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Biology and Medicine

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*T Jain[1], H Chopra[2], Y Mohan[3], S Rao[1]
[1] Community Medicine, Saveetha Medical College, Kanchipuram Distt, Tamil Nadu, India.
[2] Community Medicine, LLRM Medical College, Meerut, UP, India.
[3] AHERF, Chennai, Tamil Nadu, India.

The study was done as a part of PG project in Department of Community Medicine in LLRM Medical College, Meerut.

*Corresponding Author: dr.timsi@gmail.com

Abstract
Many studies in recent times have highlighted the high prevalence of anemia among adolescent girls in India; however, there is limited published literature on prevalence of anemia among adolescent boys. A cross sectional study was done among school going children across a wide section of society to get a representative sample from urban Meerut. Sample of 400 boys were selected using random sampling across both English and Hindi medium schools. In addition to Hemoglobin estimation, weight and height was recorded, and socio economic history was taken. Overall 43% of the boys were found to be anemic with 23% having moderate to severe anemia. Prevalence of anaemia was significantly higher among children who took 2 meals per day (49%) compared to those who took 3 meals per day (39%). Anemia had no correlation with BMI, with 50% of overweight and obese children having anemia. The prevalence of mild anemia was found to be high even among boys coming from higher socio economic classes, although the prevalence of severe anemia was significantly higher among lower socio economic classes.

Keywords: Adolescent boys; anemia; urban; India.

Introduction

Adolescence is a period of transition from childhood to adulthood. Adolescence has been defined by WHO as the period of life between 10-19 years (World Health Organization, 1996). These are the formative years when the maximum amount of physical and psychological growth takes place. During this time, 20% of final adult height and 50% of adult weight are attained. As a consequence of this rapid growth, adolescents are vulnerable to nutrition deficiencies, especially iron deficiency anemia (World Bank, 2003).

During this period, iron requirement increases dramatically in both adolescent boys and girls, from preadolescent level of 0.7-0.9 mg Fe/day to as much as 2.2 mg Fe/day. This increase in iron requirement is the result of expansion of total blood volume, increase in lean body mass and the onset of menstruation in adolescent females (Beard, 2000). Iron needs are highest in males during peak pubertal development because of a greater increase in blood volume, muscle mass and myoglobin (Hyder *et al.*, 2007).

Iron deficiency and anemia are associated with impaired cognitive functioning, lower school achievement and most likely lower physical work capacity. World Health Organization has estimated that 27% of adolescents in developing countries are anemic. ICRW studies have documented 55% adolescents are anemic in India, 42% in Nepal, 32% in Cameroon and 48% in Guatemala (World Bank, 2003).

Proper nutrition plays an important part in a teenager's growth and development (National Anemia Action Council, 2009). Since bioavailability of iron in Indian diets is poor, on an average 8.5 mg Fe/1000 Kcal consumed (Nair and Iyengar, 2009). Iron supplements have to be provided to the adolescents, both boys and girls. In our country, most of the National Programmes related to supplementary nutrition (Integrated Child Development Scheme, ICDS), iron supplementation (Reproductive and Child Health Program, RCH) are focusing only on adolescent girls as they are the future mothers, but none of the programmes are there for the adolescent boys.

Most of the published literature focuses on anemia among adolescent girls, while there is a paucity of information on status of anemia among adolescent boys. The present study was designed to find out the status of anemia among

adolescent boys and its relation with socio-demographic factors.

Materials and Methods
Total 400 boys in the age group of 10 to 19 years were selected for the study. The sample size was calculated assuming prevalence of anemia to be 50% with 95% confidence interval and relative precision of 10%. An equal number of 200 boys from Hindi medium and 200 boys from English medium schools of urban Meerut were included in order to cover a wide spectrum of the socio-economic classes of the society.

All the schools of Meerut were listed. Three schools each from English and Hindi medium were randomly selected. From 1 school each of Hindi and English medium, 5th to 7th class, 8th to 10th class and 11th to 12th class was selected respectively. A prior consent was taken from the respective school authorities explaining the objective of the study. The study process was discussed with children in the presence of the teachers, and only those children who volunteered were included in the study.

Students were interviewed using a pre tested questionnaire to elicit information regarding their socio-demographic profile. Height and weight (nearest 1 cm and 0.5 kg respectively) was recorded for every student using standardized instruments. Blood samples were taken by finger prick method using sterilized needles by a trained lab attendant. Hemoglobin estimation was done by cyan-methaemoglobin method using calorimeter.

The data was coded and transferred to a master chart in MS Excel. Statistical analysis was done by using the statistical software, SPSS Version 10.0, proportions were calculated and chi square test was used as a test for significance.

Results
Total 171 (42.8%) boys were found to be anemic, with 23% of the boys having moderate to severe anemia.

Table 1: Distribution of anemia in adolescent boys according to its severity (De Maeyer *et al.*, 1989).

Severity Hb (gm/dl)	No. of Adolescents	Prevalence
Mild (10- cut off)	79 (46.4)	19.8
Moderate (7-10)	67 (39.1)	16.8
Severe (<7)	25 (14.5)	6.2
Total	171 (100.0)	42.8

Table 2: Age-wise prevalence of anemia* and severity of anemia in relation to age**.

