Original Article

To Study the Prevalence of Anaemia in Young Males and Females with Respect to the Age, Body Mass Index (BMI), Activity Profile and the Socioeconomic Status in Rural Punjab

Adolescent Section

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ABSTRACT

Background: Anaemia is one of India's major public health problems. The prevalence of anaemia was found to range from 30% to 98% in different studies from different regions. The National Family Health Survey–3 data showed that Punjab, along with Manipur, Mizoram, Goa, and Kerala, had the lowest levels of anaemia throughout the country.

Objectives: The present study was designed to assess the prevalence of anaemia among the apparently healthy young males and females from rural Punjab.

Materials and Methods: The young population, both males (5-20 years) and females (5-30 years) from rural Punjab, was studied for the prevalence of anaemia with respect to the body mass index, the activity profile and the socio-economic status.

Results: The prevalence of anaemia in females (5-30 years) was 89.5%, which included 49.8% of mild, 38.2% of moderate and 1.5% of severe anaemia cases. The prevalence of anaemia in males (5-20 years) was 89.9%, with 51.2% suffering from mild, 38% from moderate and 0.7% from severe anaemia. Both males and females who were in the younger age group, who were underweight, who belonged to a lower socio-economic status and who had a low activity life style, had a higher prevalence of anaemia.

Conclusions: The present study found a high prevalence of anaemia in both males and females in the rural population, thus indicating that the problem of anaemia was related to a wider population than the traditional groups of the pregnant and lactating females and children. More detailed studies are needed to find out the cause and the type of anaemia along with other risk factors in all the age groups, irrespective of sex.

Key Words: Prevalence, Anaemia, Young males, Females, Body mass index, Activity profile, Socioeconomic status, Rural, Punjab

KEY MESSAGE

- India is facing a grave public health problem, with the prevalence of anaemia in India being > 40%.
- Anaemia is an indicator of poor nutrition and poor health with major consequences for the human health, as well as for the social and economic development of a population.
- In our study, the prevalence of anaemia was 89.5% in females and 89.9% in males. It was more in the younger age groups, in the lower BMI groups, in the lower socio-economic groups and in those with a sedentary life style.

INTRODUCTION

Anaemia is a global public health problem which affects both the developing and the developed countries and it is an indicator of poor nutrition and poor health with major consequences for human health, as well as for the social and economic development of a population. Worldwide, at any given moment, more individuals have iron-deficiency anaemia than any other health problem [1]. Anaemia is the most common indicator which is used to screen for iron deficiency and so the terms anaemia, iron deficiency and iron deficiency anaemia are sometimes used interchangeably [2]. Globally, anaemia affects 1.62 billion people, which corresponds to 24.8% of the population [3]. Anaemia is one of the most common health problems in India which is much more prevalent in the rural than in the urban areas [4, 5]. The prevalence of anaemia in pregnant and lactating females and children has been found to vary from 50-90% in different parts of India [5].

The data from the District Nutrition Project (Indian Council of Medical Research) in 16 districts of 11 states of India, on the prevalence of anaemia in non-pregnant adolescent girls (11-18 years), showed rates as high as 90.1% for severe anaemia (Hemoglobin <7 g/dl) in 7.1% of the girls [6]. Another report stated that over 90% of the Indian women, adolescent girls and children were anaemic [7]. The National Family Health Survey-3 [8] data showed that 55% of the women and 24% of the men were anaemic and that Punjab, along with Manipur, Mizoram, Goa and Kerala had the lowest levels of anaemia throughout the country. Even in these states, however, more than 30 % of the women were found to be anaemic. Anaemia can result in maternal mortality, weakness, diminished physical

and mental capacity, increased morbidity from infectious diseases, perinatal mortality, premature delivery and low birth weight and impaired cognitive performance, motor development, and scholastic achievement in children [9]. Studies have shown that infants who were born to mothers with severe anaemia had a higher risk of irreversible brain damage, lower school achievement, a reduced physical and exercise tolerance and a poor immune response [10]. Anaemia in young children is a serious concern because it can result in an impaired cognitive performance, behavioural and motor development, lack of co-ordination, language development and scholastic achievement, as well as an increased morbidity from infectious diseases [8, 11]. Anaemia in the school age children is associated with the retardation of growth, decreased immunity and a poor cognitive development which results in a lower Intelligence Quotient (IQ) and behavioural abnormalities [12]. Moreover, studies from Egypt [13], India [14] and USA [15, 16] have conclusively shown that anaemia delays the psychomotor development and impairs the cognitive performance of infants, pre-school and school-aged children. Anaemia in childbearing women increases the maternal mortality [17], pre-natal and peri-natal infant loss and prematurity [18, 19].

