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Dietary deficiencies among families of air warriors: Use of iron deficiency anemia as an index

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ABSTRACT

Introduction: Anemia is a prevalent health problem in India affecting all age groups. It has shown the highest prevalence among preschool children and occurs more commonly in the lower socioeconomic group. Observationally, it was noticed at an Air Force station that preschool children of air warriors had iron deficiency anemia at levels similar to those seen in lower socioeconomic groups. This prompted us to evaluate dietary practices among families of air warriors as a contributory factor to iron deficiency in these children.

Material and Methods: All anemic children diagnosed of iron deficiency in the age group of 6–59 months were included in the study. Data were compiled from the clinical history, dietary habits and laboratory parameters obtained. The dietary habits were analyzed based on parameters defined in the current infant and young child feeding guidelines such as exclusive breastfeeding, minimum meal frequency, minimum dietary diversity, and minimum acceptable diet. Mann–Whitney U-test was used to determine statistical significance of difference between means of two independent groups. Spearman correlation analysis between two independent variables was done and multiple linear regression analysis was performed to identify predictor variables for iron deficiency anemia.

Results: About 74.1% of the anemic children fell into age group of 6–23 months (infants and young children). 75% of children of the age group of 6–23 months were started on cow's milk at the time of weaning. The average amount of cow's milk consumed in a day was 0.7 L. In this age group, the minimum dietary diversity was observed in 11.1%, minimum acceptable diet in 5.5% and minimum meal frequency in 22.2% of the children. In the same age group, a statistically significant negative correlation was observed between cow's milk quantity given per day and hemoglobin ($\rho = -0.77$). A significant negative correlation was found between cow's milk quantity and variables such as age and number of solid meals received in a day ($\rho = -0.553$ and -0.526, respectively). In multiple regression analysis with hemoglobin as the dependent variable, a significant negative association was observed with cow's milk quantity. Age showed statistically significant positive correlation with hemoglobin ($\rho = 0.762$) which was also seen on linear regression analysis. Serum ferritin was low in 44.5% while total iron-binding capacity was raised in 100% of the cases.

Conclusion: Iron deficiency anemia was disproportionately distributed among infants and young children (age group 6–23 months). Copious consumption of cow's milk in this age group led to fewer solid feeds per day and lack of dietary diversity which led to an iron deficient state in these children. This probably resulted in manifestation of anemia in this population. The study brings out the need for dietary counseling for air warriors and their families to ensure better health and lower disease burden.

Keywords: Iron deficiency anemia, Complimentary feed, Dietary diversity, Cow's milk

INTRODUCTION

Anemia is a global health problem affecting the developing countries with major consequences on human health. The World Health Organization (WHO) has estimated that globally 1.62 billion

people are anemic, the highest prevalence of anemia being among preschool children (47.4%).[1]

Anemia is a severe public health problem in India. The National Family Health Survey done in 2015–2016 revealed that 58.6% of preschool children aged 6–59 months were anemic (hemoglobin [Hb] <11.0 g/dl). The most common cause of anemia in this age group was iron deficiency.[2]

Iron deficiency anemia is disproportionately concentrated in low socioeconomic groups.[3] Observationally, it was noticed at an Air Force station that preschool children of air warriors had nutritional anemia at levels similar to those seen in lower socioeconomic groups. This prompted three questions. First, was this a serendipitous observation or an actual trend? Second, if the answer to the first question is yes and air warriors have a good socioeconomic status,[4] why then do they have trends similar to those from a poor socioeconomic stratum? Third, what is the way forward to ensure adequate nutrition amongst air warriors and their families?

MATERIAL AND METHODS

This cross-sectional observational study was conducted at the department of pathology and pediatrics at a multispecialty hospital at an Air Force station in Uttar Pradesh. Ethical clearance was sought as per the norms of the institution. Children of air warriors, aged 6–59 months, who were diagnosed to have iron deficiency anemia were included in the study. However, those with comorbidities such as hemoglobinopathies, chronic liver disease, chronic renal disease, leukemia, tuberculosis, or nephritic syndrome were excluded from the study.

