

# MENTZER INDEX AS A DIAGNOSTIC TOOL OF THALASSEMIA TRAIT IN CHILDREN

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## ABSTRACT

**Background:** Beta thalassemia exists in widespread prevalence across Southeast Asia including Pakistan. Proper identification of beta thalassemia trait remains essential to stop major thalassemia children from being born. Testing with the cost-effective Mentzer Index tool lets healthcare providers separate patients with iron deficiency anemia traits from beta thalassemia traits through analyses of total blood count data.

**Objectives:** The study assessed the Mentzer Index's ability to detect thalassemia trait among children aged 12 months to 5 years through Hb electrophoresis tests which functioned as the gold standard.

**Study design:** A Descriptive Cross-Sectional Study

**Place and duration of study:** Department of Pediatrics Oncology, Combined Military Hospital Rawalpindi include all the children with anemia. From Jan 2023 to Jan 2024

**Methods:** The current cross-sectional Study focused on 255 anemic children at Department of Pediatrics Oncology, Combined Military Hospital Rawalpindi. Study participants whose Mentzer Index measurement results in MCV divided by RBC aligned less than 13 confirmed thalassemia status. Hb electrophoresis confirmed the diagnosis. SPSS software evaluated the data to produce sensitivity results together with specificity measurements alongside predictive value calculations.

**Results:** The mean age of patients was 3.2 years ( $\pm 1.1$ ), with a male-to-female ratio of 1.2:1. The clinical assessment of the Mentzer Index demonstrated 89% sensitivity and 81% specificity during the study period with a confirmed statistical significance ( $p < 0.05$ ). The predictive accuracy revealed positive value at 85% alongside negative predictive value at 86%.

**Conclusion:** The Mentzer Index functions as an affordable diagnostic measure which efficiently determines beta thalassemia trait when testing limited resources. The diagnostic tool can support reductions in undiagnosed thalassemia carriers thus promoting better preventative healthcare practices.

**Keywords:** Mentzer Index, Thalassemia Trait, Pediatrics, Diagnosis

**How To Cite This Article:** Rasool, F. S., Manzoor, R., Ahmed, A., Naz, S., Kibzai, H., & Pirjan. Mentzer Index as a diagnostic tool of thalassemia trait in children. *J. Bacha Khan Med. Coll.* 2024;5(2), 226–230.

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**Received:** 12<sup>th</sup> September, 2024

**Revised:** 16<sup>th</sup> October, 2024

**Accepted:** 31<sup>th</sup> November, 2024

**Published:** 6<sup>th</sup> January, 2025

**DOI:** <https://doi.org/10.69830/jbkmc.v5i02.187>.

## INTRODUCTION

1.5% of global population develops beta thalassemia carrier status each year resulting in roughly 60,000 new cases annually with Southeast Asia containing the world's largest

thalassemia minor population (1). It is estimated that 5000-9000 children with  $\beta$ -thalassemia are born per year(2). Effective population screening for thalassemia trait can

dramatically decrease the incidence of thalassemia major births, for which peripheral smear examination is an invaluable tool along with red blood cell indices(3).The patients with beta thalassemia minor are asymptomatic and may be diagnosed because of presence of microcytic hypochromic red blood cells with mild anemia(4).These people do not require blood transfusion. Its diagnosis is based on the finding of raised Hb A<sub>2</sub>, i.e. between 3.5- 7.0% (normal 1.5-3.0%) on hemoglobin electrophoresis(5).The prevalence of beta thalassemia trait is about 18.5 % in Pakistan(6).The main preventive strategies for thalassemia include appropriate information of the disease and importance of screening through awareness programs, screening and counseling of target families, screening of general population, premarital and prenatal screening(7).The Mentzer index is helpful in differentiating iron deficiency anemia from beta thalassemia. Laboratory results from a complete blood count form the basis for calculating this diagnostic measure. Research shows that thalassemia becomes more likely when MCV (in fL) links with RBC (in Millions per microliter) produces a ratio that drops below 13. A result greater than 13 would indicate the patient has iron-deficiency anemia but not thalassemia(8). Research shows Mentzer Index delivers a sensitivity of 89% with specificity at 81% according to data presented in (9).

## METHODS

### Study Design and Setting

This descriptive cross-sectional study was conducted in the Department of Pediatrics Oncology, Combined Military Hospital Rawalpindi include all the children with anemia. From jan 2023 to jan 2024 focusing on anemic children between 12 months and 5 years of age.

