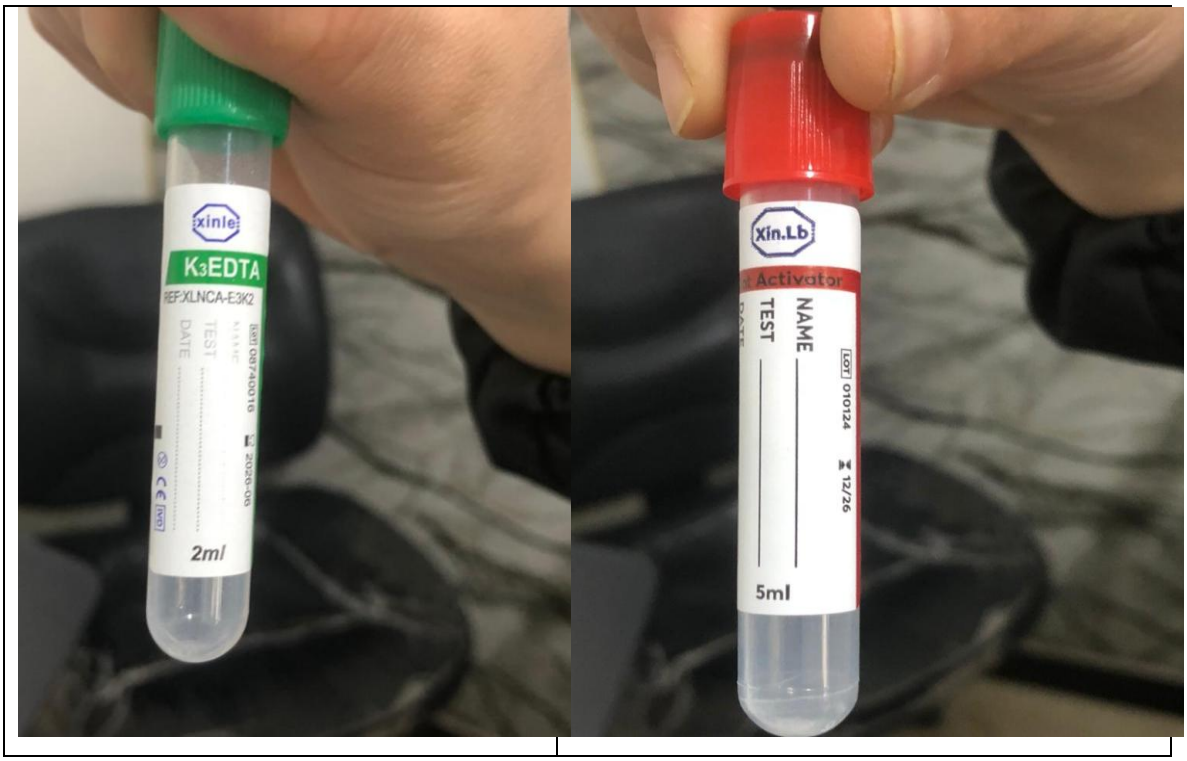

Figure 2.2. EDTA and red-top tubes used for blood samples collection.

Figure 2.3. Dymind DF50 blood analyzer used for complete blood analysis.

Figure 2.4. COBAS integra 400 plus used for ferritin level measurement.

Figure 2.5. Williams periodontal probe, pocket dept or WHO probe. utilized for various periodontal health surveys, such as the Community Periodontal Index (CPI). evaluates the state of the periodontal tissue and aids in the detection of calculus, bleeding, and periodontal pockets through probing.

2.9.Ethical Considerations

The study received ethical approval from the Postgraduate Academy's scientific committee. Prior to clinical and laboratory studies, all subjects provided written informed consent. Throughout the study, participants' privacy and confidentiality were rigorously protected.

2.10. Statistical analysis

SPSS version 23 was used to code, enter, and analyze all of the data that was gathered. Demographic and clinical features were summarized using descriptive statistics including frequency, percent, mean, and standard deviation. Hematological parameter and inflammatory marker differences between the two groups were evaluated using comparative analysis (r Pearson and ANOVA). To investigate the connection between changes in hematological markers and the severity of periodontitis, correlation analyses were conducted. At $P < 0.05$, statistical significance was taken into account.

Chapter Three

Results

3. Results

3.1. Descriptive data of the study participants (Anemic pregnant women and those with periodontitis) according to age and total number.

Descriptive overview of the study population shown in (Table 3.1 and Figure 31.) detailing the distribution and mean ages of anemic pregnant women with and without periodontitis in Gharyan City. Out of a total of 112 participants, 50 women (45.4%) were diagnosed solely with anemia, while a slightly larger proportion, 62 women (56.3%), had both anemia and periodontitis.

The mean age for anemic pregnant women without periodontitis was 27.28 years (± 4.90 SD), whereas the mean age for those with periodontitis was marginally higher at 27.68 years (± 4.64 SD). This close similarity in mean ages and standard deviations indicates that the two groups are comparable in terms of age distribution, which is important for reducing potential age-related confounding effects when analyzing hematological variations. The relatively young mean age reflects the typical reproductive age range in the studied population and aligns with regional demographics where women commonly conceive during their mid-to-late twenties.

Table 3.1. Total number, frequencies, mean and standard deviation of participants according to age in years

Participants group	Patients number	Percent %	Age (years)	
Anemic pregnant women	50	45.4 %	Mean	27.28
			± SD	4.899146
Anemic pregnant women/Periodontitis	62	56.3 %	Mean	27.67742
			± SD	4.636895
Total	112	100 %		

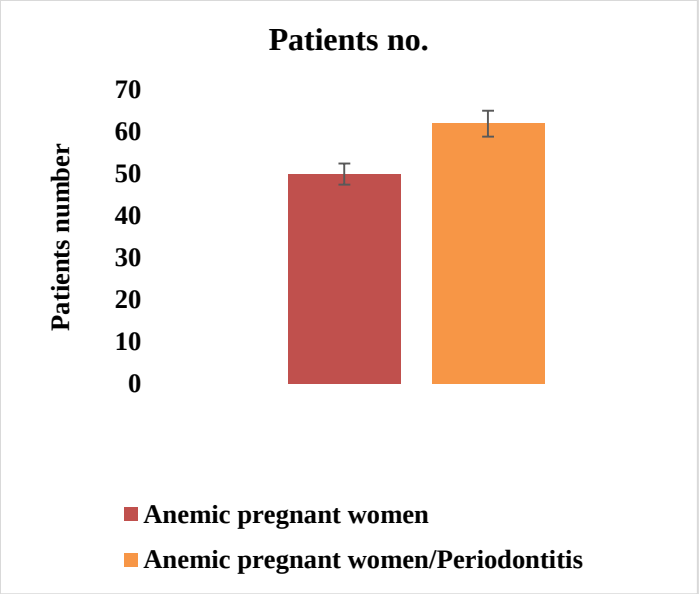

Figure 3.1. Total number, frequencies, mean and standard deviation of participants according to age in years.

3.1.1. Descriptive data of the first group (anemic pregnant women) of the participants depending on the periodontal gum examination

Results summarized in (Table 3.2) provides the periodontal examination findings for the first group of participants **(**anemic pregnant women without diagnosed periodontitis) and provides insight into their gestational stage, oral hygiene status, and gingival health indicators. On the other hand, among these women, the distribution across pregnancy trimesters shows that 40% were in the first trimester**,** 24% in the second**,** and 36% in the third trimester. This relatively even distribution ensures that different stages of pregnancy are represented, which is important as physiological changes related to gestational age can affect both hematological and periodontal status.

Regarding oral hygiene, 36% had no detectable plaque**,** 38% had only a film of plaque**,** and 26% had moderate plaque accumulation. Notably, no participant had large amounts of plaque. This indicates that while mild plaque accumulation is common, severe oral hygiene neglect is absent in this group. This moderate-to-good plaque control could explain the generally healthy periodontal status seen in other indices.

Moreover, the Gingival Index (GI) reveals that 46% had normal gingiva, while 54% exhibited mild inflammation**.** No cases of moderate or severe gingivitis were recorded, which is consistent with the low plaque levels. This mild inflammation may be due to hormonal changes common in pregnancy, which increase gingival vascularity and susceptibility to mild gingivitis even in the presence of minor plaque deposits.

All participants (100%) had a PPD between 0–3 mm, which is indicative of healthy gingival attachment with no signs of moderate or severe periodontitis. This confirms that this group indeed represents anemic pregnant women without periodontal disease, validating the study's grouping criteria. About 32% of participants showed bleeding on probing, while 68% did not. Bleeding is a sign of gingival inflammation; thus, this finding aligns with the GI results showing that mild inflammation is present in about half the participants. All women in this group (100%) were recorded without gum swelling or inflammation, which might initially seem consistent with the PPD data.

However, this likely reflects mild pregnancy-associated gingival changes rather than true periodontitis, as confirmed by the absence of deep pockets or severe plaque. Additionally, regarding gum color, 46% had pale gums**,** while 54% had normal pink gums, and no redness was observed. Pale gums may reflect underlying anemia — consistent with the selection of this group — since anemia can cause mucosal pallor due to reduced hemoglobin levels and oxygenation.