Studies from India have consistently shown an association between anaemia and under-nutrition [20] and the occurrence of anaemia in undernourished children and in those belonged to the poor socio-economic status are a well documented fact [21-23]. But studies have also revealed that anaemia was a major health problem among the well-nourished school children who belonged to the upper and middle socio-economic classes also [24]. The low-cost food that is generally affordable to the poor is low in nutritional value and high in fats, sugars and additives and therefore, obesity is oftentimes a sign of poverty and malnutrition [25].

Reports from countries such as the United States, Israel and Canada have shown that overweight and obese children had a higher prevalence of iron deficiency than the normal weight children [26, 27]. Another possible reason for anaemia in the overweight and obese could be the poor bio-availability of iron in the Indian diets [23], as vegetarian diets are a poor source of iron [28]. The rising trend of consuming snacks and junk foods which supply empty calories is also responsible for the so called 'healthy' but anaemic children.

According to the classification of anaemia as a problem of public health significance, the prevalence of anaemia which was >40% was considered to be a severe public health problem, that which was <4.9% to be not a public health problem, that which was between 5.0 to 19.9% to be a mild public health problem and that which was between 20.0 to 39.9% to be a moderate public health problem [2] . India is facing a grave public health problem, since the prevalence of anaemia in India is > 40%. A vast amount of studies were done on pregnant females and young children, but reliable data on the prevalence of anaemia in the adult population (non- pregnant females and adult males) is not available [5, 29], especially among young males and females in Punjab, which was till recently considered to be a rich state. So, the present study was designed to assess the prevalence of anaemia among the apparently healthy, young males and females from the rural areas of Punjab.

MATERIALS AND METHODS

We studied 1221 young males (5-20 years) and 3099 females (5-30 years) from the rural areas in Punjab during the heath check up camps in villages around Bathinda and during the medical check up of healthy attendants who accompanied the patients who visited the hospital for treatment.

Exclusion Criteria: The subjects below or above 5 to 20 years among the males, below or above 5 to 30 years among the females and pregnant females were not included in the study. Those suffering from any chronic disease like diabetes, hypertension, arthritis, renal disease or any gastrointestinal disease and those who were on some medication, whether desi or allopathic, were excluded from study. Only rural subjects were included in the study.

Criteria for Anaemia: All the young males and females underwent haemoglobin (Hb) estimation by the Cyanmethaemoglobin Method which was used by all the studies to estimate the haemoglobin levels. The cyanmethemoglobin method is being commonly used and has been considered to be accurate as compared to the hemocue or the hematology counter [30]. Anaemia was defined as an Hb of <13g/dl in males and an Hb of < 12g/dl in females. Mild anaemia was defined as an Hb of 10-12.9 g/dl in males and an Hb of 10-11.9 g/dl in females. Moderate anaemia was defined as an Hb of 7-9.9 g/dl and severe anaemia as an Hb of < 7 g/dl in both males and females.

Body Mass Index (BMI): All the individuals had their height and weight measured. BMI was calculated as the weight in kilograms, divided by the square of the height in meters. The BMI was further categorized into low (<18.5 kg/m^2), normal (18.5-24.9 kg/m^2) and high (≥25 kg/m^2) according to the WHO criteria [31].

Socioeconomic status (SES): The socioeconomic status was represented by the approximate monthly family income. Three groups were constituted and the subjects were categorized into low SES (<5000), middle SES (5000-15000), and high SES (15000 and above).

