'ANEMIA IN URBAN AND RURAL SCHOOL GIRLS AGED 12 –16 YEARS, SHIMLA - A COMPARATIVE STUDY'

By

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(MAE-FETP Scholar 2002-2003)

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CERTIFICATION

This is to certify that this dissertation, entitled **'Anemia in urban & rural School Girls aged 12 –16 years, Shimla -A Comparative study'**, submitted by Dr. Vinod Kumar Mehta, in partial fulfillment of the requirements for the degree of Master of Applied Epidemiology, is the original work done by him and has not been submitted earlier, in part or whole, for any other (Publication or degree) purpose.

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DIRECTOR

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Date **Vinod Kumar Mehta**

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ABSTRACT

Background: Adolescence is a period of rapid growth, weight gain and blood volume expansion. Overt anemia is precipitated even by marginal iron deficiency during this period with adverse consequences. Not many studies are available on adolescent anemia in India and the State of Himachal Pradesh.

Objective: The primary objectives were to 1) estimate the prevalence of anemia among school girls aged 12 to 16years in urban and rural areas of Shimla district Himachal Pradesh. 2) assess knowledge of anemia and its treatment and prevention in these girls.

Methods: A cross-sectional survey was conducted among 691 schoolgirls (aged 12 - 16 years) studying in government schools at Shimla (urban; n=350) and Kumarsain Block (rural; n=341) Himachal Pradesh. Approximately equal numbers of girls were selected in each age group. Age was determined from the school register. Hemoglobin was estimated using cyanmethaemoglobin technique. WHO classification of anemia was used to estimate and compare prevalence after applying altitude correction factor for haemoglobin. A semi-structured questionnaire was used to obtain data on socio-demographic variables, knowledge, treatment and prevention of anemia among study subjects. Academic performance was assessed using school records for first terminal examinations. Data collected was analyzed using Epi Info 6.04d.

Results: Overall prevalence of anemia (Hb <12g/dl) among rural and urban schoolgirls was 66.6% (95% CI 61.25-71.50) and 68.2% (95% CI 64.56-74.42) respectively. Poor academic performance was associated with anemia among rural school girls (χ^2= 10.69; P =0.001). The urban girls and teachers had a better knowledge about anemia.

Conclusion: Prevalence of anemia was high and similar in rural and urban schoolgirls of Shimla District. Adopting Nutritional education in school curriculum and enlarging the scope of the existing National Nutritional Anemia Control programme may help in preventing adolescent anemia. Further studies are needed to address the problem of adolescent anemia among girls.

1. INTRODUCTION

Anemia is a major public health problem world wide, particularly in women of reproductive age group of developing countries. Iron deficiency is believed to cause the largest part of anemia globally[1]. About 2 billion Persons in the world suffer from iron deficiency and its anemia[2]. Fourth report on World Nutrition Situation[2] reports that in developing countries 56% of pregnant women, 53% of school age children and 44% of non-pregnant women suffer from iron deficiency anemia. The prevalence of anemia in developing countries is three to four times higher than the industrialized countries. South East Asian countries have the highest prevalence of anemia, with almost 80% of pregnant women in this region being anemic[3].

According to National Family Health Survey[4] (NFHS II), (1998-1999) the distribution of anemia among the adolescents girls of age group (15-19 years) in hilly states of India is ranging between 74.8% in Sikkim, to 31.5% in Manipur. In Himachal Pradesh the prevalence of anemia is 43.2% in the age group of 15-19 years as per WHO definition.

National Nutrition Monitoring Bureau[5] Hyderabad (2000-2001) conducted an multi-centric study in eight States of India and found prevalence of anemia in adolescence girls in the age group of 12-14 years ranging from 53.7% in Tamilnadu to 90.1% in West Bengal. In the age group of 15- 17 years it ranged from 49.2 % in Kerala to 87.6 % in West Bengal.

The government of India started the National Nutritional Anemia Prophylaxis's programme (NNAPP) way back in Year 1970. It was focused to improve the nutritional anemia in children aged 1-11 years and women of child bearing age. In 1989 Indian

Council of Medical Research[6] evaluated NNAPP and found the prevalence of anemia in pregnant women to be 87.6%. A study done by National Institute of Nutrition, Hyderabad[7] showed the prevalence of anemia to be 44% in children aged 3 to 5 years. In 1991 NNAPP was renamed as National Nutritional Anemia Control Programme (NNACP) with new strategies to control nutritional anemia.

In view of the current high prevalence and the proposed efforts to reduce the prevalence of anemia, it is essential that an institutional mechanism is set up to monitor periodically prevalence of anemia at the state level so that data will be available to plan interventions and also monitor their impact. Under the tenth[8] plan it is advocated that operational research to assess the feasibility of at least once a year screening for detection and correction of anemia in school children as part of school health check up needs to be explored and implemented.

2. JUSTIFICATION

Adolescence is a period of rapid growth, weight gain and blood volume expansion. The overall iron requirement increases from a pre-adolescent level of approximately 0.7-0.9 mg iron per day to 2.2 mg iron /day or perhaps more in heavily menstruating women[9]. A large amount of iron is needed to meet the growth requirements of adolescence and even a marginal iron deficiency during this period can precipitate overt anemia. The studies conducted in India on micronutrient deficiency confirms the high prevalence of anemia among adolescent girls[5, 28,35,36, 37,68].

Importantly targeting adolescent girls for reduction of iron deficiency anemia serves to complement ongoing efforts to address the problem during pregnancy and infancy. It is targeting another vulnerable time in the life cycle. Targeting adolescent girls as a time to reduce anemia can be based on three considerations. First many girls are anemic by the time they become pregnant[24]. Second, pregnancy is too short a period of time to reduce any preexisting anemia particularly when large proportion women do not seek antenatal care. Third intervention channels already exist through which to target adolescents with iron intake.

Compared to vast amount of work done on pregnant women and young children there are relatively few studies on the prevalence of anemia in adolescent girls. Most of the studies available are only for the children of the age group of 6-35 months and for women of reproductive age group. It is this age group (6-35 months and 15-45 years), which reflects the existing problem of anemia in the adolescents. Considering the magnitude of the problem and the multiple adverse effects of iron deficiency, assessment of the anemia status of the adolescence population is important. In this context not many studies are available in the published literature particularly relating iron deficiency status from the State of Himachal Pradesh. Hence this study is aimed to assess the magnitude of the problem, knowledge and practice about anemia, in this setting among adolescent girls aged 12 to 16 years.

3. OBJECTIVES

Primary Objectives:

1. To estimate the prevalence of anemia among school girls aged 12 to 16years in urban and rural areas of Shimla district Himachal Pradesh.
2. To assess knowledge of anemia and its treatment and prevention in these girls.

Secondary Objective:

1. To compare the academic performances of anemic and non-anemic girls in the respective school.
2. To assess the knowledge about anemia among class and science teachers in the respective school.

4. LITERATURE REVIEW

4.1 Introduction:

In the last two decades, the importance of anemia and iron deficiency as a public health problem has been recognised by health authorities and policy makers. Iron deficiency affects a significant part, and often a majority of the population in nearly every country in the world .The magnitude of the problem varies globally from 9% in Industarilised countries to 53% in non Industralised Countries[1]. The prevalence of anemia in developed countries is much less than that in developing countries and is mostly confined to women in general. The World Health Organisation (WHO) /World Bank supported analysis of the global burden of disease ranked iron deficiency anemia as the third leading cause of loss of disability adjusted life years (DALYs) for females aged 15-44 across the globe[10]. Using different but equally compelling criteria, United States Agency for International Development[10] produced a 1994 analysis estimating that in South Asia, a two third reduction in anemia would result in US$ 3.2 billion increase in agricultural production over the seven year period 1994-2000.

4.2 Historical Background:

Anemia was known to Ancient Greeks as muscular weakness. They recognised the benefits of iron salts to improve muscular weakness in injured war veterans. The weakened sufferers used to drink the water in which sword was rusted and hoped to assume some of the strength of this metal[11]. Anemia symptoms were identified by the term Chlorsis – a Greek term meaning green. In the 16th Century it was associated with a series of symptoms: pallor, fatigue, poor appetite and gastrointestinal, neurological, and menstrual disturbances, commonly found in adolescent girls. In the 18th Century blood

was shown to contain iron, and from 1832 to 1843 Chlorosis[12] was noted to be associated with low levels of iron in the blood and a reduced number of red cells.

The merging of knowledge of the chemical composition of blood with the description of morphologic characteristics of red cells in health and disease was made possible by modern haematology. This has allowed significant advances in our understanding of the aetiology of anemia in modern times. Haemoglobin was discovered in the 19th Century by Hoppe- Seylers who showed that blood pigment was composed of haematin, which contained iron and protein. A means of estimating its concentration in blood by colour comparison to a standard was described by Gowers about 1880, and was followed quickly by more accurate methodology, i.e. Sahli hemoglobinometre, modification of which are still used today. Progress in understanding anemia was enhanced further around the 1890 when Hufner, Haldane, and Smith demonstrated stoichimetric relationships between haemoglobin and its iron content, iron, and oxygen, and haemoglobin and oxygen carrying capacity.