### Study Population

A total of 255 children with anemia symptoms were enrolled. Participants were assessed using CBC and Mentzer Index, with hemoglobin electrophoresis confirming beta thalassemia trait; specific exclusion criteria were applied. On this study included 255 children aged 12 months to 5 years who showed signs of anemia. Based on complete blood count (CBC) reports researchers calculated Mentzer Index values for all study participants. The study excluded children with blood transfusion history of less than three months duration, malignancies or congenital

anomalies. The study used hemoglobin electrophoresis to verify beta thalassemia trait and matched its laboratory results against Mentzer Index measurements.

### Ethical Approval Statement

The Institutional Review Board (IRB) of Combined Military Hospital, Rawalpindi granted ethical approval through (**Approval No:IRB-326-06-2022**). The research respected all ethical standards while protecting all participant information. The study began with obtaining informed consent from parents or legal guardians who received complete information about the study's functions and operational methods and associated threats.

### Inclusion Criteria

The Study included children from 12 months old to 5 years old who displayed anemic symptoms. Hospitals selected their participants through CBC reports after which Mentzer Index values obtained measurements from all cases. The medical team used hemoglobin electrophoresis to verify Beta thalassemia trait through testing of laboratory findings versus Mentzer Index results.

### Exclusion Criteria

The Study excluded children who received blood transfusions less than three months ago or had malignancies or congenital anomalies. All participants placed outside the study faced exclusion because they had any hematological condition apart from beta thalassemia trait and iron deficiency anemia.

### Data Collection

Alepective participant's parents gave their informed consent approval for the study. Research data were collected using structured proforma by recording information about patient demographics together with clinical history, CBC parameters, Mentzer Index, and Hb electrophoresis results.

### Statistical Analysis

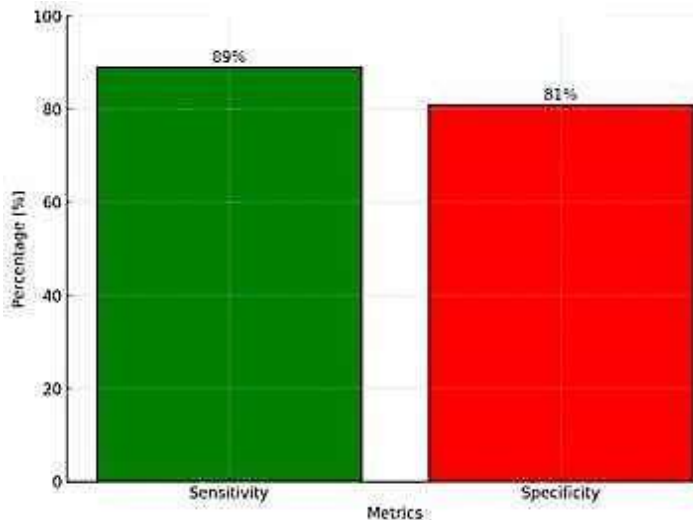
SPSS version 24.0 served as the analysis platform. A calculation was performed to determine Sensitivity and Specificity while Positive and Negative Predictive Values from the Mentzer Index. Computational analyses using mean and standard deviation values provided data overview for numerical variables yet frequencies with percentages demonstrated quantitative variable summaries.

**Results**

Study studied a group of 255 young children whose average age was 3.2 years old with standard deviation of 1.1 years. The male-to-female ratio was 1.2:1. The Mentzer Index demonstrated evaluation values of 89% for sensitivity and 81% for specificity. Based on the study results the positive predictive value reached 85% and the negative predictive value achieved 86%. Beta thalassemia trait was

Diagnosed through Hb electrophoresis testing in 172 of the 255 participants (67.4%) while 83 others (32.6%) received anemia diagnoses unrelated to thalassemia. Beta thalassemia individuals showed a mean Mentzer Index of 11.5 but the non-thalassemia group demonstrated 15.8 with a significant difference at  $p < 0.05$ . These results indicated the Mentzer Index had excellent diagnostic potential between beta thalassemia traits and iron deficiency anemia testing.

