

Original Research Article

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Regional Disparity Analysis for Iron Status of School-Going Children from Punjab, India

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ABSTRACT

The aims of this study were to assess regional disparity in anemic status and to identify the sociodemographic factors associated with the prevalence of anemia among school-children from Punjab, India. A school-based cross-sectional study was conducted on 210 children (11-17y) randomly selected from government schools of three regions of Punjab, namely Majha (n=45), Doaba (n=45) and Malwa (n=120). Data on sociodemographic characteristics and dietary intake of children were collected through questionnaire based survey. Information on clinical signs/symptoms of anemia and compliance to iron-folic acid supplementation was obtained. Hemoglobin concentration was estimated by cyanmethaemoglobin method. Data were analyzed by Tukey's post-hoc test and Fisher's exact test using SPSS version 23.0. Overall, children's diets were highly inadequate in iron, i.e., less than 43% of the recommended dietary allowances. Clinical examination showed more than half of the subjects exhibiting signs/symptoms of anemia. Compliance to iron-folic acid supplementation was 100% in Majha region subjects, while, it was 93 and 77% in Doaba and Malwa region subjects, respectively. Anemia prevalence was 91, 98 and 100%, among school-children of Majha, Malwa and Doaba region, respectively. Mean hemoglobin level of the subjects from Majha region (10.7g/dl) was statistically significantly ($p=0.029$) higher than Doaba region (10.4 g/dl) and non-significantly higher than Malwa region subjects (10.4g/dl); however, the age and gender specific mean hemoglobin values of all the subjects was lower than the reference values for their corresponding age groups. In Majha region, caste ($p=0.02$) and family income ($p=0.01$) were found significantly associated with anemia. The study finds anemia as a severe public health problem among school-children of Punjab. This paper fulfills an identified need to undertake more studies considering regional variations across the states, in order to obtain a clearer picture on magnitude of the problem, causes and factors associated with anemia.

Keywords

School Children,
Iron Status, Region,
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Introduction

Globally, Iron Deficiency Anemia (IDA) is the most common micronutrient deficiency disorder, mainly affecting preschool children,

pregnant women and lactating mothers (Kotecha, 2011). "Anemia" is used for a group of conditions that result from an inability of erythropoietin tissues to maintain a normal hemoglobin (Hb) concentration on

an account of inadequate supply of one or more nutrients leading to a reduction in the total circulating hemoglobin. For the formation of and normal growth of RBCs, iron and vitamins, like folic acid and B₁₂ are essential (Srilakshmi, 2005). Lack of circulating Hb leads to fatigue and diminished capability to perform hard labour; however, they occur out of proportion to the degree of anemia and probably are due to a depletion of proteins that require iron as a part of their structure. Increasing evidence suggests that deficiency or dysfunction of non-hemoglobin proteins has deleterious effects such as muscle dysfunction, pagophagia (pica), dysphagia (difficulty or discomfort in swallowing), poor scholastic performance, altered resistance to infection, and altered behaviour (Harper and Conrad, 2015).

Pallor indicated by yellow discoloration of the skin, mucosa and body secretions, mainly conjunctiva, nail beds and crease of palm, is considered as the most vital clinical sign of anemia. The clinical manifestations of anemia depend on whether anemia is of rapid or insidious onset. Anemia of gradual onset (if mild) may be asymptomatic or simply manifest as fatigue, headache and pallor; whereas if anemia is more severe, present with features such as dyspnoea (difficult breathing), tachycardia, palpitations, angina, light-headedness, faintness, and signs of cardiac failure (Weatherall and Hatton, 2010).

In India, there is the widespread occurrence of IDA; that may be attributed to undesirable cultural practices in the cooking and preparation of foods such as discarding the cooking water from cereals, mainly seen in the rural areas of the country reduces the nutritive value of food (Shekhar and Babu, 2009). About 73% of the children aged 5-11 years, in India, are suffering from anemia. Based on India State Hunger Index, Punjab has the lowest level of hunger in India

(Menon *et al.*, 2009). As per Planning Commission of India (2011-12), the percentage of below poverty line (BPL) population in Punjab is 8.3%, which is significantly lower than the national average. According to National Sample Survey (NSS)-68th round (2011-12), the average Monthly Per Capita Expenditure (MPCE) of rural Punjab was the second highest among major states after Kerala. Despite the economic progress, Punjab lags behind in social development, particularly in the area of health of children. According to National Family Health Survey (NFHS-3, 2005-06), in Punjab, majority (66%) of the children under five years of age were suffering from anemia.

