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Review Article

Iron deficiency anaemia among children in South East Asia: Determinants, importance, prevention and control strategies

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ABSTRACT

Iron deficiency anaemia is one of the most widely prevalent nutritional problems across the world, affecting almost all ages, sex and physiological groups especially the vulnerable groups like preschool children, adolescent girls, and pregnant and lactating women. It adversely affects the morbidity and mortality among children. A large number of surveys and epidemiological studies have shown its high prevalence, risk for maternal and child mortality, various causes and determinants in developing countries. A large number of anaemic children live in South East Asian countries signifying the need for immediate, concerted efforts towards prevention and control. The impact of interventions till date has been varied and unsatisfactory as the prevalence has either increased or shown marginal improvements in these countries. It is time that iron deficiency anaemia is tackled by appropriate interventions utilizing various strategies, delivered through an efficient system while ensuring availability, accessibility, affordability and acceptability of interventions.

1. Introduction

Anaemia, a condition in which the haemoglobin (Hb) concentration or the number and size of red blood cells falls below an established cut-off value, leading to impaired capacity of blood to transport oxygen around the body, is an indicator of poor nutrition and poor health.[1] Table 1 shows the Hb levels used for diagnosis of anaemia at sea level.[2] Anaemia and iron deficiency lead to reduction in individuals' wellbeing, fatigue and lethargy, impaired physical capacity and work performance. Anaemia has an adverse effect on: health and quality of life of millions of women and children; development and learning among children; and economic productivity and development of nations. Anaemia resulting from severe iron deficiency (ID) is the most widely prevalent nutrition-related health problem in infants and young children in developing countries and public health interventions have not yielded significant results.[3]

ID results from sustained negative iron balance and is one of the common nutritional deficiencies during childhood. Initially, the haematocrit and Hb levels are normal while the body stores of iron, ferritin and haemosiderin are reduced, Later, there is reduced level of serum iron, increased iron binding capacity, reduction of transferrin saturation percentage and red blood cells. This stage is called 'iron deficiency without anaemia'. The advanced stage of hyposiderosis, with low Hb and haematocrit, dysfunctional oxygen transport system, erythrocyte cytology and morphology changes, leading to microcytosis and hypochromia is called as IDA.[4]

Inadequacies in dietary intake, absorption or utilization of iron, increased iron requirements during growth, or blood loss due to parasitic infections, are the direct causes of ID. Additionally, other micronutrient deficiencies like vitamin B12, folate and vitamin A, chronic inflammation and inherited disorders of Hb are other causes.[2] Socioeconomic and cultural factors contribute as indirect causes. Measurement of Hb concentration is required for diagnosis of anaemia, while serum ferritin and serum soluble transferrin receptor levels are indicators of iron status. IDA is a combination of anaemia and ID.[2]

Promotion of dietary diversification, anthelminthic treatment, mass fortification, home fortification of foods, and provision of supplements are key public health interventions among children. However, economic, behavioural and programmatic factors impact the effectiveness of such interventions at mass scale.[5] The adherence to and effectiveness of a proven intervention viz. iron supplementation for increasing Hb concentration in children, are variable and adversely affected due to low coverage, insufficient

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Table 1
Haemoglobin levels to diagnose anaemia at sea level (g/dl).

Population	Non-anaemia	Anaemia		
		Mild[a]	Moderate	Severe
Children 6–59 months	≥11.0	10.0–10.9	7.0–9.9	<7.0
Children 5–11 years	≥11.5	11.0–11.4	8.0–10.9	<8.0
Children 12–14 years	≥12.0	11.0–11.9	8.0–10.9	<8.0

Source: Adapted from Ref. 2.
[a] Mild is a misnomer as ID has consequences even when no anaemia is clinically apparent.

availability, prolonged duration of intervention, associated side-effects (e.g. gastrointestinal discomfort, constipation and staining of teeth with drops or syrups), and other community and programmatic issues.[6]

Effective interventions to improve iron status will accrue large health benefits and reduction in prevalence of ID among children and are dependent on well-designed policy and programmes, coupled with efficient and effective implementation. Enhanced demand and compliance are other essentials for reduction in current prevalence levels and future prevention.

