Original Article

Validity of Mentzer Index as a Screening Tool for Iron Deficiency Anemia in Children 6-12 Years of Age

Maria Javed[1], Lubna Riaz[1], Asfand Tariq[1], Neelam Faryad[1], Rubab Saleem[1] and Shazia Rizwan[2]

ABSTRACT

Objective: To assess the validity of Mentzer index as a screening tool for iron deficiency anemia in children 6-12 years of age and to find an optimal cut off point for our population with best sensitivity and specificity.
Study Design: Cross-sectional study
Place and Duration of Study: This study was conducted at the Department of Pediatrics, Shaikh Zayed Hospital Lahore from September 2021 to February 2022.
Materials and Methods: A sample of 100 subjects was recruited through non-probability consecutive sampling according to selection criteria. The study was divided into a survey phase and a diagnostic phase. In the diagnostic phase, 100 children with hypochromic microcytic anemia were tested for serum Iron, TIBC and Mentzer index calculated. We analyzed the validity of Mentzer Index in comparison with serum Iron and TIBC.
Results: We studied 100 children, of which 57% were males and 43% were females. 65% patients were 6-9 years of age while 35% were 10-12 years old. The ROC curve showed 59.3% AUC for a Mentzer index cut off point 13 (≤13 shows IDA,>13 not IDA) sensitivity 78.4%, specificity 49.0% and accuracy 64%.
Conclusion: Mentzer index is not valid as a screening tool for hypochromic microcytic anemia in 6-12 years old children in comparison with serum Iron, TIBC. Further large-scale studies should be done to establish the validity.

Key Words: Mentzer index, iron deficiency anemia, serum iron, total iron binding capacity (TIBC)

Citation of article: Javed M, Riaz L, Tariq A, Faryad N, Saleem R, Rizwan S. Validity of Mentzer Index as a Screening Tool for Iron Deficiency Anemia in Children 6-12 Years of Age. Med Forum 2023;34(7):166-169. doi:10.60110/medforum.340739.

INTRODUCTION

Among anemias, Iron deficiency anemia secures the topmost rank. High incidence of iron deficiency anemia in developing and under-developed countries is associated with countless morbidities including growth and development failure, poor cognition, low immunity, and decreased work capacity.[1] The statistics of low and middle-income countries estimated up to 40% of preschool children to be iron deficient and/or anemic.[2] A recent study shows that approximately 25% of people worldwide have anemia. Among them, 50% cases belong to iron deficiency anemia. In Pakistan, all age group prevalence is 65% which is alarming.[3]
Iron deficiency anemia is the most common type of hypochromic microcytic anemia.[4]

[1.] Department of Pediatrics, Shaikh Zayed Hospital, Lahore.
[2.] Department of Pediatrics, LMDC/`Ghurki Trust Teaching Hospital, Lahore.

Correspondence: Dr. Maria Javed, Trainee Resident, Department of Pediatrics, Shaikh Zayed Hospital, Lahore.
Contact No: 03086866489
Email: kemcolian93@gmail.com

Received: February, 2023
Accepted: April, 2023
Printed: July, 2023

Various tests that are used to investigate iron deficiency anemia are complete blood count, serum iron, TIBC (total iron binding capacity), serum ferritin and bone marrow iron staining (gold standard). However, the above-mentioned investigations are costly and not easily available in all set ups. Therefore, researchers have developed different indices to screen iron deficiency anemia using widely available and affordable tests. Commonly used indices are Mentzer Index, England and Fraser Index, Srivastava Index, Green and King Index, Shine and Lal Index, Red blood cell count, red blood cell distribution width and red blood cell distribution width index.[5] All these indices only require complete blood count picture. Multiple studies have shown that Mentzer index is the most accurate of all the above-mentioned indices.
Mentzer index is MCV divided by RBC count obtained on complete blood count. Numerous studieshave shown that its value >13 reflects iron deficiency anemia. A study conducted in Indonesia revealed the cut-off value of13.51 with sensitivity 93%, specificity 84%, and accuracy 90% for detection of iron deficiency anemia in children.[6] Another study done in Turkey showed that the sensitivity and specificity of Mentzer index was 82.3% and 98.7%, respectively for detection of iron deficiency anemia in children. In our country, a study conducted in Peshawar confirmed the cut off value to be 13 but it didn't talk about the sensitivity and

specificity of Mentzer index.[7] No study has been done in Punjab showing the sensitivity and specificity of Mentzer index and it's cut off value in our population.[8]

The current study was done to check the validity of Mentzer index for screening of iron deficiency anemia in children attending a tertiary care hospital. Varied data has been observed in literature regarding the accuracy of Mentzer index for detection of iron deficiency anemia. There is lack of local evidence. The cost of various tests e.g., CBC, serum Iron, TIBC, serum Ferritin etc. required to diagnose iron deficiency anemia ranges from 1000 to 5000 rupees including government and private laboratories. But using Mentzer index, this cost can be limited to 100 to 500 rupees only. Affordable diagnostic tests can help parents save money for treatment. We conducted this study to find the accuracy of Mentzer index for better detection of iron deficiency anemia and to apply reliable results in future in a local setting. This will help in refining our knowledge and guidelines in future with a cost-effective test.