An appropriate diet has a considerable effect on society's health improvement. Eating habits in adolescence often differ substantially from those in any other phase of life. An unbalanced diet in the adolescents could damage their health and quality of life (Barzegari *et al.*, 2011). Anemic children are more likely to be underweight too, because in developing countries like India, poor bioavailability of dietary iron coupled with low intake of heme-iron derived from animal foods is a major etiological factor for anemia. Such higher rates of anemia among children could affect their physical work capacity and cognition; and because of these adverse impacts, studies on the magnitude of anemia among school age children have paramount importance (Assefa *et al.*, 2014).

The geographic location of a child is an important determinant of his/her nutritional status, as the regions with poor nutritional status of the population tend to pull the overall health status of the country down (Bishwakarma, 2011). Many countries maintain a degree of heterogeneity between its states or regions due to different ethnic or religious groups, economic development, geography or climate. All these are reflected

on socio-economic indicators as well as health indicators (Smith *et al.*, 2005). The analysis of the nutritional status of children in India would be incomplete without paying attention to the health related sociodemographic and regional disparities that exist between and within the states, and the inequalities that persist among different sub-groups of the population. However, only few studies have attempted to quantify the contribution of these factors in child nutrition outcomes. In this regard, the study aimed to assist policy makers and state health ministries, by assessing the regional disparity in anemia and identifying the factors associated with anemia among 210 school-children aged 11-17 years, from Punjab (India).

Materials and Methods

Study setting and sampling techniques

Using a multistage sampling technique, total five districts; one each from Majha (n=45) and Doaba (n=45) regions and three districts from Malwa region (n=120) of Punjab were selected targeting school-children. In the next stage of sampling, two blocks from each district were selected. The last stage included selecting two rural and one urban government school from each block selected in order to have a total random sample size of 210 children in the age group of 11-17 years. As Malwa region makes up the majority of Punjab state (65% of the total area and 59% of the total population), it is considered as the biggest region in Punjab (Census of India, 2011). Thus in the study also, the proportion of school-children from Malwa region was more.

Anemic status was defined based on the WHO (2011) criteria for different hemoglobin cut-offs for children aged 11-17 years. Inclusion criteria consisted of healthy children

aged 11-17 years, residing in the study area for a minimum period of 6 months; children enrolled in government schools; and who were able to provide verbal or written consent to participate in the study. Exclusion criteria comprised of children with significant medical conditions (e.g., asthma, comorbidities); who were unwilling to provide blood samples; and age outside of study limits were excluded from the study. Ethical clearance for the study was taken from the Institutional Review Board of Punjab Agricultural University, Ludhiana (Punjab, India). Consent of each participant was also ascertained from the parents through the school authorities.

Data collection tools and methods

A well-structured questionnaire was formulated and pre-tested to ensure the validity of the questionnaire. On the basis of information collected and difficulties faced, necessary modifications were incorporated into the final questionnaire. A survey was conducted using a questionnaire based interview to obtain information on sociodemographic characteristics, dietary iron intake, clinical signs/symptoms of anemia, compliance to WIFS or iron-folic acid supplementation and Hb concentrations.

Sociodemographic characteristics

Subjects were divided into different categories according to age (11-12, 13-15, 16-17y); gender (girls and boys); religion (Sikh, Hindu and Others-Muslim, Christian, Jain) and caste (general, scheduled caste/SC, backward class/BC). In India, SCs are considered as the lowest caste and socially excluded group of people, facing discrimination in terms of health services, economies and education (PACS, 2016). Data on parent's occupation (farming, service, labour, self-employment/business and non-

working), family income (\leq Rs. 10,000 and above 10,000/month) were collected. Parent's education was categorized into no education, up to matric and above higher secondary. In India, matric or matriculation refers to the final year of tenth class, which ends at 10th Board (10th grade), and the qualification consequently received by passing the national board exams or the state board exams, commonly called "matriculation exams" (IPFS, 2018).

Dietary iron intake

Data pertaining to iron intake of the subjects was collected by 24-hour recall method for the four meals consumed (i.e., breakfast, lunch, dinner and snacks), in three consecutive days was used (Gibson and Ferguson, 1999). The subjects were provided with different sets of standardized bowls and glasses to record the exact amount of foods and beverages consumed by them. The mean daily iron intake was then assessed using DietCal software (Kaur, 2015) and compared with the recommended dietary allowances (RDA) of Indian Council of Medical Research (ICMR, 2010). The percent adequacy of iron intake was also calculated.