Physical Activity: The individuals were asked about their habitual physical activity. The questionnaire was interviewer administered, focusing on classifying the individuals as having low, moderate and high-activity levels, based on the activities which were performed. According to the Netherlands Nutrition Council [32], a low level activity was required for occupations such as clerical work, driving, shop keeping, teaching, studying, housework and all other light occupations; a middle level activity was required for occupations such as factory work, plumbing, carpentry, and farming: and a high level activity was required for occupations such as manual work, rickshaw pulling, construction work, and regular sports.

Rural/Urban Classification: Subjects who belonged to areas which were governed by panchayats were classified as rural subjects and those from areas which were governed by municipal councils or corporations were classified as urban subjects.

Statistical Analysis: The results were analyzed on a percentage scale.

RESULTS

The prevalence of anaemia in young females in the age group of 5-30 years (n-3099) with respect to the age, BMI, activity profile and socioe-conomic status (SES) in rural Punjab has been presented in [Table/Fig-1]. The prevalence of anaemia in young females in our study was 89.5%, which included 49.8% mild, 38.2% moderate and 1.5% severe anaemia cases. The prevalence of anaemia was 95.2% among younger females of the age group of 5-9 years (n-807), 87% in the age group of 10-19 years and 88.6% in the age group of 20-30 years. The prevalence of anaemia in young males in the age group of 5-20

Hb (g/dl)	Hb of >12gm%	Hb of <12 gm%			
		Total	11.9–10	9.9–7	< 7
Total n-3099	10.5 (324)	89.5 (2775)	49.8 (1545)	38.2 (1185)	1.5 (45)
Age Group					
5-9 years (n-807)	4.8 (39)	95.2 (768)	26.8 (216)	67.7 (546)	0.7 (6)
10-19 years (n-1425)	13.0 (186)	87 (1239)	67.1 (957)	19.0 (270)	0.9 (12)
20-30 years (n-867)	11.4 (99)	88.6 (768)	42.9 (372)	42.6 (369)	3.1 (27)
BMI					
Low (<18.5) (n-2490)	8.6 (213)	91.4 (2277)	50.2 (1251)	39.6 (987)	1.6 (39)
Normal(18.5-24.9) (n-495)	16.4 (81)	83.6 (414)	50.3 (249)	32.7 (162)	0.6 (3)
High (>25) (n-114)	26.3 (30)	73.7 (84)	39.5 (45)	31.6 (36)	2.6 (3)
Activity					
Sedentary (n-624)	4.3 (27)	95.7 (597)	21.7 (135)	72.1 (450)	1.9 (12)
Moderate (n-2241)	11.2 (252)	88.8 (1989)	58.0 (1299)	29.5 (660)	1.3 (30)
Active (n-234)	19.2 (45)	80.8 (189)	47.4 (111)	32.1 (75)	1.3 (3)
SES					
Low (n-501)	1.2 (6)	98.8 (495)	37.1 (186)	59.3 (297)	2.4 (12)
Middle (n-2451)	12.4 (303)	87.6 (2148)	51.1 (1254)	35.2 (861)	1.3 (33)
High (n-147)	10.2 (15)	89.8 (132)	71.4 (105)	18.4 (27)	0 (0)

[Table/Fig-1]: Prevalence of anaemia in females in rural Punjab, according to age group, BMI, activity and socio-economic status (SES).

