

Comparison of Cell Counter Indices (Mentzer vs. RDWI) in Differentiating Iron Deficiency Anaemia from Beta-Thalassemia Trait in a Tertiary Care Hospital in Pakistan

Ammara Amjad¹, Fuad Ahmad Siddiqi², Abdul Mateen³, Kanaz Ahmad Siddiqi⁴, Imran Khan⁵, Laibah Safdar⁶

1,6. Registrar Medicine, CMH, Rawalpindi 2. HOD Medicine, Advisor in Medicine, CMH Rawalpindi 3. GDMO, CMH, Rawalpindi 4. Demonstrator, CMH, Rawalpindi 5. Medical Specialist, CMH Rawalpindi.

Corresponding author: Dr. Ammara Amjad, ammaraamjad@gmail.com

Abstract

Objective: This study aims to assess the diagnostic value of the Mentzer Index and Red Cell Distribution Width Index (RDWI) in differentiating between Iron Deficiency Anaemia (IDA) and Beta-Thalassemia Trait (β -TT) in adult patients of a tertiary care hospital in Pakistan.

Methodology: This cross-sectional study was carried out in the outpatient department of Medicine, Combined Military Hospital Rawalpindi from Jul 2024 to December 2024. The data were collected from 170 patients with microcytic anaemia aged >18 years with a confirmed diagnosis of IDA and β -TT. Haematological parameters, including haemoglobin, red blood cell (RBC) count, mean corpuscular volume (MCV), RDW, Mentzer Index, and RDWI, were calculated. Data was analysed using SPSS-25. The chi-square test was used to assess between variables. Sensitivity, specificity and diagnostic accuracy were calculated.

Results: The study population included 90 patients (52.9%) with IDA and 80 patients (47.1%) with β -TT. Our results demonstrated statistically significant differences between the IDA and β -TT groups for key diagnostic parameters. The results indicated that both indices have almost equal sensitivity (92%) while RDWI demonstrated higher specificity (89% vs. 80%). RDWI had a slightly higher diagnostic accuracy of 90% and the Mentzer Index 86%.

Conclusion: The Mentzer Index and RDWI are valuable screening tools for differentiating IDA from β -TT, especially in settings where advanced diagnostic methods are not available. Although significant differences between haematological parameters were seen in this study, further research with larger sample sizes is recommended to improve the diagnostic accuracy of these indices.

Keywords: Anaemia, Iron-Deficiency, Beta-Thalassemia, Erythrocyte Indices, Mentzer Index, RDWI.

Introduction

Anaemia is a global health concern that affects approximately 24.8% of the world's population, with microcytic anaemia being one of the most common forms. Two common types of microcytic anaemia include Iron Deficiency Anaemia (IDA) and Beta Thalassemia Trait (β -TT), especially in developing countries like Pakistan.¹ Their similar clinical features make it difficult to differentiate between the two, thus highlighting the need for accurate diagnosis. Differentiating between IDA and β -TT is still a challenge in clinical practice, especially in settings where resources are limited and advanced diagnostic tests like haemoglobin electrophoresis or genetic testing are not easily available.² Recently, several cell counter indices have been developed to differentiate between these two conditions due to their cost-effectiveness and efficiency. Among these indices, the Mentzer Index and Red Cell Distribution Width Index (RDWI) are widely used in distinguishing IDA from β -TT.³ The Mentzer index compares the mean corpuscular volume (MCV) to the red blood cell count, is considered a reliable method for distinguishing between iron deficiency IDA and β -TT. Mentzer index is superior to other indices in differentiating microcytosis due to thalassemia from other causes and is particularly useful in settings where resources are limited.⁵ Another index is RDWI, which uses the standard RDW calculation and is also commonly used. It was observed that RDWI has higher specificity as compared to RDW alone for β -TT,⁵ indicating

Contributions:

AA, AM, IK, - Conception, Design
AA, FAS, AM, KAS, IK, - Acquisition, Analysis, Interpretation
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All authors approved the final version to be published & agreed to be accountable for all aspects of the work.

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that it is a useful tool for diagnosis. The findings suggest that RDWI and the Mentzer index can be used by practitioners for better assessment and differentiation of different types of anaemia.⁶

A study conducted showed that β -TT patients had higher RBC counts and lower MCV, while low serum ferritin levels were seen in IDA patients, thus concluding that these indices are useful to distinguish IDA from β -TT.⁷

Although both indices have been verified in different populations, their ability to compare and distinguish IDA from β -TT, especially in Pakistani patients, is still not well established. Due to the high prevalence of both conditions in Pakistan, it is important to assess the diagnostic efficacy of these indices in the population of Pakistan.