Table 3.2. Descriptive data of the first group (anemic pregnant women) of the participants depending on the periodontal gum examination

The question	Category	Frequency	Percent %
Gestational Age (Weeks)	First trimester (1–12 weeks)	20	40 %
	Second trimester (13–26 weeks)	12	24
	Third trimester (27–40 weeks)	18	36
Plaque Index (PI)	No plaque	18	36
	A film of plaque detected by probe	19	38
	Moderate accumulation of plaque	13	26
	Large amounts of plaque in the gingival pocket	0	
Gingival Index (GI)	Normal gingiva	23	46
	Mild inflammation	27	54
	Moderate inflammation	0	0
	Severe inflammation	0	0
Probing Pocket Depth (PPD)	0–3 mm (Healthy)	50	100
	4–6 mm (Moderate Periodontitis)	0	0
	Greater than 6 mm (Severe Periodontitis)	0	0
Bleeding on Probing (BOP)	Present	16	32
	Absent	34	68
Presence of Gum Swelling or Inflammation	Yes	0	0
	No	50	100
Presence of Gum Discoloration	Redness	0	0
	Pale gums	23	46
	Normal pink color	27	54

3.1.2. Descriptive data of the first group of the participants depending on the presence of anemia

On the other hand, (Table 3.3) provides a simple but essential confirmation of the hematological status of the first study group (the anemic pregnant women without periodontitis). The table shows that 100% (n = 50) of the participants in this group were confirmed to have anemia, while 0% were non-anemic. This reinforces that the inclusion criteria for this subgroup were strictly applied and that there was no misclassification.

This finding is significant because it establishes a clear baseline for the group's systemic health status: all participants are uniformly anemic but do not have periodontal pockets or clinical periodontitis. This homogeneity is methodologically important because it allows any hematological variations detected later in your study to be more confidently attributed to the presence or absence of periodontitis, rather than to inconsistencies in anemia status.

Additionally, this 100% prevalence of anemia aligns with the study's primary aim — to investigate how periodontal disease may interact with anemia-related hematological imbalances during pregnancy. By ensuring that every participant in this subgroup is anemic, you strengthen the internal validity of later comparisons with the second group (anemic women with periodontitis).

Table 3.3. Descriptive data of the first group (anemic pregnant women) of the participants depending on the presence of anemia.

Category		Frequency	Percent %
Anemic patients	Yes	50	100 %
	No	0	0
Total		50	100

3.2. Descriptive data of the second group (anemic pregnant women/periodontitis) of the participants

The distribution of participants across trimesters is similar to the first group, with 38.7% in the first trimester, 27.5% in the second, and 33.8% in the third trimester. This comparable spread again helps control for gestational influences on both periodontal and hematological parameters (Table 3.4). According to the Plaque Index (PI); unlike the first group, none of these participants were plaque-free. The majority (53.2%) had large amounts of plaque in the gingival pocket, and 43.5% had moderate plaque accumulation, while only 3.3% had just a thin film of plaque.

This high plaque burden is a major contributing factor to the development and severity of periodontal disease, consistent with the diagnostic classification of this group. A clear contrast emerges in the level of gingival inflammation; 67.8% had moderate inflammation, 32.2% had severe inflammation and no participants had normal or only mild inflammation. This shows that gingival inflammation is widespread and severe in this group, which aligns with the plaque findings and confirms the presence of active periodontal disease.

The probing depth data further validates the periodontitis diagnosis and revealed that 58.1% had pockets 4–6 mm, indicating moderate periodontitis, 41.9% had pockets greater than 6 mm, indicating severe periodontitis and no participants had healthy pocket depths (0–3 mm), which strongly distinguishes this group from the first group, where all pockets were healthy. On the other hand**,** bleeding on probing, a clinical marker of active inflammation, was present in 98.3% of participants. This near-universal bleeding highlights significant gingival tissue destruction and inflammation, characteristics of advanced periodontitis.

Regarding presence of gum swelling or inflammation; all participants (100%) showed visible gum swelling or inflammation, reinforcing the severity of periodontal disease in this group. Unlike the first group, where many women had pale gums due to anemia, 100% of women in this group showed gum redness. This intense erythema is a classic sign of inflamed, infected gingival tissue in periodontitis and may mask any anemia-related pallor in the gingiva.

Table 3.4. Descriptive data of the second group (anemic pregnant women/periodontitis) of the participants depending on the periodontal gum examination

The question	Category	Frequency	Percent %
Gestational Age (Weeks)	First trimester (1–12 weeks)	24	38.7
	Second trimester (13–26 weeks)	17	27.5
	Third trimester (27–40 weeks)	21	33.8
Plaque Index (PI)	No plaque	0	0
	A film of plaque detected by probe	2	3.3
	Moderate accumulation of plaque	27	43.5
	Large amounts of plaque in the gingival pocket	33	53.2
Gingival Index (GI)	Normal gingiva	0	0
	Mild inflammation	0	0
	Moderate inflammation	42	67.8
	Severe inflammation	20	32.2
Probing Pocket Depth (PPD)	0–3 mm (Healthy)	0	0
	4–6 mm (Moderate Periodontitis)	36	58.1
	Greater than 6 mm (Severe Periodontitis)	26	41.9
Bleeding on Probing (BOP)	Present	61	98.3
	Absent	1	
Presence of Gum Swelling or Inflammation	Yes	62	100
	No	0	0
Presence of Gum Discoloration	Redness	62	100
	Pale gums	0	0
	Normal pink color	0	0

3.2.1. Descriptive data of the second group of the participants depending on the presence of anemia

Regarding the second group (pregnant women diagnosed with periodontitis), out of 62 participants in this group, 60 women (96.8%) were confirmed to be anemic, while only 2 women (3.2%) were found not to be anemic (Table 3.5, Figure 3.5). This result is

important for two reasons. The overwhelming majority of this group is anemic, aligning with the study's focus on anemic pregnant women.

The presence of 2 non-anemic women is likely due to slight physiological variation or possible recovery during pregnancy (e.g., due to iron supplementation or dietary improvement). Statistically, this small number is unlikely to affect group-level hematological results but should be noted when interpreting any outliers.

Table 3.5. Descriptive data of the second group (anemic pregnant women/periodontitis) of the participants depending on the presence of anemia.

Category		Frequency	Percent %
Anemic patients/periodontitis	Yes	60	96.7 %
	No	2	3.3%
Total		62	100 %

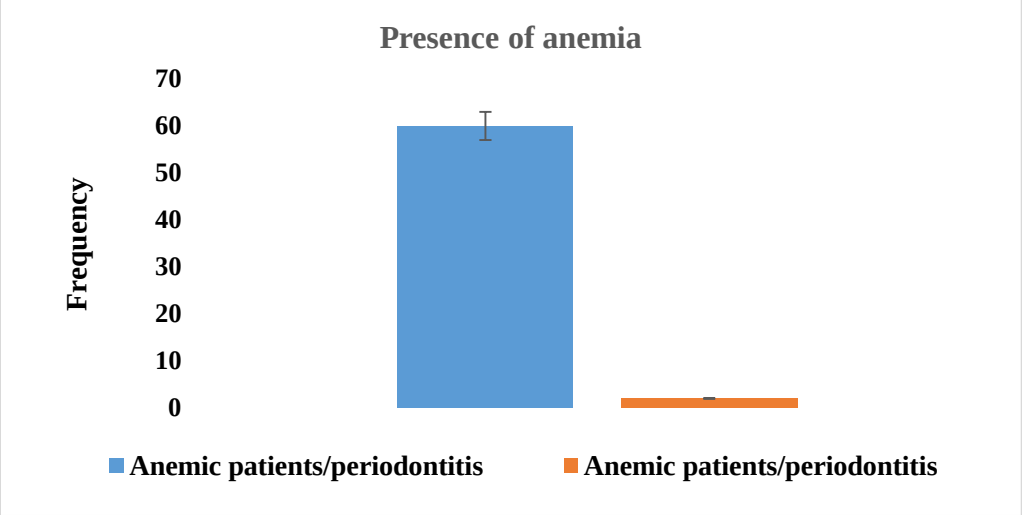

Figure 3.2. Descriptive data of the second group (anemic pregnant women/periodontitis) of the participants depending on the presence of anemia.

3.3. Comparative explanation of descriptive data for both groups of participants.

The following descriptive figures (Figures 3.3–3.8) visually illustrate the differences and similarities between the two study groups (anemic pregnant women with healthy

periodontium and anemic pregnant women with periodontitis) across key variables: gestational age, plaque accumulation, gingival inflammation, bleeding on probing, and gum discoloration.

The distribution across pregnancy trimesters is broadly comparable between the groups. In the first group (anemic only), 40% were in the first trimester, 24% in the second, and 36% in the third. In the second group (anemic with periodontitis), 38.7% were in the first trimester, 27.5% in the second, and 33.8% in the third. This balanced distribution suggests that any observed differences in periodontal or hematological findings are unlikely to be due to gestational age alone, but rather the presence or absence of periodontitis.

On the other hand, a clear contrast is evident in plaque accumulation. The first group showed generally good oral hygiene: 36% had no plaque and 38% had only minimal plaque, with none having large accumulations. In stark contrast, in the periodontitis group, 53.2% had large plaque deposits and 43.5% had moderate levels, while no participant was plaque-free. This highlights the strong association between poor plaque control and the development of periodontitis in this population.

The pattern of gingival inflammation further distinguishes the groups. In the anemic-only group, 46% had healthy gums and 54% showed only mild inflammation; no cases of moderate or severe inflammation were recorded. Conversely, in the anemic + periodontitis group, no participant had healthy or mildly inflamed gingiva; instead, 67.8% showed moderate inflammation and 32.2% had severe inflammation. This reflects the advanced stage of periodontal breakdown among women with significant plaque accumulation.

Conversely, the prevalence of prevalence of the bleeding on probing (BOP) was much higher in the periodontitis group (98.3%) compared to the anemic-only group (32%). This dramatic difference emphasizes the inflammatory burden imposed by periodontitis, as BOP is a key clinical sign of active disease and gingival tissue destruction.

