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# MENTZER INDEX AS A SCREENING TOOL FOR IRON DEFICIENCY ANEMIA IN 6-12 YEARS OLD CHILDREN

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**Date Received:**

May, 7<sup>th</sup> 2022

**Date Revised:**

July, 25<sup>th</sup> 2022

**Date Accepted:**

September, 27<sup>th</sup> 2022

**This article may be cited as**

Awais M, Ahmad A, Farid A, Khan H. Mentzer index as a screening tool for iron deficiency anemia in 6-12 years old children. *J Postgrad Med Inst* 2022;36(4):235-38. <https://doi.org/10.54079/jpmi.36.4.3099>.

## ABSTRACT

**Objective:** To validate Mentzer Index as a screening tool for Iron Deficiency Anemia (IDA) in 6 to 12 years old children.

**Methodology:** This cross sectional validation study was conducted at Department of Pediatric, Combined Military Hospital, Peshawar and Department of Pediatrics, Khyber Teaching Hospital, Peshawar from February 2021 to January 2022. Following set inclusion and exclusion criteria, a sample of 419 participants were enrolled using non-probability convenience sampling. A pre-designed performa was used to extract all the data, which was analyzed using SPSS v.25.0. Validation statistics were applied on the data extracted Mentzer Index, which is used as screening tool for IDA.

**Results:** The mean age of the sample was of  $7.28 \pm 1.07$  years, in which 174 (41.5%) were males and 245 (58.5%) females. Hemoglobin was recorded as  $10.11 \pm 1.09$  g/dl, hematocrit as  $31.82 \pm 2.56\%$ , Serum Ferritin as  $24.46 \pm 27.28$   $\mu\text{g/l}$ , Mean Corpuscular Volume (MCV) as  $65.09 \pm 8.31$  fL and Red Blood Cell (RBC) as  $5.17 \pm 0.705 \times 10^6$  / $\mu\text{L}$ . In validation statistics, sensitivity was 67.3%, specificity 93.8%, Positive Predictive Value (PPV) 80%, Negative Predictive Value (NPV) 88.6%, diagnostic accuracy as 86.63%. The area under curve was recorded as 0.805, which shows excellent discrimination between diseased and non-diseased.

**Conclusion:** The study concludes that Mentzer Index has a better specificity, PPV, NPV, and diagnostic accuracy. Similarly a better area under the curve was recorded, which proves it to be an excellent discriminator.

**Keywords:** Iron Deficiency Anemia; Mentzer Index; Sensitivity; Specificity; Diagnostic Accuracy.

## INTRODUCTION

The inability to synthesize sufficient hemoglobin from iron leads to one of the common hematological disease called as Iron Deficiency Anemia, which is considerably more prevalent in infants and children; estimated to be as 30% of the global population.<sup>1,2</sup> This IDA is thought to be most common nutritional deficiency in the world. The data shows that the developing world is suffering more than developed world.<sup>1</sup> It is recorded that with increasing age the prevalence of the IDA has increased.<sup>3</sup> The word anemia and IDA are mostly interchangeable, but on a few instances IDA alone has been recorded to cause damage to the body tissues.<sup>3</sup> From low iron intake, to low iron stores, to low production of hemoglobin are few stages that are encountered in any IDA case.<sup>4</sup> Pakistan, being a developing country also has a high prevalence of IDA, as per Nutritional Survey 2018 conducted by United Nations International Children's Emergency Fund, the prevalence of IDA was found to be 28.6%.<sup>5</sup>

Among different indices used, Mentzer Index is considered to high sensitivity and specificity.<sup>2</sup> This index was devised was Mentzer in 1973, and involves two hematological values of Mean Corpuscular Volume and Red Blood Cell.<sup>6</sup> This index shows different validation statistics in different age groups and conditions. A study conducted on the child age group to differentiate IDA from thalassemia recorded a Sensitivity of 98.7%, and Specificity of 82.3%.<sup>2</sup> In another study conducted Mentzer Index showed a sensitivity of 91%, while specificity of 83%.<sup>7</sup> The use of Mentzer Index as screening or differentiating tool has shown different statistics of validation, its discriminatory role in children as per international literature is evident.<sup>2</sup> Due to its high acceptability, it is adopted at many regions of the world.