4.3 Epidemiology of Anemia:

4.3.1 Global:

Anemia[1] is a major public health problem world wide, particularly in women of reproductive age group of developing countries. Iron deficiency is believed to cause the largest part of anemia globally. About 2 billion Persons in the developing world suffer from iron deficiency anemia[2]. The trend in anemia among adult women in last two decades or so have deteriorated in all regions except South America, The Near East, and North Africa[13]. Among the school age children (5-14 years) the prevalence[2] has been estimated to be as high as 63% in South East Asia to 21% in Western Pacific as compared to industrialised countries where it ranges 5% in North America to 22% in Europe.

4.3.2 South East Asia Region:

According to 4th report of the world nutrition situation[2] 600 million people in the region are suffering from iron deficiency anemia, predominantly affecting adolescent girls, women of reproductive age and young children. The condition has a prevalence of 74% among pregnant women in the region with a wide range of 13.4% in Thailand to 87% in India.

4.3.3Indian scenario:

Anemia is a major nutritional deficiency disorder in India. Large population survey[14] in Rural India indicates that the prevalence of anemia ranges from 38% to 72% depending upon age and sex. In female child of 6-14 years it ranges from 55- 97% and in the age group of 15-22 it ranges between 63.7- 96.7% and these prevalence's are quite high. According to NFHS II[4], (1998-1999) prevalence of anemia among adolescents girls of age group 15-19 years was 56%. It was higher in the rural (53.9%) area than in the urban (45.7%) area. In Himachal Pradesh the prevalence of anemia was 43.2% in the age group of 15- 19 years with a similar prevalence of 38.5% in urban and 40.7% in rural area respectively.

Table 1. WHO *criteria for anemia diagnosis by estimation of Haemoglobin.

Age group	Haemoglobin (g/dl)
Children 6 months to 59 months	< 11g/dl
Children 5-11 years age	<11.5g/dl
Children 12-14 years age	<12g/dl
Pregnant women	< 11g/dl
Non pregnant women above 15 years of age	<12g/dl
Adult man	< 13g/dl

*Ref; [15]

Hence, anemia is a major public health problem with adverse consequences for women of reproductive age group and for children. Over 90% of the affected children live in developing countries. In infants and children it causes impaired physical and cognitive development[16]. In adults iron deficiency anemia is associated with weakness and fatigue, which reduces capacity for physical work and productivity[17]. In women of reproductive age group it can lead to low birth weight or pre-mature babies, perinatal and neonatal mortality, inadequate stores for the newborn and risk of maternal mortality and morbidity[16]. United Nations Administrative Committee on Coordination / Sub Committee on Nutrition[18], in 1991 documented that severe anemia may be a contributory factor in up to 50% of maternal deaths, and is the main cause of up to 20% of maternal death in developing countries. The most common causes of anemia are poor bioavailability of iron consumed, insufficient quantity of dietary iron intake, increased requirements at certain stages in life cycle, blood loss due to both menstruation and child birth and parasitic infestation most importantly Hookworm and to lesser extent *Schistosoma, Whiporm* and *Amoebiasis*[17].

4. 4 Anemia in adolescence:

4.4.1 Prevalence:

World Health Organisation (WHO) /United Nations Children's Emergency Fund (UNICEF) / United Nation University[19] (UNU) in 1993-documented that anemia is a public heath problem, not only among pregnant mothers, infants, and young children but also among school age children including adolescents. Growing children requires large amount of iron for continuous increase in body mass and are therefore vulnerable to iron deficiency and its consequences. At a meeting of the International Nutritional Anemia Consultative Group[20] at Durban in 1999, it was stated that school children aged 5-14 years must be recognized as a high-risk group because the percentage of anemic children is as high as that of pregnant women. As per WHO/UNICEF/UNU[19] over one third of the school population is anemic; the problem is most pronounced in South East Asia and Sub-Saharan Africa where anemia is linked to poverty.

4.4.2 Developed Countries:

Data from developed countries in America and Europe indicate a much lower prevalence of anemia among adolescent populations. In a Nationally representative cross sectional survey in United States[21] prevalence of anemia was found to be 2%-3% among adolescents girls aged 12 to 19 years. A study from England[22] documented that while overall prevalence of anemia among the adolescent girls was 20% it was 11% for Caucasian girls compared to 22-25% for Asian girls.

Jackson RT[23] and colleagues in a school-based study in Kuwait among adolescents girls documented the prevalence of anemia to be 30% as per WHO criteria.

4.4.3 Developing Countries:

Studies from developing countries indicate that the prevalence of anemia varies widely. Kurz[24] and colleagues documented in a multi-country study on the nutritional status of adolescents, anemia prevalence ranging from 32-55%. Cai Mq[25] documented 61.8% of prevalence of iron deficiency anemia among the adolescence Chinese girls. A study from Taiwan identified teenaged females at risk of iron deficiency anemia with the prevalence ranging from 9.38-26.4%. A nutritional survey conducted by Simon Tatala[26] and colleagues in 1992 at Lindi district of Tanzania documented the prevalence to be 66.8 among the school children with no difference between boys and girls.

4.4.4 India:

Studies conducted on adolescent girls in India have shown the prevalence of anemia ranging between 27% in rural Hyderabad[27] to 90.3% in rural area of Haryana[36].

In a multi-centric study done by National Nutrition Monitoring Bureau[5] Hyderabad in eight States of India covering eighty villages in each State in the year 2000-2001 the prevalence of anemia in adolescence girls in the age group of 12-14 years ranged from 53.7% in Tamilnadu to 90.1% in West Bengal. In the age group of 15- 17 years it ranged from 49.2 % in Kerala to 87.6 % in West Bengal (Table 2).

Table 2. Prevalence of Anemia 12-17 years Adolescents girls in

Eight States of India 2001	Age group 12-14 years		Age group 15-17 years	
States	**n**	**(%)**	**n**	**(%)**
Kerala	324	54.4	364	49.2
Tamilnadu	407	53.7	406	59.4
Karnataka	399	62.7	399	68.4
Andhra Pradesh	443	72.7	446	72.9
Maharashtra	399	56.6	403	64.3
Madhya Pradesh	327	71.9	326	74.8
Orissa	436	82.1	433	77.6
West Bengal	435	90.1	437	87.6
Pooled	3188	68.6	3214	69.7

G. Vasanthi[27] and colleagues in 1993 conducted an cross-sectional study among the adolescent girls aged 11-16 years attending local schools of rural area and urban slum of

Hyderabad documented the prevalence of anemia to be 27 and 22 % in rural and urban girls who had not attained menarche and 24.2 and 27.8% in those who had attained menarche. The overall prevalence was 25%. With increasing age urban girls who had attained menarche showed an increase in the prevalence of anemia.

A cross sectional study by Swapna Chaturvedi[28] and colleagues in 1996 among the poor group of rural area of Rajasthan in 18 villages of Jaipur District recorded the prevalence of anemia to be 73.7% among 941 adolescent girls aged 10-18 years belonging to lower socio-economic groups.

M Verma[29] and colleagues (1997) in a cross-sectional study amongst urban school children aged 5-15 years in Ludhiana, Punjab documented the overall prevalence to be 51.5% and the prevalence was inversely proportional to age.

Jolly Rajaratnam[30] and colleagues in 1988 conducted a cross-sectional study among adolescent girls of rural Tamilnadu and recorded the prevalence of anemia to be 44%.

A study done by K.Anand[31] and friends, among adolescent school children in September 1998 at government senior secondary school in village Chandawali of district Faridabad Haryana among student of class VI-XII recorded the prevalence of anemia as 51%(age group 12-14 years) and 38.5% (age group 15-18 years) among the girls.

Tiwari K[32] and friends (2000) conducted a cross-sectional study in urban areas of Kathmandu amongst school going adolescent girls aged 10-18 years and recorded the prevalence of anemia to be 60.5%.

In a cross sectional study by Binay Kumar Shah[33] and colleagues in 1998 amongst the adolescent girls aged 11-18 years of semi urban area of Nepal recorded the prevalence to be 68.8%.

A study done by Kapoor G[34] and friends in urban Delhi among 454 school girls aged 11-18 years among higher and lower socio-economic status girls documented the prevalence to be 46.6% and 56% respectively by cyanmethaemoglobin method.

Study done by Kanani S[35] and colleagues documented a prevalence of 81% among 203 adolescent girls aged 10 -16 years in the slums of urban Vadodara Baroda in the year 1998. She also recorded a prevalence of 75%; among 2090 school girls aged 10-19 years in urban Vadodara Baroda.

A study done by Raina N[36] and colleagues at rural Haryana among adolescent girls aged 13 –17 years school going and non-school going girls documented the prevalence to be 80.8% and 90.3% respectively.

In a school based study[37] in urban area of Delhi and rural parts of Bhratpur Rajasthan among adolescents girls aged 11 to 18 years belonging to poor communities the prevalence of anemia was documented to be 61.9% and 85.4% in urban and rural areas respectively

All these studies indicate; despite all efforts little progress has been made in reducing the prevalence of anemia. It is now accepted that to prevent the overt anemia of pregnancy and there by preventing the intergenerational cycle of under nutrition the adolescent girls

have to be targeted. The Tenth steering committee on nutrition in their tenth five year[8] plan have also foreseen this problem and advocates early detection of micronutrient deficiency through screening of all school children and initiating appropriate remedial measures. In an attempt to increase the awareness of policy makers to the seriousness of the problem, it has been proposed by the WHO[15] that countries may be classified with respect to the degree of public health significance of anemia. An anemia prevalence of ≥40% is severe; 20.0-39.9% is moderate; 5.0-19.9 is mild ≤ 4.9 is normal. These rates apply to all ages and physiological age group.