MATERIALS AND METHODS

We conducted a cross-sectional study in the Department of Pediatrics, Shaikh Zayed Hospital Lahore from September 2021 to February 2022 after approval from Institutional Review Board (IRB number: SZMC/IRB/Internal/353/2021). All 6–12-year-old children who fulfilled the selection criteria were recruited in the study via non-probability consecutive sampling. Informed consent was taken from the guardian. We estimated the sample size of 100 cases with 95% confidence level. All 6–12-year-old children who had any two of the signs and symptoms like pallor, fatigue, growth failure, lightheadedness, poor exercise tolerance, angular cheilitis, stomatitis, koilonychia, atrophic glossitis and pica etc. were considered for a CBC. 100 cases of hypochromic microcytic anemia were included in the study. We excluded all those children who had thalassemia, chronic diseases, severely malnourished, already on treatment of IDA, H/O blood loss in last month or any H/O blood transfusion in last month.

Data was collected on a predesigned proforma in the form of demographics, history, and physical examination. Blood sampling was done in two steps. In the first step, CBC was done of all the children meeting the inclusion criteria.In the second step, Serum Iron and TIBC were sent for those with hypochromic microcytic anemia. All the laboratory tests were done by Beckman Coulter Automatic Analyzer. Mentzer Index calculated on CBC.

Hypochromic Microcytic Anemia was defined as Hb < 11.5 g/dL, MCH < 25pg, MCV < 77fl. Mentzer Index calculated by dividing RBC by MCV, considering >13 indicative of IDA. Serum Iron <50 ug/dL and TIBC ≥ 450 ug/dL were labeled as positive for IDA (10,11). Although Serum Ferritin is more accurate for diagnosis of IDA, but this test is not available in our setup.

Validity tests were performed to estimate the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio, negative likelihood ratio to assess the screening accuracy of Mentzer Index. A receiver operator curve was drawn to find the Mentzer Index cut off point of our population. Statistical analysis was done by SPSS version 20.0.

RESULTS

The subject recruitment was done in two steps. In the first step, we surveyed 500 children for signs and symptoms of iron deficiency anemia as mentioned in inclusion criteria.210 children were suspected anemic. A CBC performed on 210 children, 100 turned out to be hypochromic microcytic anemic. They were enrolled in the study. Mentzer index calculated. A second blood sample withdrawn for serum Iron and TIBC (Figure 1).

Table No. 1: Baseline Subject Characteristics

Characteristics	n (100)	%
Age		
6- 9 years	65	65
9-12 years	35	35
Gender		
Male	57	57
Female	43	43

Table No. 2: Serum Iron, TIBC level according to age and gender

			Iron < 50 and TIBC >450			
			IDA		NOT IDA	
			Mean (SD)	Min-Max	Mean (SD)	Min-Max
Gender	Male	Iron	17.87 (5.16)	8-29	24.00 (12.69)	9-52
		TIBC	522.31(53.57)	452-656	390.00(42.66)	299-450
	Female	Iron	17.38(6.04)	9-28	20.66 (11.70)	8-44
		TIBC	493.88(39.98)	451-586	413.83(26.55)	351-450
Age	6-9 years	Iron	17.33(5.11)	9-29	22.82 (12.51)	8-45
		TIBC	510.03(49.51)	451-656	399.97(39.31)	299-450
	10-12 years	Iron	18.33(6.65)	8-28	22.70 (12.36)	9-52
		TIBC	504.40(49.47)	459-615	397.00(39.53)	299-450

Subjects' characteristics, stratification of serum iron, TIBC levels according to age and gender and cross tabulation between serum Iron, TIBC and Mentzer index are shown in table 1,2 and 3 respectively. CBC showed the following: mean hemoglobin of 8.2 (SD 2.0) g/dL, red blood cell (RBC) counts 4.8 (SD 1.04) 106/mm3, MCV 56.45 (SD 10.8) fl and MCH 18.2 (SD 6.1) pg. Mean family income was 56,620 (SD 13729) rupees, mean father education 12 (SD 2.667) years and mean mother education 11 (SD 11.1) years.

The ROC curve revealed the AUC of 59.3%(95% Confidence Interval 47.6-71.0, P value 0.11) with sensitivity of 78.4% and specificity of 49.0% at cut off point of 13.0. For our population, a better cut off point is 12.0 with sensitivity of 76.5% and specificity of 55.1%.

