Iron deficiency anemia from diagnosis to treatments in children 1 to 5 years

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Abstract

Iron deficiency is the most common nutritional deficiency worldwide and an important public health problem especially in developing countries. Since the most important indicator of iron deficieny is anemia, the terms “iron deficiency” and “iron deficiency anemia” are often used interchangeably. However, iron deficiency may develop in the absence of anemia and the tissues may be affected from this condition. The most common causes of iron deficiency in children include insufficient intake together with rapid growth, low birth weight and gastrointestinal losses related to excessive intake of cow’s milk. If insufficient intake can be excluded and there is insufficient response to oral iron treatment in patients with iron deficiency especially in older children, blood loss should be considered as the underlying cause. The main principles in management of iron deficiency anemia include investigation and elimination of the cause leading to iron deficiency, replacement of deficiency, improvement of nutrition and education of the patient and family. Oral iron supplements are desirable as first-line therapy. Follow-up is very important to confirm the diagnosis and to ensure that anemia is adequately treated.

Keywords: Anemia, children, Ferritin, Iron deficiency.

Introduction

Iron deficiency is the most common nutritional deficiency worldwide and an important public health problem especially in developing countries. There is no clear data about how many individuals are affected by iron deficiency worldwide, but it is estimated that ID is present in most of the pre-school children and pregnant women in developing countries and in at least 30–40% in developed countries when anemia is used as an indirect indicator of ID (1). According to the 2001 World health Organization (WHO) data, 30% of the children aged between 0 and 4 years and 48% of the children aged between 5 and 14 years are anemic in developing countries (1). In our country, the frequency of iron deficiency anemia (IDA) has been reported to range between 15.2% and 62.5% in different studies conducted with children (2–3). It is the commonest cause of anemia and is also a common deficiency among nonanemic children, especially among children of resource limited countries. A study by Ekwochi et al. showed that iron deficiency was present in 27.5% of nonanemic children under 5 [4]. Iron is

necessary for healthy function and development of brain. There is evidence that its deficiency without anemia causes fatigue. It can affect visual and auditory functioning and is weakly associated with poor cognitive development in children [5–6]. It is believed that retinol deficiency reduces the availability of iron stores from macrophages and the liver to erythropoiesis and, consequently, to the synthesis of hemoglobin. Some studies indicate that this ratio is related to an increased expression of hepcidin, a liver hormone that regulates the availability of iron storage. High concentrations of hepcidin imply that there is an internalization and lysosomal degradation of ferroportins, transmembrane proteins that allow transport of iron into the blood stream. As there is no available circulating iron, red cell production is impaired, leading to anemia. However, this metabolic process is still hypothetical, with no clear conclusions yet.

METHODS

The children included in the study were apparently healthy as perceived by parents or guardians and general clinical evaluation. Data collection was performed at BHU by trained nutritionists, undergraduate students of Nutrition, and technical nursing staff. The children were accompanied by their parents or guardians. A structured questionnaire was applied, which included sociodemographic, economic, and dietary data. Subsequently, the anthropometric and biochemical assessment of the children was performed. Among the sociodemographic and economic data, the child's age, premature birth, gender, maternal age, number of people in family, and social class were evaluated. A child was considered premature if he/she had been born after less than 37 gestational weeks (GW); borderline premature, between 37 and 38; and full-term, after 38 GW. For assessment of social class, a questionnaire adapted from the 2000 Census was used,[15] consisting of a list of ten consumer goods and information on the education level of the household head.

In this survey, anemia testing was performed by measuring hemoglobin (Hb) concentration from a drop of blood obtained from by finger prick. Children with severe anemia refers to the proportion of children under age 5 classified as having severe (below 7.0 g/dl) anemia. Children with moderate anemia refer to proportion of children under age 5 classified as having moderate (7.0–9.9 g/dl) anemia. Children with mild anemia refer to proportion of children under age 5 classified as having mild (10.0–10.9 g/dl) anemia. Children with any anemia referred to proportion of children under age 5 classified as having any anemia. For this analysis, we selected a sample of 112714 children from the NFHS with available data on hemoglobin and anemia. For children below 5 years of age ferritin levels below 12 ng/ml were labeled as low ferritin levels and for children above 5 years of age ferritin level <10 ng/ml was defined as low ferritin level. Those with both hemoglobin and ferritin levels below normal were categorized as having iron deficiency anemia.

Epidemiology

Approximately 8% of toddlers in the Indians have iron deficiency, and 2–3% have iron deficiency anemia (IDA) [3]. As age increases, prevalence decreases until adolescence. Sixteen percent of adolescent girls have iron deficiency, and 3% have IDA [4]. Among India children aged 1to 5 years, the incidence of iron deficiency was 9% and the incidence of IDA was 2%; in the age group 1 to 5 years, the incidence was 11 and 3%, respectively [5]. Less than 1% of adolescent males had iron deficiency. Higher incidence of iron deficiency was found in both male and female adolescents in some other countries [6, 7]. The rate of iron deficiency did not decline much during the last 40 years, but there were significant improvements in some subgroups of young children. For example, in children aged 12–24 months, iron deficiency rates declined from 23 to 11% between two study periods [3].

Definitions

Iron deficiency is a condition when the body lacks sufficient iron to maintain normal physiological functions. It is defined as decreased total body iron or, in some cases, by serum ferritin level <12 mg/l in children up to 1 years and <15 mg/l in children 5 years and older. Although the serum ferritin level is useful in defining iron deficiency, this definition can be considered only if other conditions that can affect ferritin levels (i.e., inflammation or liver disease) are absent. For children less than 5 years of age with concurrent infection, serum ferritin concentrations <30 mg/l are reflective of depleted iron stores [17]. Anemia is defined as a hemoglobin concentration more than 2 standard deviations below the mean reference value for age- and sex-matched healthy population. WHO hemoglobin thresholds used to define anemia in different age groups [2].