4.5 Causes of Anemia

Adolescence is a significant period of human growth and maturation, unique changes occur and many adult patterns are established. Following early childhood (<2yr), during the adolescent growth spurt, the risk of iron deficiency and anemia reappear for both boys and girls[9] after which it subsides for boys but remains for girls because of menstrual blood loss.

Iron deficiency is believed to cause the largest part of anemia globally[1]. While there are regional differences, prevalence across the globe are remarkably similar, reflecting the underlying determinants that includes diet low in heme-iron and high in phytes, parasitic infestation and frequent reproductive cycling that decreases iron stores[17] Although many causes of anemia have been defined it is agreed that nutritional deficiency[38] due primarily to low bioavailability of dietary iron accounts for majority of cases. Apart from phytate, tannins present in diets suppress iron absorption to a significant extent[39]. Dietary intake of iron in adolescent in India as compared to recommended dietary allowances is low[40]. The prevalence of anemia[41] is reported to be significantly higher in Indian adolescent consuming a vegetarian diet (45.8%) as compared to those consuming a

mixed diet, which includes animal food. More ever, habitual consumption of tea / coffee immediately after meals by adolescent girls was associated with higher prevalence of anemia (50%) compared to those who did not consume tea or coffee after meals (34%)

Intestinal parasitism and anemia is a priority health problem. In India studies carried out in various parts have reported prevalence of intestinal parasitism up to 30-50% and anemia from 40-73% among school going girls. In a study done at Gulbarga Karnatka by Vinod Kumar[42] and colleagues demonstrated the prevalence of worm infestation as 86.66%, 68.16% and 82.97% in mild moderate and severely anemic groups. Overall worm infestation was found to be 76.8%. In a study conducted at Lindi district of Tanzania on low dietary iron availability by Simon Tatala[26] and colleagues 1998, it was found that anemia was associated with parasitic infestations in school children and adolescents. A study done by Stoltzfus RJ[43] and colleagues on epidemiology of iron deficiency anemia in Zanzibari school children concluded that infections with malaria, *Trichuris trichuria, Ascaris luumbricoides,* and *Hookworms* were all associated with worse iron status. Stoltzfus[43] reported that in school age children with more than 2000 hookworm eggs per gram of feces, the incidence of high protoporphyrin levels and moderate to severe anemia was significantly higher in Zanzibari. In a study conducted by Chakma T and colleagues[44] in Tribal area of Madhya Pradesh the prevalence of severe anemia was 30% and intestinal parasites were found in 50% of them under microscopic examination of stools.

Malaria increases risk of anemia. Acute and chronic Haemolysis, Secondary folate deficiency and Dyserythropoiesis has been implicated as a etiology of Malaria Anemia[16].A significant association between severe anemia and malaria was documented in young children of Kassena-Nankana District of Northern Ghana[45]. A study in Tanzania confirmed the role of malaria as the largest contributor to the etiology of severe

anemia in infants in highly endemic area accounting for 60% of all cases, compared with iron deficiency, which accounted for about 30% of severe anemia episodes[46].

Physiological Status: Following menarche, adolescent females often do not consume sufficient iron to offset menstrual losses. Menstrual bleeding causes an additional loss of 0.4 to 0.5 mg daily. As a result peak in the prevalence of iron deficiency frequently occurs among females during adolescence[9].

Socio-economic: Iron deficiency anemia is most common among groups of low socio-economic status. In a study done by Chaturvedi S[28] and colleagues in 18 villages of Jaipur among adolescent girls aged10-18 years belonging to low socio economic status the prevalence of anemia was 73.7%. Similarly in a study done by Rawat CMS and colleagues[47] among adolescent girls of rural area of Meerut District anemia was significantly associated with lower socio-economic status.

4.6 Consequences of Anemia:

Anemia impairs human functions at all stages of life. It has serious consequences including maternal death, and it can be prevented and treated. The consequences of iron deficiency are numerous as iron plays a central part in the mechanism for oxygen transportation and it is essential in many enzyme systems. In 1993, WHO/UNICEF/UNU consultations stated that even in mild to moderate forms of iron deficiency in which although anemia is absent, tissues are still functionally impaired. The health risks of severe anemia are profound. Although moderate degree of anemia may not seriously affect day to day work, most of which corresponds to sedentary to moderate levels of activity, impaired work capacity is seen only in those engaged in hard physical labour with moderate to severe anemia[16].

Iron deficiency anemia during childhood and adolescence has serious implications for a wide range of outcome. They can be further classified as impaired physical growth[48], weakened behavioral and cognitive development[49]; reduced physical fitness and work performance/ capacity and diminished concentration in work and school performances[50]. Even moderate anemia (Hb < 10mg/dl) has been constantly shown to be associated with depressed mental and motor development in children[51].

It affects the immune status and predisposes for infections. The consequences of anemia for women of reproductive age group includes increased risk of low birth weight, or pre-maturity, peri-natal and neonatal mortality, inadequate iron stores for the new born, increased risk of maternal morbidity and mortality[52]. Anemia is associated with lowered physical activity, mental concentration and productivity. Women with even mild anemia may experience fatigue and have reduced work capacity[16].

In a study carried out by nutrition foundation of India[53] (n=469) there were a significantly higher proportion of children with Intelligent Quotient (IQ) above 110 and a significantly lower proportions of children with IQ below 90 in the non anemic group when compared to the severely anemic children. Both the verbal and performance IQ scores of the children decreased progressively with falls in haemoglobin levels. These finding suggest that all functions are not affected in anemia; and that among those affected, different functions are compromised at different levels of severity of anemia. (The statistical analysis indicated that the observed influence of anemia could be attributed to associated under nutrition *per se*). The children's mean arithmetic tests score were found to decrease with the severity of anemia.

4.7 Prevention and control

Iron deficiency anemia like most nutritional deficiency of public health concern is mainly a consequence of poverty and ignorance. Most countries have policy statements and directives regarding iron supplementation of pregnant women, but most of these directives are not fulfilled[18]. The availability of cost effective interventions forms the basis of growing advocacy for prevention and control of iron deficiency anemia[10]. In India, National Nutritional prophylaxis programme was initiated in 1970 to control iron deficiency anemia in the vulnerable groups through daily supplementation of iron folic acid tablets. The suggested prophylactic dose of iron and folic acid respectively were 60 mg and 500 μg for pregnant women and 20 mg and 100μg for children's per day for 100 days. An evaluation in 11 States during 1985-86 indicated very poor coverage and performance of the programme. After this evaluation, the dose of iron in iron folic acid tablet was increased from 60 to 100mg in 1992[54].

At present, there are three basic approaches to prevent iron deficiency anemia[15]. Iron status may be improved through food-based strategies (iron fortified foods and dietary modification) and non-food based strategies (primary iron supplementation and parasitic disease control).

.**Dietary diversification** has been recognised as the most effective long-term sustainable strategy for overcoming the multiple nutrient deficiencies that may play a role in nutritional anemia. To achieve this, promoting appropriate dietary habit through effective nutrition education has been reported to have a positive impact on reducing iron deficiency anemia. Studies undertaken in Baroda[55] demonstrated that children who consume green leafy vegetables frequently (once a week or more) tend to have higher haemoglobin level than those who are infrequent or non-consumers. Daily supplementation of guava fruit with two major meals resulted in significant increase in

haemoglobin of 2.2g/dl in young anaemic women while the non- supplemented subjects showed non-significant increase of 0.3g/dl. Similar positive impacts of nutritional education have been reported in urban poor school girls (8-13 years) who were encouraged to improve their dietary practices using inexpensive local foods[41].

Food fortification: At the population level, food fortification is the best option if a suitable food vehicle can be identified. In a placebo-controlled trial in South Africa[56] micronutrient fortified biscuits and cold drinks were given to 6-11 years old school children for 12 months. A significant improvement in serum ferritin, serum iron, transferrin saturation, haemoglobin, and hematocrit levels were seen in the experimental groups. The greatest benefits were for children with poor iron status. In India, two different technologies of fortification of common salt were developed at the National Institute of Nutrition Hyderabad. In depth studies carried out with these strategies have clearly shown that fortified iron salt improves haemoglobin status[57].

Supplementations: A study done by Viteri[58] proposed that weekly iron supplementation for school age children (36-50 doses of 60 mg of iron per year) could serve as cost effective, community based strategy, aimed at the primary prevention of iron deficiency as well as increasing iron reserves among adolescent and adult women. Similarly a study done by Anshu Sharma and colleagues[37] among adolescent girls concluded that, considering compliance, feasibility and cost factors, a public health approach consisting of once weekly distribution of iron/folate through schools and welfare centres can be aimed at prevention of anemia among adolescent girls. The Third report on the World[3] Nutrition Situation had documented that in countries where anemia prevalence exceeds 40% of pregnant women, universal supplementation of iron to adolescent girls and women of child-bearing age is warranted. WHO[15] recommends iron supplementation of

60m/day with 400 microgram of folic acid for three months in a year in pubertal girls where prevalence is more than 40%.

Control of parasitic infections: Control of infections, particularly those producing chronic blood loss is another important strategy to control anemia[16]. Preventive measures to break parasite transmission include keeping faeces out of the soil through using pit latrines, observing adequate hygiene and sanitation practices and avoiding skin contact with soil by use of foot wear. Routine de-worming has been recommended as a cost effective strategy to control anemia, especially in area where hookworm infestation is heavily endemic[43].