On the other hand, an interesting pattern is observed in gum color. In the anemic-only group, 46% had pale gums — reflecting anemia-induced mucosal pallor — and 54% had normal pink gums. No redness was noted. In contrast, all women in the periodontitis group exhibited gum redness (100%), a hallmark of inflamed gingival tissue. The redness associated with periodontal inflammation may mask pallor, making anemia less visually detectable at the gingiva in these patients. < ,

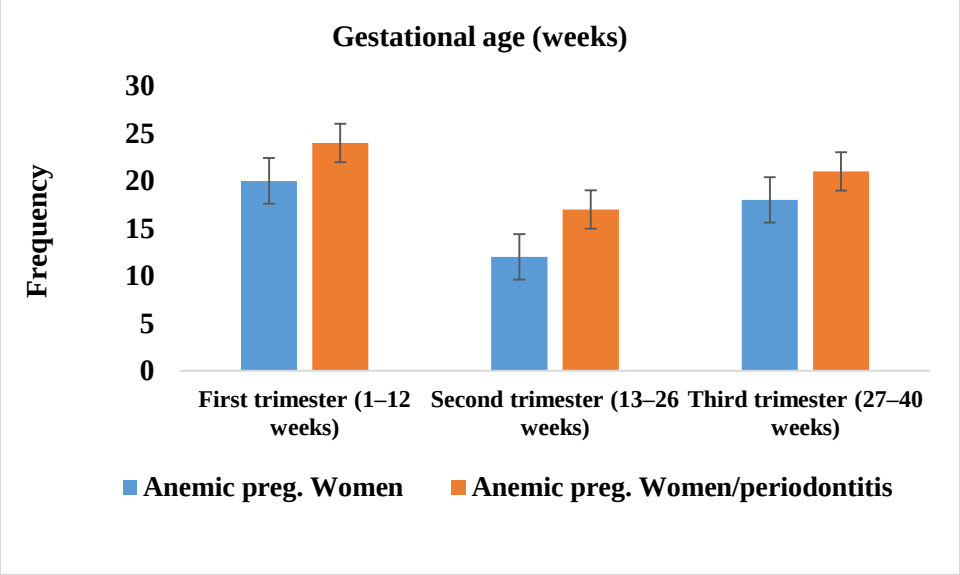

Figure 3.3. Distribution of all pregnant women according to the gestational age/weeks

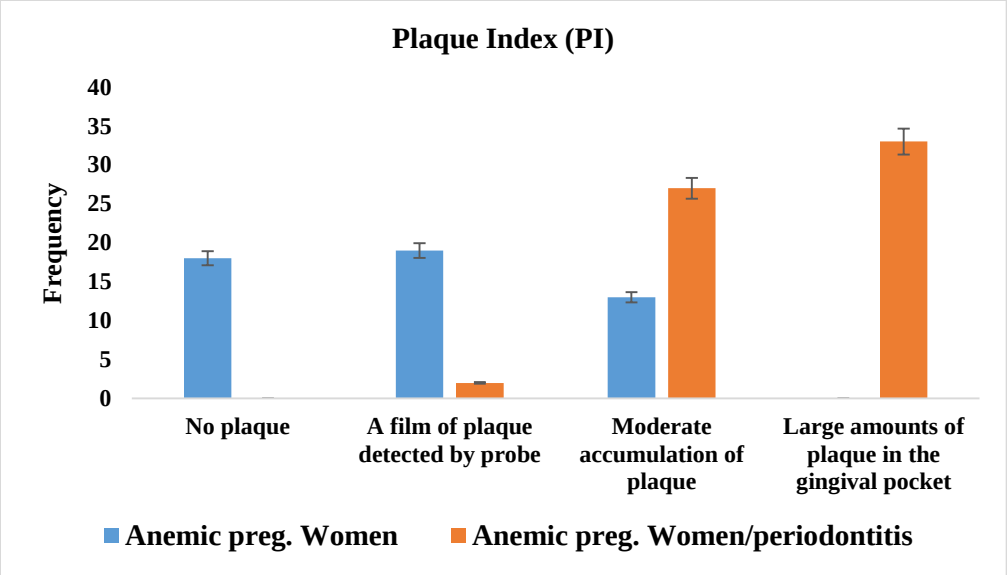

Figure 3.4. Distribution of all pregnant women according to the Periodontal and Gum Examination (plaque index (PI)).

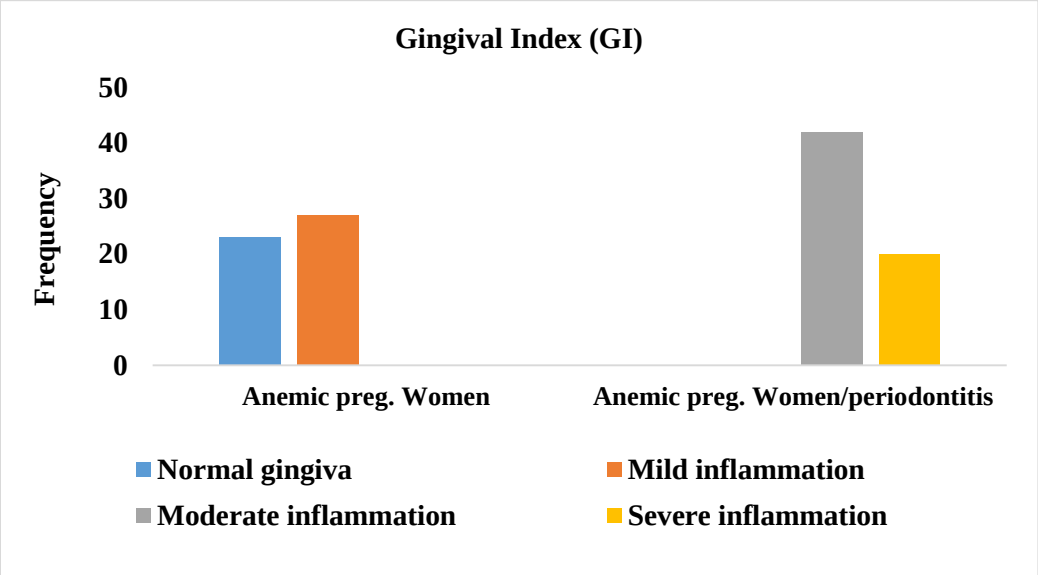

Figure 3.5. Distribution of all pregnant women according to the Periodontal and Gum Examination (Gingival index (GI)).

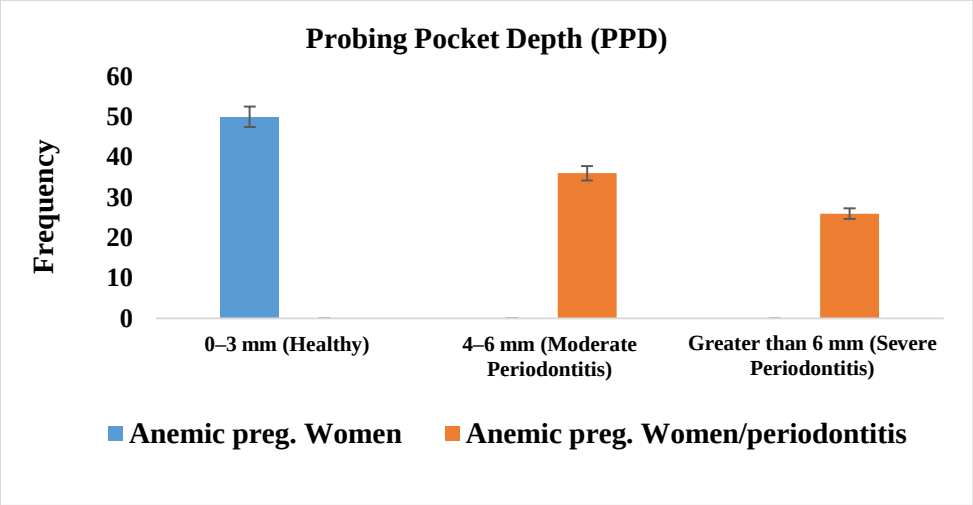

Figure 3.6. Distribution of all pregnant women according to the Periodontal and Gum Examination (plaque index (PI)).

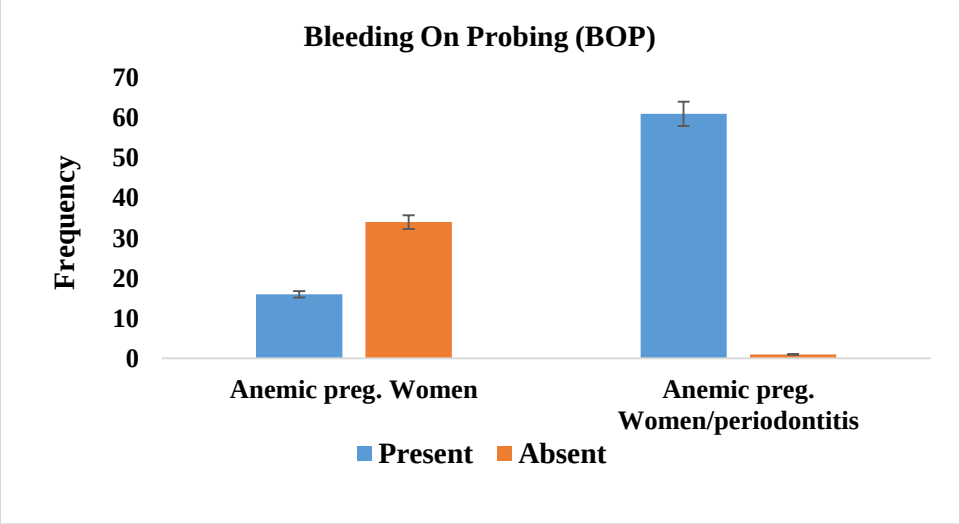

Figure 3.7. Distribution of all pregnant women according to the Periodontal and Gum Examination (Bleeding on probing (BOP)).