Clinical examination for the signs/symptoms of anemia

Clinical examination of the subjects was done by a physician. Information on various signs and symptoms of anemia such as paleness of skin or conjunctiva, paleness and smoothness of tongue, flat or spoon shaped nails, lethargy/breathlessness, headache etc., was recorded as prescribed by Jeliffe (1966).

Compliance to weekly iron-folic acid supplementation Program (WIFS)

In 2012, the government of India has initiated weekly iron folic acid supplementation

scheme (WIFS) (100 mg elemental Iron and 500 μ g folic acid with biannual de-worming), under National Rural Health Mission (NRHM), to address nutritional (iron deficiency) anemia among school going children and adolescents (aged 10-19 years) enrolled in government/government aided/municipal schools in both rural and urban areas (NRHM, 2013). Subject's adherence to WIFS or iron-folic acid supplementation (IFA) for the past 6 months was ascertained.

Hb estimation

A finger prick blood sample of each subject for Hb determination were collected by a laboratory technician, using a portable hemoglobinometer instrument (HemoCue). Hb concentration was estimated by cyanmethaemoglobin method of International Nutritional Anemia Consultative Group (INACG, 1985). The WHO (2011) categories to classify anemia were used. Mild anemia corresponds to Hb concentration of 11-11.4 g/dl for children aged 11y; and 11-11.9 g/dl for children aged 12-14y, and also for females aged 15y and above. For males aged 15y and above, mild anemia corresponds to Hb level of 11-12.9 g/dl. For all the age groups, moderate anemia corresponds to Hb level of 8-10.9 g/dl, while severe anemia corresponds to level less than 8 g/dl. The cut-off criterion indicating anemia is the Hb level of 11.5 g/dl for children aged 11y; 12 g/dl for children aged 12-14y and females aged 15y and above; while, for males aged 15y and above, it is 13 g/dl.

Statistical analysis

Data analyses were conducted using SPSS version 23.0 (SPSS Inc., USA). Dichotomous dependent variable was anemia (Yes or No), whereas, independent variables were age, gender, caste, religion, parent's education,

occupation and family income. Descriptive statistics consisted of simple frequency distributions, percentages and means with standard deviations (SD) of selected variables. To assess significant regional differences in the mean Hb level and iron intake (continuous variables) of the subjects, Tukey's post-hoc test (ANOVA) was applied. The Shapiro-Wilk test ($p < 0.05$) and a visual inspection of their histogram, box-plots, and normal Q-Q plots showed that, for all the independent variables, anemia was not normally distributed; and therefore non-parametric test was applied. Bivariate association between dependent and independent variables was tested using Fisher's Exact Test (two-tailed). A p -value of ≤ 0.05 was considered to indicate statistical significance.

Results and Discussion

Sociodemographic characteristics

Bivariate association between anemia and sociodemographic characteristics of school-children from Majhregion, is shown in Table 1. Prevalence of anemia according to sociodemographic characteristics of school-children from Doaba and Malwa region, is presented in Table 2 and 3, respectively.

A total of 210 school-children participated in the study, of which, majority were girls. The mean age of school-children was 14.0 ± 1.8 years. Most of the children from Majha (89%) and Malwa region (79%) were Sikhs, whereas, from Doaba region, Hindus (58%) predominated. From all the regions, the proportion of SC subjects was more compared to other castes. Doaba region had maximum number of SC subjects (82%), followed by Majha (53%) and Malwa region (50%). Among all the Indian states, Punjab, has the highest percentage (32%) of SC population (Census of India, 2011). Majority of the

children's parents were educated up to matric and very few had above higher secondary education, thus indicating that number of those without any worthwhile schooling was quite substantial. Majha region had the highest and Doaba region had the least proportion of illiterate parents. Labour was the most pursued occupation of the fathers; and mothers were mostly housewives. Regarding family income, it was found that from Majha, Doaba and Malwa region, most (62%, 80% and 75%, respectively) of the subjects were from low socio-economic status households earning \leq Rs. 10,000/month.

Dietary iron intake

Mean daily (mg) and percent adequacy (%) of iron intake of school-children from three regions of Punjab, is presented in Table 4. Overall, mean iron intake of girls from Majha, Doaba and Malwa region was 11.6 vs. 10.5 vs. 8.8 mg, respectively. Majha region girls had significantly higher mean values than Doaba ($p=0.010$) and Malwa ($p=0.000$) region girls.

On the other hand, the mean daily iron intake (11.1 mg) of Malwa region boys was higher than Majha (10.8 mg) and Doaba region (10.0 mg) boys; although no significant regional differences ($p=0.286$) were found. Children's diets were highly inadequate in iron, i.e., less than 43% of the RDAs of ICMR (2010).