Hb (g/dl)	Hb of >13gm%	Hb of <13gm%			
		Total	12.9–10	9.9– 7	<7
Total N-1221	10.1 (123)	89.9 (1098)	51.2 (624)	38 (465)	0.7 (9)
Age Group					
5-9 years (n-822)	9.5 (78)	90.5 (744)	37.2 (306)	52.2 (429)	1.1 (9)
10-20 years (n-399)	11.3 (45)	88.7 (354)	79.6 (318)	9.1 (36)	0.0 (0)
BMI					
Low(<18.5) (n-990)	8.2 (81)	91.8 (909)	49.7 (492)	41.5 (411)	0.6 (6)
Normal(18.5-24.9)(n-165)	21.8 (36)	78.2 (129)	67.3 (111)	9.1 (15)	1.8 (3)
High (>25) (n-66)	9.1 (6)	90.9 (60)	31.8 (21)	59.1 (39)	0.0 (0)
Activity					
Sedentary (n-417)	9.4 (39)	90.6 (378)	20.1 (84)	69.1 (288)	1.4 (6)
Moderate (n-681)	11.1 (75)	88.9 (606)	64.7 (441)	23.8 (162)	0.4 (3)
Active (n-123)	7.3 (9)	92.7 (114)	80.5 (99)	12.2 (15)	0.0 (0)
SES					
Low (n-402)	3.7 (15)	96.3 (387)	34.4 (138)	61.2 (246)	0.7 (3)
Middle (n-780)	13.1 (102)	86.9 (678)	59.3 (462)	26.9 (210)	0.7 (6)
High (n-39)	15.4 (6)	84.6 (33)	61.5 (24)	23.1 (9)	0.0 (0)

[Table/Fig-2]: Prevalence of anaemia in males in rural Punjab, according to age group, BMI, activity and socio-economic status (SES).

years (n-1221) with respect to the age, BMI, activity profile and socio-economic status in rural Punjab has been presented in [Table/Fig-2]. Almost similar results on the prevalence of anaemia as in the females were observed in the males of the age group of 5-20 years (n-1221), that is 89.9%, with 51.2% suffering from mild, 38% from moderate and 0.7% from severe anaemia.

The prevalence of anaemia in males in both the age groups of 5 to 9 years (n-822) and 10-20 years (n- 399) was almost similar, that is 90.5% and 88.7% respectively. Both males and females who were in the younger age group, who were underweight, who belonged to a low socio-economic status and who had a low activity life style, had a higher prevalence of anaemia. In general, the mild anaemia was more prevalent as compared to the moderate and severe forms of anaemia in both males and females, but in the age group of 5 to 9 years, in those with a low activity life style. In females of the lower socio-economic group, moderate anaemia was more prevalent. Similarly, the moderate anaemia was more prevalent in young males in the age group of 5 to 9 years, in the obese, low activity life style and low socio-economic groups.

DISCUSSION

The exact figures for the prevalence of anaemia vary from study to study, but there is no doubt that anaemia is an extremely serious public health problem in India, especially among the pregnant women and children. Our study presents the prevalence of anaemia among the rural males (5-20 years) and females (5-30 years) in Punjab. In our study, the overall prevalence of anaemia was 89.5% in females and 89.9% males, which was more than the

global prevalence. The prevalence of anaemia in different regions of the world has been expressed in [Table/Fig-3].

[Table/Fig-4] shows the global prevalence of anaemia including those in developed and developing countries and India (rural and urban), among children who were <5 years, children who were >5 years, men, women and pregnant women.

[Table/Fig-5] shows the prevalence of anaemia in India according to different studies from different regions and population groups, along with the prevalence of anaemia in the present study.

[Table/Fig-6] shows the prevalence of mild, moderate and severe anaemia among women (15-49 years) in some states of India,[8] whereas in the present study, the prevalence of mild anaemia was 49.8%, that of moderate anaemia was 38.2% and that of severe anaemia was 1.5%, with a total prevalence of 89.5% among females in the age group of 5-30 years. Almost similar results were shown by Bulliyy et al [33], that the prevalence of mild, moderate and severe anaemia among non school going adolescent girls in three districts of Orissa were 45.2%, 46.9%, and 4.4%, while the total prevalence was 96.5%.

In a study among the adolescent girls of Nepal, the prevalence of anaemia (68.8%) was found to be lower than that of the Indian females in the present study (89.5%) [38]. Within India, the highest prevalence of anaemia was found in the Jharkhand State, where almost all the adolescent girls were anaemic [39], which was more as compared to the findings of our study. There is a paucity of studies which have explored the prevalence of anaemia among males in Punjab. In our study, the prevalence of anaemia among males (5-20 years) was 89.9%, which was much more as compared to a 24% prevalence of anaemia among men in the NFHS 3 data [8].

