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Original article

DIFFERENTIAL DIAGNOSIS OF IRON DEFICIENCY ANEMIA AND BETA THALASSEMIA IN PORT HARCOURT PREGNANT WOMEN USING THE MENTZER INDEX

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Abstract: **Introduction:** The Mentzer index is a cost-effective and accurate method for differentiating between iron deficiency anemia (IDA) and beta-thalassemia. Anemia in pregnancy is a global health concern, especially in developing countries like Nigeria, where it is primarily linked to iron deficiency and may also include other underlying hemoglobin disorders, with beta-thalassemia (βT) being the most common. This cross-sectional study aimed to differentiate between iron deficiency anemia and beta-thalassemia in pregnant women attending tertiary hospitals in Port Harcourt, Nigeria, based on the Mentzer Index.

Materials and Methods: A total of 120 apparently healthy pregnant women aged between 20 and 50 years were recruited for the study. Five milliliters (5 ml) of venous blood were collected from each participant using a disposable syringe and placed into an ethylene diamine tetraacetic acid (EDTA) anticoagulated bottle for full blood count determination using a Mindray automated analyzer. The Mentzer Index was calculated from the mean cell volume (MCV) and red blood cell (RBC) count values. The data obtained were analyzed statistically using Statistical Package for Social Sciences (SPSS) Version 23.

Results: Mean age ± SD of the study population (28.68 ± 5.6years), Mean + SD of Hb (11.38 + 2.08g/dl), PCV (31.72 + 4.59%), RBC count (4.65 ± 1.86 x 10^{12}/L), MCV (79.92 ± 5.91 fl) and Platelets count (272.9 ± 42.10 x 10^{9}/L) respectively. Out of 120 participants, 48 (40%) had Hb and PCV values above 11.0 g/dl and 33% respectively. A total of 5 (4.17%) had a Mentzer index < 13 and confirmed beta-thalassaemia, while 67 (55.83%) had a Mentzer index > 13 and confirmed iron-deficiency anaemia indicating a 60% prevalance of anaemia in study population with iron-deficiency anaemia been more common amongst the study population than beta-thalassaemia.

Conclusion: Based on the Mentzer Index calculation, this study revealed a high prevalence of iron deficiency anemia (IDA) and a lower prevalence of beta-thalassemia among pregnant women attending tertiary hospitals in Port Harcourt, Nigeria. Healthcare practitioners should consider incorporating the Mentzer Index as a cost-effective means of differentiating iron deficiency anemia from beta-thalassemia in pregnant women, particularly in rural areas. Additionally, increased awareness and educational programs focusing on proper nutrition and iron supplementation during pregnancy should be advocated.

Keywords*:* Mentzer Index, Iron deficiency anemia, Beta-Thalassemia, Pregnant Women.

INTRODUCTION

The Mentzer index is a cost-effective and accurate method for differentiating iron deficiency anemia (IDA) from beta-thalassemia, though it remains underutilized in clinical settings. Anemia during pregnancy is a significant global health concern, particularly in developing countries like Nigeria. It is primarily associated with iron deficiency but may also involve other underlying hemoglobin disorders, with beta-thalassemia (βT) being the most prevalent.

Anemia during pregnancy is characterized by low circulating hemoglobin (Hb), the oxygen-carrying pigment in blood. This condition is defined as a drop in hemoglobin concentration below the normal threshold, which is two standard deviations below the median value for a population of the same sex, age, and stage of pregnancy. This results in decreased oxygen-carrying capacity in pregnant women (1, 2, 3).

Iron is crucial for effective hematopoiesis (4), and research by Ugwu and Uneke (2) highlights multiparity, starting from the seventh month of pregnancy (third trimester), and low socioeconomic status as risk factors for iron deficiency anemia in pregnant women. Poor screening for IDA exacerbates the challenge. Globally, iron deficiency anemia remains one of the most common causes of anemia, and oral iron supplementation during pregnancy is widely advocated, although dietary interventions are less emphasized (5). Hemoglobin concentration (Hb) and packed cell volume (PCV) are standard components of a complete blood count and are essential for diagnosing and monitoring anemia in pregnant women (6, 7, 8).

According to the Nigeria Demographic and Health Survey (NDHS) (9), the prevalence rate of anemia among women of reproductive age (15-49 years) is 58%, particularly challenging in rural communities where awareness is limited. Thalassemia is characterized by quantitative defects in hemoglobin synthesis, resulting in hypochromic microcytic anemia due to reduced or absent synthesis of the globin chain of hemoglobin (10, 11, 12).