Regional variation in the nutrient intake can cause significant health disparity, and this variability may be mediated by factors such as food availability, food customs and culture. Interpreting whether the nutrient intake among children are adequate or not, will help support health care providers, nutritionists and food-based companies in developing appropriate strategies and nutrition policies to tackle nutrient deficiencies and disorders and eradicate health disparities.

Clinical examination for the signs/symptoms of anemia

As shown in Figure 1, from Majha region, majority (80%) of the subjects reported of breathlessness, followed by headache (78%), lethargy (76%), loss of appetite (73%), pale conjunctiva (53%) and pale skin (51%). From Doaba region, majority (69%) had lethargy, followed by breathlessness and pale skin (62% each), headache (60%), pale conjunctiva (58%) and loss of appetite (56%). From Malwa region, about 61% children had breathlessness, followed by headache and lethargy (52% each), pale skin (47%), pale conjunctiva (45%) and loss of appetite (40%). Hair changes and koilonychias (spoon shaped nails) are evident only when there is severe degree of anemia. Overall, more than half of the subjects from all the regions exhibited one or more clinical signs/symptoms of anemia. However, negligible percentage of them had paleness/smoothness of tongue and spoon shaped nails; while, no hair changes were observed; thus indicating that severe form of anemia may not present among children from Punjab. Consistently, other studies also showed IDA associated signs/symptoms of anemia (Sabale *et al.*, 2013; Gupta *et al.*, 2014; Habib *et al.*, 2016). The presence and degree of anemia and its underlying etiology can be identified clinically by careful physical examination and the appropriate therapy could be administered for evaluation and management of this condition. The clinical signs and symptoms of anemia can therefore assist in diagnosis where facilities for biochemical testing are not available.

Compliance to WIFS program

In Majha region, compliance to WIFS or iron-folic acid supplementation (IFA) was 100% in the subjects; whereas in Doaba and Malwa region, it was ensured by 93 and 77%

subjects, respectively. During the research survey, when children were asked about the reasons for not taking supplements, stomach pain, nausea, vomiting, general disliking of tablets due to metallic taste and peer influence were found to be predominant causes for refusal of IFA tablets. Conversely, other studies reported far lower compliance (16-53%) to IFA in school-children because of the perception that IFA tablets causes weight gain and adverse side effects, with nausea and vomiting as the most common (Priya *et al.*, 2016; Sajna and Jacob, 2017). Another reason for low consumption of supplements by the children from Malwa region, could be partly attributed to lack of concern among teachers regarding administration of IFA tablets; and partly due to low coverage of WIFS in some government schools of Malwa region, especially those located in remote areas. In this context, a study reported that despite the awareness among teachers, about the ongoing WIFS, only 80% and 40% knew the composition of IFA tablet and name of the deworming tablet, respectively; which indicated that compliance to IFA was likely to have been influenced by the teacher's thorough knowledge regarding WIFS program (Sau, 2016). Thus, along with state and district-level planning, implementation and monitoring of micronutrient intervention policies and programs, efforts should be focused on community level programs too, because sometimes status of these intervention programs at the community level do not necessarily reflect those at the state level.

Hb estimation

Blood Hb levels of school-children from three regions of Punjab, is given in Table 5. Regional disparity analysis showed that mean Hb levels of children aged 11y from Majha, Doaba and Malwa region was 10.6, 10.1 and 10.3g/dl; of those aged 12-14y, was 10.9, 10.1

and 10.2g/dl; whereas, mean Hb values of girls vs. boys aged 15-17y was 10.0 vs. 11.0, 10.7 vs. 10.6 and 10.7 vs. 10.8g/dl, respectively. No significant regional differences ($p=0.485$) were noted in mean Hb level of girls; whereas, substantial ($p=0.05$) disparity was found in mean Hb level of boys. The mean Hb level (11.1g/dl) of boys from Majha region was higher than those from Doaba (10.4g/dl) and Malwa region (10.7g/dl). However, a Tukey post-hoc test revealed that statistically significant ($p=0.05$) difference was found only between Majha vs. Doaba region boys, but not between Doaba vs. Malwa region boys ($p=0.550$), and Majha vs. Malwa region boys ($p=0.164$).