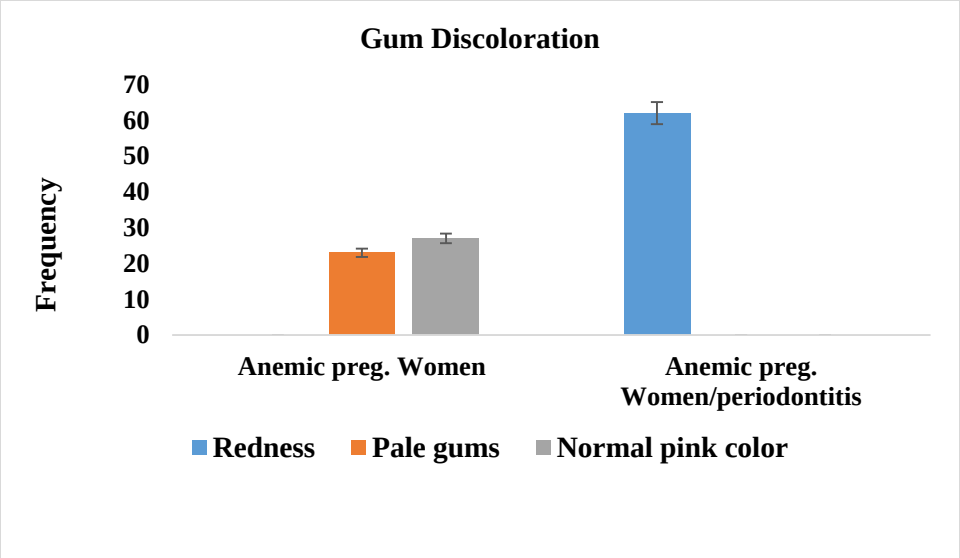

Figure 3.8. Distribution of all pregnant women according to the Periodontal and Gum Examination (Gum Discoloration).

3.4.Results of the laboratory investigations among participants

The results in (Table 3.6) is crucial because it shows how the additional burden of periodontal disease may influence anemia-related and inflammation-related blood markers during pregnancy. The mean Hb level is slightly lower in the periodontitis group (9.7 g/dL) compared to the anemic-only group (10.1 g/dL). This suggests that the presence of periodontitis may be associated with a slight further reduction in hemoglobin levels. This aligns with existing evidence that chronic periodontal inflammation can contribute to systemic inflammatory responses, which may exacerbate anemia of chronic disease by affecting iron metabolism and erythropoiesis.

On the other hand, the RBC count and hematocrit values show a similar trend. The periodontitis group has a slightly lower mean RBC (3.5 $\times 10^6$/µL) and HCT (29.06%) compared to the anemic-only group (RBC: 3.7×10^6/µL, HCT: 30.3%). Again, this indicates that chronic inflammation associated with periodontal disease might contribute to a mild but notable worsening of anemia indices.

Conversely, the MCV is slightly higher in the periodontitis group (77.4 fL) compared to the anemic-only group (74.9 fL), while the MCH is nearly the same (24.1 vs. 24.4 pg). This suggests that the type of anemia is predominantly normocytic to slightly microcytic

in both groups — typical for iron deficiency or anemia of chronic disease. The small increase in MCV in the periodontitis group might reflect mixed features due to inflammation affecting iron utilization.

An interesting difference appears in platelet counts. The mean PLT is higher in the periodontitis group ($293.6 \times 10^3/\mu L$) compared to the anemic-only group ($246.1 \times 10^3/\mu L$). Elevated platelet counts can occur as a reactive response to chronic inflammation (known as thrombocytosis) and support the hypothesis that periodontal disease adds a significant inflammatory burden in these women. A marked difference is seen in WBC counts: the periodontitis group has a higher mean WBC ($9.27 \times 10^3/\mu L$) compared to the anemic-only group ($6.7 \times 10^3/\mu L$). This notable increase is consistent with the presence of active local and systemic inflammation due to periodontitis, further supporting the role of periodontal disease in elevating inflammatory markers.

Moreover, ferritin, which reflects iron stores but also acts as an acute-phase reactant, is lower in the periodontitis group (10.3 ng/mL) than in the anemic-only group (13.2 ng/mL). This may indicate that the inflammatory burden of periodontitis worsens iron deficiency or alters iron metabolism, further lowering available iron stores in an already anemic population.

Table 3.6. Mean and standard deviation of different laboratory investigation results among participants.

Participant groups	Statistical measurements	Hb	RBC	HCT	MCV	MCH	PLT	WBC	Ferritin
Anemic pregnant women Sample no. (50)	Mean	10.1	3.7	30.3	74.9	24.4	246.1	6.7	13.2
	± SD	0.7	0.3	2.3	6.4	1.4	64.9	1.1	3.9
Anemic pregnant women with periodontitis Sample no. (62)	Mean	9.7	3.5	29.06	77.4	24.1	293.6	9.27	10.3
	± SD	0.7	0.5	3.0	8.15	3.3	65.4	1.6	3.5

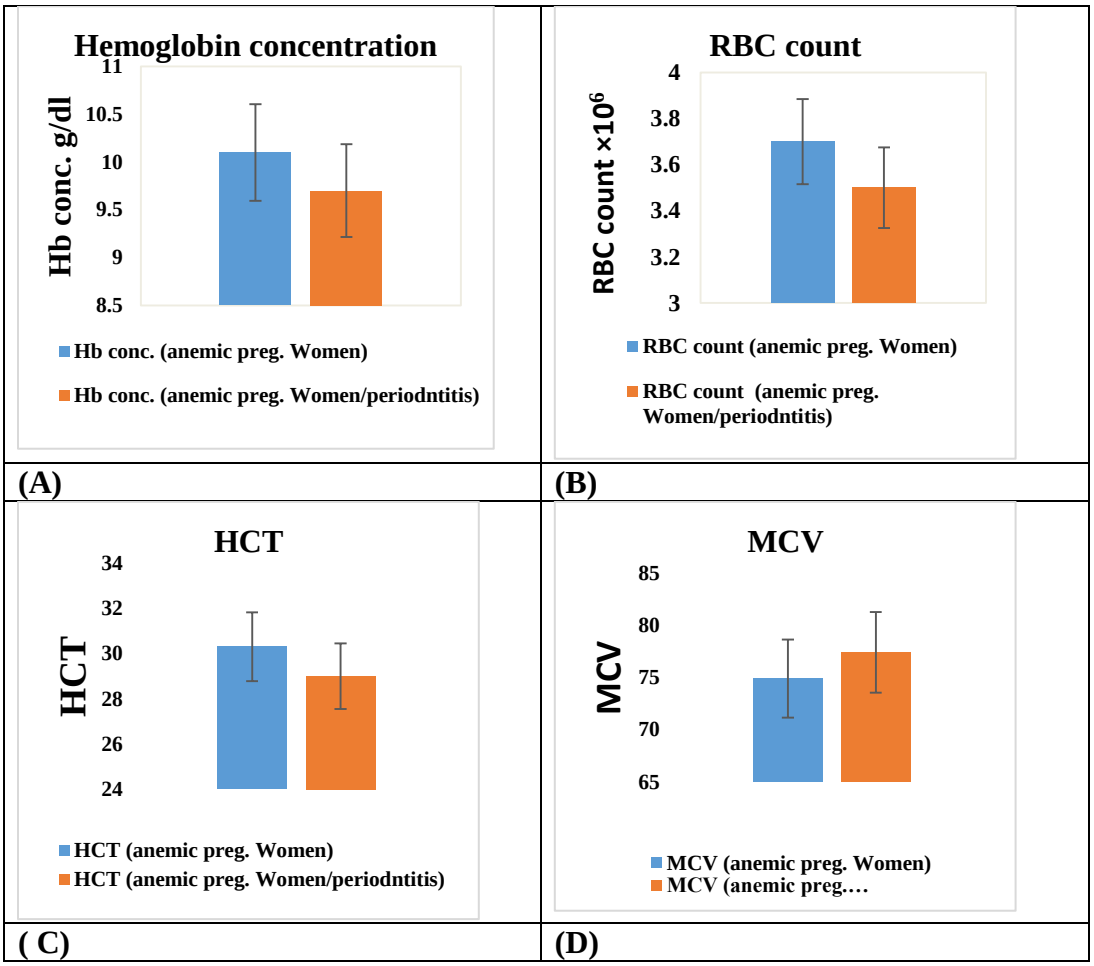

Figure 3.9; (A, B, C, D). Mean and standard deviation of hemoglobin, RBC, HCT and MCV among both groups of participants.

