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Validity of Mentzer Index in Predicting Iron Deficiency Anaemia

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ABSTRACT

Objective: To determine the diagnostic accuracy of the Mentzer index as a screening tool for iron deficiency anaemia, using an iron profile as the gold standard in patients presenting with hypochromic microcytic anaemia.

Study Design: Cross-sectional study.

Place and Duration of Study: Department of Pediatrics, Pak Emirates Military Hospital, Rawalpindi Pakistan, from Dec 2021 to May 2022.

Methodology: Data was collected from 163 patients with hypochromic microcytic anaemia. Red cell indices were noted for each patient and recorded on a defined proforma.

Results: The mean age of the patients was 8.23±3.57 years. 85(52.1%) patients were males and 78(47.9%) were females. Moreover, out of 163 patients, the specificity, sensitivity, negative predictive value, positive predictive value, and diagnostic accuracy of the Mentzer index for the diagnosis of iron deficiency anaemia were 90.1%, 90.1%, 84.6%, 93.8%, and 90.8%, respectively.

Conclusion: The cell-count-based indices, especially the Mentzer index, are reliable and available methods for diagnosing iron deficiency anaemia. They have an accurate discrimination ability.

Keywords: Erythrocyte indices, Iron profile, Iron deficiency anaemia, Mentzer index, Ferritins, Transferrin.

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INTRODUCTION

Iron deficiency anaemia (IDA) is a widespread solitary nutrient ailment which occurs in nearly one billion individuals globally.[1] As per the estimates of the World Health Organization (WHO) in 2004, IDA has accounted for 273,000 cases of mortality and 19.7 million disability-adjusted life years have been lost, which account for 1.3% of the worldwide total, and 97% happening in middle and low-income countries.[2] There is great clinical significance in the differential diagnosis of microcytic anaemia, as each entity entails a unique treatment and prognosis.[3]

Among thalassemia patients, it is noted that microcytic anaemia is caused by diminished synthesis of the globin chain and reduced synthesis of haemoglobin (Hb), which, therefore, causes hypochromia and microcytosis. 1.5% of the global population has genes for β-thalassemia.[4] People who have beta thalassemia trait (β-TT) are often found to be asymptomatic. β-TT is noted to be the most prevalent hemoglobinopathy, which relies on genetic transmission.[5] Scientists have used cell counters, which are electronic, to calculate indices of red cells as a primary marker of β-TT.[6] The reason for depending on indices to differentiate the type of anaemia is to find people with a higher chance of needing relevant follow-up and decrease unwarranted investigations. A perfect discrimination index would be highly specific and sensitive. [7-10]

This study was conducted to determine the diagnostic accuracy of the Mentzer index as a screening tool for iron deficiency anaemia, using an iron profile as the gold standard in patients with hypochromic microcytic anaemia. This may help establish a regional perspective, as there is a paucity of local data, and prevalence differs globally due to lifestyle, diet, socioeconomic, and cultural variables.

METHODOLOGY

The cross-sectional study was carried out from December 2021 to May 2022 at the Department of Paediatrics, Pak Emirates Military Hospital, Rawalpindi Pakistan after approval from the Ethical Review Committee (letter no EC/362/2021). The sample size was calculated using the WHO sample size calculator, taking a reported prevalence of 87.9%.[4]

Inclusion Criteria: Patients aged 1-16 years from either gender, having Hemoglobin ≤11.5 g/dl, MCV ≤77 fL,

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MCH ≤25 pg, ferritin level <10 ng/ml, transferrin saturation < 12% were included.

Exclusion Criteria: Patients who had been hospitalised for 14 days or had a history of tuberculosis, pneumonia, asthma, congenital heart disease, cerebral palsy and surgery within the last year, were excluded.

One hundred sixty-three cases who presented with hypochromic microcytic anaemia for more than one week were enrolled. Consent was obtained from the patient's parents after full disclosure. A brief history of the duration of the illness was taken from the mother. The researcher collected the blood sample sterilely for a complete blood picture and iron profile. The patients' haemoglobin, mean corpuscular volume, mean corpuscular haemoglobin, iron, TIBC and ferritin levels were noted and transferrin saturation was calculated.

Data was compiled and analysed using Statistical Package for the Social Sciences (SPSS) Version 22. Mean±SD was reported for the normally distributed variables, while median (IQR) was reported for the non-normality distributed quantitative variables. Frequency and percentages were calculated for qualitative variables. Sensitivity, specificity, positive and negative predictive values and diagnostic accuracy of the Mentzer index were calculated by taking the iron profile as the gold standard for diagnostic confirmation. Investigation outcomes aredefined in the Table-I.

RESULTS

Out of 163 patients, the age ranged between 1-16 years (mean age 8.23±3.57 years). Mean haemoglobin and anaemia duration were 8.04±1.78 g/dl and 5.08±2.51 weeks, respectively. 102(62.6%) had iron deficiency anaemia, and 61(37.4%) did not. The Mentzer index data showed that out of 163 patients, 98(60.1%) had iron deficiency anaemia. 85(52.1%) patients were males and 78(47.9%) were females. There were 98(60.1%) patients who had a duration of <4 weeks and 65(39.9%) had a duration of 3 four weeks. By analysing educational status, we found that out of 163 patients, 16(9.8%), 34(20.9%), 41(25.2%) and 72(44.2%) belonged to educational groups of illiterate, primary, secondary and higher groups, respectively. Frequency distribution of family income groups showed that 7(4.3%), 39(23.9%), 35(21.5%), 54(33.1%), and 28(17.2%) patients belonged to family income groups of lower income, lower middle income, middle income, upper middle income and upper-income group respectively. There were 34(20.9%) patients who had a previous history of anaemia, whereas 129(79.1%) did not have a previous history of anaemia (Table-II).

