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ORIGINAL ARTICLE

Estimation of Serum Ferritin Level to Detect Iron Deficiency Anemia in Children less than 5 Years of age

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ABSTRACT

Objective: To evaluate serum ferritin levels in children less than five years as screening measure for iron deficiency anemia (IDA).

Subjects and Methods: A cross-sectional study was conducted at Benazir Bhutto Hospital Rawalpindi from 1st March 2010 to 31st Jan 2011. A simple random sampling technique was adopted for study proceedings. Fifty children of less than five (5) years of age were enrolled in the study. The study population included children, aged less than five presenting at pediatrics outpatient department. The children with known hematological abnormality, infection, inflammation were excluded from the study. Blood complete picture for hemoglobin and serum ferritin level estimation were the diagnostic tools used and correlated afterwards. Data were collected and entered in Statistical Package for Social Sciences (SPSS, version 16) for analysis. Descriptive statistics were calculated. Chi-square test was applied for evaluation and calculation of significance in each of the characteristics of the population at $P \leq 0.05$.

Results: A total of 50 children with age range of 3-60 months, were recruited for the study. The study population was categorized into three groups; Infants (3-12 months), Toddlers (13-23 months) and Preschool-age (24-60 months) groups. The mean hematocrit of the study population was 33.5 (2.8%) and the mean serum ferritin level was 52.4 ng/ml with a range value of 0.2-353.0 ng/ml. Thirty-eight (38) patients of the study population were iron-deficient, with serum ferritin levels of less than 12 ng/ml.

Conclusion: Serum ferritin level is a good screening test for detection of iron deficiency in children

Key words: Children less than five years, Iron deficiency anemia, Serum ferritin levels.

Author's Contribution

¹ Conception, synthesis, planning of research and manuscript writing

^{2,3} Interpretation and discussion Data analysis, ³ Interpretation, manuscript writing and Active participation in data collection

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Introduction

Iron deficiency anemia (IDA) is one of the most prevalent nutritional deficiency and accounts for almost one-half of anemia cases. It is more prevalent in the developing countries. In most cases, this deficiency disorder may be diagnosed through complete blood count and low levels of serum ferritin.¹ It is the commonest cause of nutritional

anemia in infancy and childhood.² Children aged 0–5 years, women of childbearing age, and pregnant women are particularly at risk.³ About 1.2 billion people worldwide show varying levels of iron deficiency. Prevalence rates vary among countries. In Pakistan 33.2% under five children are suffering from nutritional anemia.⁴ A thorough

review of current literature reveals that iron deficiency (ID) and iron deficiency anemia (IDA) widely persist in Pakistan and necessitate immediate remedial actions.⁵ Several lab tests of iron homeostasis like total iron binding capacity, serum iron level, serum ferritin level, serum transferrin, and bone marrow iron staining have been used. These tests are used either single or in combination to assess iron stores in patients. Major form in which iron is stored in the body is serum ferritin. It can detect early changes in body iron store. Many authors recommend it as the most important blood test for the diagnosis of iron deficiency.⁶⁻⁸ It causes little patient discomfort as compared to bone marrow iron studies. In this study, we used serum ferritin level to assess the level of iron storage in the children less than five years of age. We used serum ferritin level below 12 ng/ml to diagnose iron deficiency state, according to WHO recommendations. Iron stores are depleted below this value.⁹ The poor school performance due to cognitive dysfunction and behavioral deficit is associated with iron deficiency anemia.¹⁰ Hence, primary prevention by way of screening for iron deficiency in apparently non-anemic individuals especially children is very important.

Subjects and Methods

This prospective study was carried out at the Benazir Bhutto Hospital, Rawalpindi. This is a tertiary care teaching Hospital, affiliated with Rawalpindi Medical University, Rawalpindi. The study population included fifty (50) children, aged less than five presenting at pediatrics outpatient department. The children with known hematological abnormality, infection, inflammation were excluded from the study. For ethical considerations, the study was approved by Ethical Committee of Benazir Bhutto Hospital, Rawalpindi. Informed consent was obtained from parents of all the participant children. Personal data of the recruited children was recorded in a performa. Five milliliters of blood were drawn from these children and divided into two halves one for CBC other was centrifuged to separate the serum for ferritin level estimation. The serum samples were stored in the deep freezer and Ferritin analysis was carried out in batches. Serum ferritin was assayed by sandwich Enzyme Link Immunosorbid Assay (ELISA)

technique. CBC was performed on Sysmax® hematology analyzer.

Data were collected and entered in Statistical Package for Social Sciences (SPSS, version 16) for analysis. The study population was categorized into three groups; Infants (3-12 months), Toddlers (13-23 months) and Preschool-age (24-60 months) groups. Descriptive statistics were calculated. Chi-square test was applied for evaluation and calculation of significance in each of the characteristics of the population at $P \leq 0.05$.

Results

A total of 50 children with age range of 3-60 months, were recruited for the study. Table 1 shows the age groups of the study population.

Table 1: The study population by age groups				
Ages (Months)	Frequency	Percentage	Chi square X^2	p-Value
Infants (3-12)	14	28	0.06	\leq 0.88
Toddlers (13-24)	24	48		
Preschool-age (25-60)	12	24		
Total	50	100		

Mean serum ferritin level of the study population was 52.4 ng/ml with a range value of 0.2-353.0 ng/ml (Figure 1).