In another study, the prevalence of anaemia in the 16-70 years age group among males was 44.3% [40]. The present study highlights a higher prevalence of anaemia in males as compared to that in the existing data. [Table/Fig-7] shows a statewise prevalence of anaemia among men (15-49 years), which showed a less prevalence of anaemia among males as compared to that in the present study.

The prevalence of anaemia does not vary with the sex of the child and is considerably higher in the rural areas, among children of women with no education, among the scheduled castes and tribes and among children from households in the lower wealth quintiles. The anaemia status of the children is closely linked with the anaemia status of the mother [8]. In the present study, the prevalence of anaemia was almost the same in 5 to 9 year old males (90.5%) as in females of the same age group (95.2%).

The prevalence of anaemia decreases with an increase in the standard of living index among both males and females (15-49 years), as shown in [Table/Fig-8].

Country	Men	Women	Pregnant women	<5 yrs	>5 yrs.
Africa	20	49	63	56	49
North America	4	8		8	13
Latin America	13	17	30	26	26
East Asia	11	18	20	20	22
South Asia	32	58	65	56	50
Europe	2	12	14	14	5
Oceania	7	19	25	18	15

[Table/Fig-3]: Prevalence of anaemia in the world

De Mayer E M Tegman A (1998) *Prevalence of Anaemia in the World: World Health Statistics Quarterly*, 38:302-316.

Studies or Regions	Characteristics	Prevalence of anemia
Present Study	5-30 years females	89.5%
Present Study	5-20 years males	89.9%
Toteja GS et al [6]	Adolescent girls	90.1%,
Bulliyy et al [33]	Adolescent girls	96.5%
India (WHO) [34]	Pregnant Women	88%
India (WHO) [35]	Non-pregnant women	74%
Luxmi et al [35]	Rural preschool children (1-5 years)	99%
Kapoor & Aneja [36]	Adolescent girls.	50.8%
Rural Rajasthan [37]	Adolescent girls.	73.7%
NFHS-3 [8]	Women	55%

[Table/Fig-5]: Prevalence of anaemia is India in different studies from different regions and population groups

States	Mild	Moderate	Severe	Total
Punjab	26.2	10.4	1.4	38.0
Arunachal Pradesh	36.6	12.5	1.6	50.6
Kerala	25.8	6.5	0.5	32.8
Himachal Pradesh	31.6	10.5	1.2	43.3
Haryana	37.6	16.7	1.7	56.1
West Bengal	45.8	16.4	1.0	63.2
Rajasthan	35.2	15.4	2.5	53.1
Jharkhand	49.6	18.6	1.3	69.5
India	38.6	15.0	1.8	55.3
Present Study	49.8	38.2	1.5	89.5

[Table/Fig-6]: Prevalence of anaemia among women (15- 49 years), by state, 2005-06

International Institute for Population Sciences (IIPS) and Macro International, 2007. *National Family Health Survey (NFHS-3)*, 2005–06: India: Volume I. Mumbai: IIPS.

	Global (1993-2005)*	Global (1998)	Developed	Developing	India	
					Urban	Rural
Children < 5 yrs	47.4	43	12	51	60	70
Children > 5 yrs	25.4	37	7	46	50	60
Men	12.7	18	3	26	35	45
Women	30.2	35	11	47	50	60
Pregnant Women	41.8	59	14	51	65	75

[Table/Fig-4]: Global prevalence of anaemia in developed, developing countries and India

De Mayer E M Tegman A (1998) *Prevalence of Anaemia in the World, World Health Statistics Quarterly* 38:302-316.
*Worldwide prevalence of anaemia1993–2005: WHO Global Database on Anaemia: Edited by Bruno de Benoist, Erin McLean, Ines Egli and Mary Cogswell.

States	Mild	Moderate	Severe	Total
Punjab	6.6	5.5	1.5	13.6
Arunachal Pradesh	13.8	13.0	1.2	28.0
Kerala	3.8	3.7	0.4	8.0
Himachal Pradesh	10.6	8.1	0.2	18.9
Haryana	12.8	5.9	0.5	19.2
West Bengal	18.3	13.3	0.7	32.3
Rajasthan	12.0	10.6	1.0	23.6
Jharkhand	18.5	17.7	0.3	36.5
India	13.3	9.9	1.3	24.2
Present Study	51.2	38.0	0.7	89.9

[Table/Fig-7]: Prevalence of anaemia among men (15-49 years), by state, 2005-06

International Institute for Population Sciences (IIPS) and Macro International, 2007. *National Family Health Survey (NFHS-3)*, 2005–06: India: Volume I. Mumbai: IIPS.