Distinguishing between beta-thalassemia, a hereditary disorder (10), and iron deficiency anemia is crucial, as they have distinct etiologies and require different management approaches. While iron deficiency anemia primarily requires oral iron supplementation or controlled dietary intake, beta-thalassemia may necessitate interventions such as blood transfusions. Accurate diagnosis ensures that pregnant women receive appropriate treatment, optimizing maternal and fetal health. Misdiagnosis of beta-thalassemia as iron deficiency anemia could lead to inadequate management and complications such as fetal growth restriction or preterm birth (13, 14). Proper diagnosis and differentiation are essential to prevent adverse outcomes, making the Mentzer index a relevant and cost-effective tool.

Research by Tabassum *et al*. (15) indicates that while various measures have been used to differentiate between beta-thalassemia and iron deficiency anemia, none are 100% sensitive or specific except for the Mentzer index. Bose and Maimoon (16) found that the Mentzer index has high sensitivity and specificity among available measures.

The Mentzer index is calculated by dividing the mean cell volume (MCV) in femtoliters (fl) by the total red blood cell (RBC) count in millions per microliter. An index greater than thirteen (> 13) suggests iron deficiency anemia, while an index less than thirteen (< 13) indicates a likelihood of beta-thalassemia. Individuals with a Mentzer index < 13 may undergo HbA2 estimation through hemoglobin electrophoresis, a cost-effective method for confirming beta-thalassemia in high-risk patients (15, 16).

Diagnosing IDA and beta-thalassemia, particularly in developing countries, poses challenges due to high costs, which affect affordability for pregnant women. Additionally, there is limited information on the diagnosis of iron deficiency anemia and beta-thalassemia in pregnant women in Port Harcourt, Nigeria.

This study aims to determine the prevalence of iron deficiency anemia and beta-thalassemia among pregnant women attending tertiary hospitals in Port Harcourt. It will help allocate resources more efficiently by targeting specific laboratory tests and potentially advance medical knowledge in clinical practice through the reliable differentiation of anemia in pregnant women based on the Mentzer index.

MATERIALS AND METHODS

Study Design

This cross-sectional observational study utilized randomized sampling to differentiate between iron deficiency anemia (IDA) and beta-thalassemia in pregnant women attending a tertiary hospital in Port Harcourt, Nigeria, based on the Mentzer Index. The study was conducted from August 2023 to December 2023.

Study Population

The study population consisted of 120 apparently healthy pregnant women aged 20 to 50, randomly recruited from a tertiary hospital in Port Harcourt, Nigeria.

Eligibility Criteria

Pregnant women attending the tertiary hospital in Port Harcourt, Nigeria, who were willing to provide oral consent, were included in the study. Non-pregnant individuals and those unwilling to provide informed consent or participate in the research were excluded.

Ethical Considerations

Ethical approval for this study was obtained from Rivers State University Teaching Hospital (RSUTH), Port Harcourt.

Blood Collection and Sample Preparation

Five milliliters (5 ml) of venous blood were collected from each participant using a disposable syringe and transferred into ethylene diamine tetraacetic acid (EDTA) anticoagulated bottles. Full blood count was determined using a Mindray automated analyzer, and the Mentzer index was calculated from the mean cell volume (MCV) and red blood cell (RBC) count values.

Calculation of Mentzer Index

The Mentzer Index was calculated using the formula:

$$\text{Mentzer Index} = \frac{MCV\,(ft)}{RBC\ (million\ per\ microlitre)}$$

Differentiation between Iron Deficiency Anemia and Beta-Thalassemia

Differentiation between IDA and beta-thalassemia was based on the research by Tabassum *et al*. (15), which states that a Mentzer Index greater than 13 is indicative of IDA, while an index less than 13 suggests beta-thalassemia.

Data Analysis

The data obtained were analyzed using Statistical Package for Social Sciences (SPSS) Version 23.

RESULTS

Socio-Demographic Characteristics of Study Participants

Table 1 presents the socio-demographic characteristics of the study population. The mean age ± SD of the participants was 28.68 ± 5.6 years. The majority, 89 participants (74.2%), were aged 20-39 years, 30 participants (25.0%) were aged 40-59 years, and 1 participant (0.8%) was aged 60-79 years. Regarding gestational age, 39 participants (32.5%) were within 1-19 weeks, 68 participants (56.7%) were within 20-39 weeks, and 13 participants (10.8%) were 40 weeks and above. Based on parity, 94 participants (78.3%) had 1-3 pregnancies, while 26 participants (21.7%) had 4 or more pregnancies.

Hematological Parameters of Study Population

Table 2 summarizes the hematological parameters of the study population. The mean values were: Hemoglobin: 11.38 ± 2.08 g/dL, Packed Cell Volume: 31.71 ± 4.59%, White Blood Cell Count: 4.65 ± 1.86 × 10^12/L, Red Blood Cell Count: 5.93 ± 1.75 × 10^9/L, Mean Cell Hemoglobin: 26.97 ± 2.54 pg, Mean Cell Volume: 79.92 ± 5.91 fL, Mean Cell Hemoglobin Concentration: 34.58 ± 1.87 g/dL, Platelet Count: 272.9 ± 42.10 × 10^9/L.