2. Determinants

ID in the developing countries is multifactorial and IDA originates in a broader context of biological, cultural and socioeconomic factors with direct as well as indirect causes and components.[5] Additionally, high prevalence of haemoglobinopathies and inflammation coexist with other factors and poor screening and diagnostic facilities preclude their identification. Magnitude of IDA among pregnant women and infants is also influenced by high fertility rates. Moreover, short inter-birth intervals increase the risk of IDA among women and newborns.[7,8] Anaemia of inflammation has not been given much cognizance in the developing world.[9]

2.1. Socioeconomic conditions

Socioeconomic conditions in a country contribute directly or indirectly to prevalence of IDA.[10] Populations living in rural, peri-urban areas and slums are at a higher risk due to unemployment, low wages, poor housing and sanitation, education, health conditions, and also availability, accessibility and affordability of health care services. Other important factors are low availability of foods rich in iron, especially those high in heme iron and vitamin C, non-universalizaion of exclusive breast feeding, parents' level of education and large families with two or more siblings aged less than 5 years. A higher level of education is associated with better chances of being employed and earning with easier access to foods rich in iron. Large families are at an increased risk due to their inability to meet the increased demand for food, healthcare and other facilities.[11–14]

2.2. Food intake and nutritional status

A diet low in iron content and bioavailability is another important factor. ID during pregnancy is positively correlated with number of low birth weight (LBW)/preterm births. In the ID environment, the newborn's requirements of rapid growth and restoration of iron lost in faeces, urine and by the skin are met through the iron stored by the foetus. Exclusive breastfeeding during first 6 months of life suffices to meet infant's physiological requirements, due to high bioavailability of iron in human milk. However, this bioavailability decreases by 80% by early introduction of complementary foods and may lead to IDA. Nutrition has a pivotal role after the sixth month as the iron stores are depleted by then.[15]

Iron absorption is directly affected by a large number of factors. Meats and vitamin C are powerful stimulators of non-heme iron absorption. Animal foods like beef, poultry, fish, goat, liver and pork provide a high bioavailability of heme iron while enhancing the absorption of non-heme iron. Phytates, tannins (polyphenols), calcium, phosphates, eggs, etc. inhibit iron absorption by forming precipitates binding to iron, thus hampering its absorption. The inhibitory effect of calcium on iron absorption has a significant nutritional, pharmacological and health programme importance. ID among pregnant women and consequent malnutrition at birth is regarded as a determining factor for IDA among children especially infants.[11,12] Thus, not only the economic factors of affordability, the social mores and customs also have a direct bearing on the iron intake and absorption in the body.

2.3. Morbidity

Some studies have found suppression of immune system and an increased risk for infection by ID, while others show mild ID benefitting the immune system. The effects of inflammation and infections on iron metabolism are important confounding variables while assessing iron content. The immune system is suppressed by ID and thus some pathogenic agents may have a higher virulence in such individuals, enhancing the risk of infection. However, studies in malaria endemic areas have shown iron to be necessary for the growth and/or reproduction of parasites. Thus, some researchers have proposed that anaemia in infections and chronic diseases may be nonspecific immunological defense mechanism as host response to pathogenic agents and not a disorder associated with infection/inflammation. There is an increased probability of IDA after an acute infection episode, depending upon the length and severity of the disease and its effect on food intake.[9]

2.4. Health care

Efficient Reproductive and Child Health (RCH) services are a must in prevention and control of IDA among pregnant women, to reduce the incidence of LBW and prematurity. The follow-up of child growth and development also reduces the risk of IDA. In developed countries like USA and Australia, ID is no longer a public health problem in children. This reduction of ID rates happened in 1980s consequent to improvement of child health care and nutritional status, increased rate of breastfeeding, implementation of healthy eating habits and also food fortification.[16,17]

2.5. Age and sex

Studies assessing children according to age show a higher prevalence of IDA among 6–24 months as compared to 24–59 months. Accelerated growth and development during first 2 years of life increase the iron requirement. These findings have been similar in both the sexes.

3. Importance of IDA

The importance of IDA can easily be gauged from the magnitude as it is a severe public health problem in many parts of the world and in almost all developing countries with a high burden in many countries of SEA. The consequences of IDA though extremely important at an individual level, gain tremendous importance at population level due to high prevalence.