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DIAGNOSTIC UTILITY OF MENTZER'S INDEX IN IRON DEFICIENCY ANEMIA ASSESSMENT: A COMPREHENSIVE STUDY IN CHILDREN AGED 6 MONTHS TO 5 YEARS

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ABSTRACT **Introduction:** Anemia represents a significant global health concern, affecting populations across all economic spectra. Iron deficiency is the primary cause of anemia1 but current diagnostic methods are often time-consuming, costly, and inaccessible, particularly for lower socioeconomic groups. This study aims to establish the diagnostic value of Mentzer's index as an alternative, less invasive, and more cost-effective tool for diagnosing iron deficiency anemia (IDA) compared to serum ferritin levels, especially in children aged 6 months to 5 years. **Materials and methods:** This is a longitudinal observational design involving 150 children aged 6 months to 5 years attending a Tertiary Care Hospital from AndhraPradesh. A total of 150 subjects were included .Mentzer's index was calculated from mean corpuscular volume and red cell count. Subjects with Mentzer's index greater than 13 were considered to have IDA, and serum ferritin levels were measured to confirm iron deficiency. **Results:** Out of the 150 subjects, 137 children had Mentzer's index above 13, and among them, 119 had serum ferritin levels below 12 ng/dl. The study demonstrated a significant correlation between Mentzer's index and serum ferritin levels.Sensitivity and specificity of Mentzer's index for diagnosing IDA were found to be 93.4% and 84.6%, respectively, with an overall diagnostic accuracy of 92.6%. **Conclusion:** Mentzer's index is a simple and affordable method that accurately identifies iron deficiency anemia in children under 5 years old.

KEYWORDS :

INTRODUCTION:

Anaemia affects 1.62 billion people globally, with the highest prevalence of 47.4% among preschool children.[2] In low-development countries, the prevalence is 43%, compared to 9% in high-development nations.[3] South East Asia faces the greatest burden, with 60% of women, 36% of men, and 66% of children affected, contributing to 324,000 deaths and 12,500,000 Disability Adjusted Life-Years (DALYs).[4] Prevalence of anaemia in India is 74.3%[5].India faces a severe anemia burden, particularly among vulnerable groups, according to National Family Health Survey-3 data. Approximately 80% of children under 3 and 69.5% of those under five are affected, with 7 out of 10 children aged 6-59 months being anemic.[6] The World Health Organization defines anemia in children under six as hemoglobin levels below 10.0 g/dl.[7] Iron deficiency anemia (IDA) is a major cause, linked to cognitive impairment, reduced physical capacity, and compromised immunity.[8] Addressing anemia requires a comprehensive approach to identify and tackle contributing factors, emphasizing the need for public health authorities in India to reassess strategies. Mentzer's index, calculated by dividing mean corpuscular volume (MCV) by red blood cell count, proves to be a reliable and cost-effective tool for distinguishing between IDA and Thalassemia.[9] Studies by Dr. Ajeet Gopchade and Sri Lestari S. Alam demonstrate its effectiveness, especially in children aged 6-12 with microcytic hypochromic anemia.[10] The index's validity surpasses expensive serum ferritin tests, offering a practical alternative for diagnosing IDA in resource-limited settings.[11] This underscores the significance of Mentzer's index in efficiently identifying and differentiating these hematological conditions, particularly in economically constrained populations.

This study aims to assess the diagnostic efficacy of Mentzer's index in identifying iron deficiency anemia (IDA) and compare its performance with Serum Ferritin levels. The secondary objective is to establish an effective and straightforward diagnostic index for IDA, offering a practical and accessible method for healthcare professionals.

MATERIALS AND METHODS:

This cross-sectional study aims to evaluate Mentzer's index as a diagnostic tool for iron deficiency anemia (IDA) in children aged 6 months to 5 years visiting a tertiary care centre in East Godavari, Andhra pradesh. The sample size of 150 was determined based on a 50% prevalence of IDA in Andhra Pradesh. Inclusion criteria include anemic children not on treatment or transfusions, with hemoglobin below WHO cutoffs and microcytic hypochromic anemia. Exclusions include those with specific medical conditions. The study involves clinical evaluations, CBC, peripheral smear, CRP, and serum ferritin measurements. Mentzer's index above 13 prompts serum ferritin confirmation, aiming to establish a practical diagnostic approach. Collected data was entered into an Excel sheet and analyzed using SPSS version 27. Statistical tests include chi-square for independent variables, Pearson's correlation for variable correlation, and diagnostic accuracy metrics. Receiver Operator Curve (ROC) analysis will determine the optimal Mentzer's index cutoff point for iron deficiency anemia.