Summary

The prevalence of anemia is very high in India and other developing countries. The most common causes of anemia are iron deficiency, malaria and hookworm infection. Iron deficiency anemia is highly prevalent in India and other developing as a result of various causes, which can be summarised as:

1. Poverty and ignorance that leads to lack of purchasing power to afford foods containing heme iron.
2. Low socio-economic status leading to poor sanitation and hygiene.
3. Low iron intake, poor bioavailability of dietary iron.
4. Infections and parasitic infestation.

Consequences of anemia in can be summarised as: impaired physical growth, weakened behavioral and cognitive development, reduced physical fitness and work performance/ capacity and diminished concentration in work and school performances among the adolescents. In women of reproductive age it is associated with increased maternal morbidity and mortality.

At present there are three basic approaches to prevent iron deficiency anemia:

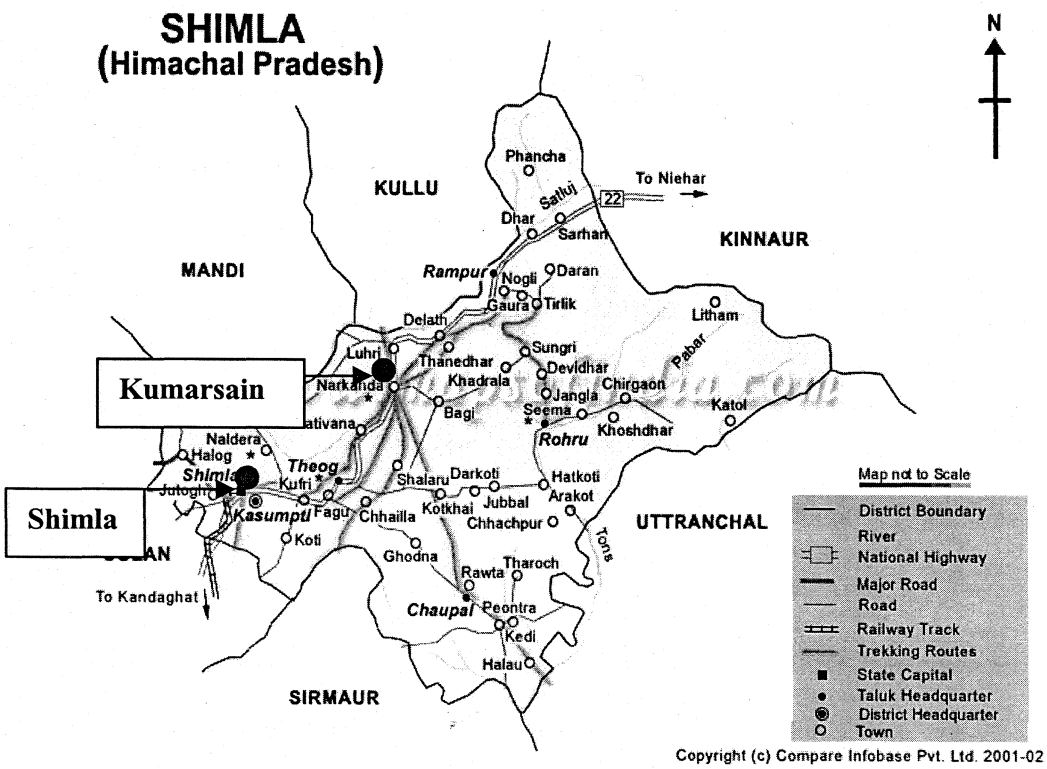
1. Iron fortified foods and dietary modification
2. Primary iron supplementation
3. Parasitic disease control.

5. METHODOLOGY

5.1 Study Area:

The topography of the district Shimla is mountainous with altitude ranging from 300 meters to 5000 meters above mean sea level (Figure 1). The total geographical area of the district is 5131 km^2 and the population is 7,21,745 as per census 2001. Means of communication is by roads or foot owing to topography. Extreme winters are experienced especially from November to March. Shimla the capital city of Himachal Pradesh is situated at an altitude of 6000 ft to 8000 ft above the sea level. Shimla was selected as an urban area for the study. Kumarsain Block which is 120 Km. from Shimla city was selected as an rural area. Kumarsain block is situated between 4000 to 8500 ft above the sea level. The altitude of the selected schools varied between 6000ft - 8000ft (Figure 1).

Figure 1. Map of Shimla District showing the study area.



5.2 Study Design:

Study design was cross-sectional.

5.3 Study Subjects:

The study was conducted in two senior secondary schools, one high school and one middle school at Kumarsain block the rural area of district Shimla and one girls senior secondary school at Shimla, the capital city of Himachal Pradesh between August and October 2003. The state government run schools were selected as they are considered to be representative of middle and lower socio-economic group children.

The schools in both urban and rural area were purposively selected taking into consideration the time constraint that is, the feasibility of completing the data collection in three months time. The study was conducted in the following schools.

1. Government Girls Senior secondary school Portmore situated at Shimla. (Urban)
2. Government Senior secondary school situated at Kumarsain (Rural)
3. Government Senior secondary school situated at Baragaon, Kumarsain (Rural)
4. Government High school situated at Narkanda, Kumarsain (Rural)
5. Government middle school situated at Jarol, Kumarsain (Rural)

Girls aged 12-16 years were enrolled for the study from the above mentioned schools.

5.4 Sample size:

As per NFHS II[4] data prevalence of anemia in Himachal Pradesh in women in the age group of 15-24 is 40.7%. Assuming that about 20% of the urban school girls as compared to 30% of rural school girls in 12 to 16 years age group would be anemic, the

sample size required for an α- error of 5% and β- error of 20% would be 313 respectively as shown below.

The formula used for sample size calculation was

$$\text{Sample Size} = \frac{2pq \quad (Z_{1-\alpha/2} \times Z_{1-\beta})^2}{d^2}$$

Prevalence of anemia in rural (p_1)= 30%

Prevalence of anemia in urban (p_2)= 20%

$$p = \frac{p_1 + p_2}{2} = 25\% \quad q = 1-p = 75\%, \quad d = p_1 - p_2 = 10\%$$

$Z_{1-\alpha/2} = 1.96$

$Z_{1-\beta} = 0.842$

$$n = \frac{2 \times 0.25 \times 0.75 \times 7.86}{(0.10)^2} = 313$$

Allowing for 10% non – responses the size required for each group would be 350. Data was collected and examined for 341 girls in the rural area and 350 girls in urban.

5.5 Sampling design:

One Government school from urban and four schools from rural area of Shimla district of Himachal Pradesh were selected to full fill the desired sample size of school girls aged

12 to 16 years. The schools were identified with feasibility of completing the study in three months because of the time limits. A line listing of these school girls aged 12-16 was done from the available school record. Age was determined from the register of the school. The school insists on a birth certificate at the time of admission and from that birth certificate age was increased by one every year. Only those school girls who were listed in the register in the age group of 12 to 16 years were enrolled. Age was measured to the nearest six months: i.e. a girl 13 year old was any girl who had completed 12 year six months and was less than 13 year six months. Approximately equal number of girls were selected in each age group. To ensure this adequate number of girls in each group more than one school was identified in the rural area. Apparently healthy girls i.e. not suffering from evident clinical illness were included in the study.

5.6 Study Team:

A six-member team was constituted, which included.

1. The FETP –Scholar (the author of this study) as a principal investigator.
2. One laboratory technician.
3. One laboratory assistant.
4. Three female health workers.

The Class Teachers of respective classes in each school helped us in collection of data and in maintaining discipline among the study subjects. They also assisted in verification of date of birth from the school registers as well as the academic performance of these girls in the examination held just before the study.

5.6.1 Training of the study team:

Principal investigator was trained at the National Nutrition Monitoring Bureau situated at Chennai. As the team was formed at Kumarsain the principal investigator imparted training to the team members and was assisted by Block Medical Officer, Kumarsain in conducting the training. The duration of training was three days.

5.7 Data collection technique and tools:

5.7.1 Administering interview schedule:

A semi-structured questionnaire was designed to assess the socio-economic status and knowledge and practices about anemia. The questionnaire was translated into local language for the understanding of these girls (The questionnaire was first translated to local language spoken in this area and than back translated from the local language version to English by an expert. Questionnaire is given as Annexure I). Data was collected on caste, religion, parental education, type of house, place of living highest occupation in the family, highest assets in the house, ownership of apple orchard, number of brother and sisters, type of food they eat. To assess the knowledge about anemia among these school girls they were interviewed and right responses were recorded. All the girls of a particular section or class who were eligible for our study from VI to XI standard attending the school on the day and time of our survey were included. Efforts were made to examine the students who were absent on that particular day to examine on the next day. On an average 10-15 minutes were spent on one study subject.

Socio-economic status was assessed using place of living, type of house, highest education in the family, highest occupation in the family and assets. A categorical score was assigned to them. The minimum score assigned was 1 and maximum score was 23

respectively for both urban and rural areas. The distribution was further divided in to three categories. The lowest 1/3 being low-income group, middle 1/3 being middle-income group and upper 1/3 being high-income group.

To compare the academic performances in the school among the enrolled study subjects, available school records for the first terminal examinations, which were held in the month of June 2003, were utilised. The actual percentage of marks awarded were taken and children classified as Poor (<33%), Average (34%-45%), Good (46%-59%), Very Good (60%-74%) and excellent (>75%).

