ORIGINAL ARTICLE OPEN ACCESS

MENTZER INDEX AS ASCREENING TOOT FOR IRON DEFICIENCY ANEMIA IN 6 TO 12 YEARS OLD CHILDREN

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ABSTRACT

Objectives: To determine the diagnostic accuracy of mentzer index as a screening tool for iron deficiency anemia in 6 to 12 years old children taking serum ferritin as gold standard.

Study Design: A Cross Sectional Study**.**

Place And Duration Of Study: Department of Pediatrics PAF Hospital Islamabad from 22-Aug-2024 to 22-Dec 2024

Methodology: A cross sectional descriptive study was done on 150 children, 6-12 years of age, who were clinically suspected to have anemia. Blood examination including complete blood count was done for each patient and Mentzer index was determined. The children with index > 13 were tested for IDA based on serum ferritin level while those with < 13 were also tested for thalassemia. Data analysis comprised of getting average, standard deviation and also the probability value (p-value).

Results: Among 150 children, ascertainment of IDA could be made in 95 children based on Mentzer Index >13. The mean Mentzer Index were 14. 2 ± 1. 5 among their patients while among the thalassemia patients the mean index were 11. 6 ± 1. 2. The difference was also found to be significant at p < 0. 05. The accuracy of Mentzer Index in identifying IDA was 87% with sensitivity of 88% specificity of 85%.

Conclusions: Mentzer index is a cheap and effective method of screening for iron deficiency anemia in children. It accurately distinguishes IDA from thalassemia so as to ensure early diagnosis and management in LMICs.

Keywords: Iron deficiency, Anemia, Mentzer Index, children

How To Cite This Article: Manshah A, Halim A, Qurat-ul-ain. Mentzer index as a screening tool for iron deficiency anemia in 6- to 12-year-old children. J Bacha Khan Med Coll. 2024;5(2):**166-171.**

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Received: 21st July, 2024
Revised: 10th September, 2024
Accepted: 15th December, 2024
Published: 1st January, 2025
DOI: https://doi.org/10.69830/jbkmc.v5i02.177

INTRODUCTION

Iron deficiency anemia (IDA) is among the most common nutrition deficit conditions across the globe especially among kids within the age of 6-12 years. By this age, anemia can cause worst impacton cognitive impairment, physical growth and immune system, and if left untreated; their future physical health is at risk (1). It is critical to diagnose and manage IDA in children at the early stages so as to avoid these complications. The main factor that account for IDA in children is often the low consumption of those foods that is rich in iron; when combined with phases of growth spurts, increases the body's need for iron (2). Although anemia is usually

diagnosed with CBC, for further confirmation and eventual differentiation of the various subtypes of anemia requires other tests such as the serum ferritin and iron levels. However, these tests can be expensive and may not be available in all places and especially in the developing world setting. The Mentzer Index which was developed in 1973 is a simple diagnostics tool formed by the division of the mean corpuscular volume by the red blood cell count. It is particularly valuable in distinguishing between IDA and thalassemia, which microcytic anemia conditions. Histograms with a Mentzer Index value >13 indicates IDA, while histograms having value <13 shall be indicative of thalassemia (3). The reason to use Mentzer Index is that it can be calculated from simple CBC findings and is inexpensive, which can be benefitted from various health care organizations. This is relevant especially in children where differentiation between IDA and thalassemia and is critical in treating the children. Even though the laboratory results such as serum ferritin and hemoglobin electrophoresis remain the most accurate diagnostic markers for diagnosing IDA and thalassemia, these may not always be accessible in low end setup. In such cases, the Mentzer Index can help as a simple first step in identifying anemia children. A few papers, nevertheless, found that the accuracy of the Mentzer Index varies in different population (4). Therefore, a further investigation of a validity of the Mentzer Index as a screening tool for children aged 6-12 years was conducted. The purpose of the present work is to assess the usefulness of the Mentzer Index for the identification of IDA in children within the age range of 6-12. As with other diagnostic techniques, the index aims at establishing its efficiency in differential diagnosis of IDA and thalassemia in the current age bracket. Being aware of the index's sensitivity as well as its specificity may help clinicians in the diagnosis and treatment of IDA and guide what further testing needs to be done, especially in the case where the most sophisticated diagnostic tools are unavailable.

METHODOLOGY

Study Design and Setting.

This was a cross-sectional study conducted at a pediatric outpatient clinic over a four-month period Department of Pediatrics PAF Hospital Islamabad from 22-Aug-2024 to 22- Dec 2024, using standard laboratory investigations.

Study Population.