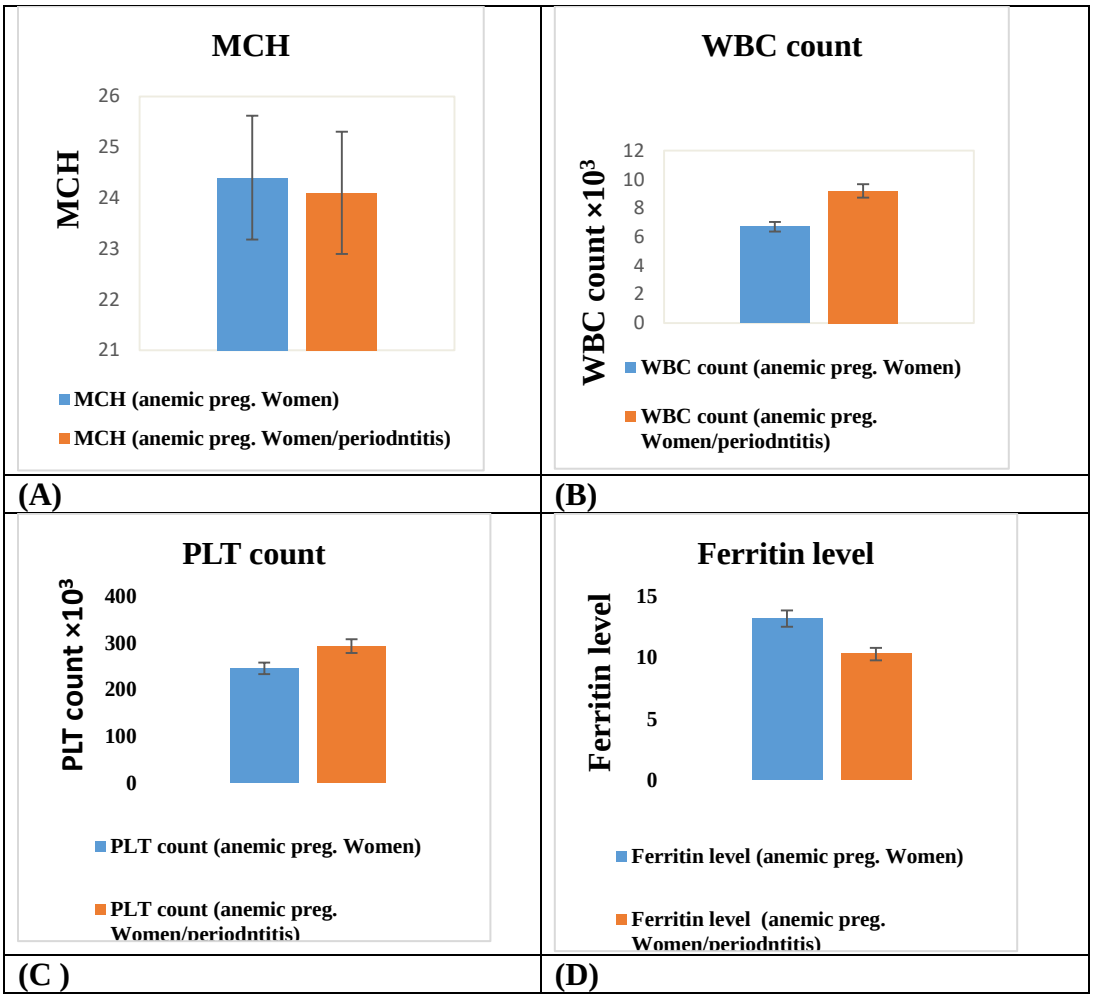

Figure 3.10; (A, B, C, D). Mean and standard deviation of MCH, WBC count, PLT count and Ferritin level among both groups of participants.

3.5.Pearson correlation and significance value between different variables results among both groups of participants

Table 3.7 shows the correlation analysis (Pearson's correlation coefficient, *r*) and the statistical significance (p-values) for relationships between Hb and other key hematological variables in the two study groups. This table is important because it tests whether periodontal disease alters the strength or direction of relationships between hemoglobin and other hematological parameters that reflect anemia severity and systemic response.

For the first group, only the correlation of Hb is reported. The correlation coefficient is 1.000, which simply means Hb is perfectly correlated with itself (this is expected when only Hb is reported without other variables). At the same time, the p-value is 0.000, indicating that this is statistically significant, but this holds no practical meaning here because it's the same variable. Therefore, no other correlations were obtained or shown between other parameters in this group of participants.

In the second group, the current study has tested correlations between Hb and multiple hematological variables (HCT, PLT, MCV, MCH, Ferritin) and between RBC and some variables. As shown in (Table 3.7) regarding possible correlation between Hb and HCT, correlation coefficient (r = 0.682) shows a strong positive correlation which is mean that as Hb increases, HCT also increases. This is expected physiologically because both reflect red cell mass. The p-value is 0.000, which is highly significant ($p < 0.01$), confirming this relationship is statistically meaningful.

On the other hand, the correlation between Hb and PLT revealed negative correlation (r = -0.301) which is mean that as Hb increases, platelet count tends to decrease. The p-value is 0.017, which is significant at $p < 0.05$. This suggests that in anemic pregnant women with periodontitis, lower Hb may be linked to higher platelet counts, possibly reflecting a compensatory inflammatory response, as thrombocytosis often occurs in chronic inflammation and iron deficiency.

Opposite to that regarding the correlation between RBC and ferritin level. Results demonstrated a weak positive correlation (r = 0.245). The p-value is 0.055, just above the typical *0.05* cut-off, so it is borderline significant. This suggests a mild tendency that higher RBC counts may be associated with higher ferritin levels, which makes sense since ferritin reflects iron stores available for erythropoiesis. Moreover, a moderate negative correlation (r = -0.332) with p = 0.008 (significant) was observed between HCT and PLT. This means lower hematocrit may be associated with higher platelet counts which consistent with an inflammatory reaction.

Interestingly, results of correlation testing revealed that the relation between HCT and MCV was strong (r = 0.434, p = 0.000) which was strong, significant positive relationship. The same result obtained regarding the relation between HCT and MCH (r = 0.412, p = 0.001) which was strong and positive relation too. These are logical relationships, as HCT rises with larger or more hemoglobin-rich red cells. Additionally, strong positive correlation (r = 0.618), p = 0.000 was observed between MCV and MCH which was highly significant. This is expected since MCV and MCH are closely linked physiologically.

Table 3.7. Comparison between Pearson correlation and significance values of different variable results among both groups of participants.

Groups of participants	Variables	Significance (P value)	HCT	PLT	MCV	MCH	Ferritin
First group	**Hb**	**P correlation**	**1.000**				
		Sig. (2 tailed)	**0.000****				
		N	**50**				
Second group	**Hb**	**P correlation**	**0.682**	**- 0.301**			
		Sig. (2 tailed)	**0.000****	**0.017***			
		N	**62**	**62**			
	RBC	**P correlation**	**0.257**				**0.245**
		Sig. (2 tailed)	**0.043***				**0.055***
		N	**62**				**62**
	HCT	**P correlation**		**- 0.332**	**0.434**	**0.412**	
		Sig. (2 tailed)		**0.008****	**0.000****	**0.001****	
		N		**62**	**62**	**62**	
	MCV	**P correlation**				**0.618**	
		Sig. (2 tailed)				**0.000****	
		N				**62**	

***. Correlation is significant at the p value less than 0.05 level (2-tailed).**
****. Correlation is significant at the p value less than 0.001 level (2-tailed).**

3.6. ANOVA and significance value between different variables results among both groups of participants

A) First group of the participant

Table 3.8 presents the one-way ANOVA results for the first group of participants (anemic pregnant women without periodontitis). The analysis showed that both Hb and HCT levels differed significantly within this group (*p = 0.031*), indicating some variation in

these core anemia markers, which may reflect individual differences in gestational age, nutritional status, or anemia severity.

In contrast, no significant differences were found for RBC, MCV, MCH, PLT, WBC, or ferritin levels ($p > 0.05$), suggesting that these parameters remained relatively uniform among women in this group. The platelet count approached significance ($p = 0.054$), hinting at possible mild variability in platelet response even among women without periodontal disease.

Table 3.8. ANOVA test analysis between different variables among the participants in the first group.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Hb	Between Groups	17.552	19	.924	2.132	.031
	Within Groups	13.002	30	.433		
	Total	30.554	49			
RBC	Between Groups	2.263	19	.119	.878	.609
	Within Groups	4.068	30	.136		
	Total	6.330	49			
HCT	Between Groups	157.969	19	8.314	2.132	.031
	Within Groups	117.015	30	3.901		
	Total	274.984	49			
MCV	Between Groups	811.875	19	42.730	1.069	.425
	Within Groups	1199.642	30	39.988		
	Total	2011.517	49			
MCH	Between Groups	41.226	19	2.170	1.025	.464
	Within Groups	63.481	30	2.116		
	Total	104.707	49			
PLT	Between Groups	113326.503	19	5964.553	1.916	.054
	Within Groups	93387.517	30	3112.917		
	Total	206714.020	49			
WBC	Between Groups	29.135	19	1.533	1.219	.306
	Within Groups	37.748	30	1.258		
	Total	66.883	49			

Fe	Between Groups	253.840	19	13.360	.798	.692
	Within Groups	502.159	30	16.739		
	Total	755.999	49			

B) Second group of the participant

Additionally, (Table 3.9) shows the results of the ANOVA test for the second group (anemic pregnant women with periodontitis). Unlike the first group, none of the tested hematological variables showed statistically significant differences within this group ($p > 0.05$ for all parameters). This indicates that hemoglobin, RBC count, hematocrit, MCV, MCH, platelet count, WBC count, and ferritin levels were relatively consistent among these participants, with no substantial internal variation detected. Overall, these findings suggest that in anemic pregnant women affected by periodontitis, the hematological status is more uniformly influenced by the common inflammatory burden of periodontal disease, resulting in minimal variation within the group itself.