Overall, significant ($p=0.024$) disparity was observed in mean Hb levels of the subjects from three regions of Punjab. Furthermore, a Tukey post-hoc test revealed that the mean Hb level of subjects from Majha region (10.7g/dl) was significantly higher ($p=0.029$) compared to Doaba region (10.4 g/dl) subjects. Although the mean Hb level of subjects from Majha region was higher compared to Malwa region subjects (10.4g/dl), the difference was not statistically significant ($p=0.052$). For most of the age groups, Majha region subjects had marginally higher mean values as compared to other regions, however, the age and gender specific mean Hb values of all the subjects was lower than the reference values for their corresponding age groups. Similar results have been reported by Hussain et al (2013); whereas, in contrast, Achouri et al (2015) found much higher mean Hb values among school-children in Kenitra, Northwest of Morocco.

Prevalence of anemia

Prevalence of anemia among school-children from three regions of Punjab, on the basis of (WHO, 2011) classification, is depicted in

Table 6. Regional disparity analysis showed that overall, prevalence of anemia among children from Majha, Doaba and Malwa region was 91 vs. 100 vs. 98%, out of which, majority (71 vs. 84 vs. 80%) were moderately anemic and 20 vs. 16 vs. 18% had mild anemia, respectively. There was no case of severe anemia in children. Almost similar prevalence rates have been reported among children from different districts of Punjab such as Amritsar (Majha), Ludhiana, Moga, Faridkot and Patiala (Malwa) (Sidhu *et al.*, 2007; Gupta *et al.*, 2011; Bhatia, 2013; Kaur *et al.*, 2015; Garg and Bhalla, 2016). Contrarily, several studies reported much lower prevalence of anemia among school children from other states of India and worldwide (NFHS-4, 2015-16; Birhanu *et al.*, 2018; Cruz-Gongora *et al.*, 2018; Rakesh *et al.*, 2018; Tezera *et al.*, 2018). Similarly, regional disparities in the prevalence of anemia were observed in China, Brazil, Ghana and in 107 countries worldwide (Luo *et al.*, 2011; Horta *et al.*, 2013; Stevens *et al.*, 2013; USAID, 2014).

According to WHO (2011), anemia is considered as a severe public health problem when the prevalence is greater than $\geq 40\%$. Accordingly, above 90% prevalence of anemia in all the regions confirmed the existence of severe public health problem in the study area.

However, the prevalence of anemia was lower and blood Hb levels were better among children from Majha region as compared to Doaba and Malwa region. The lowest prevalence in Majha region could be partly explained by the reason that all the subjects were taking iron supplements provided by school authorities; and their mean daily iron intake was also better than subjects from other regions. Similar results have been reported by Bhoite and Iyer (2011) and by Low *et al.*, (2013).

Table.1 Association between anemia and sociodemographic characteristics, school-children, Majha region

Variables	^a Anemic n (%)	Non-anemic n (%)	^b P value	Total subjects (N=45)
Age (years)				
11-12	11 (92)	1 (8)	0.79	12 (27)
13-15	20 (87)	3 (13)		23 (51)
16-17	10 (100)	0 (0)		10 (22)
Gender				
Boys	14 (88)	2 (12)	0.60	16 (36)
Girls	27 (93)	2 (7)		29 (64)
Religion				
Sikh	36 (90)	4 (10)	0.99	40 (89)
Hindu	2 (100)	0 (0)		2 (4)
Others	3 (100)	0 (0)		3 (7)
Caste				
General	9 (90)	1(10)	0.02*	10 (22)
SC	24 (100)	0(0)		24 (53)
BC	8 (73)	3(27)		11 (25)
Mother's education				
No education	21 (88)	3(12)	0.68	24 (53)
Up to Matric	18 (95)	1 (5)		19 (42)
Above higher secondary	2 (100)	0 (0)		2 (4)
Father's education				
No education	17 (94)	1 (6)	0.76	18 (40)
Up to Matric	19 (86)	3 (14)		22 (49)
Above higher secondary	5 (100)	0 (0)		5 (11)
Mother's occupation				
Service	1 (100)	0 (0)	0.64	1 (2)
Labour	9 (100)	0 (0)		9 (20)
Self-employment/Business	1 (100)	0 (0)		1 (2)
Non-Working (Housewife/Late)	30 (88)	4 (12)		34 (76)
Father's occupation				
Farming	7 (100)	0 (0)	0.36	7 (15)
Labour	20 (95)	1 (5)		21 (47)
Self-employment/Business	10 (83)	2 (17)		12 (27)
Non-working/Late	4 (80)	1 (20)		5 (11)
Family Income (Rs.)				
≤ 10,000	28 (100)	0 (0)	0.01*	28 (62)
Above 10,000	13 (77)	4 (23)		17 (38)

