

Prevalence of Folate, Ferritin and Cobalamin Deficiencies amongst Adolescent in India

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ABSTRACT

Background: In India, 60-90% of adolescent suffer from anemia. Studies have documented folate, ferritin, and cobalamin deficiencies to be the major causes of nutritional anemia. However, limited data is available on the prevalence of folate, ferritin, and cobalamin deficiencies amongst adolescent from India. **Objectives:** The present study was carried out to find out the magnitude of folate, ferritin, and cobalamin deficiencies amongst adolescent of 11-18 years of age in National Capital Territory (NCT) of Delhi, India. **Materials and Methods:** A cross-sectional, school-based study was conducted in NCT of Delhi, India in the year 2010-2011. About 347 adolescent belonging to low- (LIG), middle- (MIG), and high-income groups (HIG) were selected using the probability proportionate to size (PPS) sampling methodology. Serum ferritin, serum folate, and serum cobalamin levels were determined by the enzyme-linked immunosorbent assay (ELISA) method, radioimmunoassay (RIA) method, and radioisotopic method, respectively. Hemoglobin (Hb) estimation was done by cyanmethemoglobin method in all the blood samples collected. **Results:** The prevalence of deficiency of ferritin in HIG, MIG, and LIG categories of adolescent was found to be 52.9, 67, and 58.8%, respectively. In the HIG, MIG, and LIG categories of adolescent, the prevalence of folate deficiency was 22.5, 40.4, and 52.2%, respectively. The prevalence of deficiency of cobalamin in HIG, MIG, and LIG categories of adolescent was 47.1, 80.7 and 87.5%, respectively. About 48, 66.1, and 68.4% of adolescent in the HIG, MIG, and LIG categories, respectively had Hb levels less than 12 g/dL and were found to be suffering from anemia. **Conclusions:** A high prevalence of anemia existed along with deficiency of ferritin, cobalamin, and folate amongst adolescent. The strategies for prevention of anemia amongst adolescent in India should also include cobalamin along with iron and folate supplementation for prevention and control of nutritional anemia. Primary care physicians should suspect all the three causes for anemia.

Keywords: Cobalamin deficiency, folate deficiency, iron deficiency

Introduction

A study conducted in 16 districts of 10 states in India reported that 90% of adolescent suffer from anemia.^[1] The deficiencies of folate, iron, and cobalamin have been documented in the etiology of nutritional anemia, especially amongst vegetarians.^[2,3] A study revealed that there was a high prevalence of deficiency of iron, folate, and vitamin B12 amongst children in the age group of 5-18 years.^[4] The population-based data on the prevalence of folate, iron, and cobalamin deficiencies is scarce from the country, hence, the present study was carried out to find out magnitude of folate, ferritin, and cobalamin deficiencies amongst adolescent in National Capital Territory (NCT) of Delhi, India.

Materials and Methods

A cross-sectional, school-based study was conducted in the NCT of Delhi, India in the year 2010-2011. The adolescents in 11-18 years of age and belonging to low, middle, and high socioeconomic groups were selected using the probability proportionate to size (PPS) sampling methodology. The following steps were adopted in selection of adolescent.

- Three independent lists of schools catering to low- (LIG), middle- (MIG), and high-income groups (HIG) in NCT were prepared
- Adolescents attending municipal corporation or government schools, which had nil monthly tuition fees, were considered as to be catering to (LIG)
- Adolescents studying in Kendriya Vidyalayas (central schools), made by Government of India, for its employees, with tuition fees Rs. 200 per month were considered to be catering to MIG

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- Adolescents studying in reputed private public schools where the tuition fees was Rs. 2000 per month or more, were considered to be catering to HIG.

From each category of the schools (LIG, MIG, and HIG category), 30 schools (clusters) were selected by using PPS sampling methodology. In each school, all the adolescents were enlisted and three to four adolescents were selected with help of random number table, for inclusion in the survey.

A total of 347 adolescents; 102 in HIG, 109 in MIG, and 136 in LIG; were enrolled in the study.

The following inclusion and exclusion criteria was adopted.

Inclusion criteria

- The subjects should be between 11 and 18 years of age
- The subjects should be permanent resident of the study area
- Consent of parents and subject to participate in the study.

Exclusion criteria

- The adolescent with any morbidity during last 14 days were excluded.

The nonfasting venous blood samples were drawn from the antecubital vein and collected in amber-colored polypropylene tubes. The samples were transported in ice packs to the central laboratory at All India Institute of Medical Sciences, New Delhi for separation of serum. The serum was subsequently collected in Ependorff vials, labeled, and stored at -80°C until analysis.

Serum ferritin was determined by the enzyme-linked immunosorbent assay (ELISA) method and levels less than 12 ng/mL were indicative of iron deficiency.^[5,6]

Serum folate was determined by the radioimmunoassay (RIA) method and levels less than 3 ng/mL were considered as indicative of folic acid deficiency.^[7]

Serum cobalamin was estimated utilizing the radioisotopic method and levels less than 200 pg/mL were considered as indicative of cobalamin deficiency.^[8]

For internal quality control, serum sample of known levels of ferritin, folate, and cobalamin were estimated with each batch of assay. If the ferritin, cobalamin, or folate levels of the control were found to be over- or underestimated, the entire batch of assay was repeated.