Table 3.9. ANOVA test analysis between different variables among the participants in the second group.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Hb with periodontitis	Between Groups	3.656	18	.203	.301	.996
	Within Groups	28.331	42	.675		
	Total	31.987	60			
RBC with periodontitis	Between Groups	5.803	18	.322	1.540	.124
	Within Groups	8.793	42	.209		
	Total	14.596	60			
HCT with periodontitis	Between Groups	68.972	18	3.832	.334	.993
	Within Groups	482.003	42	11.476		
	Total	550.974	60			
MCV with periodontitis	Between Groups	990.841	18	55.047	.755	.736

	Within Groups	3060.876	42	72.878		
	Total	4051.716	60			
MCH with periodontitis	Between Groups	121.036	18	6.724	.498	.944
	Within Groups	567.361	42	13.509		
	Total	688.396	60			
PLT with periodontitis	Between Groups	47838.079	18	2657.671	.549	.915
	Within Groups	203196.774	42	4838.018		
	Total	251034.852	60			
WBC with periodontitis	Between Groups	49.767	18	2.765	.971	.507
	Within Groups	119.546	42	2.846		
	Total	169.313	60			
Fe with periodontitis	Between Groups	210.733	18	11.707	.886	.597
	Within Groups	555.165	42	13.218		
	Total	765.898	60			

Chapter Four

Discussion

4. Discussion

It is now widely recognized that the hallmark of Periodontal disease (PD), the most common public health problem in the world, is inflammation of all the tissues surrounding the teeth, including the gingiva (gum tissue), cementum (the outer layer of the tooth roots), alveolar bone (the sockets into which the teeth are anchored), and periodontal ligaments (the connective tissue fibers between the cementum and the alveolar bone). PD can affect up to 90% [2, 3] of populations [4].

Furthermore, compared to women who are not pregnant or nursing, periodontal problems are more common during pregnancy and breastfeeding [11] because of hormonal factors (high levels of progesterone and estrogen) and the subsequent impact on the gingival arteries [12]. The prevalence of periodontal disease peaks during the eighth month of pregnancy and begins to decrease two months after delivery [13,14].

As a discussion, descriptive data analysis of the current study summarizes the age distribution of all study participants. The results show that the mean ages of the two groups are very similar: 27.28 ± 4.90 years for anemic pregnant women without periodontitis and 27.68 ± 4.64 years for anemic pregnant women with periodontitis. This close similarity in mean age and standard deviation indicates that age is unlikely to have acted as a confounding factor in this study.

By ensuring that both groups are comparable in age, the study strengthens the reliability of its findings — supporting that any observed differences in hematological parameters can be more confidently attributed to the presence or absence of periodontitis rather than differences in maternal age. (Table 3.2) describes the periodontal status of the first group — anemic pregnant women without clinical periodontitis. The distribution shows that most participants had healthy periodontal conditions overall: 36% had no detectable plaque, while the rest showed only minimal to moderate plaque accumulation, with none presenting large deposits. Similarly, all participants had healthy probing pocket depths (0–3 mm) with no cases of moderate or severe periodontitis.

Gingival health was generally good, with 46% having normal gingiva and 54% showing only mild inflammation, which is common in pregnancy due to hormonal effects. Bleeding on probing was present in about one-third of cases (32%), likely reflecting mild localized gingival inflammation rather than true periodontal disease.

Additionally, nearly half showed pale gums (46%), consistent with clinical anemia, while no cases of redness were recorded. Overall, these findings confirm that the first group was genuinely free from periodontitis, providing a valid baseline to compare with the second group and assess the independent impact of periodontal disease on hematological outcomes. With the exception of one study, the authors [46, 47] proposed that anemia was a contributing factor rather than a result of destructive periodontitis.

On the other hand, results of this study summarize the detailed periodontal examination findings for the second group (anemic pregnant women with periodontitis). Unlike the first group, this group shows clear evidence of advanced periodontal disease. None of the participants were plaque-free: over half (53.2%) had large amounts of plaque in the gingival pocket, and 43.5% had moderate plaque accumulation, confirming poor oral hygiene as a major risk factor.

Gingival inflammation was severe: no participant had normal or mildly inflamed gingiva instead, 67.8% had moderate inflammation and 32.2% had severe inflammation, indicating advanced gingivitis progressing to periodontitis. Probing pocket depth data further supports this, with no healthy pockets; 58.1% had moderate periodontitis (pockets 4–6 mm) and 41.9% had severe pockets (>6 mm).

Bleeding on probing was nearly universal (98.3%) and all participants had gum swelling and obvious redness (100%), consistent with active periodontal inflammation. Unlike the first group, none showed pallor at the gums — the inflammation likely masked typical anemia-related pale gingiva.

Together, these findings confirm that this group had clinically significant periodontitis superimposed on existing anemia, fulfilling the criteria to assess the additional systemic impact of periodontal disease in pregnancy. Moreover, this baseline demographic data

supports the study’s internal validity by demonstrating that the two groups are age-matched. This strengthens the interpretation of subsequent analyses comparing hematological markers, as differences can be more confidently linked to the periodontal status rather than age discrepancies.

Physiologically, pregnancy-related changes to a woman's metabolism represent a special and one-of-a-kind time in her life. In order to better support fetal growth, blood supply, nutrition, and oxygen intake, several modifications are made to the usual physiology. The body is ready for pregnancy, childbirth, and lactation thanks to these modifications [96].

According to the results of this study, the distribution by trimester is broadly similar in both groups, with a balanced spread across first, second, and third trimesters. This similarity helps rule out gestational age as a confounding factor, reinforcing that difference in periodontal status and hematological findings are not due to significant differences in pregnancy stage.

Pregnancy has an impact on the gastrointestinal, pulmonary, renal, cardiovascular, and hematological systems. Plasma volume and blood cell mass increase to provide a greater proportion of the oxygen required by maternal and placental tissues. The heart rate must increase to satisfy the fetus's needs. Blood pressure will drop at the beginning of the second trimester, which may lead to hypotensive supine decubitus syndrome, also called vena cava syndrome, which occurs in approximately 8% of cases in the latter stages of pregnancy. This illness manifests as nausea, lightheadedness, and fainting, as well as a decrease in blood pressure.

Changes in the plasma levels of coagulation factors VII, VIII, IX, X, and XI, an increase in fibrinogen, and a drop in leukocyte and erythrocyte counts put pregnant women at risk for thromboembolic events such pulmonary embolism and deep vein thrombosis [97,98]. Breathing becomes more challenging due to the force that the uterus exerts on the diaphragm. During the third trimester, up to 75% of pregnant women may have a dyspnea episode, and the lungs' remaining functional capacity may decrease by as much as 20% [99].

The comparison of plaque accumulation reveals a marked contrast. The anemic-only group (Figure 3.4) shows mostly low plaque levels, with a notable proportion plaque-free and no cases of heavy deposits. By contrast, the periodontitis group (Figure 3.6) shows a clear shift toward higher plaque accumulation: the majority have moderate to heavy plaque deposits. This confirms the role of poor plaque control in periodontal disease progression and supports its identification as a modifiable risk factor in this population.

Gingivitis is the most prevalent oral pathology in terms of pathology, affecting 35 to 100% of pregnant women. It can be caused in two ways: either non-biofilm-induced or biofilm-induced. Between the third and eighth months of pregnancy, gingivitis typically manifests, and it progressively goes away after delivery [100, 101]. The development of edema, erythema, increased crevicular fluid, and bleeding may be explained by the beneficial effects of progesterone and estrogens on gingival vascularization during pregnancy [95].

By comparison, gingival health differences are similarly pronounced. Most women in the healthy group have normal to mildly inflamed gingiva, consistent with pregnancy-related gingivitis but without advanced disease. In contrast, the periodontitis group shows moderate to severe inflammation in almost all cases, highlighting the transition from reversible gingivitis to destructive periodontitis when plaque control is poor and local inflammation is sustained.

On the other hand, bleeding on probing, a key sign of active gingival inflammation, is significantly more prevalent in the periodontitis group. While only about a third of the anemic-only group show BOP, nearly all women in the periodontitis group do. This reinforces the clinical evidence that periodontitis adds a significant additional inflammatory burden on top of pregnancy-related gingival changes. Moreover, gum color highlights the interaction between anemia and periodontal inflammation. In the anemic-only group, many women show pale gums — a visible sign of anemia. However, in the periodontitis group, pale gums are absent; instead, 100% show redness due to severe gingival inflammation and increased blood flow in inflamed tissues, which masks typical anemia-related mucosal pallor.

Therefore, results of this study demonstrate that although both groups share similar age and gestational characteristics and are anemic by definition, the presence of plaque accumulation and the progression from mild gingivitis to severe periodontitis drastically change the periodontal health picture. The additional inflammation, tissue damage, and local infection reflected in these figures support the core premise of this study: that periodontitis likely contributes to a heightened systemic inflammatory state in already anemic pregnant women, which may worsen hematological imbalances and impact maternal and fetal health.

In terms of anemia, the authors discovered that the most prevalent kind in pregnant women is microcytic hypochromic anemia, which is probably caused by iron deficiency. The second class of anemia is normocytic normochromic anemia, and dimorphic picture types with elevated reticulocyte production index are less common [102].

The results of this study demonstrate that both groups are clearly anemic, as indicated by Hb levels (10.1 g/dL in the anemic-only group vs. 9.7 g/dL in the periodontitis group). The slightly lower Hb and HCT in the periodontitis group (29.06% vs. 30.3%) suggest that periodontal disease may contribute to an additional burden that can modestly worsen anemia severity.

Additionally, the RBC also shows a slight reduction in the periodontitis group (3.5 million/µL) compared to the anemic-only group (3.7 million/µL), consistent with a mild aggravation of anemia parameters. Interestingly, the MCV is somewhat higher in the periodontitis group (77.4 fL vs. 74.9 fL), which could reflect a mixed picture of iron deficiency and inflammation-related anemia, while the MCH remains comparable in both groups. A notable difference is seen in the PLT count: it is higher in the periodontitis group ($293.6 \times 10^3/\mu L$) than in the anemic-only group ($246.1 \times 10^3/\mu L$). This finding supports the idea that chronic periodontal inflammation triggers a mild reactive thrombocytosis — an expected systemic response to inflammation and tissue damage.

