Section: Paediatrics

Original Research Article

PREVALENCE OF LATENT IRON DEFICIENCY IN CHILDREN AT TERTIARY CARE CENTRE

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ABSTRACT

Background: Iron deficiency is the most prevalent micronutrient deficiency in children worldwide and often precedes the onset of anemia. Latent iron deficiency (LID) refers to iron depletion where hemoglobin remains within normal limits, yet biochemical and hematological markers suggest deficiency. If undetected and untreated, LID can lead to iron deficiency anemia (IDA) and long-term neurodevelopmental consequences. This study aimed to determine the prevalence of latent iron deficiency in children with normal hemoglobin levels and to evaluate associated hematological indices and nutritional status.

Materials and Methods: A prospective observational study was conducted on 100 children aged 6 months to 12 years admitted to a tertiary care hospital in Navi Mumbai. Children with normal hemoglobin but with one or more abnormal red cell indices (low MCV, MCH, MCHC, or elevated RDW) were further evaluated with serum iron testing. A serum iron level of <50 mcg/dL was considered diagnostic of LID.

Results: Out of 100 children with normal hemoglobin, 66% were found to have low serum iron levels. Additionally, 41% had low MCV, 38% had low MCH/MCHC, and 28% had elevated RDW. Most children (67%) had normal anthropometric status, suggesting that LID can exist independently of undernutrition.

Conclusion: A significant number of children with normal hemoglobin levels have underlying latent iron deficiency. Reliance on hemoglobin alone may delay diagnosis and treatment. Incorporating red cell indices and serum iron analysis into routine screening could enable early intervention and prevent progression to anemia and associated developmental issues.

Keywords: Latent iron deficiency, serum iron, pediatric anemia, red cell indices, MCV, MCH, RDW.

INTRODUCTION

Iron deficiency (ID) is the most prevalent micronutrient deficiency worldwide and a significant public health issue, particularly among children. It accounts for nearly 50% of anemia cases globally and can occur even in the absence of anemia—a state referred to as latent or non-anemic iron deficiency (IDWA).[1,2] Iron plays a crucial role in numerous physiological functions, including oxygen transport, energy metabolism, and neurological development. Thus, even marginal deficiency can lead to fatigue, cognitive impairment, and immune dysfunction.[3]

Iron deficiency manifests in a progressive spectrum. In its early stage—known as the pre-latent stage—iron stores are depleted while hemoglobin (Hb) remains normal. As the deficiency progresses, it reaches the latent stage, where serum iron and transferrin saturation begin to fall, but Hb is still within normal limits.[4] Eventually, prolonged deficiency results in iron deficiency anemia (IDA), characterized by low Hb and microcytic hypochromic red blood cells.

According to the National Family Health Survey (NFHS-5), 67.1% of Indian children aged 6–59 months are anemic.[5] This marks a concerning increase from NFHS-4 data (58.6%) and highlights the importance of early detection strategies. The

Comprehensive National Nutrition Survey (2016–2018) also reported that iron deficiency contributes to nearly 69% of anemia cases in children aged 1–4 years, 51% in ages 5–9, and 65% in adolescents aged 10–19.[6]

Latent iron deficiency (LID) is an often-overlooked stage that can have substantial subclinical consequences. Neurological effects, including delayed cognitive development, attention deficits, and behavioral issues, have been observed even in the absence of anemia.[7,8] If untreated, LID can progress to full-blown IDA with more pronounced clinical outcomes.

In clinical practice, anemia remains the primary trigger for screening iron deficiency. However, by the time hemoglobin levels decline, significant functional and cellular impairments may already be present. Therefore, it is critical to identify and manage iron deficiency before anemia develops. This requires examining red cell indices such as mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and red cell distribution width (RDW), as well as serum iron levels.[9]

There is limited literature from India focusing on the prevalence of latent iron deficiency in pediatric populations. Early identification of LID offers a window of opportunity for intervention through dietary counseling and iron supplementation, thereby preventing the progression to anemia and its complications.

This study was undertaken to determine the prevalence of latent iron deficiency in children admitted to a tertiary care hospital with normal hemoglobin levels but suggestive hematological indices and also to assess their nutritional status and correlate it with LID.

MATERIALS AND METHODS

This was a prospective observational study conducted among 100 children aged between 6 months and 12 years who were admitted to the paediatric ward of the Department of Paediatrics at a tertiary care hospital in Navi Mumbai. hildren included in the study were those aged between 6 months and 12 years who had normal hemoglobin levels for their respective age group but demonstrated one or more hematological indicators suggestive of latent iron deficiency. These included low or decreased Mean Corpuscular Volume (MCV), defined as <70 plus age in years, Mean Corpuscular Hemoglobin (MCH) <27 pg, Mean Corpuscular Hemoglobin Concentration (MCHC) <30%, and increased Red Cell Distribution Width (RDW) >14%. Children were excluded from the study if they were already diagnosed with anemia based on age-specific hemoglobin cut-off values as per WHO guidelines, or if they were receiving any iron supplementation at the time of recruitment.

The study spanned a period of 1.5 years following the approval from the institutional ethics committee. Informed written consent was collected from the parents or guardians of all neonates enrolled in the study.

All children admitted to the paediatric ward were initially screened with a complete blood count (CBC) as part of their routine work-up. Hemoglobin levels were first assessed to determine the presence or absence of anemia. Children with hemoglobin levels within the normal range for age were further evaluated. Those with normal hemoglobin were then subjected to evaluation of their red blood cell indices, including MCV, MCH, MCHC, and RDW. If any of these indices were suggestive of early iron deficiency, i.e., low MCV, low MCH, low MCHC, or high RDW, the child was considered to be at risk of latent iron deficiency and underwent further evaluation with serum iron studies. Serum iron levels were measured using a standard biochemical method. A serum iron level of <50 mcg/dL was considered indicative of iron deficiency. Children with normal hemoglobin but reduced serum iron levels were diagnosed as having latent iron deficiency.