A semi-structured questionnaire was also designed by us to assess the knowledge about anemia among the class teachers and science teachers of these 12-16 year school girls. The questionnaire was translated in to local language for better understanding. To assess the knowledge about anemia the teachers were interviewed and responses were recorded.

5.7.2 Biochemical analysis:

Hemoglobin estimation of identified girls was done using cyanmethemoglobin technique. Under supervision of principal investigators the laboratory technician carried out estimation of haemoglobin who was also assisted by laboratory assistant. The process adopted for haemoglobin estimation was as follows:

Finger prick sample of blood (20µl) was collected from the study subjects using 20µl Fin Pipette. This was added to 5ml of standardized Drabkins solution (J. Mitra & Co. Ltd.) in a vial. The vial was inverted several times to mix the solution. It was allowed to stand for 10 minutes. The solution was read in a Photo Calorimeter at 540nm and values of haemoglobin were calculated against a standard table. All observations were made by one laboratory technician so as to prevent inter-observer bias. Every 20^{th} of the sample

was sent on Whatman# 1 filter paper to a local accredited hospital laboratory to keep a check on the precision of the haemoglobin estimation in the field situation.

5.7.3 Definition for Anemia:

Anemia is usually defined as hemoglobin concentrations below normal cutoff values that are based on age, sex, physiological states and altitude[15] Table 3.

Table 3. Anemia Classification (World Health Organization*).

Anemia Level	Haemoglobin Concentration (g/dl)
No anemia	≥ 12
Mild anemia	10 to 11.9
Moderate anemia	7 to 9.9
Severe anemia	≤ 7

*Ref.[14]

This definition was used as working definition for the study with altitude correction. The altitude at which the blood sample was taken was rounded up or down to nearest 500m.The altitude correction factor was calculated using Centers for Disease Control[59] Atlanta USA. stated formula, which is:

Hb = -0.32 x (altitude in meters x .0033) + 0.22 x (altitude in meters x 0.0033)^2

For the altitude ranging between 6000ft - 7000ft altitude correction factor calculated was 0.7g/dl and it was subtracted from the original value of hemoglobin obtained to define anemic and non-anemic status as per WHO definition. For altitude ranging between 7000ft - 8000ft altitude correction factor calculated was 1g/dl and it was subtracted from the original haemoglobin value obtained to define anemic and non-anemic status as per WHO definition.

5.8 Ethical Issues:

Before conducting the study in the school, written permission was obtained from Director of Education and Director Health and Family Welfare services Himachal Pradesh. Informed consent from respective school authorities were obtained. Each student was explained about the purpose of the study.

Beneficence: Appropriate treatment was given to all girls identified as mild to moderate anemic. Girls found with severe anemia were referred to nearest health institutions for appropriate management.

Malevolence: Known standard equipments for hemoglobin estimation were used. These have been proved to cause no side effects .The girls found anemic were given iron tablets and explained about the minor side affects of the tablets.

Issue of public good: It is accepted that this study has limited itself to four schools in rural and one school in urban. Since no such studies have been done previously, the present study was undertaken as pilot project. This is a project for MAE-FETP programme to be undertaken with limited resources (Time money and manpower) There fore, a large-scale project was not undertaken. However based on the findings of this pilot project, a similar study will be recommended to cover a larger population to the appropriate authorities.

Compensation for lost opportunity: No formal classroom teaching was undertaken for that class till examination procedure was completed for all the girls as per decision taken by teachers and school authorities, and this was done during school hours and no inconvenience was caused to anyone.

5.9 Data analysis:

The Data were scrutinized for completeness and analysis was done using Epi-info Version 6.04[60]. Chi square tests (Yates corrected), Chi square trend were used and 'P' value of less than 0.05 was considered statistically significant.

6. RESULT

The study was designed to have equal number of school girls in 12-16 year age group both in urban and rural areas. Table 4 shows the distribution of the study population. There were 691 girls in the study out of which 350 belonged to a government school located in Shimla (urban) and 341 were from four government schools of rural area of Shimla (Kumarsain block) situated 120 k.m. from Shimla. Four rural schools had to be selected for getting the required equal number as the urban school in the rural area.

Table 4. Distribution of adolescent school* Girls by age, Shimla

Age (in years)	Rural (n=341)		Urban (n=350)	
	n	(%)	n	(%)
12	65	19.1	70	20
13	70	20.5	70	20
14	66	19.4	70	20
15	70	20.0	70	20
16	70	20.0	70	20

*State Government schools: catering to students from lower middle and poor sections

6.1 Prevalence of anemia:

The overall prevalence of anemia (Hemoglobin level of less than 12 g/dl after altitude, correction) was 68.2%. The prevalence of anemia was slightly higher in the urban area 69.57 (95% CI 64.56-74.42) as compared to rural area where it was 66.6 %(95% CI 61.25-71.50). This difference was not statistically significant (χ^2= 0.65; p= 0.42). The distribution of hemoglobin (g/dl) in urban and rural school girls aged 12-16 years is shown as frequency polygon in figure 2.

Figure 2. Frequency Polygons of Haemoglobin (g/dl) in rural & urban school girls aged 12-16 years Shimla 2003

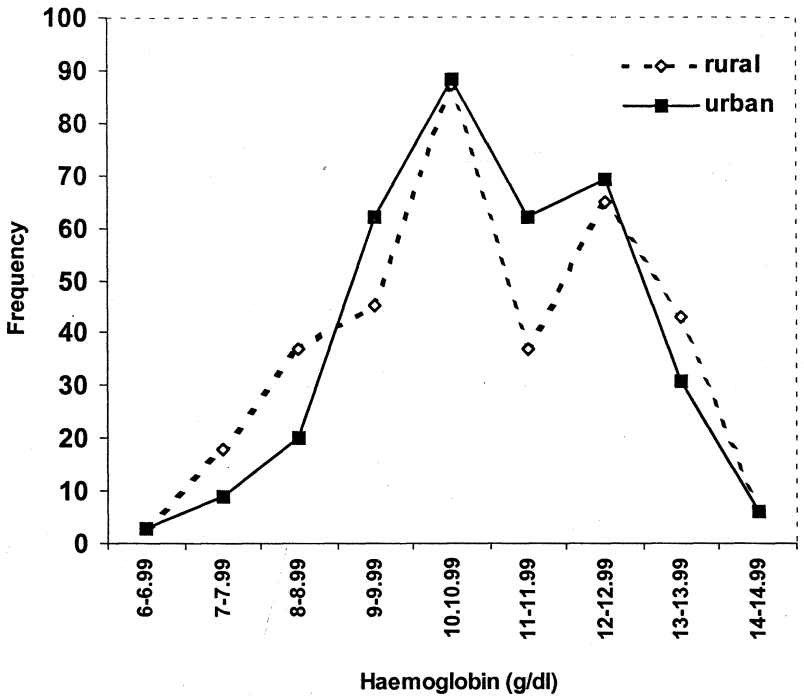


Table 5 shows prevalence of anemia according to severity. Mild (Haemoglobin value between 10.0g/dl – 11.9g/dl) anemia was more prevalent than the moderate (Haemoglobin value between 7.0g/dl – 11.9g/dl) and severe (Haemoglobin value less than 7g/dl) anemia. In urban area, the prevalence of mild anemia was slightly higher than the rural area. Moderate anemia was more prevalent in the rural area. Severe anemia was quite low and similar in both the groups. The distribution of anemia (mild Vs moderate+ severe) in urban and rural areas was not statistically significant (χ^2= 1.99; P = 0.16).

Table 5. Prevalence of Anemia according to severity in rural (n=227) & urban (n=244) School Girls aged 12 –16 years, Shimla.

Area	Mild		Moderate		Severe	
	n	%	n	%	n	%
Rural	124	54.61	100	44.1	3	1.3
Urban	150	61.5	91	37.3	3	1.2
Total	274	58.2	191	40.6	6	1.3

6.2 Prevalence of anemia by age group:

In urban schoolgirls moderate and severe anemia taken together showed an increasing trend from 12-15 years of age. However, in rural girls there was an increase between 12-13 years of age only and after that remained similar. Statistically it was significant in the urban area (Table 6). The prevalence of anemia by age group in urban and rural school girls is shown in figure 3.

Table 6. Age specific prevalence of severity of Anemia in rural & urban School Girls aged 12 –16 years, Shimla.

Age in Years	Rural* (n=341)			Urban† (n=350)		
	Moderate + Severe n (%)	Mild n (%)	Non Anemic n (%)	Moderate + Severe n (%)	Mild n (%)	Non Anemic n (%)
12	16 (24.6)	26 (40.0)	23 (35.4)	11 (15.7)	32 (45.7)	27 (38.6)
13	23 (32.9)	19 (27.1)	28 (40.0)	15 (21.4)	27 (38.6)	28 (40.0)
14	18 (27.3)	26 (39.4)	22 (33.3)	20 (28.6)	28 (40)	22 (31.4)
15	22 (31.4)	25 (35.7)	23 (32.9)	26 (37.1)	28 (40)	16 (22.9)
16	24 (34.3)	28 (40.0)	18 (25.7)	22 (31.4)	35 (50.0)	13 (18.6)
	*χ^2= 5.98; P= 0.64			†χ^2= 17.16; P= 0.02		

Figure 3 Prevalence (%) of anemia (all grades) by age group in rural and urban school girls Shimla 2003

6.3 Prevalence of anemia by socio-economic factors:

6.3.1Education of parents:

The prevalence of anemia decreases (Table7) as the educational status of parents increases in rural area. However, in urban area significant pattern is not observed. [(Fathers: χ^2 for trend = 0.27; P= 0.60) and (Mothers: χ^2 for trend = 0.39; P= 0.53)]. Anemia in rural area was found to be statistically significant.