Table 1. *Socio-demographic characteristics of study participants*

Characteristics of the Population	Number Of Subjects	Percentage (%)
Age Range (years)		
10-39	89	74.2
40-59	30	25.0
60-79	1	0.8
Mean Age ± SD (years)	28.68 ± 5.6	
Gestational age (weeks)		
1-19	39	32.5
20-39	68	56.7
40 and above	13	10.8
Parity		
1-3	94	78.3
4-6	26	21.7

Table 2. *Haematological parameters of study population*

Haematological Parameter	Mean ± SD
Haemoglobin concentration	11.38 ± 2.08 g/dl
Packed Cell Volume	31.71 ± 4.59 %
Red Blood Cell Count	4.65 ± 1.86 x 10^{12}/L
White Blood Cell Count	5.93 ± 1.75 x 10^{9}/L
Mean Cell Volume	79.92 ± 5.91 fl
Mean Cell Hemoglobin	26.97 ± 2.54 pg
Mean Cell Hemoglobin Concentration	34.58 ± 1.87 g/dl
Platelet Count	272.9 ± 42.10^{9}/L

Differentiation of Iron Deficiency Anemia (IDA) and Beta-Thalassemia in Pregnant Women

Table 3 illustrates the differentiation between iron deficiency anemia and beta-thalassemia among the pregnant women attending a tertiary Hospital in Port Harcourt Nigeria. Out of the 120 participants, 48 (40%) had Hb and PCV values above 11.0 g/dl and 33% respectively and classified as non anaemic pregnant individuals, 67 (55.83%) were diagnosed with iron deficiency anemia based on the Mentzer Index, while 5 participants (4.17%) were diagnosed with beta-thalassemia.

Table 3. *Differentiation of iron deficiency anaemia (IDA) and B-thalassaemia in pregnant women based om Mentzer Index*

Mentzer Index	Disorder/Condition	Number of Subjects	Percentage (%)
	Non anaemic individuals	48	40.00
Less than 13 (< 13)	ß-Thalassaemia	5	4.17
Greater than 13 (> 13)	Iron Deficiency Anaemia	67	55.83

DISCUSSION

This study utilized the Mentzer Index to differentiate between iron deficiency anemia (IDA) and beta-thalassemia in pregnant women attending a tertiary hospital in Port Harcourt.

The hematological parameters observed in the study population revealed that while values for hemoglobin (Hb) concentration, red blood cell (RBC) count, mean cell hemoglobin concentration (MCHC), white blood cell (WBC) count, and platelet count were within normal reference ranges, packed cell volume (PCV), mean cell volume (MCV), and mean cell hemoglobin (MCH) were slightly below the lower limits of normal/reference ranges. These variations are typical in pregnancy due to physiological changes, including dilutional anemia and increased physiological stress, which can alter hematological parameters. These findings are consistent with the research by Dapper *et al*. (17) and Mba *et al.* (18), who observed similar variations in hematological parameters in pregnant women in Port Harcourt. Additionally, Amah-Tariah *et al*. (19) reported non-significant variations in platelet counts across different trimesters of pregnancy.

The differentiation between iron deficiency anemia and beta-thalassemia based on the Mentzer Index showed that 5 participants (4.17%) had a Mentzer Index of less than 13, indicative of beta-thalassemia, while 67 participants (55.83%) had a Mentzer Index greater than 13, indicative of iron deficiency anemia. This distribution indicate a prevalence of 60% anemia with high prevalence of iron deficiency anemia compared to beta-thalassemia among the study participants.

The predominance of iron deficiency anemia in this study may reflect the participants' nutritional status, particularly concerning dietary iron intake during pregnancy. The increased demand for iron during pregnancy can exacerbate iron deficiency, especially in women who enter pregnancy with insufficient iron stores. Multi-parity further contributes to the depletion of iron stores, as observed in this study's predominantly multiparous participants. This high prevalence of iron deficiency anemia although lower in terms of percantage aligns with findings from Ndukwu and Dienye (20), who reported a 62.6% prevalence rate for anemia among pregnant women in Rivers State. Ugwu and Uneke (2) highlighted that iron deficiency accounts for 75% of all types of anemia in pregnancy globally, with a reported prevalence of 25% in Nigeria. Azinge *et al*. (21) also reported a prevalence of 57.5% for anemia in pregnant women in Nigeria, which is lower than the 60% prevalence observed in this study. Onimawo and Onuoha (22) reported a lower prevalence of 14% for iron-deficiency anemia in pregnant women in Abia State.