Patients with chronic periodontitis also had reduced Hb%, RBC, and other hematocrit values compared to healthy controls, according to various observational studies [62, 63].

A little increase in MCV, MCH, and MCHC levels after periodontal therapy is indicative of normocytic and normochromic anemia, which is not caused by a vitamin or iron deficiency [64].

Similarly, the WBC count is significantly higher in the periodontitis group ($9.27 \times 10^3/\mu L$) compared to the anemic-only group ($6.7 \times 10^3/\mu L$). This clearly indicates the presence of an active inflammatory process in women with periodontitis, which aligns with the clinical signs of gingival inflammation and bleeding seen in these patients.

Lastly, the ferritin level is slightly lower in the periodontitis group (10.3 ng/mL) than in the anemic-only group (13.2 ng/mL), suggesting that ongoing periodontal inflammation may exacerbate iron depletion or impair iron mobilization, contributing to further deterioration of iron status. In summary, while both groups share anemia as a baseline condition, the additional burden of periodontitis is associated with slightly worse red cell parameters, higher WBC and platelet counts, and lower iron stores; all pointing to the systemic inflammatory impact of periodontal disease on hematological balance during pregnancy.

After applying the Pearson correlation analysis for key hematological variables in both study groups. The study results revealed that in the first group (anemic pregnant women without periodontitis), only the correlation of Hb with itself was tested, yielding a perfect correlation as expected ($r = 1.000,\ p = 0.000$). No other correlations were reported for this group, indicating that significant internal relationships among other variables were either absent or not explored in this analysis.

In contrast, the second group (anemic pregnant women with periodontitis) shows several significant correlations, demonstrating a more complex interplay between hematological parameters in the presence of periodontal inflammation. Notably, Hb shows a strong positive correlation with HCT ($r = 0.682,\ p < 0.001$), which is physiologically expected since both reflect red cell mass. Additionally, a significant negative correlation was observed between Hb and PLT count ($r = –0.301,\ p = 0.017$), suggesting that lower

hemoglobin levels are associated with higher platelet counts, likely reflecting a mild reactive thrombocytosis driven by chronic periodontal inflammation.

RBC count shows a weak but significant positive correlation with ferritin ($r = 0.245$, $p = 0.055$), which borders statistical significance and suggests a mild tendency for better iron stores to support higher RBC levels. The HCT also correlates negatively with PLT ($r = –0.332$, $p = 0.008$) but positively with MCV and MCH ($r = 0.434$ and 0.412, $p < 0.001$), indicating that higher hematocrit is associated with larger and more hemoglobin-rich red cells.

A strong positive correlation between MCV and MCH ($r = 0.618$, $p < 0.001$) reflects the expected physiological link between cell size and hemoglobin content per cell. Therefore, these correlation patterns reinforce that periodontitis adds a clear inflammatory component that interacts with anemia-related hematological markers. The stronger and more complex inter-variable relationships in the periodontitis group (especially the inverse link between Hb and platelet count) highlight how chronic oral inflammation can influence systemic hematological balance in pregnant women.

The ANOVA test results comparing variation within the first group (anemic pregnant women without periodontitis) and the second group (anemic pregnant women with periodontitis) across multiple hematological parameters. The first group showed statistically significant differences for Hb and HCT values ($p = 0.031$ for both). This indicates that there was some measurable variation in anemia severity within the anemic-only group; likely reflecting individual differences in dietary iron intake, gestational stage, or other mild personal factors that affect red cell indices during pregnancy.

However, all other parameters, including RBC count, MCV, MCH, PLT, WBC count, and ferritin, showed no significant internal differences ($p > 0.05$). Platelet count approached significance ($p = 0.054$), suggesting a mild trend toward variability but not enough to be conclusive. Overall, this pattern implies that while some hematological differences exist within the anemic-only group, they are limited mainly to core red cell indices, with other markers remaining stable.

In contrast, (Table 3.9) shows that none of the hematological variables in the second group (anemic pregnant women with periodontitis) displayed any significant variation ($p > 0.05$ for all tests). This uniformity suggests that the presence of periodontal disease creates a shared systemic inflammatory condition that affects all participants in a similar way, producing more consistent patterns in anemia severity, platelet response, and inflammatory markers across the entire group. In summary, these analyses strengthen the conclusion that periodontitis is not only a local oral health issue but also has clear systemic effects that influence blood parameters in a predictable and uniform way in pregnant women already vulnerable to anemia.

Chapter Five

Conclusion and Recommendations

5. Conclusion and Recommendations

5.1. Conclusion

The present study investigated the variations in hematological parameters among anemic pregnant women with and without periodontitis in Gharyan City, with the aim of clarifying whether periodontal disease exerts an additional systemic impact on hematological health during pregnancy.

The descriptive data demonstrated that the two groups were comparable in terms of age and gestational distribution, effectively minimizing confounding by these factors. Periodontal examination revealed stark contrasts: the anemic-only group showed predominantly healthy gingival conditions with mild, pregnancy-related gingivitis in some cases, while the periodontitis group displayed clear clinical signs of advanced periodontal disease, including heavy plaque accumulation, moderate to severe gingival inflammation, deep probing pocket depths, almost universal bleeding on probing, and pronounced gum redness.

Hematological analyses highlighted that both groups were anemic by definition, yet important differences were evident. Women with periodontitis had slightly lower mean hemoglobin and hematocrit levels than their anemic-only counterparts, indicating a trend toward more severe anemia in the presence of chronic periodontal inflammation. Moreover, these women demonstrated higher mean platelet and white blood cell counts, reflecting a systemic inflammatory response to the periodontal infection. Ferritin levels were lower in the periodontitis group, further suggesting that chronic inflammation may contribute to iron depletion or dysregulation of iron metabolism.

The correlation analysis provided further evidence of the systemic impact of periodontitis: in the periodontitis group, significant correlations emerged between hemoglobin, hematocrit, RBC, platelet count, and iron stores, highlighting a more complex interaction between anemia and inflammation. Notably, the inverse correlation between hemoglobin and platelet count supports the idea that periodontal disease may trigger a reactive increase in platelets, a known marker of inflammation.

The ANOVA tests reinforced these observations. While the anemic-only group showed some variation in hemoglobin and hematocrit levels, reflecting natural variability among pregnant women, the periodontitis group exhibited no significant internal variation. This indicates that the chronic inflammatory burden of periodontitis acts as a common systemic stressor that levels out differences, producing a more uniform pattern of hematological response among affected women.

Taken together, the study's findings demonstrate that periodontitis is not just a localized oral health condition but a significant systemic factor capable of aggravating anemia and triggering systemic inflammatory responses in pregnant women. This underscores the importance of early periodontal screening and management as an integral part of prenatal care to help mitigate the compounding effects of anemia and periodontal inflammation on maternal and fetal health outcomes.

In conclusion, effective prevention and treatment of periodontal disease in pregnant women, especially those already anemic, should be emphasized as part of routine antenatal care strategies to support better hematological stability and overall pregnancy health.

5.2. Recommendations

Based on the findings of this study, the following recommendations are proposed to help improve maternal oral health and minimize the compounding effects of periodontitis on anemia during pregnancy:

1. Integrate Routine Periodontal Screening into Antenatal Care: All pregnant women (especially those diagnosed with anemia) should undergo regular oral health check-ups as part of routine antenatal visits. Early identification of gingival inflammation and plaque accumulation can help prevent progression to advanced periodontitis.

2. Promote Oral Health Education for Pregnant Women: Targeted health education campaigns should be implemented in local healthcare facilities to raise awareness among pregnant women about the importance of daily oral hygiene, correct brushing techniques, plaque control, and the potential systemic consequences of untreated periodontal disease during pregnancy.

3. Provide Timely Periodontal Treatment During Pregnancy: Where appropriate, pregnant women diagnosed with periodontitis should be referred for safe, evidence-based periodontal treatment — including professional plaque removal, scaling and root planing, and tailored oral hygiene instructions — to reduce the inflammatory burden.

4. Strengthen Interdisciplinary Collaboration: Obstetricians, family physicians, and dental professionals should collaborate closely to ensure that women at higher risk of anemia and periodontitis receive coordinated care. Clear referral pathways should be established between maternity services and dental clinics.

5. Monitor Hematological Parameters Together with Oral Health: Routine hematological testing should be coupled with periodontal assessments, especially for women with moderate to severe anemia, to detect early signs of worsening anemia or systemic inflammation linked to untreated oral disease.

6. Community-Based Preventive Programs: Community outreach and preventive oral health programs should be strengthened, particularly in regions with high prevalence of anemia and limited access to dental services, such as Gharyan City. School-based and community-based education can build awareness long before pregnancy.

7. Encourage Further Research: Larger-scale longitudinal studies should be conducted to further explore the causal pathways linking periodontal inflammation to worsening anemia and pregnancy outcomes. Such research should also evaluate the cost-effectiveness of including dental care in prenatal health packages.

8. Policy Support and Training: Health policymakers should consider updating maternal health guidelines to formally include oral health screening and treatment in prenatal care packages. Training midwives and antenatal care providers to recognize signs of periodontal disease can facilitate timely intervention.