Table No. 3: Cross tabulation between Mentzer Index and Serum Iron, TIBC

Mentzer Index	Serum Iron <50 ug/dL, TIBC ≥ 450 ug/dL		Total
	IDA	NOT IDA	
≤13	40	25	65
>13	11	24	35
Total	51	49	100

Sensitivity 78.4%, Specificity 49.0 %, Positive Predictive Value 61.5%, Negative Predictive Value 68.6%, Accuracy 64%

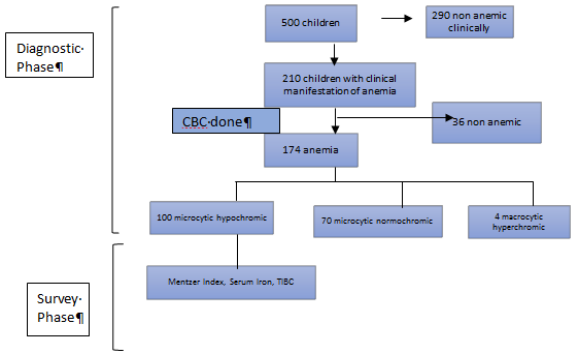

Figure No. 1: Subject Recruitment Process

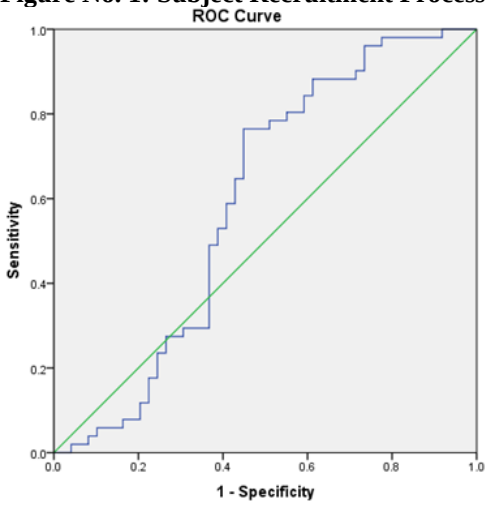

Figure No.2: ROC Curve with sensitivity and specificity

DISCUSSION

Iron deficiency anemia is the most prevailing anemia in the world. It takes a great toll on the health by affecting growth and development, poor cognition, and poor work performance. The American Academy of Pediatrics and WHO (World Health Organization) has recommended universal screening of all infants for anemia at one year of age.[9,10] Various screening tools have been identified based on complete blood count. Mentzer index is the most accurate screening tool till date.[7] We aim to check the validity of Mentzer Index against a widely used diagnostic test for iron deficiency anemia i.e. Serum Iron and TIBC. The gold standard test for diagnosing iron deficiency anemia is Bone marrow iron staining but due to its invasive nature, serum ferritin is considered in clinical practice.[11] But this test is not available in our setup on a regular basis. Serum ferritin has a disadvantage of being acute phase reactant, hence raised in inflammatory conditions. Serum Iron is fluctuated by last meal iron content.

In our subjects, we found that there were 57% male and 43% females which shows predominance of iron deficiency anemia in males. It is consistent with the results of Sri. S. Alam et al.[8] 65% patients were of 6-9 years while 35% were of10-12 years of age revealing greater incidence of iron deficiency anemia in younger children.[12] The average family income was 56,620 rupees with a range of 30,000 to 87000 rupees. The low mean family income in our population is responsible for poor nutrition of children resulting in high incidence of iron deficiency anemia in underdeveloped countries.[13]

In our study, we used the reference values of serum Iron <50 ug/dL and TIBC >450 ug/dL for diagnosing iron deficiency anemia (10,11). Mentzer index calculated, and receiver operator curve obtained. The area under the curve was 59.3% with 95% confidence interval between 47.6%-71.0% and p value 0.11 which shows it to be less accurate screening tool. Our study showed sensitivity of 78.4% and specificity of 49.0% at cut off point of 13. This is not consistent with many international studies who showed sensitivity 93%, 82.3%, specificity 84%,98.7% respectively.[6,7] Ehsani et al showed sensitivity 94.6% and specificity 95.5% whereas Ghafouri et al reported sensitivity of 90.9% and specificity of 80.3% (16,17). There is scarcity of local evidence with only one study from Peshawar reported Mentzer index validity, but this study did not mention the sensitivity and specificity.[7]

Most of the studies have used serum ferritin as standard test for diagnosing iron deficiency anemia. Few studies have used serum iron and TIBC along with serum ferritin, but they have not interpreted the results according to serum iron and TIBC.[7] Our study shows that Mentzer Index ≤13 shows IDA and >13 shows not IDA. This unexpected result could be due to using serum Iron, TIBC as standard tests. An ideal screening

test has high sensitivity and specificity. An optimal cut off point for our population could be 12 (≤12 shows IDA) with sensitivity of 76.5% and specificity of 55.1%.