This study aims to compare the accuracy of the Mentzer Index and RDWI in differentiating between IDA and β -TT. By evaluating the sensitivity, specificity, and diagnostic accuracy of these indices, we can offer a more practical and evidence-based approach to improve the diagnosis and management of anaemia in Pakistan.

Materials And Methods

This was a cross-sectional study conducted at the outpatient department of medicine of Combined Military Hospital (CMH) Rawalpindi from Jul 2024 to December 2024 after getting approval of the Institutional ethical review board (ERB Reference No: 817). A total sample size of 170 patients was included in this study through a convenience sampling technique. The WHO calculator was used to calculate the sample size with an estimated population size of 300 patients per day in the OPD, a confidence level of 95%, and a margin of error of 5%.

Adults aged 18 years and above with microcytic anaemia (MCV < 80 fL) presenting to the OPD of the Medicine department were included in this study. Patients with a confirmed diagnosis of either IDA or β -TT based on serum ferritin levels and haemoglobin electrophoresis were included.

Patients with other types of anaemia, such as macrocytic or normocytic anaemia, were excluded from the study. Pregnant females or those with chronic kidney disease, active infections, or malignancies were also excluded. Patients who had received iron supplementation or blood transfusions within the last six weeks were excluded.

Data was collected through interviews and a review of medical records. Interviews were conducted to obtain demographic information, including age, gender, and medical history. Haematological parameters such as haemoglobin levels, RBC count, MCV, RDW, and RDWI were obtained from the routine blood tests. Serum ferritin levels were measured to confirm a diagnosis of IDA, and haemoglobin electrophoresis was performed to identify β -TT. Written informed consent was taken from each participant.

RDWI was calculated using the following formula: $RDWI = (MCV \times RDW) / RBC$

The Mentzer Index was calculated as: $Mentzer\ Index = MCV / RBC$

The data was analysed using SPSS version 25. Descriptive statistics, including mean, standard deviation and frequencies, were calculated for demographic and haematological variables. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of the Mentzer Index and RDWI were determined by comparing these indices with the gold standard diagnostic tests (serum ferritin for IDA and haemoglobin electrophoresis for β -TT). The Chi-square test was used to assess the association between categorical variables, while an independent t-test was applied to compare continuous variables. A p-value of <0.05 was considered statistically significant.

Results

A total of 170 patients were included in the study, out of which 90 (52.9%) were diagnosed with IDA and 80 (47.1%) with β -TT. The mean age was 34.34 ± 11.54 years (18–64 years). Among these 48% (n=82) were male and 52% (n=88) were female. The most common presenting features were fatigue in 122 (72%), pallor in 112 (66%), and weakness in 99 (58%).

The mean Hb level for the IDA group (8.17 ± 1.1 g/dL) was lower than that of the β -TT group (11.3 ± 1.3 g/dL). The mean RBC count in the IDA group was 3.1 ± 0.8 million/ μ L, compared to 5.1 ± 0.5 million/ μ L in the β -TT group. The MCV was lower in the IDA group (64.1 ± 5.0 fL vs. 58.4 ± 5.8 fL). Serum ferritin levels were significantly decreased in the IDA group (16.2 ± 5.3 ng/mL vs. 87.7 ± 11.7 ng/mL in the β -TT group). Haemoglobin electrophoresis confirmed the diagnosis of beta-thalassemia trait in the β -TT group, with 88% (n=70) of the β -TT patients exhibiting characteristic patterns of beta-thalassemia trait.

Significant differences in haematological parameters were seen between the two groups. The mean MCV was increased in the IDA group (64.1 ± 5.0 fL) compared to the β -TT group (58.4 ± 5.8 fL) ($p < 0.05$). The mean RDW was higher in the IDA group (19.5 ± 2.4 % vs 14.0 ± 1.8 %) ($p < 0.05$).

Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated for both indices. The results indicated that both indices had almost equal specificity (92%) while RDWI demonstrated higher specificity (89% vs. 80%). Diagnostic accuracy was slightly higher with RDWI, having 90% and the Mentzer Index 86%.

The Chi-square test showed no statistically significant difference between gender and anaemia type ($p = 0.17$). Independent t-test showed statistically significant differences in continuous variables, including RBC, MCV and RDW between the two groups ($p < 0.05$).