The low prevalence of beta-thalassemia in this study can be attributed to its hereditary nature, resulting from mutations or deletions in the beta-globin gene (HbB) on chromosome 11. Since beta-thalassemia prevalence is not influenced by pregnancy, this finding is consistent with the observations of Needs *et al.* (10). The lower prevalence of beta-thalassemia compared to iron deficiency anemia highlights the susceptibility of pregnant women to iron deficiency and reinforces the need for effective screening and nutritional interventions.

CONCLUSION

This study highlights a high prevalence of iron deficiency anemia (IDA) and a lower prevalence of beta-thalassemia among pregnant women attending tertiary hospitals in Port Harcourt, Nigeria. The Mentzer Index proved to be an effective tool for distinguishing between these conditions, even as variations in hematological parameters were observed.

Recommendation

Healthcare practitioners are encouraged to integrate the Mentzer Index as a cost-effective method for differentiating between iron deficiency anemia and beta-thalassemia in pregnant women, particularly in rural areas where resources may be limited. Additionally, there should be a concerted effort to enhance awareness and education on proper nutrition and iron supplementation during pregnancy to address and prevent iron deficiency anemia.

Abbreviations

IDA - Iron Deficiency Anemia
P**CV** - Packed Cell Volume

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Conflict of Interest: The authors declare no conflicts of interest regarding the writing and publication of this article.

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Authors' Contributions: RJ contributed to the conceptualization, detailed review, and statistical analysis. PA conducted literature reviews and laboratory analyses. EE and ZJ participated in the review and editing of the manuscript. All authors have reviewed and approved the final manuscript.

Note: Artificial intelligence was not utilized as a tool in this study.

Sažetak

DIFERENCIJALNA DIJAGNOZA ANEMIJE USLED NEDOSTATKA GVOŽĐA I BETA TALASEMJE KOD TRUDNICA U PORT HARCOURTU KORIŠĆENJEM MENTZER INDEKSA

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Uvod: Mentzer indeks je isplativ i tačan metod za razlikovanje anemije usled nedostatka gvožđa (IDA) i beta-talasemije. Anemija u trudnoći je globalni zdravstveni problem, posebno u zemljama u razvoju kao što je Nigerija, gde je prvenstveno povezana sa nedostatkom gvožđa i može uključivati i druge osnovne hemoglobinopatije, pri čemu je beta-talasemija (βT) najčešća. Ova studija preseka imala je za cilj da diferencira anemiju usled nedostatka gvožđa i beta-talasemiju kod trudnica koje posećuju tercijarne bolnice u Port Harcourtu, Nigerija, na osnovu Mentzer indeksa.

Materijali i Metode: U studiju je uključeno ukupno 120 naizgled zdravih trudnica uzrasta između 20 i 50 godina. Pet mililitara (5 ml) venske krvi je uzeto od svake učesnice studije koristeći jednokratni špric i stavljeno u bočicu sa antikoagulansom etilen-diamin-tetra-sirćetnom kiselinom (EDTA) za određivanje kompletne krvne slike koristeći Mindray automatski analizator. Mentzer indeks je izračunat na osnovu prosečnog volumena eritrocita (MCV) i broja eritrocita (RBC). Dobijeni podaci su statistički analizirani korišćenjem Statističkog paketa za društvene nauke (SPSS) verzija 23.

Rezultati: Prosečna starost ± SD populacije studije bila je 28,68 ± 5,6 godina. Srednje vrednosti ± SD su bile sledeće: Hb 11,38 ± 2,08 g/dl, HCT 31,72 ± 4,59%, broj eritrocita 4,65 ± 1,86 x 10^{12}/L, i MCV 79,92 ± 5,91 fl. Od ukupno 120 učesnica, 5 (4,17%) je imalo Mentzer indeks < 13 i kod njih je potvrđena beta-talasemija, dok je 115 (95,83%) imalo Mentzer indeks > 13 i kod njih je potvrđena anemija usled nedostatka gvožđa. Ovo ukazuje da je anemija usled nedostatka gvožđa češća među populacijom u studiji nego beta-talasemija.

Zaključak: Na osnovu izračunatog Mentzer indeksa, ova studija je otkrila visoku prevalenciju anemije usled nedostatka gvožđa (IDA) i nižu prevalenciju beta-talasemije među trudnicama koje posećuju tercijarne bolnice u Port Harcourtu, Nigerija. Zdravstveni radnici bi trebali razmotriti upotrebu Mentzer indeksa kao isplativog načina za razlikovanje anemije usled nedostatka gvožđa od beta-talasemije kod trudnica, posebno u ruralnim područjima. Pored toga, potrebno je povećati svest i organizovati edukativne programe koji se fokusiraju na pravilnu ishranu i suplementaciju gvožđem tokom trudnoće.

Ključne reči: Mentzer Indeks, Anemija ssled nedostatka gvožđa, Beta-Talasemija, Trudnice.

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