^aAnemia was classified as having Hb < WHO (2011) cut-offs for different age groups

^bFisher's exact test (two-tailed)

* Significant at 5 % level

Table.2 Prevalence of anemia according to sociodemographic characteristics, school-children, Doaba region

Variables	^aAnemic n (%)	Non-anemic n (%)	Total subjects (N=45)
Age (years)			
11-12	14 (100)	0 (0)	14 (31.1)
13-15	22 (100)	0 (0)	22 (48.9)
16-17	9 (100)	0 (0)	9 (20)
Gender			
Girls	34 (100)	0 (0)	34 (76)
Boys	11 (100)	0 (0)	11 (24)
Religion			
Sikh	15 (100)	0 (0)	15 (33)
Hindu	26 (100)	0 (0)	26 (58)
Others	4 (100)	0 (0)	4 (9)
Caste			
General	3 (100)	0 (0)	3 (7)
SC	37 (100)	0 (0)	37 (82)
BC	5 (100)	0 (0)	5 (11)
Mother's education			
No education	9 (100)	0 (0)	9 (20)
Up to Matric	31 (100)	0 (0)	31 (69)
Above higher secondary	5 (100)	0 (0)	5 (11)
Father's education			
No education	6 (100)	0 (0)	6 (13)
Up to Matric	34 (100)	0 (0)	34 (76)
Above higher secondary	5 (100)	0 (0)	5 (11)
Mother's occupation			
Service	2 (100)	0 (0)	2 (5)
Labour	4 (100)	0 (0)	4 (9)
Self-employment/Business	1 (100)	0 (0)	1 (2)
Non-working (Housewife/Late)	38 (100)	0 (0)	38 (84)
Father's occupation			
Farming	1 (100)	0 (0)	5 (11)
Service	5 (100)	0 (0)	21 (47)
Labour	21 (100)	0 (0)	15 (33)
Self-employment/Business	15 (100)	0 (0)	3 (7)
Non-working/Late	3 (100)	0 (0)	
Family income (Rs.)			
≤ 10,000	36 (100)	0 (0)	36 (80)
Above 10,000	9 (100)	0 (0)	9 (20)

^a Anemia was classified as having Hb < WHO (2011) cut-offs for different age groups

No measures of association are computed for the cross tabulation of dependent and independent variables because dependent variable (anemia) was a constant

Table.3 Prevalence of anemia according to sociodemographic characteristics, school-children, Malwa region

Variables	^aAnemic n (%)	Non-anemic n (%)	Total subjects (N=120)
Age (years)			
11-12	24 (100)	0 (0)	24 (20)
13-15	63 (98)	1 (2)	64 (53.3)
16-17	31 (97)	1 (3)	32 (26.7)
Gender			
Boys	31 (97)	1 (3)	32 (27)
Girls	87 (99)	1 (1)	88 (73)
Religion			
Sikh	94 (99)	1 (1)	95 (79)
Hindu	22 (96)	1 (4)	23 (19)
Others	2 (100)	0 (0)	2 (2)
Caste			
General	39 (98)	1 (2)	40 (33)
SC	60 (100)	0 (0)	60 (50)
BC	19 (95)	1 (5)	20 (17)
Mother's education			
No education	43 (100)	0 (0)	43 (36)
Up to Matric	67 (98)	1 (2)	68 (57)
Above higher secondary	8 (89)	1 (11)	9 (7)
Father's education			
No education	41 (100)	0 (0)	41 (34)
Up to Matric	64 (98)	1 (2)	65 (54)
Above higher secondary	13 (93)	1 (7)	14 (12)
Mother's occupation			
Service	4 (100)	0 (0)	4 (3.3)
Labour	33 (100)	0 (0)	33 (27.5)
Self-employment/Business	5 (100)	0 (0)	5 (4.2)
Non-Working (Housewife/Late)	76 (97)	2 (3)	78 (65)
Father's occupation			
Farming	15 (100)	0 (0)	15 (12)
Service	7 (100)	0 (0)	7 (6)
Labour	65 (98)	1 (2)	66 (55)
Self-employment/Business	26 (96)	1 (4)	27 (23)
Non-working/Late	5 (100)	0 (0)	5 (4)
Family Income (Rs.)			
≤ 10,000	89 (99)	1 (1)	90 (75)
Above 10,000	29 (97)	1 (3)	30 (15)

^a Anemia was classified as having Hb < WHO (2011) cut-offs for different age groups

No measures of association are computed for the cross tabulation of dependent and independent variables because dependent variable (anemia) was a constant