The limitation of our study was small sample size and using less accurate standard test. It is highly recommended to conduct this study at major tertiary care centers of Pakistan using both serum Iron, TIBC and ferritin as standard test to report the validity of Mentzer Index and the best cut off point for our population.

CONCLUSION

We conclude that Mentzer index is not a good screening tool for screening iron deficiency anemia. However, it is very cheap screening tool for low- and middle-income countries. Further studies should be done to check its validity and optimal cut off point.

Author's Contribution:

Concept & Design of Study:	Maria Javed
Drafting:	Lubna Riaz, Asfand Tariq
Data Analysis:	Neelam Faryad, Rubab Saleem, Shazia Rizwan
Revisiting Critically:	Maria Javed, Lubna Riaz
Final Approval of version:	Maria Javed

Conflict of Interest: The study has no conflict of interest to declare by any author.

REFERENCES

1. Ullah Z, Khattak AA, Ali SA, Hussain J, Noor B, Bano R, et al. Evaluation of five discriminating indexes to distinguish Beta-Thalassemia Trait from Iron Deficiency Anaemia. J Pak Med Assoc 2016;66(12):1627–31.
2. Mantadakis E, Chatzimichael E, Zikidou P. Iron deficiency anemia in children residing in high and low-income countries: risk factors, prevention, diagnosis and therapy. Mediterr J Hematol Infect Dis 2020;12(1).
3. Latif M, Ayaz S Bin, Manzoor M, Ishaq M. Frequency and Severity of Anemia in Children Less Than 15 Years of Age at Gwadar Development Authority Hospital, Gwadar, Baluchistan. Pak Armed Forces Med J 2018;68(5):1088–92.
4. Aydogan G, Keskin S, Akici F, Salcioglu Z, Bayram C, Uysalol EP, et al. Causes of hypochromic microcytic anemia in children and evaluation of laboratory parameters in the differentiation. J Pediatr Hematol Oncol 2019;41(4):e221–3.
5. Bose S, Maimoon S. Is Mentzer index a reliable diagnostic screening tool for beta thalassemia trait. IOSR J Dent Med Sci 2018;17(7):7–11.
6. Alam SLS, Purnamasari R, Bahar E, Rahadian KY. Mentzer index as a screening tool for iron deficiency anemia in 6-12-year-old children. Paediatr Indones 2014;54(5):294–8.
7. Munir AH, Ali K, Khan MI, Sultana N, Khan SZ. Mentzer index as a diagnostic tool for screening thalassemic patients and differentiating iron deficiency anemia from thalassemia. J Khyber Coll Dent 2019;9(4):103-6.
8. Robert K, Joseph G, Nathan B, Samir S, Robert T, Karen W. Iron Deficiency Anemia. In: Richard B, editor. 21st ed. Elsevier; 2021.p. 2522–2525.
9. Keith K, Lauren M, Matthew M. Iron Indices. The Harriet Lane Handbook. 22nd ed. Elsevier;2020.p. 361.
10. Kohli-Kumar M. Screening for anemia in children: AAP recommendations--a critique. Pediatr 2001;108(3):E56.
11. Asif N, Ijaz A, Rafi T, Haroon ZH, Bashir S, Ayyub M. Diagnostic Accuracy of Serum Iron and Total Iron Binding Capacity (TIBC) in Iron Deficiency State. J Coll Physicians Surg Pak 2016;26(12):958-961.
12. Gupta PM, Perrine CG, Mei Z, Scanlon KS. Iron, Anemia, and Iron Deficiency Anemia among Young Children in the United States. Nutrients. 2016 May 30;8(6):330. doi: 10.3390/nu8060330. Erratum in: Nutr 2017;9(8).
13. Mantadakis E, Chatzimichael E, Zikidou P. Iron Deficiency Anemia in Children Residing in High and Low-Income Countries: Risk Factors, Prevention, Diagnosis and Therapy. Mediterr J Hematol Infect Dis 2020;12(1):e2020041.
14. Ehsani MA, Shahgholi E, Rahiminejad MS, Seighali F, Rashidi A. A new index for discrimination between iron deficiency anemia and beta-thalassemia minor: results in 284 patients. Pak J Biological Sciences 2009;12(5): 473–475.
15. Ghafouri M, MostaanSefat L, Sharifi L. Comparison of cell counter indices in differention of beta thalassemia trait and iron deficiency anemia. The Scientific J Iranian Blood Transfusion Organization 2006;2(7):385–389.