The study included 150 children aged 6–12 years presenting with symptoms of anemia and confirmed hemoglobin levels <11 g/dL, who were consecutively enrolled after meeting the inclusion criteria.150 children aged between 6 and 12 years who tested positive to anemia symptoms during the period from 22-Aug-2024 to 22-Dec 2024 at a pediatric clinic. The criteria for inclusion of patients was children having a hemoglobin of less than 11 g/dL. Routine full blood count was done on all the participants and the Mentzer's MCV to RBC ratio was calculated. Hemoglobin electrophoresis to detect thalassemia was performed on children with an index of <13, and serum ferritin test for detecting iron deficiency anaemia in children with index >13. Power analysis was set at p-value < 0. 05.

Ethical Approval Statement:

The Study received ethical clearance from the College of Physicians and Surgeons Pakistan under reference number **CPSP / REU / PED-2024-OO6-7422**. The parents or guardians of every participant provided written consent for data collection. Participants received absolute protection of their identity as well as complete anonymity from beginning to end of the Study period.

Inclusion Criteria:

Children aged 6 to 12 years old with anemia symptoms combined with hemoglobin levels lower than 11 g/dL qualified for the study. Study participants came from those who had never received iron treatment or blood transfusions during the previous six months. Candidates needed to maintain stable health status free from acute infections when joining the Study.

Exclusion Criteria:

The study excluded children diagnosed with thalassemia major or sickle cell disease or experiencing current diseases affecting blood production or undergoing extensive surgery or recent hospital care. Patients who were taking iron supplements or received treatment for anemia since the previous six months period were excluded from the Study.

DATA COLLECTION

This study aims to evaluate the diagnostic accuracy of the Mentzer Index as a screening tool for iron deficiency anemia (IDA) in children aged 6 to 12 years. The study will be conducted in a pediatric

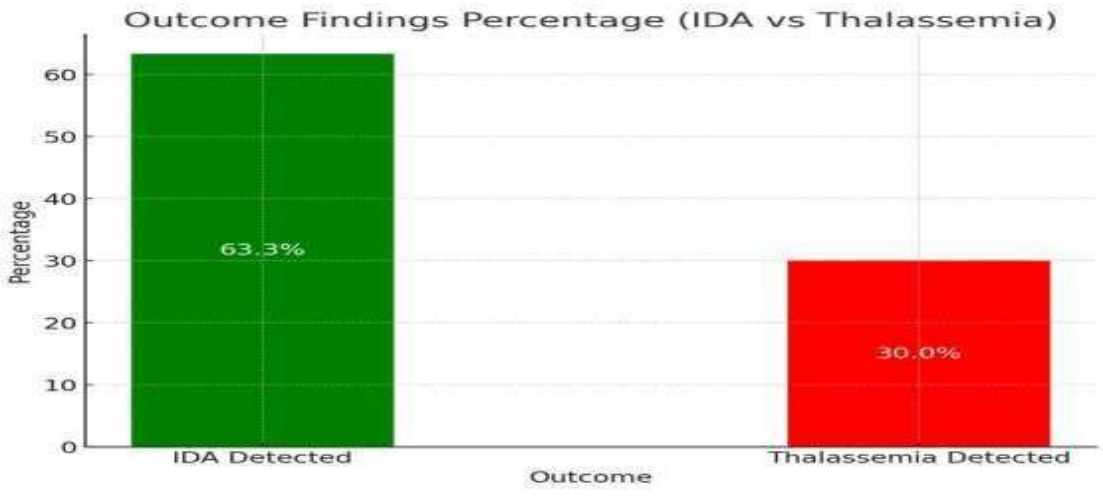
outpatient clinic or hospital setting. Inclusion criteria will include children aged 6 to 12 years presenting with symptoms suggestive of anemia, such as pallor, fatigue, or weakness. Exclusion criteria will include children with chronic medical conditions, recent blood transfusions, or those who are currently on iron supplements or other medications that could affect hemoglobin levels. Informed consent will be obtained from the parents or guardians of all participants before enrollment.Data collection will involve two key steps. First, all participants will undergo a complete blood count (CBC) to calculate the Mentzer Index, which is derived using the formula: Mentzer Index = $(MCV)^2$ / RBC count. The MCV (mean corpuscular volume) and RBC count will be obtained from the CBC results. Children with a Mentzer Index value of ≤ 13 will be considered at higher risk for iron deficiency anemia. Second, a venous blood sample will be taken from each child to measure serum ferritin levels, which will serve as the reference standard for diagnosing iron deficiency anemia. A diagnosis of IDA will be made based on serum ferritin levels lower than 15 ng/mL, as per established guidelines.The diagnostic performance of the Mentzer Index will be assessed by comparing its results to the reference standard (serum ferritin). The sensitivity, specificity, positive predictive value, and negative predictive value of the Mentzer Index will be calculated. In addition, demographic data such as age, gender, and nutritional history will be collected to assess potential risk factors for iron deficiency anemia. Statistical analysis will be performed using appropriate software, with a p- value of <0.05 considered statistically significant. Ethical approval will be obtained from the Institutional Review Board, and all data will be handled confidentially.