Characteristic	Men <13g/dl	Women <12g/dl
Lowest Wealth Index	37.9%	64.3%
Second Wealth Index	30.2%	60.3%
Middle Wealth Index	24.8%	56.0%
Fourth Wealth Index	18.8%	52.2%
Highest Wealth Index	14.2%	46.1%

[Table/Fig-8]: Prevalence of anaemia among men & women (15- 49 years), by wealth index, 2005-06

International Institute for Population Sciences (IIPS) and Macro International. 2007. *National Family Health Survey (NFHS-3), 2005–06: India: Volume I*. Mumbai: IIPS.

A similar trend was also observed in the National Family Health Survey 2 [41] (NFHS 2) data, where the prevalence of anaemia in women (15-49 years) was 60.2% in the low, 50.3% in the medium and 41.9% in the high living index group. Aggarwal, et al [42], in a government school based study from a middle socio-economic group of North East Delhi, reported the prevalence of anaemia as 45%. A study by Jondhale, et al. [43] reported the prevalence of anaemia as 14% in adolescent girls where the household income was more than Rs. 5000 per month and as 26% where the household income was less than Rs. 5000 per month. The same trend was expressed in the present study and the prevalence of anaemia was found to be decreased with an increase in the socio-economic status. It was 96.3% among the low socio-economic group males, 86.9% among the middle socioeconomic group males and 84.6% among the high socio-economic group males, whereas the prevalence was 98.8%, 87.6% and 89.8% among females of the low, middle and the high socio-economic group.

In the literature, there is a paucity of data regarding the prevalence of anaemia with respect to the BMI in young males and females in Punjab. A study by Ramachandra et al. [44] has shown the association between the higher prevalence of anaemia and a low BMI. In the NFHS 2 study [41], it was stated that shorter women and women with a low BMI had a somewhat higher prevalence of anaemia than other women. In our study also, the prevalence of anaemia in females was found to increase with a decrease in the BMI, that is, the prevalence was 91.4% in females with low BMI, 83.6% in those with normal BMI and 73.7% in females with high BMI. Similarly, in males, the prevalence of anaemia was 91.8%, 78.2% and 90.9% in those with low, normal and high BMI respectively.

The pattern of anaemia by its characteristics is similar for men and women, except for the differentials by age. Age is not an important determinant of anaemia in women, but the anaemia varies substantially by age for men. The prevalence of anaemia was more than 50% higher for men who were aged 15-19 years than for men who were aged 20-24 years. After the age of 20-24 years, the anaemia was found to increase steadily to a maximum of 33% for men who were aged 50-54 years [8]. In the present study, the prevalence of anaemia was found to be consistent with the above statement and it was 90.5% in males of the younger age group (5-9 years) and 88.7% in males of the older age group (10 to 20 years). But in our study, the results showed that females in the age group of 5-9 years had a more moderate anaemia (67.7%) as compared to that in the age group of 20-30 years (42.6%). This was paradoxical, as menstruating females are more likely to be anaemic. The limitation of our study was that we did not do the sub group analysis of the correlation between BMI and anaemia, as the prevalence of severe malnutrition in females of the age group of 5 to 9 years could have been one explanation for this paradox. Another possible reason for this could have been the poor bio-availability of iron in the Indian diet [23]. Another reason which we did not explore was the type of diet which was consumed by the study population, as evidence indicated a higher prevalence of anaemia among children who had a vegetarian diet, because vegetarian diets are a poor source of iron [28, 45]. Verma et al. [24] also found a higher prevalence of anaemia among the vegetarian than the non-vegetarian schoolgirls (66% vs. 38%). In developing countries such as India, the poor bio-availability of dietary iron, coupled with a low intake of iron which was derived from animal foods, is a major aetiological factor for anaemia [46]. Other important reason which could not be investigated in our study was that young females may have been receiving some iron supplements from the health centers, thus leading to a lesser prevalence of anaemia in the age group of 20-30 years than in the 5-9 years age group. Although the dietary habits of the children were not studied in present study, it was likely that females of the 5-9 years age group may have taken a nutritionally deficient diet and may have been more susceptible to parasitic infestations and other chronic infections, thus leading to a higher prevalence of anaemia. However, more studies are needed to support or disapprove this observation.

