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Original Article

Role of Mentzer Index (Mi) In Screening Iron Deficiency Anemia (Ida) In Children At Tertiary Care Hospital

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ABSTRACT

Objective: To verify the significance of the Mentzer index as a method of screening Iron deficiency anemia (IDA) in preschool children.

Study Design: Analytical cross-sectional study.

Place and Duration of Study: Combined Military Hospital (CMH), Rawalpindi, Pakistan, from Aug 2023 to Feb 2024.

Methodology: Using non-probability consecutive sampling, 358 children presenting to the Emergency Department (ED) and Outpatient Department (OPD) were included. Anemia in preschoolers (3–5 years old) was identified using World Health Organization (WHO) criteria. The Mentzer index (MI) was calculated for each participant. Samples were collected for serum ferritin levels, to confirm the diagnosis of IDA.

Results: The mean age of participants in our study was 3.97±0.88 years. Of the 358 participants, 187 were females (52.20%) and 171 were males (47.80%). The mean hemoglobin level was 9.06±1.16g/dl, the Red Blood Cell (RBC) count was 5.02±0.808 x106/µL, the Mean Corpuscular Volume (MCV) was 64.10±8.61 fL, the hematocrit level (HCT) was 28.79±2.82% and the average serum ferritin level was 12.57±10.28 µg/l. The results of the validation statistical model were obtained including sensitivity (88.14%), specificity (84.43%), Positive Predictive Value (91.67%), Negative Predictive Value (78.63%), and diagnostic accuracy (86.87%).

Conclusion: The Mentzer Index exhibits satisfactory validation statistics, including diagnostic accuracy, sensitivity, specificity, and NPV, making it a reliable screening tool for IDA.

Keywords: Anemia, Ferritin, Iron Deficiency, Mentzer Index, Screening

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INTRODUCTION

Iron deficiency anemia is a hematological condition that arises as a result of the body's inability to produce sufficient hemoglobin due to inadequate iron reserves, particularly in infants and children compared to other age groups while also effecting 30% of all women between the ages of 15 and 49 years, nearly 40% children between the ages of 6 months and 5 years, and 37% of all pregnant women[1]. In 2019, there was a significant loss of 50 million years of healthy life due to anemia-related disabilities[2]. The main etiological factors discovered for anemia were dietary iron deficiency, sickle cell and thalassemia trait, and infection with malarial parasites[2]. The American Academy of Pediatrics (AAP) advises that at least two tests for anemia should be done between 9 and 12 months of age, with more testing possibly needed between 1 and 5 years for at-risk children3. Iron deficiency is common in preschoolers, causing damage to growing tissues[4] due to low intake of iron, insufficient iron stores, and the subsequent poor production of hemoglobin[5]. IDA occurrence among preschoolers in Pakistan was found to be 28.60% as per 2018 Nutritional Survey 2018 6. The Mentzer Index has high sensitivity and specificity[6] due to two values: Red Blood Cell (RBC) Count and Mean Corpuscular Volume (MCV)[8]. In a study on anemia in children, a specificity of 82.30% and a sensitivity of 98.70% was noted[7] while a sensitivity of 91% with Specificity of 83% was obtained in pregnant women[9]. A substantial body of literature exists on the Mentzer Index as a screening method, however, within the specific context of preschool children, it is imperative to assess the reliability of this index, which was the objective of this study, to prove the effectiveness of using the Mentzer Index as screening technique for IDA in preschool children.

METHODOLOGY

Our cross sectional study was conducted from 1st August 2023 to 29 Feb 2024 at the Combined Military Hospital Rawalpindi, Department of Pediatrics, after

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the grant of approval from ethical review committee (ERC LETTER Number, Date of Issuance:). Sample size of 358 was calculated with Arifin sample size calculator using a prevalence rate of 28.60% for IDA according to the data from Nutritional Survey 2018 (UNICEF)6 at a precision rate of 0.10%, Confidence Interval of 95% and expected drop-out rate of 4 to 5%.

Inclusion Criteria: All preschool children, between 3 and 5 years of age, belonging to either gender, with anemia as defined by WHO, presenting to CMH Rawalpindi Department of Pediatrics OPD and ER were included in the study.

Exclusion Criteria: Patients above or below the preschool age group, diagnosed with another microcytic anemia, history of blood transfusions in the last three months, bleeding history in the last year, a chronic disease associated with anemia such as Thalassemia, blood disorders, chronic liver disease or kidney disease, syndromes and congenital disorders or any surgical procedure in last one year were excluded.