The children were diagnosed of anemia based on the WHO criteria for this age group.[5] Iron deficiency was diagnosed based on age-specific cutoff values for serum ferritin.[6] In cases where the children suffered from acute infections, serum total iron-binding capacity (TIBC) was considered as the criterion for diagnosing iron deficiency since serum ferritin is an acute-phase reactant.

A detailed history including perinatal history, associated illnesses, pica, and passage of worms in stools was obtained. Emphasis was laid on dietary history, especially the relative quantity of milk and supplementary feeds given to the children. Based on the dietary history, indicators for assessing infant and young child feeding practices were calculated as follows:[2]

Minimum meal frequency was defined in breastfed and non-breastfed children of 6–23 months age, who had received solid or semi-solid foods (including milk feeds for non-breastfed children). Minimum required meal frequency was defined as 2 solid/semisolid meals per day for breastfed infants who were 6–8 months old and 3 meals per day for breastfed children of 9–23 months age. For children who were not breastfed, receiving solid or semi-solid food or milk feeds at least 4 times a day were considered the minimum requirements.

Minimum dietary diversity was defined in children of 6–23 months age as having received food from 4 or more food groups during the previous day. The food groups used for the calculation of this indicator were as follows:

a. Infant formula, milk other than breast milk, cheese, or yogurt or other milk products
b. Foods made from grains or roots, including porridge or gruel, fortified baby food
c. Vitamin A-rich fruits and vegetables
d. Other fruits and vegetables
e. Eggs
f. Meat, poultry, fish, shellfish, or organ meats
g. Beans, peas, lentils, or nuts
h. Foods made with oil, fat, ghee, or butter.

Minimum acceptable diet was considered achieved if the minimum dietary diversity and the minimum meal frequency had been achieved.

With informed consent of the parents or guardians, samples were drawn for the assessment of hematological parameters such as Hb, mean corpuscular volume, mean corpuscular hemoglobin (MCH), MCH concentration, reticulocyte count, and differential leukocyte count.

The hematological parameters were assessed using automated hematology analyzer (Beckman Coulter LH 750). The serum iron and TIBC estimation (Coral, Tulip) were done using semi-automated biochemistry analyzer. Serum ferritin (Calbiotech) was estimated by ELISA method.

High-performance liquid chromatography for Hb was done to rule out hemoglobinopathies in cases where reticulocyte count was high or Mentzer index was low (MI <12).[6]

Statistical methods

Mean and standard deviation were computed for numerical variables. Mann–Whitney U-test was utilized to determine statistical significance in difference between means of two independent groups. Spearman correlation analysis between two independent variables was done. Multiple linear regression analysis was performed to identify predictor variables for iron deficiency anemia. $P < 0.05$ was considered statistically significant.

RESULTS

Twenty-seven children fulfilled the inclusion criteria and formed the study population. All mothers had received iron supplementation during the antenatal period and none of the

children were diagnosed of anemia before 6 months of age. About 97% of the children were born at term and 25.9% of children had low birth weight. 11.1% of children were found to be underweight.

The frequency distribution of iron deficiency anemia with age is shown in Table 1. 74.1% of cases belonged to the age group of 6–23 months (infants and young children). The mean Hb of the study population was 8.75 g/dl (95% CI 8.15–9.35). For age group 6–23 months, the mean Hb was 8.3 g/dl (95% CI 7.6–8.99) as compared to age group 24–59 months where the mean Hb was 9.96 g/dl (95% CI 9.43–10.49). The difference between mean Hb of these two age groups was statistically significant by Mann–Whitney U-test ($P = 0.028$).

All the cases of severe anemia belonged to the age group of 6–23 months while 73.3% of those with moderate anemia were infants and young children. A significant positive correlation was observed between Hb and age ($\rho = 0.54$, $P = 0.003$).