Pathophysiology

Iron is an essential micronutrient in the human body. It plays an important role in many metabolic processes, such as oxygen transport, electron transport, and DNA synthesis. Iron is a component of many cellular proteins and enzymes. Heme proteins, hemoglobin and myoglobin, contain about 3/4 of total body iron. The rest of body iron is stored in ferritin and hemosiderin, and about 3% is part of enzyme systems, such as catalase and cytochromes [11]. Iron is mostly recycled from senescent RBCs by macrophages. Only a small proportion of total body iron enters and leaves the body on a daily basis. Consequently, mechanisms that affect intestinal absorption and intercellular iron transport have great impact on iron balance. The serum iron concentration is regulated by absorptive cells in the proximal small intestine, which can regulate iron absorption to compensate for iron body loss. There are three different pathways of iron uptake in the small intestine: the heme pathway and two specific pathways for ferric and ferrous iron, respectively.

Risk factors

During the intrauterine period, the only source of iron is the iron that is crossing through the placenta. The majority of healthy infants have iron stores of about 80 mg/kg, and 2/3 of total iron is bound in hemoglobin molecules. Normal hemoglobin concentration is 15–17 g/dl. Healthy infants have enough body iron for the first 5–6 months of life [12, 13]. There are some conditions that can reduce iron stores at birth or can act through other mechanisms, thus increasing the risk for developing IDA during the first months of life. These conditions are maternal iron deficiency, prematurity, administration of erythropoietin for anemia of prematurity, fetal-maternal hemorrhage, twin-twin transfusion syndrome, other perinatal hemorrhagic events, and insufficient intake of dietary iron during early infancy. Delayed clamping of the umbilical cord (approximately 120–180 seconds after delivery) can improve the amount of iron and significantly reduce the risk of IDA [14]. Risk factors and outcomes links were first assessed by using univariate correlation. Multiple-regression models were then iteratively developed. Variables were retained where the P value for their coefficient remained ≤0.05.

Discussion

In our study, the prevalence of IDA in children aged 6–59 months was 33.2% which according to the WHO criteria represents a 'moderate burden' [2]. We also found a substantial prevalence of low hemoglobin levels, vitamin A deficiency, zinc deficiency, stunting, wasting, and underweight and food insecurity amongst children aged 6–59 months living in India.

The prevalence of IDA in our study is lower than in previous studies in other low resource countries such as Palestine and Kenya [9–10] and substantially below the estimate from a previous study in India [14]. These differences could be attributed to variations in the study settings or factors such as the rate of parasitic infections and dietary habits. The previously published study from India, reported a prevalence of IDA of 63% from a smaller sample (n = 320) taken from a semi urban area, which is not comparable with this population based survey additionally it was conducted 1 to 5 years ago, before the introduction of the iron fortification in India [15]. Our findings are consistent with IDA prevalence reported in Meerut (32.4%) [32], Budaun (34.2%) [16] and the Indian National Nutrition Survey (36%) under-taken in 2001 [13] but are higher than studies conducted in U.P. (20.4%) [14], India (23.1%) [15] and USA (29.1%) [16].

Our study found that the food insecurity status of households is significantly associated with IDA in children, a finding that is consistent with the available literature examining this association [37, 38, and 39]. Food insecurity is characterized by either unavailability of food or inability to procure and access food and has consequences in both macro and micronutrient deficiencies. In India the widespread food insecurity situation reflects the economic instability of many areas of the country [40]. The study found a relationship between maternal iron deficiency

anemia and IDA in children that confirms previous reports [18, 41–43] and high-lights that IDA is common in pregnant and non-pregnant women of reproductive age in India [13]. In our study clinical examination of children detected clinical anemia in 53.6% of IDA cases. This sign can therefore assist in diagnosis where facilities for biochemical testing are not available.

We found the prevalence of IDA to be significantly associated with children's age, with the youngest children having the highest odds of IDA. This finding is consistent with similar studies conducted in Iran, India and the Philippines [36, 39, 44]. The first two years of life is a period of rapid growth with an increased iron requirement therefore risk of IDA is increased in this age. Moreover factors such as limited access to iron rich food, inadequate infant and young child feeding practices including lack of exclusive breast feeding, prolonged breast feeding and inappropriate weaning food and recurrent illnesses increase the chance of young children developing IDA [17, 39, and 45]. We also found that the odds of IDA increased when the child was stunted and food insecure, suggesting that malnutrition is a contributing factor for IDA [9,13, 46].

Some studies have shown that early recognition and treatment of iron deficiency with or without anemia can reverse psychomotor delay and improves psychomotor development [23, 24]. On the other hand, other studies have shown that children who suffered chronic iron deficiency in infancy did not catch up to the group with good iron status in cognitive scores over time [20]. This highlights the importance of timely recognition and treatment of iron deficiency in early childhood. Otherwise this can lead to permanent consequences. Our study has shown very high frequency of low levels among children starting 1 to 5 years .

Conclusion

Low ferritin levels are frequent among children starting 1 to 5 years Low ferritin levels are equally frequent among children with or without anemia. There is weak correlation between ferritin and hemoglobin levels. Pediatricians and other clinicians should not rely on traditional stereotypes but should be wary of the possibility of iron deficiency and subsequent anemia in all children.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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