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7. Appendices

Appendices(1): Questionnaire for the study

Section 1: Demographic Information

1. Gestational Age (Weeks):

A- First trimester (1–12 weeks)

B- Second trimester (13–26 weeks)

C- Third trimester (27–40 weeks)

2. Do you have any pre-existing health conditions? (e.g., diabetes, hypertension, etc.)

A- Yes (please specify): _____

B- No

3. Number of Previous Pregnancies: _____

Section 2: Periodontal and Gum Examination

1. General Periodontal Health Status:

A - Excellent

B - Good

C- Average

D - Poor

2. Plaque Index (PI):

A - 0: No plaque

B- 1: A film of plaque detected by probe

C- 2: Moderate accumulation of plaque seen with the naked eye

D- 3: Large amounts of plaque in the gingival pocket or on the tooth

3. Gingival Index (GI):

A- 0: Normal gingiva

B- 1: Mild inflammation (slight color change, no bleeding)

C- 2: Moderate inflammation (redness, edema, bleeding on probing)

D- 3: Severe inflammation (marked redness, edema, ulceration, spontaneous bleeding)

4. Probing Pocket Depth (PPD):

A- 0–3 mm (Healthy)

B- 4–6 mm (Moderate Periodontitis)

C- Greater than 6 mm (Severe Periodontitis)

5. Bleeding on Probing (BOP):

A- Present

B- Absent

6. Presence of Gum Swelling or Inflammation:

A- Yes

B- No

7. Presence of Gum Discoloration:

A- Redness

B- Pale gums

C- Normal pink color

8. Clinical attachment loss (CAL) = …….

A – 0–0.5 mm

B - 1–2 mm

C - 2.5–4 mm

Section 3: Anemia

1. Have you been diagnosed with anemia during your current pregnancy?

A - Yes

B - No

2. Do you experience any of the following symptoms? (Check all that apply)

A - Fatigue

B- Dizziness

C- Shortness of breath

D- Paleness or pale skin

E- Cold hands or feet

F- Headaches

G- Rapid heartbeat

3. Do you take iron or folic acid supplements?

A- Yes

B- NO

4. Have you had any blood transfusions during this pregnancy or in the past?

A - Yes

B - No

Section 4: Lifestyle Factors

28. How would you rate your diet during pregnancy?

A - Balanced and healthy

B - Occasionally healthy

C - Poor

27. Do you drink caffeinated beverages (coffee, tea, etc.)?

A - Yes

B – No

Section 5: Laboratory Tests

Parameter	Result	Reference Range	Notes
Hemoglobin (Hb)	_____ g/dL	Non-pregnant: 12.0–15.5 g/dL; Pregnant: ≥11.0 g/dL	
Red Blood Cell Count (RBC)	_____ $\times 10^{12}$/L	4.2–5.4 $\times 10^{12}$/L	
Hematocrit (HCT)	_____ %	Non-pregnant: 36–48%; Pregnant: ≥33%	
Mean Corpuscular Volume (MCV)	_____ fL	80–100 fL	
Mean Corpuscular Hemoglobin (MCH)	_____ pg	27–31 pg	
Platelet Count	_____ $\times 10^{9}$/L	150–400 $\times 10^{9}$/L	
White Blood Cell Count (WBC)	_____ $\times 10^{9}$/L	4.0–11.0 $\times 10^{9}$/L	
Serum Ferritin	_____ µg/L	15–150 µg/L	

Appendix (2): Ethical approval for the study was obtained from the scientific committee of the postgraduate academy and Gharyan polyclinic.

Ministry of Higher Education
And Scientific Research
The Libyan Academy Gharyan

وزارة التعليم العالي والبحث العلمي
الأكاديمية الليبية
فرع غريان

الأكاديمية الليبية
The Libyan Academy

الإشاري: /

التاريخ:
الموافق: 20-1-2025 ف

السادة : العيادة المجمعة/غريان

تفيدكم مدرسة العلوم الاساسية بالأكاديمية الليبية للدراسات العليا فرع غريان بان الطالبة :
حمداء المهلول البشكي.. رقم قيد 22030023 .... بقسم الطب المجهري
قد انهت مرحلة المقررات الدراسية وانتقلت لمرحلة الاعداد لأطروحة الماجستير.

لذا نامل منكم مساعدة الطالبة في اجراء بعض الاختبارات التجريبية وجمع البيانات المتاحة

وكل الامل في انكم نعم السند لطلبة العلم

د. عمر علي سعيد مفتاح
عميد مدرسة العلوم الاساسية

Appendix (3): reference range of different laboratory tests used in this study.

CBC and Ferritin in Pregnancy (Reference Ranges)

Normal Range in Pregnancy	Test
6.0 – 16.0 $\times 10^9$/L	WBC
3.8 – 4.4 $\times 10^{12}$/L	RBC
1st & 3rd trimester: ≥ 11.0 g/dL 2nd trimester: ≥ 10.5 g/dL	Hemoglobin (Hb)
32 – 42 %	Hematocrit (Hct)
80 – 96 fL	MCV
27 – 33 pg	MCH
150 – 400 $\times 10^9$/L	Platelet count
15 – 150 ng/mL (< 15 = deficiency)	Serum Ferritin

المستخلص

مقدمة: يُعد فقر الدم أثناء الحمل مصدر قلق كبير للصحة العامة، إذ يؤثر سلبًا على صحة الأم والجنين. وقد تمت الإشارة إلى أن التهاب دواعم الأسنان، وهو مرض التهابي مزمن يصيب الفم، يُفاقم الالتهاب الجهازي واختلالات الدم. تهدف هذه الدراسة إلى دراسة الاختلافات في المعايير الدموية لدى النساء الحوامل المصابات بفقر الدم، سواءً كنّ مصابات بالتهاب دواعم الأسنان أو غير مصابات به، في مدينة غريان، واستكشاف التأثير المحتمل لمرض دواعم الأسنان على الالتهاب الجهازي وشدة فقر الدم أثناء الحمل.

المنهجية: أُجريت دراسة مقطعية شملت 112 امرأة حامل مصابة بفقر الدم في مدينة غريان. قُسِّمت المشاركات إلى مجموعتين: نساء حوامل مصابات بفقر الدم دون التهاب دواعم السن (ن = 50) ونساء حوامل مصابات بفقر الدم ومُشخَّصات سريريًا بالتهاب دواعم السن (ن = 62). أُجريت فحوصات شاملة للدواعم السنية، شملت مؤشر تراكم البلاك (البكتريا)، ومؤشر اللثة، وعمق الجيب اللثوي، والنزيف عند اللمس، وتقييم تغير لون اللثة. قيست المعايير الدموية، بما في ذلك الهيموغلوبين (Hb)، وعدد خلايا الدم الحمراء (RBC)، والهيماتوكريت (HCT)، ومتوسط حجم الكريات الدموية (MCV)، ومتوسط الهيموغلوبين في الكريات الدموية (MCH)، وعدد الصفائح الدموية (PLT)، وعدد خلايا الدم البيضاء (WBC)، وفيريتين المصل. وشملت التحليلات الإحصائية الإحصاء الوصفي، ومعامل ارتباط بيرسون، واختبارات تحليل التباين (ANOVA) لمقارنة المتغيرات وربطها داخل المجموعات وفيما بينها.

النتائج: تشابهت المجموعتان من حيث العمر والتوزيع الحملي. أظهرت مجموعة التهاب دواعم السن ارتفاعًا ملحوظًا في تراكم اللويحات، والتهاب اللثة، ونزيفًا عند اللمس، واحمرارًا في اللثة. أظهر التحليل الدموي انخفاضًا طفيفًا في مستويات الهيموغلوبين وهرمونات الهيموغلوبين، وارتفاعًا في عدد خلايا الدم البيضاء والصفائح الدموية (PLT)، وانخفاضًا في مستويات الفيريتين في مجموعة التهاب دواعم السن مقارنةً بالمجموعة المصابة بفقر الدم فقط. لوحظت ارتباطات مهمة بين الهيموغلوبين ومؤشرات الدم، بما في ذلك ارتباط سلبي مع PLT، بشكل رئيسي في مجموعة التهاب دواعم السن. أشارت نتائج تحليل التباين (ANOVA) إلى اتساق أكبر في معايير الدم ضمن مجموعة التهاب دواعم السن، بينما أظهرت المجموعة المصابة بفقر الدم فقط تباينًا أكبر في الهيموغلوبين وهرمونات الهيموغلوبين.

المناقشة: تشير النتائج إلى أن التهاب دواعم السن يُسهم في حالة التهابية جهازية تُفاقم شدة فقر الدم وتُغير المعايير الدموية لدى النساء الحوامل. يعكس ارتفاع عدد الصفائح الدموية وخلايا الدم البيضاء استجابةً التهابية، بينما قد يُشير انخفاض مستويات الفيريتين إلى ضعف استقلاب الحديد بسبب الالتهاب المزمن. يُشير ثبات الملف الدموي لدى مجموعة التهاب دواعم السن إلى أن مرض دواعم السن يُعادل الجهاز، مما يُفاقم العبء الالتهابي في فقر الدم أثناء الحمل.

الاستنتاج: يؤثر التهاب دواعم السن بشكل كبير على صحة الحوامل المصابات بفقر الدم، إذ يُفاقم فقر الدم ويُسبب التهابًا جهازيًا. يُوصى بدمج فحص وعلاج دواعم السن في رعاية ما قبل الولادة للتخفيف من هذه الآثار وتحسين صحة الأم والجنين.

الكلمات المفتاحية: فقر الدم، الحمل؛ التهاب دواعم السن؛ المعايير الدموية؛ الالتهاب الجهازي؛ صحة الفم؛ صحة الأم

دولة ليبيا
الأكاديمية الليبية للدراسات العليا - فرع غريان
كلية العلوم الأساسية
قسم علوم الحياة (الطب الحيوي)

تباين المعايير الدموية لدى النساء الحوامل المصابات بفقر الدم مع أو بدون التهاب دواعم السن في مدينة غريان

رسالة مقدمة إلى كلية العلوم بأكاديمية الدراسات العليا، استكمالاً جزئياً لمتطلبات الحصول على درجة الماجستير في العلوم الطبية الحيوية

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2025