While assessing the serum iron indices, it was observed that all children had presented with associated acute infection, 48.1% of which was respiratory tract infection. Serum ferritin was found to be raised in 25.9%, normal in 29.6%, and low in 44.5% of the cases. However, serum TIBC was raised in all the cases while serum iron was low in 11 (40.74%) of the cases.

About 11.1% of children had eosinophilia. No child had associated complaints of passing worms in stools. Pica was observed in 14.8% of children. There was no correlation observed between pica and occurrence of eosinophilia.

The diet of these children was studied in detail. About 81.5% of children were exclusively breast fed till 6 months of age. The mean Hb of such children was 8.89 g/dl (95% CI 8.21–9.57) as compared to children not on exclusive breast milk where the mean Hb was 8.14 g/dl (95% CI 6.75–9.53). There was no statistically significant difference observed between the two means by Mann–Whitney U-test.

Complementary feeding was started in 88.8% of children in the study by 7 months of age. The types of complementary feeds received in the past 24 h are shown in Table 2. In the age group of 6–23 months, the minimum dietary diversity was observed in 11.1%, minimum acceptable diet in 5.5%, and minimum meal frequency in 22.2% of the children.

About 75% of children of age group 6–23 months were started on cow's milk at the time of weaning. The average amount of cow's milk consumed in a day was 0.7 L in this age group. Multivariate correlation analysis in the age group of 6–23 months between Hb, age, quantity of cow's milk consumed per day, and the number of solid meals received in a day was done, as shown in Table 3. Age showed statistically significant positive correlation with Hb ($\rho = 0.762$). On the other hand, a statistically significant negative correlation was observed between cow's milk quantity given per day and Hb ($\rho = -0.77$). A significant negative correlation was found between quantity of cow's milk and variables such as age and solid meals taken per day ($\rho = -0.553$ and -0.526, respectively). In multiple linear regression analysis with Hb as the dependent variable, significant association remained with quantity of cow's milk and age, as given in Table 4. Hb showed an inverse association with quantity of cow's milk consumed per day and a positive association with age.

DISCUSSION

Anemia is a prevalent public health problem in preschool children belonging to lower socioeconomic strata due to poor sanitary conditions, malnourishment, and poor educational status of mothers. Usually, these factors are mitigated in the families belonging to the middle socioeconomic stratum, in which the present study was performed. Anemia and its severity were found to be disproportionately distributed among the infants and young children (age group 6–23 months) hailing from air warriors' families. Considering the uniqueness of the situation, we evaluated dietary factors which might have contributed to iron deficiency in these children.

Table 1: Distribution of iron deficiency anemia with age.

Age intervals (months)	Anemia			Total number of cases (%)
	Mild number of cases (%)	Moderate number of cases (%)	Severe number of cases (%)	
6–11	1 (3.7)	4 (14.8)	2 (7.4)	7 (25.9)
12–17	0	5 (18.5)	3 (11.1)	8 (29.6)
18–23	3 (11.1)	2 (7.4)	0	5 (18.5)
24–29	0	1 (3.7)	0	1 (3.7)
30–35	1 (3.7)	1 (3.7)	0	2 (7.4)
36–41	0	0	0	0
42–47	1 (3.7)	1 (3.7)	0	2 (7.4)
48–53	1 (3.7)	0	0	1 (3.7)
54–59	0	1 (3.7)	0	1 (3.7)
Total number of cases (%)	7 (25.9)	15 (55.5)	5 (18.5)	27

Poor dietary practices while receiving complementary feeds were a constant finding in this cohort. About 75% of these children consumed cow's milk as major constituent of their diet; the average daily consumption being 0.7 L. Increasing quantity of cow's milk consumed was associated with a decrease in Hb as brought out in linear regression analysis [Table 4]. Copious consumption of cow's milk had probably resulted in a decreased solid meal frequency and dietary diversity. In addition, bovine milk proteins are known to be potent inhibitors of iron absorption because of which only 10% of iron is absorbed from cow's milk as compared to breast milk (50%).[7] Insufficient intake of iron rich foods, poor bioavailability of iron, and consumption of iron absorption inhibitors had probably made these infants and young children vulnerable to iron deficiency.