Age group	No. of boys	Anemic cases	Mild	Moderate	Severe	Mean Hb+SD
10-13	227 (56.8)	101	46 (45.6)	39 (38.6)	16 (15.8)	12.05± 3.05
14-16	130 (32.5)	49	17 (34.7)	23 (46.9)	9 (18.4)	12.95± 3.60
17-19	43 (10.7)	21	16 (76.2)	5 (23.8)	0 (0.0)	13.13± 2.51
Total	400 (100.0)	171	79	67	25	

*X^2 = 2.29; df = 2; p>0.05
**X^2 = 11; df = 4; p<0.05

The difference between prevalence of anemia in different age groups was not found to be significant. Prevalence of anemia was found more in boys who gave history of passing worms (55.6%) in comparison to those giving no history of passing worms (41.7%), however, the

difference was not found to be statistically significant. Anemia was more prevalent among boys who were having meals twice a day (49.3%) than among boys who were having meals thrice a day (38.7%) (p<0.05%).

Table 3: Prevalence of anemia according to socio-economic status (modified Kuppuswamy classification) (Mishra and Singh, 2003).

Socio-economic status	Score	No. of boys	Anemic cases	Prevalence
Upper	26-29	11	3	27.3
Upper middle	16-25	161	63	39.1
Lower middle	11-15	174	75	43.1
Upper lower	5-10	54	30	55.6
Total		400	171	42.8

X^2 = 5.565; df = 3; p>0.05 (No student of lower class was found).

Majority of upper lower class students (55.6%) were anemic and the prevalence of anemia decreased with increase in socio-economic status but the difference was not statistically significant. Prevalence of anemia was higher among boys who had illiterate mothers (47.4%) and just literate mothers (50.0%) and minimum in boys with graduate mothers (36.9%) but the difference was not statistically significant. Prevalence of severe anemia was, however, found to be significantly higher among upper lower and lower middle class (p<0.05). Thirty-nine percent of the students were underweight, and only 4.5% were overweight or obese. Even among the overweight and obese students, the prevalence of anemia was high at 50%.

Table 4: Prevalence of anemia in relation to BMI (Elizabeth and Jacob, 2005).

BMI	Category	No. of boys	Anemic cases	Prevalence
<15	Under wt.	157 (39.3)	71	45.2
15-22	Normal	225 (56.2)	91	40.0
22-25	Over wt.	14 (3.5)	7	50.0
>25	Obese	4 (1.0)	2	50.0
		400 (100)	171	42.8

X^2 =1.27; df = 3; p>0.05

Discussion

Prevalence of anemia in adolescent boys was found to be relatively high (42.8%) when compared to studies conducted by the International Center for Research on Women, which found 55% prevalence of anemia in adolescent males and females in India (Senderowitz, 1998). In Egypt (Population Council, 2008), nearly half (47%) of the adolescents suffer from anemia. The finding of the present study was found to be quite high as compared to world health statistics (De Maeyer *et al.*, 1989) that suggested 17% prevalence of anemia in adolescent boys in Asia.

Prevalence of anemia in 10-13 yrs, 14-16 yrs and 17-19 yrs age group with mean Hb was found to be 44.5% (12.05$\pm$3.05), 37.7% (12.95$\pm$3.60) and 48.8% (13.13$\pm$2.51) respectively. Prevalence of anemia was reported to be 27.8% in 12-14 yrs and 41.3% in 15-18 yrs age group of adolescent boys of schools of rural Delhi with mean Hb 12.45$\pm$0.86 and 13.04$\pm$0.68 respectively (Anand *et al.*, 1999). Moderate to severe anemia was found in 41% among 10-13 yrs and 17% of 14-16 yrs age group indicating body growth spurt and higher requirement of iron in these age groups.

In the present study, prevalence of anemia did not vary significantly among adolescents when associated with socio-economic class. Similar results have been reported by study done by population council in Egypt (Population Council, 2008). A high prevalence of anemia was found in upper

(27.3%) and upper middle (39.1%) socio-economic class. High prevalence of anemia was also reported in upper and upper middle class (14.0% and 39.4% respectively) among urban school children (5-15 years) of Punjab (Verma *et al.*, 1998). However, severe anemia was more common among lower socio economic classes. Thavraj and Reddy (1985) had also noted iron deficiency among 20% of healthy, non-anemic, high income group children. In the study on anemia among Egyptian adolescents it was found that prevalence of anemia was relatively high among adolescents belonging to higher socioeconomic stratum (43.4%) (El-Sahn *et al.*, 2000). They suggested that anemia in higher stratum of society may be related to their choice in dietary habits. No statistically significant relation was found between prevalence of anemia among adolescent boys with their mother's education. It implies insufficient awareness of anemia and iron deficiency among mothers irrespective of their education status.

A high prevalence of anemia was found in boys, those who were overweight (50.0%) and obese (50.0%). Verma *et al.* (1998) also found 47.6% prevalence of anemia in well-nourished urban school children of Punjab. This can be attributed to the fact that bioavailability of non-haem iron is poor owing to presence of phytates, oxalates, carbonates, phosphates and dietary fibre which interferes with iron absorption. Indian diet, predominantly vegetarian food, contains large amounts of inhibitors like phytates in bran, tannin in tea, oxalates in vegetables and phosphates in egg yolk, interfering with iron absorption (De Maeyer *et al.*, 1989; Nair and Iyengar, 2009).

Conclusion

This study highlights the high prevalence of anemia among the adolescent boys. Anemia is equally prevalent among well nourished boys, as well as in all socioeconomic classes indicating that iron is a specific nutrient whose requirement cannot be fulfilled through normal Indian diet in growing adolescent period. This suggests the need for routine iron supplementation even among adolescent boys across all social strata.

Acknowledgement

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