Table 7. Prevalence of Anemia in rural & urban School Girls aged 12 –16 years, Shimla by Educational Status of Parents

Educational status of parents	Rural* (n =341)		Urban† (n=350)	
	Anemic	Non Anemic	Anemic	Non Anemic
	n (%)	n (%)	n (%)	n (%)
Father ‡				
≤ Primary	32(72.7)	12(27.3)	17(65.4)	9(34.6)
Middle	50(76.9)	15(23.1)	13(68.4)	6(31.6)
≥High School	145(62.5)	87(37.5)	214(70.2)	91(29.8)
* ‡χ^2 for trend= 3.84; P= 0.05				
Mother §	126(74.6)	43(25.4)	76(69.1)	34(30.9)
≤ Primary	52(61.2)	33(38.8)	48(80.0)	12(20.0)
Middle	49(56.3)	38(43.7)	120(66.7)	60(33.3)
≥High School				
* § χ^2 for trend= 9.5; P= 0.00				

6.3.2 Highest occupation in family:

In general, highest occupation in the family (Table 8) does not show a trend in prevalence of anemia with the increase in status of occupation. The prevalence of anemia in both rural and urban areas was found to be highest in the unskilled workers. However, it was lowest in business people in rural area and in skilled people in urban area. The relationship between occupation and anemia status was statistically significant in both the areas.

Table 8. Prevalence of Anemia by status of highest Occupation in family in rural & urban School Girls aged 12 –16 years, Shimla.

Occupational status	Rural* (n =341)		Urban† (n=350)	
	Anemic	Non Anemic	Anemic	Non Anemic
	n (%)	n (%)	n (%)	n (%)
Unskilled	77(79.4)	20(20.6)	94(81.7)	21(18.3)
Semi Skilled	21(61.8)	13(38.2)	21(75.0)	7(25.0)
Skilled	64(64.6)	35(35.4)	111(61.0)	71(39.0)
Business	65(58.6)	46(41.4)	18(72.0)	7(28.0)

*χ^2 for trend= 9.38 p= 0.00 †χ^2 for trend = 10.77p =0.00

6.3.3 Ownership of orchards:

Having an apple orchard was taken as an indicator of family prosperity. The prevalence of anemia (Table 9) was lower among girls whose family own apple orchard in both urban and rural areas. The prevalence of anemia in rural area for those who did not own an apple orchard was almost 1.3 times higher than those who owned the orchard. The prevalence of anemia and ownership of apple orchard was statistically significant in rural area and not so in urban area.

Table 9. Prevalence (%)of Anemia by ownership of Apple Orchards in rural & urban School Girls aged 12 –16 years, Shimla

Ownership	Rural* (n=341)				Urban† (n=350)			
	Anemic		Non Anemic		Anemic		Non Anemic	
	n	%	n	%	n	%	n	%
No Apple orchards	111	77.6	32	22.4	162	72.6	61	27.4
Apple Orchards	116	58.6	82	41.4	82	64.6	45	35.4

*χ^2= 12.68 p = 0.0004 †χ^2= 2.13 p= 0.14

6.3.4 Socio-economic status grading:

The prevalence of anemia (Table 10) decreases as the socio-economic status increases in rural area where as, it is not so in urban area. In rural area, there is a significant difference in low and high-income group. This is in contrast to urban area where such a difference is not seen.

Table 10. Prevalence of Anemia by Socio-economic status in rural & urban School Girls aged 12 –16 years, Shimla.

Socio-economic status	*Rural (n=341)				Urban† (n=350)			
	Anemic		Non Anemic		Anemic		Non Anemic	
	n	%	n	%	n	%	n	%
Low	99	43.6	29	25.4	70	28.7	25	23.6
Middle	82	36.1	61	53.5	96	39.3	39	36.8
High	46	20.3	24	21.1	78	32.0	42	39.6

*χ^2 for trend= 4.93 p= 0.02 †χ^2 for trend= 1.97 p=0.16

6.4 Prevalence of anemia by diet:

In general, the prevalence of anemia (Table 11) was lower in those who took non-vegetarian diet both in rural and urban area. Prevalence of anemia among vegetarians

was 1.2 times higher as compared to non –vegetarians in rural area ($\chi^2 = 5.37$; p= 0.02). In urban area the prevalence was 70.9% among vegetarians and 66.3% among non-vegetarians.

Table 11. Prevalence (%)of Anemia by type of diet in rural & urban School Girls aged 12 –16 years, Shimla.

Type of diet	Rural* (n=341)				Urban† (n=350)			
	Anemic		Non Anemic		Anemic		Non Anemic	
	n	%	n	%	n	%	n	%
Vegetarian	165	70.8	68	29.2	183	70.9	75	29.1
Non - Vegetarian	62	57.6	46	42.6	61	66.3	31	33.7
	*$\chi^2 = 5.37$ p= 0.02				†$\chi^2 = 0.49$ p= 0.49			

6.5 Prevalence of anemia by Academic Performances:

Table 12 shows the academic performance among study population by their anemia status. The academic performance [(Academic performance was judged based on the marks obtained in the first terminal examination (held in June 2003). The relationship between poor (≤ 45%) or better (>45%) academic performance is presented in the table)] was better in the non-anemics as compared to anemics in both urban and rural area. Poor academic performance was 2.36 times higher in anemics as compared to non-anemics in rural area and 1.36 times in urban area. This relationship was statistically significant in rural area.

Table 12. Prevalence of Anemia by academic performances in the exams immediately pre-ceding to the study in rural & urban School Girls aged 12 –16 years, Shimla

Academic performance	Rural* (n =341)				Urban† (n =350)			
	Anemic		Non Anemic		Anemic		Non Anemic	
	n	%	n	%	n	%	n	%
Poor Performers‡	182	80.2	72	63.2	181	74.2	72	67.9
Better Performers§	45	19.8	42	36.8	63	25.8	34	32.1

*χ^2= 10.69 P =0.001 †χ^2= 1.15 P=0.28

‡Defined as ≤ 45% marks in the first terminal examination.
§Defined as >45% marks in the first terminal examination.

6.6 Anemia by menarcheal status:

The two-study samples were analysed with respect to their menarcheal status (Table13). Girls who had attained menarche have more prevalence of anemia than those not attained menarche. This is observed equally in urban and rural group but was statistically significant in the urban area.

Table 13. Prevalence of Anemia by attaining and not attaining Menarche in rural & urban School Girls aged 12 –16 years, Shimla

Menarcheal status	Rural*(n=341)				Urban† (n=350)			
	Anemic		Non Anemic		Anemic		Non Anemic	
	n	%	n	%	n	%	n	%
Attained	149	70.6	62	29.4	155	75.6	50	24.4
Not attained	78	60.0	52	40.0	89	61.4	56	38.6

*χ^2 = 3.61 p= 0.057 †χ^2= 7.49 p= 0.00

(Table14). There was no significant difference by age at menarche in both the urban and rural groups.

Tables 14. Prevalence of Anemia by age at menarche in rural & urban School Girls aged 12 –16 years, Shimla.

Age at menarche (in Years)	Rural*(n=341)				Urban† (n=350)			
	Anemic		Non Anemic		Anemic		Non Anemic	
	n	(%)	n	(%)	n	(%)	n	(%)
≤ 12years	12	75.0	4	25.0	16	66.7	8	33.3
12-14years	80	67.2	39	32.8	96	76.8	29	23.2
≥14-years	57	75.0	19	25.0	43	76.8	13	23.2
	*χ^2 for trend = 0.44 ; p= 0.51				†χ^2 for trend= 0.57; p= 0.45			

The study group was further sub-divided in to three groups by taking duration of menses (Table 15). In rural area, there was trend in increase in prevalence of anemia as the duration increased, which was not statistically significant (χ^2 for trend= 1.96; P= 0.16). However, in urban girls the prevalence of anemia was not showing marked difference by duration of menses.

Table 15. Prevalence of Anemia by duration of menstruation in rural & urban School Girls aged 12 –16 years, Shimla.

Duration of menstruation in days	Rural* (n =341)				Urban† (n =350)			
	Anemic		Non Anemic		Anemic		Non Anemic	
	n	%	n	%	n	%	n	%
≤ 3	37	64.9	20	35.1	43	82.7	9	17.3
4-5	95	71.4	38	28.6	75	71.4	30	28.6
≥6	17	81.0	4	19.0	37	77.1	11	22.9
	*χ^2 for trend= 1.96 p= 0.16				†χ^2 = 0.48 p= 0.49			

Table 18. Distribution (%) of knowledge of nature of prophylaxis and its effects among School Girls aged 12 –16 years, Shimla

Nature of prophylaxis and its effects	Rural (n =173)		Urban (n=20)	
	n	(%)	n	(%)
Nature of prophylaxis taken				
Know	104	60.0	20	100
Do not know	69	40.0	0	0
Was prophylaxis for anemia beneficial				
Yes	143	83.0	14	70.0
Do not know	30	17.0	6	30.0
If beneficial, than how				
Absence of pallor	37	26.0	8	57.0
Absence of fatigue	83	58.0	5	36.0
Absence of breathlessness	23	16.0	1	7.0

6.9 Knowledge of anemia among school teachers:

Overall there were 31 teachers who were either class teachers or teaching science for the girls in the study area (Table 19). In urban area there were 10 female teachers and in rural there were 6 female and 15 male teachers. The knowledge about anemia among school teachers was more in urban than the rural area. In urban area, teachers were able to define anemia, symptoms, adverse affects and prevention better than the rural area. In rural area majority stated deficiency of iron as cause of anemia whereas in urban area inadequate diet was mentioned. Green leafy vegetables were mentioned as food for prevention of anemia by most in urban and rural areas. All teachers in urban and the rural areas had information about anemia. The sources of knowledge were predominantly books in the rural area and medical officer in the urban area.