The prevalence of anaemia does not vary much by the work status, but women who do not work have a slightly less prevalence of anaemia than the working women [41]. In the present study also, the activity profile did not correlate with any specific degree of anaemia.

According to the WHO, if the prevalence of anaemia at the community levels was more than 40%, it was considered as a problem of high magnitude [2]. The present study thus brings out the fact that the problem of anaemia was related to a wider population than the traditionally considered groups of the pregnant females, lactating females and children. The young male population was equally susceptible in Punjab. Studies have shown that anaemia was an indicator of poor nutrition and poor health, with major consequences on the human health as well as on the social and economic development. Anaemia was linked to a depressed mental state and motor development during infancy and early childhood, which may be irreversible [47]. Anaemia during childhood also results in decreased physical activity and decreased interaction with the environment, with negative consequences on learning and school achievements [48].

In economic terms, Horton and Ross estimated the magnitude of the loss of work productivity due to childhood anaemia to be 4.5% of the country's Gross Domestic Product (GDP) [49]. The estimates of the percentage of GDP which was lost to all forms of vitamin and mineral deficiencies including IDA are 1% for India, 0.9% for Bangladesh and 1.7% for Pakistan [50]. Studies suggest that micronutrient deficiencies alone may cost India 2.5 billion US$ annually [51] and that the productivity losses (manual work only) from stunting, iodine deficiency and iron deficiency together are responsible for a total productivity loss of almost 3% of the GDP [52]. The iron deficiency in adults has been estimated to decrease the productivity by 5-17%, depending on the nature of the work which is performed [52]. The data from ten developing countries have shown that the median loss in the reduced work capacity which was associated with anaemia during adulthood was equivalent to 0.6% of the GDP, while an additional 3.4% of the GDP was lost due to the effects on the cognitive development, which was attributable to anaemia during childhood [49]. Policy makers often fail to recognize the massive economic costs, service providers often fail to recognize the significant health consequences and societies are too often ignorant of anaemia's capability to cause permanent cognitive defects, thus denying children their right to a full mental and emotional development, before they ever reach a classroom [53]. That is why, we feel that the negative consequences of anaemia on the cognitive and physical development of children and on the physical performance, particularly the work productivity in adults, are of a major concern [2].

The overall prevalence of anaemia in young males and females from the rural population in our study was relatively higher as compared to the national standards, thus indicating that the traditional rich state of Punjab, which was among the states with a lower prevalence of anaemia, as was documented by the NFHS-3, was in fact confronting with increasing threat of anaemia necessitates larger studies to be conducted, to know the prevalence of anaemia along with its cause, health and socio-economic implications in the rural as well as urban populations, irrespective of the age groups.

CONCLUSION

The present study found a high prevalence of anaemia in both males and females in the rural population of Punjab, thus indicating that the problem of anaemia was related to a wider population than the traditional groups of the pregnant and lactating females and children. Our study highlights the fact that the prevalence of anaemia was more in the younger age groups, in the low BMI groups, in the low socio-economic groups and in subjects with a sedentary life style. We suggest that there is a need for well-planned, systematic and large-scale studies by using standardized methodologies to estimate the prevalence of anaemia as well as the causes of anaemia at the community level among males and females in all the age groups, with an accurate evaluation of the socio-economic status and the representation of the different regions of India. A comprehensive study, including anthropometric data, biochemical data, clinical signs and dietary intake data will give a better insight into the situation and more importantly, it will help in devising interventions for the prevention and the treatment of anaemia, which should be directed towards all members of the community, irrespective of age and sex.

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