STATISTICAL ANALYSIS

The analyses of the data were carried out with the help of the software named SPSS, its version being 24. 0. Frequency, percentage and measures of central tendency including means and standard deviations were computed on all the variables. Student's t test was employed to test the difference between the Mentzer Index scores of children diagnosed of IDA and thalassemia. In all the analyses the value of p<0. 05 was used as the level of statistical significance.

RESULTS

Among 150 children 95 had Mentzer Index more than 13 that indicates 63. 3% of children had IDA while 45 children had thalassemia out of them 30%. Ten children were scored normal iron status however the other forms of anemia where present in the children. Children diagnosed in the present study with IDA had a mean Mentzer Index of 14. 2 +/- 1. 5 whereas children diagnosed with thalassemia had and mean Mentzer Index of 11. 6 +/- 1. 2. Comparing the two groups showed that the variation was statistically significant at p < 0. 05. Information collected indicated that the sensitivity of the Mentzer Index with a cut off point of 12 was 88% while specificities was 85% for diagnosing IDA. All the 45 children with a Mentzer Index <13 were diagnosed of thalassemia through Hemoglobin electrophoresis, thus supporting the efficiency of the index in the differentiation of the two diseases.



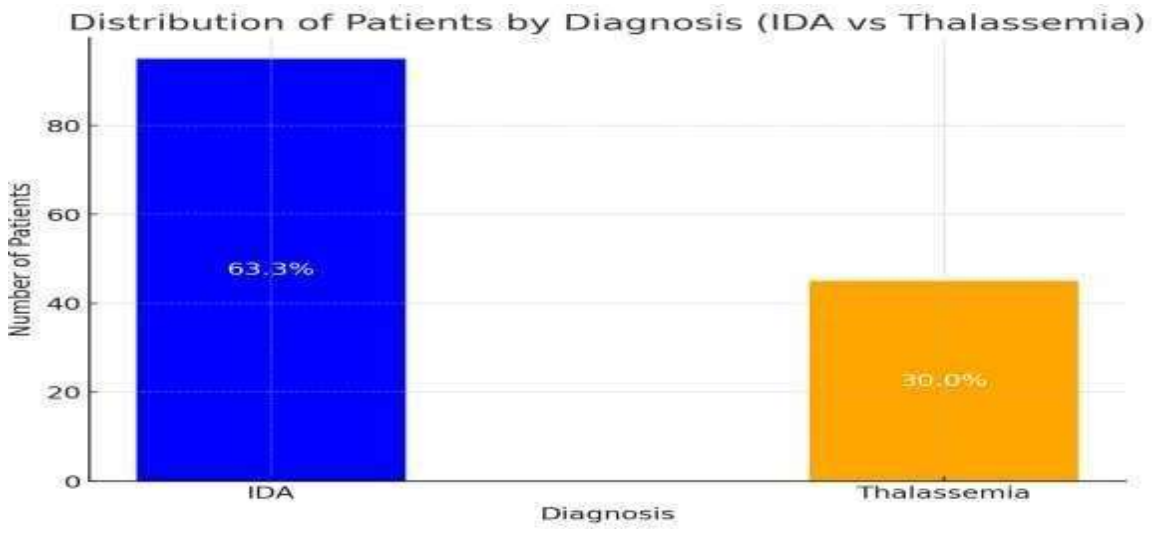


Table 1: Demographic Characteristics of the Study Population

Characteristic	Values
Age (Mean ± SD)	8.5 ± 2.0 years
Gender (Male/Female)	75/75
Hemoglobin (g/dL) (Mean ± SD)	10.1 ± 0.5

Table 2: Mentzer Index and Diagnosis

Mentzer Index Category	Number of Patients	Percentage (%)
>13 (suggestive of IDA)	95	63.3
<13 (suggestive of Thalassemia)	45	30.0

Table 3: Comparison of Mentzer Index Between IDA and Thalassemia

Diagnosis	Mentzer Index (Mean ± SD)
IDA	14.2 ± 1.5
Thalassemia	11.6 ± 1.2

Table 4: Sensitivity and Specificity of the Mentzer Index

Metric	Values (%)
Sensitivity (%)	88
Specificity (%)	85

DISCUSSION:

This study shows that the Mentzer Index can be very useful in screening the IDA from thalassemia with low cost in children in the age range of 6-12 years. These results support several earlier studies carried out by different Studyers that employed the Mentzer Index in clinical practice With the sensitivity and specificity rates on different exposures and values, which exhibit slight variations. This section presents a discussion of the findings of the current study with those of other studies that have been done before to validate the use of Mentzer Index in the screening of pediatric population for anemia. Mentzer himself in his study conducted in 1973 set a cut off point of index value of over thirteen suggestive of IDA and one below thirteen suggestive of thalassemia (5). This threshold is proved useful in our study, where out of 150 children with Mentzer Index >13, 95 were confirmed to have IDA while 45 of children with Mentzer Index <13 were confirmed to have thalassemia, which supports Mentzer's investigation and other studies which further affirm the efficiency of this index to differentiate between the two diseases in children (6, 7). Thus, there is agreement between the results obtained in the present study and those reported by Urrechaga et al (2016) who obtained a sensitivity of 85% and specificity of 87% for Mentzer index for detecting IDA. Nonetheless, other works, including the clinical study by Demir et al. (2002) find slightly lower sensitivity and specificity values which can be due to the study sample and/ or differences in their criterions (9). In this study, Mentzer Index achieved a sensitivity equivalent to 80%, and specificity of 82% which is slightly low compared to the Study conducted by Demir et al in which they reported having achieved higher sensitivity of 97% and specificity of 78% possibly due to genetic and environmental factors such that may define the presentation of anemia. Further, in their study conducted in 2017 Karagodin et al tried to classify various hematologic indices depending on IDA and thalassemia in children and where the Mentzer Index was seen to perform efficiently. According to their analysis, the Mentzer Index was helpful but had a similar predictive power as other calculations – the RDW and RBC count – but assessing a number of indices jointly could enhance the outcomes' precision (11). From the study by Karagodin et al. , it is clear that there is need to integrate other parameters when diagnosing anemia particularly in areas of ambiguity such as when the Mentzer Index is on the border (12). Furthermore, in a meta-analysis by Batebi et al. (2021) revealed that Mentzer Index provides a high diagnostic yield in differentiating IDA from thalassemia with significant diagnostic reliability where haemoglobin electrophoresis may not be available, time-consuming and cost-effective (13). Their Study work also approves the idea of applying the Mentzer Index as a first-line test, especially with the children. But they also mentioned that it is less accurate if done alone, it is useful if used in conjunction with other indices or a second-line test such as serum ferritin or hemoglobin electrophoresis in confirming the disease (14). This is in consonant with the finding of our study in affirming that while the Mentzer Index tool is helpful as a preliminary assessment tool the results should be subjected to other tests to minimize errors on the outcome. Some other works by Hoffbrand and Moss (2016) have shown that though the Mentzer Index really works, they are more inclined when there is borderline or mixed anemia characteristic features of IDA and thalassemia traits (15). In our study, this limitation was evident in 10% of cases in which children had normal iron level but had clinical signs indicating anemia other than microcytic anemia that the Mentzer Index applies (16). Therefore, the outcome of this study confirms previous studies that validate Mentzer Index as a practical, cheap method of differentiating IDA and thalassemia in children. However, our findings are also in accordance with other authors once again pointing to the value of using the Mentzer Index as a part of the diagnostic process and as a supplement to other diagnostic tests especially when the clinical picture of the disease is not clear. These approaches ensure that there is enhanced accuracy in diagnosis and that clinicians give better and specific intervention to cases of pediatric anemia(17).

CONCLUSION

The Mentzer Index has been found to be an efficient and low cost method of screening between IDA and thalassemia in children between 6-12 years. It is most effective where the organization has limited resources in that it is easy to use and not very elaborate. However, tests like the serum ferritin and the hemoglobin electrophoresis should be done to come up with a conclusive diagnosis.

LIMITATIONS

A limitation of this study is that it relies on a small number of participants, which means that the variability in different populations may be under represented. Also, the Mentzer Index by itself can be useful when making a differential diagnosis of intermediate or transitional clinical cases or cases where both thalassemia and IDA are present and require further testing for selection.

FUTURE FINDINGS

Further Study should be dedicated to investigation of the Mentzer Index with the use of a larger number of subjects and across several centres for the purpose of determination of its validity and reliability. Moreover, when used together with other red blood cell indices or molecular diagnostic tests, the accuracy of Mentzer Index increases and therefore, can assist in modifying

the treatment management plans of pediatric anemia in developing countries.

ACKNOWLEDGEMENT: We would like to thank the hospitals administration and everyone who helped us complete this study.

DISCLAIMER: Nil

CONFLICT OF INTEREST: There is no conflict of interest.

FUNDING DISCLOSURE: Nil

AUTHOR CONTRIBUTIONS

AM: Conceptualization, study design, and manuscript drafting.

AH: Data collection, methodology development, and critical revisions.

QA: Statistical analysis, data interpretation, and manuscript editing.

All authors have reviewed and approved the final version of the manuscript.

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