The use of Mentzer Index in screening of different blood related diseases is quite ordinary as per literature. However, data on Mentzer Index as a screening tool for Iron Deficiency Anemia (IDA) is something new to be checked, which would be covered in this study. The results of this study will be used by the experts

to use Mentzer Index as a screening tool at places where better diagnostic facilities are not available, if it showed better diagnostic accuracy. The objective of the study is to validate Mentzer Index as a screening tool for Iron Deficiency Anemia (IDA) in 6 to 12 years old children.

## METHODOLOGY

This cross sectional validation study was conducted at Department of Pediatric, Combined Military Hospital, Peshawar and Department of Pediatrics, Khyber Teaching Hospital, Peshawar. The study was conducted from 1st February 2021 to 31st January 2022 after grant of ethical approval. Sample size was calculated as 419, using specificity of 84% for Mentzer Index and prevalence of 28.6% for Iron Deficiency Anemia as per a Nutritional Survey 2018 (United Nations International Children's Emergency Fund) at a precision of 1.5% and Confidence Interval of 95%.<sup>5,8</sup> All patients of either gender and age between 6 to 12 year and were admitted to pediatric unit with clinical suspicion of Iron Deficiency Anemia (IDA), were included in the study. All those with bleeding history in last one year, chronic disease, and any surgical procedure in last one year were excluded from this study. The IDA was defined as a case with hemoglobin (Hb)  $\leq 11$  g/dl, haematocrit  $\leq 6.83$  mmol/l or 32%, and Serum Ferritin  $\leq 12$   $\mu$ g/l.<sup>9,10</sup> Mentzer Index is considered to be an easy mean to confirm IDA, and is calculated from complete blood count, wherein Mean Corpuscular Volume (MCV) in fL is divided by Red Blood Cell count (RBC) in Millions per micro Liter and if the value is greater than 13.51, then IDA is said to be more likely. The study utilized a pre-designed performa to extract the information. The data extraction was based on two major parts: demographic information and laboratory data. In order to extract laboratory data, a 2cc disposable syringe was used under aseptic measures to draw the blood and do the required laboratory investigations. The data

extracted was analyzed using SPSS v.25.0. Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value, and Diagnostic Accuracy was measured for Mentzer index for confirmation of IDA.

## RESULTS

The study analyzed a total of 429 participants with a mean age of  $7.28 \pm 1.07$  years, in which 174 (41.5%) were males and 245 (58.5%) females. Hemoglobin was recorded as  $10.11 \pm 1.09$  g/dl, hematocrit was as  $31.82 \pm 2.56\%$ , Serum Ferritin as  $24.46 \pm 27.28$   $\mu$ g/l, Mean Corpuscular Volume (MCV) as  $65.09 \pm 8.31$  fL and Red Blood Cell (RBC)  $5.17 \pm 0.705 \times 10^6$  / $\mu$ L.

The validation statistics of Mentzer Index as a screening tool is given in Table No. 1. The Figure No. 1 shows Receiver Operator Characteristic (ROC) curve for Mentzer index with Area Under Curve (AUC) 0.805, which is more than 0.5 and can be interpreted as excellent mean of discrimination between diseased and non-diseased.

## DISCUSSION

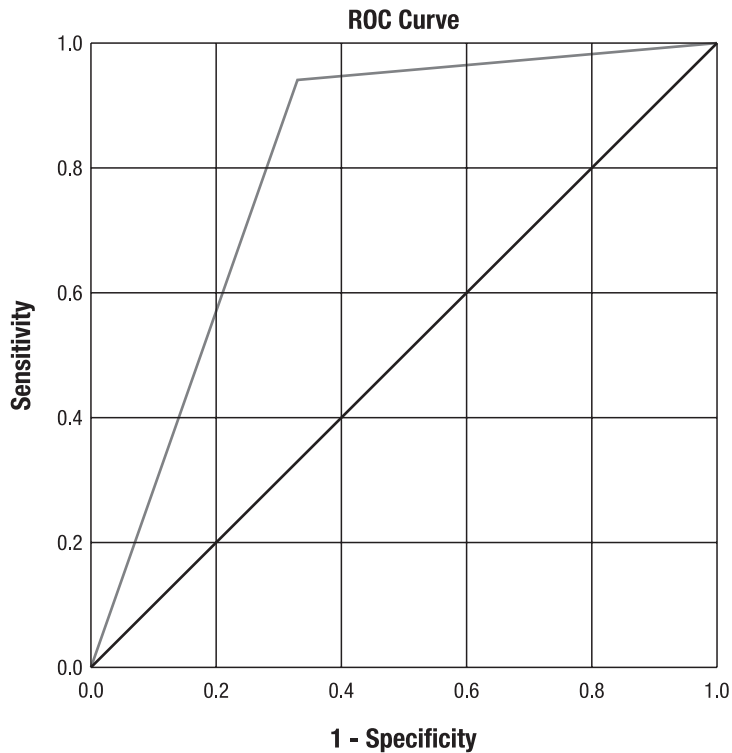
The study conducted on 419 participants for a period of one year, revealed a high diagnostic accuracy and an excellent discriminative power of Mentzer Index for Iron Deficiency Anemia (IDA) in 6 to 12 years of child age group. This study particularly targeted on the importance of a blood index i.e Mentzer Index in detection of IDA and its discrimination from other such relevant diseases.