Table 19. Knowledge about anemia among school teachers associated with school girls aged 12 –16 years in rural & urban Shimla.

Knowledge about anemia	Rural (n=21)	Urban (n=10)
	Aware n (%)	Aware n (%)
Definition of anemia	16(76)	10(100)
Symptoms of anemia	20(95)	10(100)
Causes of anemia		
Inadequate diet	3(14)	6(60)
Deficiency of iron	12(57)	3(30)
Worm Infestations	2(9)	0
Loss of Blood	4(19)	1(10)
Adverse affects of anemia	19(90)	10(100)
Prevention of anemia by diet	21(100)	10(100)
Type of food for prevention		
Green leafy Vegetables	18(85)	7(70)
Others	3(14)	3(30)
Had information on anemia	21(100)	10(100)
Sources of knowledge / information		
Friends	1(4)	0
Newspaper	1(4)	1(10)
Television	0	2(20)
Books	19(90)	1(10)
Medical Officer	0	6(60)

7. DISCUSSION

Prevalence

The 68.2% of overall anemia prevalence that was found in this study in adolescent school girls aged 12-16 years in rural and urban area of Shimla is of public health concern. Anemia prevalence of more than 40% has been defined as a problem of severe public health significance by WHO[17] for epidemiological mapping. Of particular note is that the similar prevalence of anemia i.e. 66.6% in rural and 69.7% in urban area. The prevalence of anemia in the similar age group in different setting and in different countries[20, 21,22] ranged from 2% to 30%. This was in sharp contrast to our study where the prevalence of anemia was high. Though very different from the developed countries, prevalence of anemia in the present study is comparable to the studies done in India and Nepal (Table 20).

Table 20. Prevalence of anemia in different settings among adolescent girls in India and Nepal.

Setting	Age Group	n	(%)	Reference
Rural				
Rajasthan	10-18	941	73.7	28
Tamilnadu	13-19	281	44.8%	30
Haryana (School going)	13-17	218	80.8%	36
Haryana (Non-school going)	13-17	206	90.3%	36
Rajasthan	11-18	185	85.4%	37
Urban				
Delhi (high socio economic)	11-18	251	46.6	34
Delhi (low socio economic)	11-18	195	56%	34
Slums of Vadodara, Baroda	10-18	203	81%	35
Schools of Vadodara, Baroda	10-19	2090	75%	35
Delhi	11-18	520	61.9%	37
Slums Hyderabad	10-19	2500	88%	64
Hilly area Nepal				
Urban Kathmandu	10-18	420	60.5	32
Urban Dharan Nepal	11-18	225	68.8	33

The prevalence of the present study is also comparable to the results of the multi-centric study done by National Nutrition Monitoring Bureau[5] (2000-2001) in eight States of India in adolescent girls in the age group of 12-17 years in the rural setting (Table 21).

Table 21. Prevalence of Anemia 12-17 years Adolescents girls in Eight States of India 2001

States	Age group 12-14 years		Age group 15-17 years	
	n	(%)	n	(%)
Kerala	324	54.4	364	49.2
Tamil Nadu	407	53.7	406	59.4
Karnatka	399	62.7	399	68.4
Andhara Pradesh	443	72.7	446	72.9
Maharashtra	399	56.6	403	64.3
Madhya Pradesh	327	71.9	326	74.8
Orissa	436	82.1	433	77.6
West Bengal	435	90.1	437	87.6
Pooled	3188	68.6	3214	69.7

The only prevalence data available for comparison from the State of Himachal Pradesh is the NFHS II[4] survey. The prevalence of anemia was 43.2% in the age group of 15-19 as per NFHS II[4] for the State of Himachal Pradesh. The method used by NFHS II[4] for estimation of hemoglobin was HemoCue method. Studies have shown that HemoCue method tends to overestimate the levels of hemoglobin and as a result the prevalence of anemia would be lower using this method[61]. No data is available for the age group 12 – 16 years. This prevalence is quite low compared to the prevalence of the present study.

The reason for similarity between the rural and urban areas is probably due to the homogeneity of the type of diet of population. The staple diet is a mixture of cereals, pulses, and vegetables. Bioavailability of iron from cereals and vegetables is low because

of presence of phytates, oxalates and tannins. Although no assessment of dietary intake was made, the diet in the study area is predominantly of cereals and vegetables. This type of diet provides low amount of bioavailable iron because of the high content of iron absorption inhibitors such as phytate and polyphenols[15]. This diet may therefore, significantly contribute to poor iron absorption and hence high prevalence of anemia.

Tea forms an important part of the dietary habits of this region. Consumption of tea has been shown to decrease iron absorption in the gastrointestinal tract. Polyphenols in tea are believed to form insoluble complexes with iron in the gastrointestinal tract and render the iron unavailable for absorption. It has been shown that polyphenols in tea reduce the bioavailability of non-heme iron when consumed with meals[39]. However tea only inhibits iron absorption when it is consumed simultaneously with food containing non-heme iron. Tea drinking between meals has been shown to have no effect on iron absorption[39]. Hence, a detailed dietary survey is required to address these issues.

As there is no information on dietary assessment and parasitic infestation in present study area, the real causes need to be determined in further studies. Diet surveys in Indian adolescent population have shown that the diets are inadequate in all nutrient including iron, protein calcium and calories[62]. Although inadequate nutrient intake appears to be the most probable etiologic factor, other factors like helminth infestation and malabsorption are also likely contributory factors. The poor hygiene, environmental sanitation and disposal of waste could be influencing factors for the high prevalence in both these areas as water borne diseases are second most important cause of morbidity in the state of Himachal Pradesh after Acute Respiratory Tract infections (Unpublished data from directorate of Health Services Himachal Pradesh).

Socio economic variables:

Prevalence of anemia when analysed by socio-economic factors showed that in rural area education of parents, highest occupation in the family, ownership of apple orchards, type of diet and socio-economic status made a difference whereas in urban area occupation of the father was associated significantly with anemia. These results are consistent with other studies[29, 47]. This may be because of better availability of high quality food with better socio economic status and better understanding of the needs of the adolescent girls by the parents.

Menarche:

Age at menarche and duration of menstruation did not affect the prevalence of anemia. However, the duration of mensturation in rural area showed a trend in this study. Attaining menarche was significantly associated with the urban girls but not so with the rural girls. The study did show that prevalence of anemia was more among the girls who had attained menarche than not attained in both the groups. In a study on adolescent girls Vasanthi and colleagues[26] also observed a higher prevalence of anemia among menarcheal girls aged 11-16 years of urban and rural areas of Hyderabad. Similarly Agarwal and colleagues[63] had documented that the prevalence of anemia was 46.6% in pre-menarcheal girls as compared to 48.4% in post menarcheal girls in the urban slums of North East Delhi. This finding suggests that dietary factors super-imposed on physical growth spurt of adolescence and attaining menarche are playing a role in causation of anemia.

Academic performances:

Anemia was found to be associated with poor academic performance in both the rural and urban school girls. Soemantri and colleagues[50] in Indonesia recorded that iron

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Academic performances:

Anemia was found to be associated with poor academic performance in both the rural and urban school girls. Soemantri and colleagues[50] in Indonesia recorded that iron

therapy in school age children suffering from iron deficiency anemia results in improvement in certain behavioral tests and school performances. Significant improvements in the school test were seen among iron deficient anemic children who received iron supplements.

Knowledge among students and teachers about anemia:

Although the knowledge about anemia was high among these adolescent girls from rural and urban areas but their practices to seek prophylaxis was only 51% in rural and only 6% in urban area. This reflects their ignorance about prophylaxis. However it was not enquired about actual consumption of iron tablets and duration of consumption. The School Health programme should educate these adolescent school girls about prevention of nutritional anemia along with distribution of supplements. A study done by A Saibaba and colleagues[64] on nutritional status of adolescent girls of urban slums and the impact of Information Education and Communication (IEC) on their nutritional knowledge and practices found that the IEC intervention resulted in improvement of nutritional knowledge as well as increase in consumption of iron rich foods. Manmeet Kaur and colleauges[65] at Chandigarh also noted similar finding during their study on effect of health education on knowledge, attitude and practices about anemia among rural women. Merely distributing the medicine through health workers under the school health programme may not bring desired impact.

With the focus on the health of women in general and the adolescent girl in particular, the picture of anemia seen in rural and urban area is alarming. Contributions and determinants of anemia vary in many ways. Iron deficiency anemia have profound negative effects that include increased maternal and new born mortality, impaired health and development of infants and children, limited learning capability, impaired immune function and reduced working and productive capacity of those affected. Anemia is thus, impediment to individual and National development.