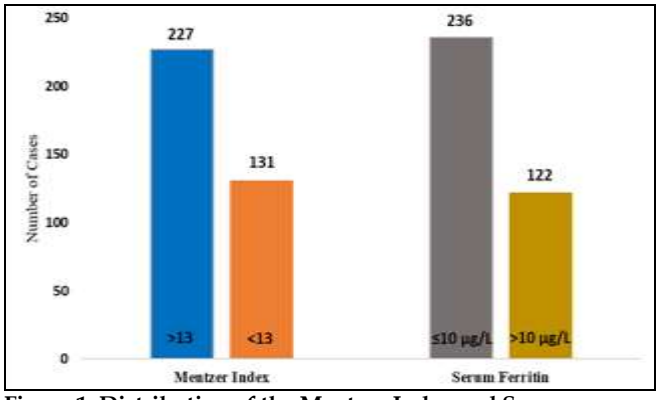

Figure 1: Distribution of the Mentzer Index and Serum Ferritin, (n=358)

The criteria for iron deficiency anemia included: hemoglobin (Hb) ≤11 g/dl, MCV ≤76fL, hematocrit ≤ 34% and serum ferritin ≤10 µg/L10. For all patients with signs of anemia (pallor, irritability, pica, loss of appetite, failure to thrive, fatigue), a complete blood count (CBC) was done. All information was collected on a predesigned proforma, including demographic information and laboratory results of all participants. In those having microcytic anemia (Hb ≤11 g/dl), low hematocrit (≤34%), low Mean Corpuscular Hemoglobin (MCH) ≤25 pg and low MCV (≤76fL), another laboratory test, serum ferritin was ordered as serum ferritin ≤10 µg/L is considered diagnostic for IDA. The Mentzer Index is calculated from the CBC by dividing the MCV in fL by the RBC in millions per microliter where a value of >13 indicates IDA. The Menzter index was calculated for all cases of microcytic anemias, and the results were compared with confirmed cases of IDA. Data was analyzed by using Statistical Package for Social Sciences (SPSS) version 22.00. Quantitative data was represented using mean ± standard deviation (SD). Qualitative data was represented by using percentage while 2×2 contingency table was used to calculate sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy.

RESULTS

Our study enrolled 358 participants with a mean age of 3.97±0.88 years, in which 187(52.20%) were females and 171(47.80%) were males. Mean hemoglobin was found to be as 9.06±1.16 g/dl, RBC was 5.02±0.808 x106 /µL,

HCT was 28.79±2.82%, MCV was 64.10±8.61 fL, and serum ferritin was 12.57±10.28 µg/L. Figure 1 shows distribution of the Mentzer index and serum ferritin, where a total of 227 cases were screened as IDA with Mentzer index method (>13) out of 236 confirmed cases of IDA with serum ferritin (<10µg/L).Out of the total 358 cases, 208 were true positive and 103 true negative cases. Analysis was carried out to generate validation parameters for the Mentzer Index as a screening method, a summary of which is shown in Table I.

Table -I: Parameters for Validation of the Mentzer Index as a Screening Method for IDA (n=358)

	Iron Deficiency Anemia	
	Yes/Positive	**No/Negative**
Mentzer Index		
Yes/Positive	208(58.10%)	19(5.30%)
No/Negative	28(7.83%)	103(28.77%)

Sensitivity= True Positive/(True Positive +False Negative) = 88.14%
Specificity= True Negative / (True Negative +False Positive) = 84.43%
Positive Predictive Value= True Positive/(True Positive + False Positive) = 91.67%
Negative Predictive Value= True Negative/ (True Negative+False Negative) = 78.63%
Diagnostic Accuracy= (True Positive +True Negative)/All Patients = 86.87%

DISCUSSION

Our study revealed excellent discriminative strength with a significant diagnostic accuracy of the Mentzer Index for IDA. Taking serum ferritin as

standard for diagnosing IDA, this study mainly targeted the relevance of this blood index in the identification of IDA in preschool children. In one study, the Mentzer Index was shown to be the third-best discriminating criterion, with sensitivity of 89.01%, specificity of 78.65%, PPV of 85.82%, and NPV of 83.14% after 24 different criteria were evaluated11 with participants being 3- to 5-year-old children, indicating a small predisposition for females over males with a ratio of 1.1:1, respectively. This is in congruence with a large study conducted in Indonesia that screened 4740 participants with female predominance[12] while another large study with a sample size of 3262 participants showed a male predominance[13]. In a similar study to ours, the sensitivity of the Mentzer Index in detecting IDA in preschoolers was 84.60% whereas the specificity was 75.90%[14] while in another study conducted on school-going children, the sensitivity was 67.30% and specificity was 93.80%[15]. In an Egyptian study, on children between ages of 2 to 4 years, the sensitivity of the Mentzer Index was calculated as 95.24% and specificity as 93.10%, NPV as 96.40, and PPV as 90.90%. These values are significantly higher than those of our study which may be attributed to the different populations, age group and larger sample size (358 in our versus 50 in the Egyptian study) among other factors[16]. A separate study that included participants aged 1 to 16 years was carried out in the same region as our study had sensitivity and specificity both of 90.1% and diagnostic accuracy of 90.8%[17] however, genetic polymorphisms could also be responsible for this variance.[18]

LIMITATION OF STUDY

One of the limitations of this study was its narrow scope, since it was conducted in a single setting and focused on a limited population. Furthermore, the research demonstrated a reduced sensitivity of the Mentzer Index in comparison to the values documented in previous investigations. An investigation into other causes of microcytic anemias, specifically Thalassemia, was not conducted, which might be addressed by a more advanced and extensive study.

CONCLUSION

Mentzer Index is a valuable discriminating index with significant diagnostic accuracy and other validation statistics for screening IDA in children between 3-5 years of age.

Conflict of Interest: None.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

MS & KJ: Data acquisition, data analysis, critical review, approval of the final version to be published.

BJ & AM: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

ST & QA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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