Table.4 Mean daily (mg) and percent adequacy (%) of iron intake of school-children from three regions of Punjab

Iron Intake	Majha (n=45)	Percent adequacy	Doaba (n=45)	Percent adequacy	Malwa (n=120)	Percent adequacy	# RDA	^a P value
Girls								
11-12y	11.8 ± 1.1 ^a	44	10.3 ± 1.3 ^b	38	8.6 ± 1.4 ^c	32	27	<
13-15y	11.6 ± 1.3 ^a	43	10.7 ± 1.7 ^a	40	9.1 ± 1.5 ^b	34	27	0.001*
16-17y	11.0 ± 1.2 ^a	42	10.5 ± 1.2 ^a	40	8.5 ± 1.1 ^b	33	26	<
Boys								0.001*
11-12y	10.3 ± 0.6	49	10.4 ± 0.0	50	6.8 ± 1.1	32	21	<
13-15y	11.1 ± 1.1 ^{ab}	35	10.5 ± 1.5 ^a	33	12.1 ± 1.5 ^b	38	32	0.001*
16-17y	1.1 ^{ab}	38	8.8 ± 1.2 ^a	31	12.2 ± 1.4 ^b	44	28	
Overall	10.7 ± 0.8 ^{ab}							0.030*
Girls	0.8 ^{ab}	43	10.5 ± 1.4 ^b	39	8.8 ± 1.4 ^c	33	27	0.048*
Boys	11.6 ± 1.2 ^a	40	10.0 ± 1.5	37	11.1 ± 2.5	41	27	0.002*
	10.8 ± 0.9							<
								0.001*
								0.286 ^{NS}

ICMR (2010)

^a One-way ANOVA

*Significant at 5% level

^{NS} Non-Significant

Means with different letter superscripts are significantly different from each other in the row between regions (Tukey's HSD)

[§] Post hoc tests are not performed because at least one group has fewer than two cases.

Table.5 Blood Hb levels of school children from three regions of Punjab (Mean ± SD)

Category	Region			^a P value
	Majha (n=45)	Doaba (n=45)	Malwa (n=120)	
Girls	10.5 ± 0.7	10.3 ± 0.5	10.4 ± 0.5	0.48 ^{NS}
Boys	11.1 ± 0.8 ^a	10.4 ± 0.6 ^b	10.7 ± 0.7 ^{ab}	0.05*
Overall	10.7 ± 0.8 ^a	10.4 ± 0.5 ^b	10.4 ± 0.6 ^{ab}	0.02*

^a One-way ANOVA

* Significant at 5% level

^{NS} Non-Significant

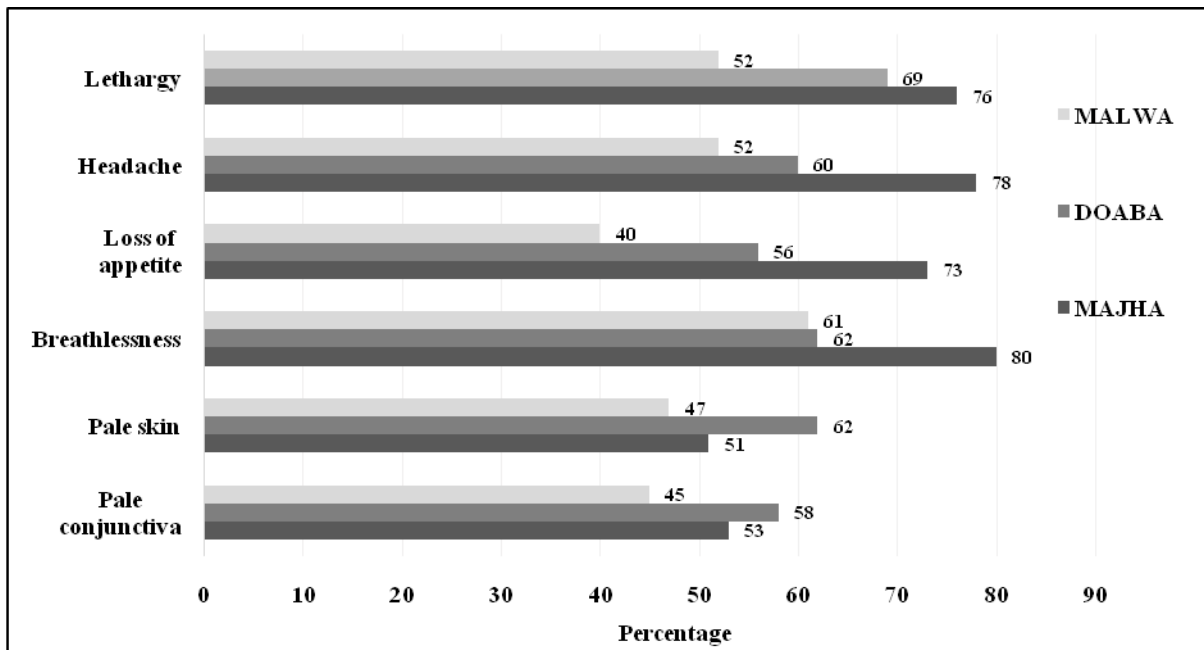
Means with different letter superscripts are significantly different from each other in the row between regions (Tukey's HSD)