The hemoglobin (Hb) estimation was done by cyanmethemoglobin method in all the blood samples collected. The Hb levels less 12 g/dL were considered as anemic.

The study was approved by ethical committee of All India Institute of Medical Sciences, New Delhi, India. The written consent was taken from parents of each child for conducting the study.

Limitations of the study

We considered the monthly tuition fees as proxy of the socioeconomic groups. In India, the tuition fee paid by a family is reflection of the family's income in majority of cases. This was the potential limitation of the study.

Results

A total of 347 adolescents were included in the study. The prevalence of deficiency of ferritin in HIG, MIG, and LIG categories of adolescent was found to be 52.9, 67, and 58.8%, respectively. The prevalence of deficiency of cobalamin in HIG, MIG, and LIG categories of adolescent was 47.1, 80.7, and 87.5%, respectively. Similarly, in the HIG, MIG, and LIG categories of adolescent, the prevalence of deficiency of folate was 22.5, 40.4, and 52.2%, respectively [Table 1].

The 48, 66.1, and 68.4% of adolescent in the HIG, MIG, and LIG categories, respectively, had Hb levels less than 12 g/dL and were suffering from anemia [Table 1].

Discussions

It was found that overall 59.7% of the all the adolescent had low serum ferritin levels, indicating high prevalence of iron deficiency among adolescents. In a community-based study conducted in an urban slum of Delhi in low socioeconomic group, 88% of the children below 6 years of age were found to have low serum ferritin levels.^[9] Similarly, in a study conducted in Faridabad district of Haryana amongst young, married, nonpregnant women aged 18 years or more, documented low ferritin (<15 ng/mL) levels among 63.8% women.^[10] The difference in the prevalence of deficiency of ferritin levels in these studies could be due to the difference in the age groups included and different cutoffs utilized in the study. The other factors responsible for the differences in the serum ferritin levels of our study as compared to these studies could possibly be due to the variation in dietary intake, infections, morbid conditions, worm infestation, etc., amongst study subjects.

In the present study, 39.8% of all adolescent had folate deficiency. An earlier study conducted in a tertiary care hospital in Delhi, also reported a high prevalence of folate deficiency (cutoff used was <5 ng/mL) of 50% among children suffering

Table 1: Distribution of study subjects according to deficiency of ferritin, cobalamin, and folate in three socioeconomic groups

Micronutrient deficiency	HIG (n=102) (%)	MIG (n=109) (%)	LIG (n=136) (%)	Total (n=347) (%)
Ferritin (<12 ng/mL)	54 (52.9)	73 (67.0)	80 (58.8)	207 (59.7)
Cobalamin (<200 pg/mL)	48 (47.1)	88 (80.7)	119 (87.5)	255 (73.5)
Folate (<3 ng/mL)	23 (22.5)	44 (40.4)	71 (52.2)	138 (39.8)
Anemia (Hb<12 g/dL)	49 (48.0)	72 (66.1)	93 (68.4)	214 (61.7)

LIG: Low-income group; MIG: Middle-income group; HIG: High-income group

from megaloblastic anemia, aged 6 months-12 years.^[11] The findings of our study are similar to a study which reported a prevalence of 27.7% for low folate levels (<3 ng/mL) among young married women.^[10] In another study, 33% of non-breastfed infants of low socioeconomic group were found to have poor ferritin levels (cutoff used was <5 nmol/L).^[12] The difference in the prevalence of deficiency of folate levels in these studies could be due to the difference in the age group of subjects included and different cutoffs used in the study. The difference could also be due to the variation in dietary intake, infections, etc.

In the present study, 73.5% of the adolescents had deficiency of cobalamin. Limited studies are documented from India on the cobalamin status amongst adolescents. Similarly, in a study conducted amongst children aged 6-30 months in an urban community documented cobalamin deficiency among 48% children.^[9] An earlier study conducted, reported a prevalence of cobalamin deficiency in 62% of children suffering from megaloblastic anemia.^[11] Cobalamin is derived from the food, of animal sources like liver, kidney, egg, fish, and milk. The vegetarians in India have lower serum cobalamin levels than nonvegetarians.^[13] In the present study, high prevalence of cobalamin deficiency could be due to the low dietary intake from vegetarian diets.

A recent study documented a prevalence of ferritin, folate, and vitamin B12 deficiencies to be 54.5, 42.0, and 67.2% for children in the age group of 5-11 years; and 55.0, 30.7, and 68.3% for adolescents in the age group of 12-18 years, respectively.^[4] In a study conducted in Bangladesh, 28% of the adolescent girls in the age group of 14-18 years had depleted iron stores (serum ferritin <12.0 mg/L), 25% had folic acid deficiency (red blood cell folic acid <317 nmol/L), and 7% had vitamin B12 deficiencies (serum vitamin B12 <150 pmol/L).^[14]

In the present study, a high prevalence of anemia was found in adolescents of LIG, MIG, and HIG.

The present study revealed that there was a high prevalence of deficiency of folate, iron, and cobalamin stores amongst adolescents studied. These findings suggest that apart from iron and folate deficiency, poor cobalamin levels may also have a role in etiology of anemia. Also, along with iron and folate supplementation, cobalamin supplementation should be considered by the policy makers as well as by primary care physicians; if there is high magnitude of cobalamin deficiency existing in the population. This could help in substantial reduction in prevalence of nutritional anemia.

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