RESULTS:

This study encompassed 150 children aged between 6 months and 5 years, with a mean age of 28.55 ± 14.86 months. The gender distribution showed a slight female predominance (77 females) with a sex ratio of 0.94:1. The age distribution revealed that 22.6% were between 6 to 12 months, 40 % between 13 to 24 months, 34% between 25 to 36 months, 32% between 37 to 48 months, and 10% between 49 to 60 months.

In terms of hematological parameters, the mean hemoglobin level was 8.88±0.487 (g/dl), mean corpuscular volume (MCV) was 76.19±5.031 (μm3), and mean red blood cell count was 4.107 ± 03.15. Additionally, the red cell distribution width (RDW) was 17.010±0. The primary focus of the study was the evaluation of Mentzer's index as a diagnostic tool for IDA. The mean Mentzer's index was calculated at 16.647±1.778, and the mean serum ferritin level was 8.20±3.303. Among the 150 subjects, 137 had a Mentzer's index greater than 13, prompting further examination of their serum ferritin levels. Out of these, 119 had serum ferritin levels below 12, while 18 were above 12. For the subjects with Mentzer's index less than 13, serum ferritin testing was not conducted.

The study explored the relationship between Mentzer's index, hemoglobin levels, and serum ferritin. Subjects with decreased hemoglobin levels had higher Mentzer's index. There is a positive correlation between decreased hemoglobin and decreased serum ferritin levels.

The correlation between Mentzer's index and serum ferritin was further examined in Figure 1, demonstrating a moderate to good negative correlation. This implies that as Mentzer's index increases, serum ferritin levels tend to decrease. This finding adds weight to the potential diagnostic utility of Mentzer's index in identifying iron deficiency anemia.

The statistical analysis involved various parameters, including sensitivity, specificity, positive predictive value, negative predictive value, and accuracy. Table 1 provides a comprehensive overview of these results. Notably, Mentzer's index showed a sensitivity of 93.4%, specificity of 84.6%, positive predictive value of 98.4%, negative predictive value of 55%, and an overall accuracy of 92.6%. The prevalence of iron deficiency anemia in the studied population was reported at 91.3%. These values underscore the diagnostic robustness of Mentzer's index in identifying iron deficiency anemia.

The receiver operator curve (ROC) analysis, presented in Figure 2, yielded an area under the curve (AUC) greater than 0.84. According to ROC interpretation standards, this suggests that Mentzer's index demonstrates an excellent ability to discriminate between subjects with and without iron deficiency anemia.

DISCUSSION:

Iron deficiency anemia (IDA) stands as the most prevalent form of nutritional anemia during infancy and childhood, presenting significant cognitive and behavioral deficits that can become irreversible if left untreated.[12] The importance of early diagnosis and intervention cannot be overstated, particularly in communities lacking advanced medical facilities and resources. This need for accessible testing has led to the exploration of indices such as Mentzer's index, which offers a potential solution for community-level screening, especially among children from low socioeconomic backgrounds.

Mentzer's index operates on the principle that in iron deficiency, the bone marrow struggles to produce enough red blood cells (RBCs), resulting in smaller cells (microcytic), leading to low RBC count and mean corpuscular volume (MCV). Consequently, the index value is greater than 13. Conversely, in thalassemia, where there's a disorder in globin synthesis, the number of RBCs produced remains normal, but they are smaller and more fragile, resulting in a lower MCV, hence an index value less than 13.[13]This index has shown promise as a screening tool for IDA in resource-limited settings.

Various studies have demonstrated differing prevalence rates of IDA, underscoring its significance across different populations and age groups. For instance, research by Ekwochi et al.[14] reported an incidence of 22.3% in children aged 2 months to 59 months, while Cogswell et al.[15] found a prevalence of 32.4% in 3 to 5-year-olds. Notably, the present study found a much higher incidence of 91%, likely due to focusing solely on anemia cases and utilizing Mentzer's index for diagnosis.