The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of the Mentzer index for diagnosing iron deficiency anaemia using an iron profile as the gold standard were 90.1%, 90.1%, 93.8%, 84.6%, and 90.8%, respectively (Table-III).

Table-I: Definition of Laboratory Investigation Outcome

	Definition
True Positive	Patients with hypochromic microcytic anemia on the basis of iron profile and Mentzer index ≥ 13
True Negative	Patients without hypochromic microcytic anemia on the basis of iron profile and Mentzer index ≤ 13
False Positive	Patients without hypochromic microcytic anemia on the basis of iron profile and Mentzer index ≥ 13
False Negative	Patients with hypochromic microcytic anemia on the basis of iron profile and Mentzer index ≤ 13

Table-II: Characteristics of the study participants (n=163)

Variables	n(%)
Iron Profile Distribution	
Positive	102(62.58)
Negative	61 (37.42)
Mentzer Index >13 Distribution	
Yes	98(60.12)
No	65(39.88)
Age Distribution	
1-8 years	92(56.44)
9-16 years	71(43.56)

Table-III: Mentzer index as diagnostic entity for Iron Deficiency Anemia by taking Iron Profile as Gold Standard (n=163)

Mentzer Index >13	Iron profile		Total
	Yes	No	
Yes	92 (Truepositive)	06 (Falsepositive)	98
No	10 (Falsenegative)	55 (Truenegative)	65
Total	102	61	163

Sensitivity 90.1%, specificity 90.1%, positive predictive value 93.8%, negative predictive value 84.6%, diagnostic accuracy 90.8%

DISCUSSION

In our study, the estimated sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of the Mentzer index for the diagnosis of iron deficiency anaemia were calculated to be 90.1%, 90.1%, 93.8%, 84.6% and 90.8%, respectively.

Beta thalassemia trait (β-TT) and iron deficiency anaemia (IDA) are the most common causes of microcytic hypochromic anaemia. Numerous utilised cell count parameters have been recommended to distinguish between the two diseases.

Alam et al.[10] showed in their study that diagnostic test analysis had a specificity of 84%, sensitivity of 93%, and accuracy of 90%. The Mentzer index in that study had good validity and proved to be economical for IDA among patients with hypochromic-microcytic anaemia. Another study,[11] showed that the index could discern between thalassemia and iron deficiency anaemia. One study estimated the Mentzer index's specificity, sensitivity, PPV, and NPV to be 94.4%, 86.9%, 97.1% and 77.3%.[12] Subsequently, the results from our study corroborate the findings and provide further evidence that the Mentzer index delivers the utmost reliability for differentiating IDA from β-TT.

Another research reported the outcomes among 284 patients for an index used to discern between iron deficiency anaemia and beta-thalassemia trait (beta-TT), the most prevalent aetiology of microcytic hypochromic anaemias. Mentzer had accurately diagnosed 269(94.71%) patients, followed by the novel index (Youden's index =85.5).[13] However, there are different results from different studies.[14] All results are not supportive of the reliability of the index. Larger research studies with bigger sample sizes are required to establish the ideal discrimination index. In addition, it is needed to corroborate the outcomes attained in this study. The study had estimated the specificity =84%, sensitivity=93%, and diagnostic accuracy =90%. One research,[15] documented that the usual reasons for hypochromic microcytic blood pictures could be distinguished. Subjects with IDA were noted to have a Mentzer index greater than thirteen; however, patients with thalassemia had a considerably reduced Mentzer index than thirteen. A comparable research was done in Indonesia by Alam *et al*. which discovered analogous outcomes.[10]

Several studies have been conducted in our region demonstrating the value of the Mentzer Index.[16,17] This information is of value as the results from our study corroborate with the results of these studies. It is crucial to decipher between non-thalassemic and thalassemic microcytosis.[18] These diseases share several traits and have significant clinical implications. Consequently, data from this research would assist in ascertaining the precision of the Mentzer index as an easy, quick, and less pricy method of characterisation and detection of hypochromic microcytic anaemia.

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CONCLUSIONS

The prevalent hypochromic and microcytic anaemias are mostly due to thalassemia trait and iron deficiency anaemia. The Mentzer index has proven to perform accurately and might be beneficial for screening patients suffering from microcytic anaemia. We can also see that although the cut-offs of the indices available are good for screening purposes, it is more useful to take out one's suitable values, as the prevalence of nutritional anaemia and demographics varies from region to region and no standard value can be used to apply in the screening of the cohort ably. This would result in significant cost savings for the health system, which is especially advantageous in underdeveloped and developing countries with limited financial resources.

Conflict of Interest: None.

Authors' Contribution

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

HZ & MTN: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

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

FI & ZA: 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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