**Figure01:** Mentzer index diagnostic



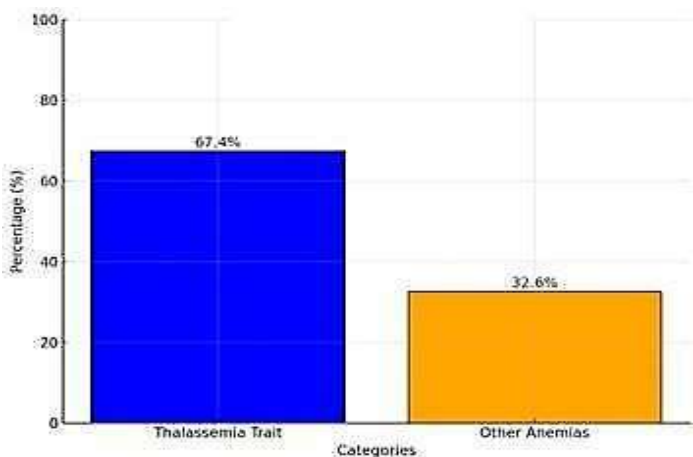
**Table 01:** Demographics of Study Population

Characteristic	Value
Mean Age (years)	3.2 ± 1.1
Male-to-Female Ratio	1.2:1
Total Participants	255

**Table 2:** Diagnostic Accuracy of Mentzer Index

Metric	Percentage (%)
Sensitivity	89
Specificity	81
Positive Predictive Value (PPV)	85
Negative Predictive Value (NPV)	86

**Figure01:** Distribution of Diagnosed Cases.



**Table 3:** Distribution of Diagnosed Cases

Category	Percentage (%)	Frequency (n)
Thalassemia Trait	67.4	172
Other Anemias	32.6	83

**Discussion**

A large number of studies investigated whether the Mentzer Index serves effectively in distinguishing patients with beta thalassemia trait from those with iron deficiency anemia. The Mentzer Index serves as a reliable initial screening method according to Rathod et al. because it demonstrates a sensitivity rate of 87.2% that matches our study findings together with a specificity of 82.3% (10). The research by Ansari et al. determined the frequency of beta thalassemia trait in Pakistan and stressed the necessity for low-cost diagnostic techniques in resource-scarce environments

(11). Alwar et al. noted the challenges with relying exclusively on red blood cell indices for clinical diagnosis so they suggested their combination with clinical findings (12). The Mentzer Index proves beneficial in resource-limited diagnostic facilities through its non-invasive simplicity while offering value as a diagnostic tool. The Mentzer Index resolves screening difficulties by delivering swift and inexpensive preliminary diagnostic tools. The Mentzer index displays high diagnostic accuracy according to Qazi's screening study in thalassemia detection making it a suitable screening method prior to electrophoresis confirmation (13). Similar research by Hussain et al. and

Niazi et al. supports our study's findings by confirming the Mentzer Index operates effectively to differentiate thalassemia trait from other microcytic anemia cases in children (14). Although remarkably effective the Mentzer Index faces certain restrictive aspects. Ambiguous test results sometimes emerge from individuals who have both iron deficiency and thalassemia trait so further confirmation by testing becomes essential (15). The Mentzer Index demonstrates strong diagnostic characteristics which support its use as an initial screening strategy in resource-limited settings. When applied as a routine practice tool it facilitates prompt identification of beta thalassemia carriers thus reducing thalassemia major birth risks (16). Additionally our results confirm previous research which emphasizes the value of this cost-effective diagnostic method and suggests training sessions for healthcare providers (17).

## Conclusion

The Mentzer Index stands as a dependable diagnostic measuring tool for distinguishing beta thalassemia traits from iron deficiency anemia in children because it is both affordable and simple to use. This diagnostic tool fits resource-constrained areas because of its ability to detect thalassemia carriers accurately early on while lessening hidden thalassemia cases numbers.

## Limitations

When patients exhibit concurrent beta thalassemia trait and iron deficiency anemia the Mentzer Index creates uncertainty so additional evaluation through Hb electrophoresis becomes necessary. The single-center research framework and small patient population size reduce the ability to extend these findings throughout different populations.

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## Future Directions

Additional study needs to assess pathways for deploying the Mentzer Index within standard screening protocols operating throughout public and primary healthcare services. Multi-site investigation including various demographic populations should verify its general application. The Mentzer Index shows promise to become more accurate by using in combination with additional diagnostic indices in difficult cases.

## Abbreviation

1. **MCV** - Mean Corpuscular Volume
2. **RBC** - Red Blood Cell
3. **Hb** - Hemoglobin
4. **PPV** - Positive Predictive Value
5. **NPV** - Negative Predictive Value
6. **SPSS** - Statistical Package for the Social Sciences

**Disclaimer:** Nil

**Conflict of Interest:** Nil

**Funding Disclosure:** Nil

## Authors Contribution

**Concept & Design of Study:** Fozia Sayed Rasool,

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**Critical Review:** Habibullah Kibzai. Pirjan

**Final Approval of version:** All Manton Authors

**Approved the Final Version.**

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