Although most of the children were started with complementary feeds by 7 months, the minimum dietary diversity was lacking in 88.9% of the cases. The most common solid food provided in the past 24 h was *khichdi* which is a poor source of iron. None of the children had consumed iron-rich food such as meat, organ meats, fish, or poultry.[2] Thus, apart from cow's milk, the solid meals received by the children were also deficient in iron.

About 74.1% of cases of anemia were found in the children of age group 6–23 months with the severity of anemia reducing as the age advanced as brought out in the linear regression analysis [Table 4]. A recent Indian survey has shown that as the children grow older, their diet transitions from being predominantly milk based on a more diverse micronutrient-rich diet.[2] Consequently, as the age progressed, the dominance of cow's milk in the diet was diminished along with its undesirable effects.

It was ironical that this high rate of anemia was observed despite no other known risk factors of iron deficiency anemia such as maternal iron status and period of gestation[8] playing a part, since all mothers had received iron supplementation during the antenatal period and none had suffered from severe anemia during pregnancy. About 97% of the children in the study population were born at term. Exclusive breastfeeding which protects against iron deficiency in the first 4–6 months of life[2,7,9] was a prevalent practice in this population. None of the children were diagnosed of anemia before 6 months of age.

The ferritin levels in the present study showed high variability and was found to be low in only 44.5% of the children. Coexisting acute illnesses were present in all the children. Serum ferritin is an acute-phase reactant and is increased in inflammation which leads to an underdiagnosis of iron deficiency in such cases.[10] In such a scenario, an alternative indicator for iron deficiency is needed to be sought. TIBC was found to be a reliable diagnostic marker for iron deficiency in this study. Serum iron, TIBC, and related indices should be relied on before completely ruling out iron deficiency in children presenting with anemia along with acute infection, especially if ferritin is normal or raised.

Table 2: Types of complimentary food given in the past 24 h to the children in the age group of 6–23 months.

Type of complimentary food	Number (%)
Khichdi	9 (29)
Cerelac	8 (25.8)
Fruit	3 (9.7)
Dal	5 (16.1)
Dal chawal	2 (6.4)
Biscuit	1 (3.2)
Roti doodh	1 (3.2)
Dal roti	2 (6.4)

Table 3: Multivariate Spearman's correlation between hemoglobin, age, quantity of cow's milk consumed per day and number of solid/semi-solid meals received per day in the age group of 6–23 months.

	HB	Age	Cow milk qty	Solid meals
Spearman correlation (ρ)				
HB	1.00	0.762	−0.77	0.483
Age	0.762	1.00	−0.553	0.752
Cow milk qty.	−0.77	−0.553	1.00	−0.526
Solid meals	0.483	0.752	−0.526	1.00
Significance (two tailed)				
HB		<0.001	<0.001	0.068
Age	<0.001		0.032	0.001
Cow milk qty.	<0.001	0.032		0.044
Solid meals	0.068	0.001	0.044	

CONCLUSION

In summary, children of air warriors were found to be anemic, despite them having an adequate socioeconomic status and resources. The associated factors in this population were high reliance on cow's milk as a complementary food and poor dietary diversity. At the same time, the study indicated

Table 4: Multiple linear regression analysis with hemoglobin as the dependent variable in the age group of 6–23 months.

Independent variables	Adjusted R square	Unstandardized coefficient B	95% confidence intervals	Significance
Cow's milk consumed per day	0.741	−2.917	−5.338–−0.495	0.022
Age		0.212	0.077–0.347	0.005

adequate antenatal care, and the children starting off with no deficiency at birth. The study brings out the need for dietary counseling for air warriors and their families to ensure better health and lower disease burden.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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