Gender disparities have also been observed, with some studies indicating a higher incidence of IDA among female children.[16] Similarly, in the present study, a greater prevalence was noted among females. Moreover, the comparison of RBC indices across studies reveals variations in mean values, highlighting the heterogeneity in population characteristics and age groups studied.

The rationale for utilizing Mentzer's index lies in its demonstrated accuracy in distinguishing between IDA and thalassemia. Studies have shown its superior sensitivity and specificity compared to other indices, making it a valuable tool, particularly in resource-poor settings.[17] In the present study, Mentzer's index was used as a preliminary screening tool, with serum ferritin evaluation reserved for cases with index values above 13.

Ensuring the reliability of serum ferritin levels necessitates excluding children with chronic diseases or severe infections, which can skew results. Serum ferritin remains the gold standard for diagnosing iron deficiency when interpreted alongside clinical parameters like total leukocyte count and C-reactive protein levels to rule out inflammation-related elevations.

The diagnostic accuracy of Mentzer's index was found to be high in the present study, mirroring findings from previous research.[18] Its correlation with serum ferritin levels further strengthens its utility as a screening tool, particularly in younger age groups where IDA prevalence is higher.

Apart from its diagnostic accuracy, Mentzer's index offers practical advantages such as rapid calculation, minimal invasiveness, and cost-effectiveness compared to conventional tests like serum ferritin. Its simplicity and accessibility make it an attractive option for community-level screening and early intervention.

Follow-up care for diagnosed cases involves oral iron supplementation, dietary counseling, and regular monitoring by pediatricians to ensure optimal growth and development. By employing Mentzer's index as a screening tool, healthcare providers can identify and manage IDA promptly, mitigating its long-term consequences on child health and development.

In summary, the use of Mentzer's index offers a viable strategy for early detection and management of IDA, particularly in resource-limited settings where access to advanced diagnostic facilities is limited. Its simplicity, accuracy, and cost-effectiveness make it a valuable tool in combating childhood anemia and promoting better health outcomes.

Study limitations include the hospital-based sample, potentially not reflecting the general population, and the exclusion of serum ferritin evaluation for children with Mentzer's index below 13. Additionally, other iron indices like iron binding capacities were not assessed, and follow-up investigations focused solely on clinical evaluation, omitting chronic and acute inflammation markers beyond total leukocyte count and CRP.

CONCLUSION: Iron deficiency anemia is a prevalent condition among children under 5 years old, necessitating accessible and efficient diagnostic tools. Mentzer's index emerged as a promising tool, displaying high accuracy, sensitivity, and specificity. Its simplicity and cost-effectiveness make it suitable for widespread use in both community and hospital settings, offering an effective means of diagnosing IDA without the need for more complex tests.

Figure 1. Correlation between Mentzer index and serum ferritin.

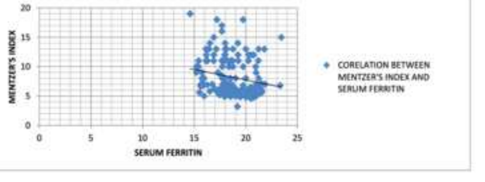

Figure 2.ROC analysis showing sensitivity and specificity.

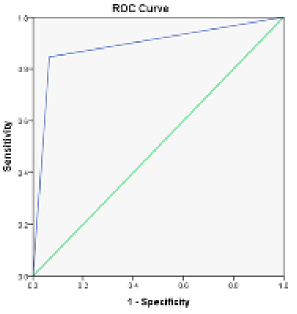

Table 1. Statistics showing diagnostic power of Mentzer index.

Statistics	Value	95% CI
Sensitivity	93.4%	87.9% to 96.9%
Specificity	84.6%	54.5% to 98.1%
Positive likelihood ratio	6.07	1.70 to 21.75
Negative likelihood ratio	0.08	0.04 to 0.15
Positive predictive value	98.4%	94.7% to 99.5%
Negative predictive value	55%	38.4% to 70.5%
Accuracy	92.6%	87.2% to 96.2%
Disease prevalence	91.3%	85.6% to 95.3%

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