This study analyzed participant between the age range of 6 to 12 years, wherein females were more predominant than males with a 1.4:1 ratio respectively, which is unlike than a study published at Indonesia on a sample which screened 4740 participants.<sup>9</sup> Similarly, another study analyzing some 3262 participants also showed male dominance.<sup>6</sup> Among laboratory investigations, this study reveals that most of the numbers are either same or slightly different than the literature published already.<sup>2,6,8</sup>

The Mentzer Index has recorded different validation statistics in different participants of the study with different objectives. It is being used to discriminate IDA with other diseases in children, IDA with thalassemia in children, IDA with beta thalassemia in pregnancy and other relevant objectives. Its use and beneficial output is being demonstrated one way or other and the same is covered in this study as well. It is add here that none of discriminant index is 100% and the standing varies differently in different studies.<sup>6</sup> In a study conducted at Egypt on children age 2-4 years, Mentzer Index recorded a sensitivity of 95.24%, specificity as 93.10%, PPV as 90.9%, NPV as 96.4, and AUC as 0.942; the results are way better than recorded in this study, which may be due to different age group more participant that is 419 in this study and 50 in that study.<sup>11</sup> In yet another study conducted at Indonesia, the sensitivity was recorded as 93%, specificity as 84%, and diagnostic accuracy as 90%, which is slightly similar as noted in this study.<sup>9</sup> In another study conducted in the same district as this study, sensitivity or specificity were

**Table 1: Validation analysis for mentzer index as a screening tool for iron deficiency anemia**

| Variable                        | Percentage |
|---------------------------------|------------|
| Sensitivity                     | 67.3%      |
| Specificity                     | 93.8%      |
| Positive Predictive Value (PPV) | 80%        |
| Negative Predictive Value (NPV) | 88.6%      |
| Diagnostic Accuracy             | 86.63%     |



Diagonal segments are produced by ties.

Figure 1: Receiver operator characteristic (roc) curve for mentzer index as a screening tool for iron deficiency anemia

recorded between 80 to 90%, PPV was above 90%, while NPV was about 70%; the validation stats were way below then recorded in this study; however, the AUC had similar picture as this study.<sup>12</sup> In yet another study evaluating 24 different discriminatory criteria, a sensitivity of 89.01%, specificity of 78.65%, PPV of 85.82%, and NPV of 83.14% was recorded, taking Mentzer Index as 3rd best criteria.<sup>13</sup> The variability among the validation results of Mentzer index may be due to age group, population selected, number of sample, type of sample.

This study was conducted at two different setting of a single district, covering a population of a same locality was among one of its limitation. Furthermore, the study also analyzed a specific age group, which may also lead to specific results. In addition, the study showed a low sensitivity as compared to those recorded in other studies also needs through workup, which may be covered by doing a much sophisticated and large scale

study. The results of the study will help the experts to discriminate IDA with other blood related diseases among children with age group of 6-12 years.

## CONCLUSION

The study concluded a high diagnostic accuracy for Mentzer Index in detection of Iron Deficiency Anemia (IDA) among child age group of 6-12 years. Furthermore, the Area Under the Curve (AUC) also reveals an excellent discriminating ability of Mentzer Index.

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#### Author's Contribution

MA, AA conceived the idea, designed the study and write up of the manuscript. AF, HK contributed in data collection, performed data analysis and final write up of the manuscript. 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.

#### Conflict of Interest

Authors declared no conflict of interest

#### Grant Support and Financial Disclosure

None

#### Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.