The data obtained was entered in Microsoft Excel 2019 and analysis was performed using IBM SPSS Statistics Version 26. The collected data were then compiled, tabulated, and analyzed using descriptive statistics. Results were expressed as percentages and proportions.

RESULTS

The present study was conducted among 100 children admitted at a tertiary care hospital in Navi Mumbai during the study period.

The majority of children fell in the 6–12 years age group (40%), followed by 1–5 years (37%) and 6 months–1 year (23%). The gender distribution was nearly equal, with a slight male predominance (54% boys and 46% girls).

Table 1: Sociodemographic profile among the study participants

Variables		Frequency	Percentages
Age	6 months – 1 years	23	23
	1-5 years	37	37
	6-12 years	40	40
Gender	Boys	54	54
	Girls	46	46

Based on anthropometric assessment, 67 children (67.0%) showed no evidence of stunting or wasting. However, 22 children (22.0%) were classified as stunted, and 11 children (11.0%) were identified as underweight. These findings indicate that while the

majority of the sample had normal growth parameters.

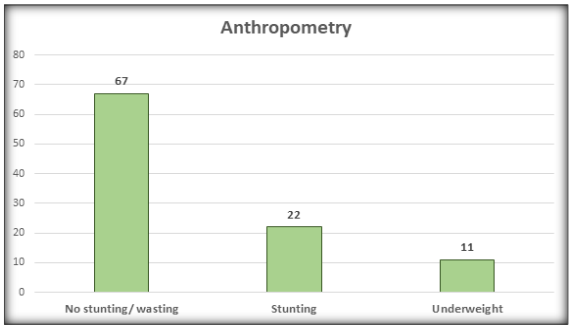

Figure 1: Distribution of nutritional status according to anthropometry

All of the study participants had normal hemoglobin levels. Despite this, 41% of the children were found to have low mean corpuscular volume (MCV), indicating microcytosis, which is an early sign of iron deficiency. Similarly, 38% of the participants had reduced mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC), further suggesting a trend toward early iron depletion. Elevated red cell distribution width (RDW), which is also associated with iron deficiency, was observed in 28% of the children. Notably, serum iron levels were low in 66% of the participants, even though their hemoglobin levels were within the normal range.

Table 2: Distribution of study subjects based on hemotological indicators

Variables		Frequency	Percentages
Hemoglobin	Normal	100	100
	Low	0	0
MCV	Normal	59	59
	Low	41	41
MCH and MCHC	Normal	62	62
	Low	38	38
RDW	Normal	72	72
	Low	28	28
Serum. iron	Normal	34	34
	Low	66	66

DISCUSSION

This study identifies a high prevalence (66%) of latent iron deficiency (LID) among children who have normal hemoglobin levels but display abnormal hematological parameters and low serum iron. This reinforces that a significant proportion of children may suffer from subclinical iron deficiency that remains undetected by conventional screening focusing solely on hemoglobin.

Latent iron deficiency is the intermediate stage in the progression from iron depletion to iron deficiency anemia (IDA), characterized by low serum iron and/or abnormal red cell indices, while hemoglobin remains within the normal range.[9] This "silent" stage of deficiency is clinically important because iron-dependent physiological functions are already impaired despite normal hemoglobin.[2]

Our finding that 41% of children had low mean corpuscular volume (MCV), 38% had low MCH/MCHC, and 28% had elevated red cell distribution width (RDW) is consistent with findings from prior studies that recommend using these red cell indices for early identification of iron deficiency.[3,10] The American Academy of Pediatrics (AAP) also emphasizes that relying on hemoglobin alone fails to detect the early, latent stages of iron deficiency.[4]

Gomber et al. reported that 42% of urban Indian children with normal hemoglobin had depleted iron stores, supporting our observation that LID is prevalent even among clinically stable, non-anemic children.[11] Kapur et al. similarly found associations between low iron stores and impaired development in non-anemic children, demonstrating that LID can significantly affect cognition and behavior.[12]

Neurologically, LID has been associated with cognitive delays, poor attention, and long-term neurodevelopmental deficits. Studies by Grantham-McGregor and Lozoff have shown that children with early iron deficiency—even without anemia—perform worse on cognitive tasks, and some effects may persist even after iron therapy.[7,8]

India's National Family Health Survey (NFHS-5) shows that 67.1% of children under 5 are anemic, reflecting a worsening trend. However, these numbers may underestimate the true burden if latent cases are not included.[5] Our study supports the need to revise current screening protocols to include red cell indices and iron studies, not just hemoglobin, to detect iron deficiency early and prevent long-term complications.

This study was conducted in a single tertiary care hospital, which may limit the generalizability of the findings to the broader pediatric population. The sample size, although adequate for observational analysis, was relatively small and confined to hospitalized children, possibly introducing selection bias. Serum ferritin, a more specific indicator of iron stores, and transferrin saturation were not measured due to resource constraints, which may have led to underestimation or overestimation of latent iron deficiency. Additionally, the cross-sectional design does not allow for assessment of long-term outcomes or the progression of latent iron deficiency to anemia over time.

CONCLUSION

Latent iron deficiency was found in two-thirds of children with normal hemoglobin levels, accompanied by suggestive changes in MCV, MCH, MCHC, and RDW. The findings demonstrate that hemoglobin-based screening alone may fail to detect early-stage iron deficiency. Integration of complete blood count indices and serum iron into routine screening can facilitate early intervention and reduce the risk of neurodevelopmental deficits. Public health policies should consider this approach, especially in high-burden regions.

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