Table.6 Prevalence of anemia among school-children from three regions of Punjab, on the basis of (WHO, 2011) classification

Categories of anemia with Hb level (g/dl)	Majha (n=45)	Doaba (n=45)	Malwa (n=120)
Severe (≤ 8)	-	-	-
Moderate (8-10.9)	32 (71)	38 (84)	97 (80)
Mild			
11y(11-11.4)	-	-	3 (2.5)
12-14 (11-11.9)	5 (12)	1 (2)	2 (1.7)
15-17y			
Female (11-11.9)	-	5 (11)	9 (7.6)
Male (11-12.9)	4 (8)	1 (2)	7 (6)
Total mildly anemic subjects	9 (20)	7 (16)	21 (18)
Total anemic subjects	41 (91)	45 (100)	118 (98)
Non Anemic			
11y (≥ 11.5)	1 (2)	-	-
12-14y (≥ 12)	3 (7)	-	-
15-17y			
Female (≥ 12)	-	-	1 (1)
Male (≥ 13)	-	-	1 (1)
Total non-anemic subjects	4 (9)	-	2 (2)

Figures in parentheses represent percentages

Fig.1 Clinical signs/symptoms of anemia among school-children from three regions of Punjab



However, the inconsistent effect of IFA supplementation has failed to make any progress in anemia control in Punjab, probably due to poor compliance of the target recipients, and other issues such as occasional unavailability or delayed supply of IFA tablets, poor awareness, and casual program implementation that includes poor coordination between schools and health department. No similar study was found to compare our findings with. Majority of the research studies investigating the prevalence of anemia are mainly based in one city or district of the state. However, the nationwide generalizations about indicators of nutritional status in children can conceal important regional patterns. This study was one of the first to report regional differences in anemic status of school-children from Punjab. More studies should be undertaken considering regional variations across the states, in order to obtain a clearer picture on magnitude of the problem, causes and factors associated with anemia.

Association of anemia with sociodemographic characteristics

In Doaba and Malwa region, no measures of association were computed for the cross tabulation of dependent and independent variables because anemia was a constant. However, in Majha region, about 91% of school-children had anemia with no significant association with gender, age, religion, parent's education and occupation; whereas caste ($p=0.02$) and family income were significantly ($p=0.01$) associated with the occurrence of anemia; wherein, compared to other categories, mostly SC children belonging to families earning less than Rs. 10,000/month, were anemic. In agreement, it was shown that children from SC had higher risk of having anemia in India (Goswami and Das, 2015; Vart *et al.*, 2015). A possible explanation of this could be unhygienic living

conditions, poor dietary habits and unawareness regarding benefit schemes for socially-disadvantaged segments of the society. Moreover, families with low household income may not purchase iron-rich foods and expensive non-vegetarian foods. Given the results of the study, it can be concluded that anemia status of the children belonging to low socioeconomic status, in Punjab, might have deteriorated; thus presenting a very distressing situation. It appears that betterment in economic status of such households and timely change in discriminatory attitude towards underprivileged communities are required for bringing about improvements in their health status.

In conclusion, children's diets were grossly inadequate in iron. There was widespread occurrence (over 90%) of anemia among government school-children from all the regions of Punjab. Although the regional differences were not much profound, to some extent, school-children from Majha region had slightly lower incidence of anemia; their iron intake (dietary/IFA tablet) and Hb levels were better compared to other regions. Among various sociodemographic factors studied, only caste and family income showed significant association with anemia in Majha region where prevalence rates were substantially higher among SCs and children from low-income families. For Doaba and Malwa regions, anemia was constant irrespective of sociodemographic characteristics. Hence, the policy-makers should give utmost priority to poverty alleviation, more privileges to marginalized communities and better implementation of prevailing health and nutrition programs in the framework of development programs of the state in order to achieve optimum physical, nutritional and health parameters of school- children.

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