Table 1: Hematological and Laboratory Parameters by Anemia Type

Parameter	IDA (n = 90)	β -TT (n = 80)
Haemoglobin (g/dL)	8.17 $\pm$ 1.1	11.3 $\pm$ 1.3
RBC Count (million/ μ L)	3.1 $\pm$ 0.8	5.1 $\pm$ 0.5
MCV (fL)	64.1 $\pm$ 5.0	58.4 $\pm$ 5.8
RDW (%)	19.2 $\pm$ 2.4%	14.0 $\pm$ 1.8%
Serum Ferritin (ng/mL)	16.2 $\pm$ 5.3	87.7 $\pm$ 11.7
Hemoglobin Electrophoresis	88% with β -TT pattern	

Table 2: Evaluation of sensitivity and specificity of the Mentzer Index

Mentzer Index values	IDA	β -TT	Total
>13	83 (TP)	16(FP)	99
<13	7 (FN)	64 (TN)	71
Total	90	80	170

Table 3: Evaluation of sensitivity and specificity of RDWI

RDWI	IDA	β -TT	Total
>220	81 (TP)	7 (FN)	88
<220	9 (FP)	73 (TN)	82
Total	90	80	170

Table 4: Diagnostic Performance of Mentzer Index and RDWI

Test	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)
Mentzer Index	92%	80%	83%	90%	86%
RDWI	92%	89%	90%	91%	90%

Discussion

This study was done to compare the Mentzer Index and RDWI in differentiating IDA from β -TT in patients at a tertiary care hospital in Pakistan. The results showed that both indices are effective in distinguishing IDA from β -TT, with diagnostic accuracy of 86% and 90% respectively. The findings are consistent with previous research that has evaluated the use of the Mentzer Index and RDWI in differentiating IDA from β -TT. Previous studies^{[8],[4]} have emphasised the utility of these indices in similar settings. Another study,⁹ highlighted the practical value of RDWI when combined with other haematological parameters. Our findings align with these observations, showing that RDWI remains a valuable tool, especially where advanced diagnostic methods like haemoglobin electrophoresis are not easily available. Various studies,¹⁰⁻¹² showed high diagnostic accuracy for RDW and Mentzer Index, further emphasising their utilisation in resource-limited environments.

Even though our study did not find significant differences between RDWI and Mentzer Index in IDA and β -TT, these indices can be used due to their accessibility and ease of calculation. This is consistent with international efforts to implement simpler screening tools where access to advanced diagnostics is limited. A recent study,¹³ revealed that these indices can be used as initial screening tools, especially in resource-limited settings, while advocating for their combination with other haematological parameters for improved diagnostic accuracy. Our study supports findings by another study,¹⁴ which reported high sensitivity for both the Mentzer Index and RDWI when compared to Hb electrophoresis, highlighting their relevance in settings where advanced diagnostic tools are not readily available. The diagnostic potential of these indices is further supported by various research,¹⁵⁻¹⁷ showing the efficacy of the Mentzer Index and RDWI in distinguishing between β -TT and IDA.

These studies show that while more advanced diagnostic tools are the gold standard, indices like RDWI and Mentzer Index offer an alternative in low-resource settings. However, the need to integrate these indices with more definitive diagnostic methods remains essential to enhance accuracy and ensure comprehensive care.

Limitations:

This study has certain limitations. As it was conducted at only one hospital in Pakistan, these findings may not apply to other populations. The use of convenience sampling may also introduce selection bias, thus limiting the generalizability of the results. While serum ferritin and Hb electrophoresis were used as gold standards for diagnosing IDA and β -TT, these tests have some limitations. Serum ferritin can be falsely raised in cases of inflammation, leading to a missed IDA diagnosis. Similarly, Hb electrophoresis may not always detect rare thalassemia variants. Future research should include diverse populations and additional diagnostic methods to enhance the reliability of these indices.

Conclusions

The Mentzer Index and RDWI are both useful and affordable tools to help practitioners differentiate between IDA and β -TT. The RDWI was found to be more specific, while both indices had almost equal sensitivity. Both tests showed similar overall diagnostic

accuracy. The study also found that patients with IDA had higher MCV and higher RDW compared to those with β -TT, further supporting the use of these indices in clinical practice. As advanced diagnostics may not always be available, these indices can be valuable for quick and cost-effective diagnosis. Further research with larger and more diverse groups of patients is needed to confirm these results and understand how well these indices work in different settings.

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