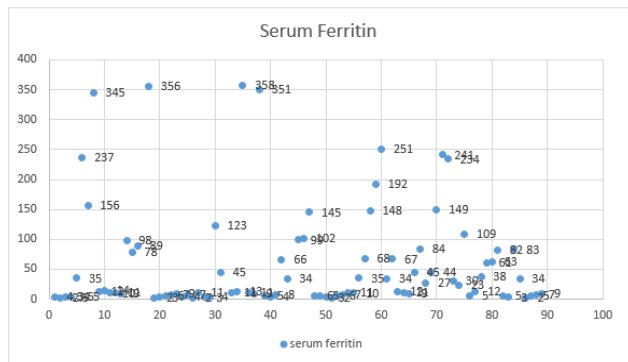


Figure 1: Scatter-gram of the serum ferritin levels of the study population

Thirty-eight (38) patients of the study population were iron-deficient, with serum ferritin levels of less than 12 ng/ml. The mean hematocrit of the study population was 33.5 (2.8%). Table 2 below shows the prevalence of iron-deficiency among various age groups.

Table 2: Frequency of iron deficiency among age groups

Age categories	n	Iron deficient (%)	Non-iron deficient (%)	Chi square (X ²)	p-Value
Infants	14	10	4	0.60	≤ 0.62
Toddlers	24	17	7		
Preschool-age	12	11	1		
Total	50	38	12		

Discussion

The serum ferritin was found less than 12ng/ml in anemic children of the study population. Serum ferritin level is a very useful clinical tool to assess iron deficiency anemia in adults. But in children less than 5 years more efforts are needed in our own population to find out its relationship with IDA. In India, a study conducted by Deeksha Kapur et al concluded that ferritin is more sensitive indicator of IDA as compared to Hemoglobin.¹¹ Paiva et al. documented that plasma ferritin levels decrease when there is a deficiency of iron that is not complicated by another concomitant disease.¹² According to the report presented by Abdullah et al, under the aegis of Canadian Pediatrics Surveillance Program “for infants of 12 months of age, several tests of iron status are available, but each has limitations. A serum ferritin of less than 10 µg/L has been suggested as a cut-off for children indicating depletion of iron stores; however, as it is an acute phase reactant, the Committee on Nutrition recommends simultaneous measurement of C-reactive protein (CRP)”.¹³

Sukanya Linpisarn et al, in a study carried out in Thailand in 1996, recognized that Serum Ferritin accurately reflects total body iron stores after 6 months of age and is only depressed in iron deficiency. As revealed by the response to oral iron, serum ferritin was the only confirmatory test and was quite accurate in their population.¹⁴

Serum ferritin concentration is an early indicator of the status of iron stores and is the most specific indicator available of depleted iron stores, especially when used in conjunction with other tests to assess iron status. Under normal conditions, a direct relationship exists between serum ferritin concentration and the amount of iron stored in the body, such that 1 µg/L of serum ferritin concentration is equivalent to approximately 10 mg of

stored iron. However, measured ferritin levels have some limitation, acute and chronic inflammation can increase serum ferritin levels and the assessment of iron status but is not a cause iron deficiency.¹⁵

Abdus Sattar Khan et al reported in his local study conducted in 2006 that serum ferritin is the only reliable and sensitive parameter for diagnosis of iron deficiency anemia and estimation of iron stores in normal and anemic individuals. It is more precise and sensitive as compared to serum iron, TIBC and transferrin saturation for detection of iron stores in normal and iron deficient subject, which was less than normal value of 15 ng/ml in all iron deficient children.¹⁶

According to a clinical report of American academy of Pediatrics, “in establishing the definitive iron status of an individual, it is desirable to use the fewest tests that will accurately reflect iron status. Any battery of tests must include Hemoglobin concentration, because it determines the adequacy of the circulating red cell mass and whether anemia is present. One or more tests must be added to the determination of Hb concentration if ID or IDA is to be diagnosed.¹⁷ In a study conducted in India by Chithambaram NS et al. concluded that, If evaluation of iron status is done only by testing number of RBC’s, Hb and hematocrit, early signs of iron depletion can go undetected and also those tests were not specific to detect iron deficiency state. By monitoring the status of storage iron (ferritin), we can detect iron deficiency state earlier and initiate appropriate treatment to prevent IDA.¹⁸

Magnus Domellof et al. recommended that age-specific cutoffs for iron status indicators, including hemoglobin and ferritin, should be used for young children.¹⁹ While characterizing a simple, easily accessible, cost effective and commonly used diagnostic test for iron deficiency anemia in developing countries and especially at primary care level, it is suggested that serum ferritin assay has been considered the best single test for the diagnosis of iron deficiency anemia. Serum ferritin at a very low level (<14 ng/ml) gives very high likelihood ratio (LR+42) and is the most powerful test with an area under the ROC curve of 0.95.

Conclusion

Serum ferritin level is a good screening test for early detection of iron deficiency anemia in children less than 5 years of age.

Suggestions

Iron deficiency is an important public health problem in developing countries. Prompt screening for iron deficiency, especially under-five years of age, presenting at a health facility should be encouraged.

Limitations

1. Small sample size
2. CRP, which would have strengthened the study, was not done, due to financial restraints.

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