Limitation of the study:

Selection of the study subjects: Schools were selected by purposive sampling in view of the operational feasibility. All eligible girls were selected in the class. In rural area all of them were Hindu and in urban more than 90% of the students were Hindu. This might not be the representative sample for all adolescent girls in district Shimla. Moreover, the study was school based and the result of this study are representative of school going adolescent girls but not necessarily representative of all the girls in this age group in the study area. Hence, the external validity of the study is limited.

Socio-demographic information was obtained from the students, which was not validated by visiting their houses. Hence, conclusions drawn from socio-economics variables should be drawn cautiously.

Academic performances were assessed on the basis of first terminal examination. The methods adopted for assessment may be different in rural and urban schools and the teachers told us that the students do not take these examinations seriously.

Recommendations:

Despite advances in scientific knowledge regarding multifactorial etiology, treatment and potential strategies iron deficiency anemia remains a significant challenge for adolescents. Evidences are showing that preventive supplementation coupled with nutritional education and long term approaches like food fortification, dietary modification, public health and disease control measures may be more effective strategies associated with better compliance and improvement in iron status of these adolescents. Hence, the following recommendations are stated.

Nutrition in School Curriculum: Promotion of educational programmes on nutrition in the educational curriculum can be adopted through the school: It was observed that teachers associated with these girls had a knowledge of anemia and if given some nutritional training can be an effective means of brining the desired results.

Dietary Modifications: Encouraging dietary and lifestyles practices that favors enhanced iron absorption forms the basis of this strategy. Adoption of the following strategies can enhance iron absorption from the available diet if properly advocated through nutritional education to these adolescence school girls:

1. Drink tea after one or two hours of taking meal. The tea will not inhibit iron absorption because most of the food will have left the stomach.
2. Advocate the use of vegetables like tubers, cabbage, carrots or cauliflower in the meal as they are rich source of vitamin C and it enhances iron absorption.
3. Advocate consumption milk of and other dairy products as a between meal snacks, rather than at meal time as the dairy products contain calcium which decreases iron absorption.

Dietary fortification: This approach has been proven to be successful for providing effective long-term approach to improve the iron status of population. The appropriate food vehicles that can be included are wheat flour and condiments like sugar and salt. Fortified food supplements can be effectively and widely distributed through general food distribution programmes e.g. promoting mid day meal programmes for these adolescence girls and also making them available at the fair price shops for the general community as a whole.

Enlarge the scope and strengthen the existing National Nutritional Anemia Control Programme: The target groups for supplementation of iron under this programme have been pregnant women and young children. However the tenth steering committee[8] on nutrition has recommended inclusion of the school going children in the programme. A good proportion of these girls can be reached at least in urban areas through the school system effectively. Creative programmes such as child- to- child trust can be incorporated in which school children who receive supplements and nutrition education can act as effective mediators of change, educating their families about the importance of iron and locally available iron rich foods. This will help in reaching rural adolescents girls also. They can also play a key role in providing iron supplements to preschoolers in the family and neighborhood. Therefore, efforts should concentrate on supplementation and nutritional programme for these adolescent girls.

Control of parasitic infections: Preventive measures that break parasite transmission can be adopted.

1. Keep faeces out of soil through using pit latrines.
2. Help observe adequate hygiene and sanitation practices.

3. Encourage use of foot wears for avoiding direct skin contact with soil.

Routine de-worming practices can be adopted through the existing school health programme and followed at six month interval and as well as screening for prevalence of worm infestation and anemia among these school girls.

Conclusion:

The present study highlights that prevalence of anemia among school girls is a major public health problem in Shimla District. Efforts are needed to prevent it by approaches, which are feasible and cost-effective. If these girls enter pregnancy with adequate iron reserves, iron supplements provided during pregnancy will be more efficient at improving the iron status of the mother and of the fetus. As a result, the risk of maternal anemia at delivery and of anemia in early infancy will be reduced and intergenerational lifecycle of malnutrition can be effectively broken. What is required is an effective nutritional programme along with sustained supplementation programme for these adolescent girls. Moreover the real causes and the determinants are required to be identified by taking up further research studies on a larger proportion.

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9. ANNEXURES

Annexure-1. Data collection format on Knowledge & Practice about Anemia among school Girls aged 12 to 16 years of District Shimla HP

I. Identification information

1. ID. No. ☐

2. Area
   Rural (1)
   Urban (2) ☐

3. Name

4. Age (calculated in years and months)

5. Date of birth ☐ ☐ ☐
   Day month year

6. Religion:

Hindu	(1)	☐
Christian	(2)	
Muslim	(3)	
Buddhist	(4)	
Sikh	(5)	
Other, specify	(89)	

7. Caste:

SC	(1)	
ST	(2)	☐
OBC	(3)	
GC	(4)	
Other, specify	(89)	

8. Standard studying

9. Addresses

10. Parents Qualification

Mother		**Father**	
Illiterate	(0)	Illiterate	(0)
Primary	(1)	Primary	(1)
Middle	(2)	Middle	(2)
High School	(3)	High School	(3)
Graduate	(4)	Graduate	(4)
Professional	(5)	Professional	(5)

11. Is child suffering from chronic illness (TB, diabetes, Heart disease or any other illness ?

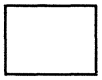
Yes (1) No (2)

III. Socio-economic status

1. Place of living: .....
   - Rented (0)
   - Own (1)
2. Type of house: .....
   - Kutcha (1)
   - Semi Pucca (2)
   - Pucca (3)
   - Bungalow (4)
3. Highest education in the family: .....
   - Illiterate (0)
   - Primary (1)
   - Middle (2)
   - High school (3)
   - Graduate (4)
   - Professional/Technical etc. (5)

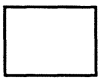
4. Highest occupation in the family.....

Presently not employed gainfully	(0)
Not Skilled	(1)
Semi Skilled	(2)
Skilled	(3)
Managerial	(4)
Professionals	(5)



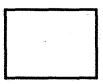
5. Assets

None of the below	(0)
Sewing machine	(1)
TV	(2)
VCP/VCD	(3)
Washing machine	(4)
Two wheeler	(5)
Refrigerator	(6)
Four wheeler	(7)
Computer	(8)



IV. Number of apple boxes in a year:

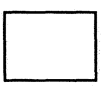
No apple boxes	(0)
Less than 100 boxes	(1)
100 to 200 boxes	(2)
200 to 400 boxes	(3)
400 to 600 boxes	(4)
More than 600 boxes	(5)



V. Knowledge and Practices about anaemia:

Q. How many brother and sister are you including yourself?

One	(1)
Two	(2)
Three	(3)
Four	(4)
More then four	(5)



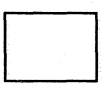
Q. Are you a vegetarian or non-vegetarian?

Vegetarian	(1)
Non-vegetarian	(2)

Q. What do you understand by anaemia?

Q. What are the symptoms of anemia?

Paleness	(1)
Tiresomeness	(2)
Palpitations	(3)
Breathlessness	(4)
Others, specify.....	(89)
Do not know	(99)



Q. What are the reasons for anemia in girls?

Inadequate diet	(1)
Deficiency of iron	(2)
Worm infestations	(3)
Infections	(4)
Loss of blood	(5)
Others, specify.....	(89)
Do not know	(99)

Q. What do you think are the adverse health consequences of anemia?

Q. Do you think anemia can be prevented by dietary modifications?

Yes	(1)
No	(2)
Do not know	(99)

Q. If yes type of foods to be consumed

Green leafy vegetables	(1)
Fresh fruits	(2)
Animal foods	(3)
Nutritious foods	(4)
Others specify.....	(89)
Do not know	(99)

Q. What do you do to treat anemia?

Consult doctor	(1)
Take iron tablets	(2)
Use of household remedies	(3)
Other specify	(89)
Do not know	(99)

Q. Have you received any prophylaxis in last one year?

Yes	(1)
No	(2)

Q. If yes than in what form?

Tablets	(1)
Iron tablets	(2)
Iron Folic acid tablets	(3)
Do not know	(99)

Q. Who gave prophylaxis / treatment to you?

Anganwari Worker	(1)
Multi Purpose Heath Worker (Female)	(2)
Medical Officer- Primary Health Center	(3)
Chemist	(4)
Other, specify	(89)

Q. Do you feel consumption of tablets was beneficial?

Yes	(1)
No	(2)

Q. If yes how?

Absence of pallor	(1)	
Absence of fatigue	(2)	
Absence of palpitations	(3)	☐
Absence of breathlessness	(4)	
Others specify.....	(89)	

Q. Have you ever experienced any side effects on taking this prophylaxis/ treatment?

Yes	(1)	
No	(2)	☐

Q. If yes what were they?

Constipation	(1)	
Loose Motions	(2)	
Black stools	(3)	
Stomach aches	(4)	☐
Giddiness	(5)	
Vomiting	(6)	
Joint pains	(7)	
Others, specify	(89)	

Q. Were you given education/information on anemia?

Yes	(1)	
No	(2)	☐

Q. Who gave the education/information?

Parents.....	(1)	
Teachers.....	(2)	
Friends.....	(3)	☐
Radio.....	(4)	
TV.....	(5)	
Books.....	(6)	
Newspaper.....	(7)	
Medical Officer	(8)	
Multi Purpose Health Worker (F)	(9)	
Anganwari Worker	(10)	
Other specify.....	(89)	

VI. Academic performances of the child from the available school records immediately preceding to the study.

Poor	(1)	
Average	(2)	
Good	(3)	☐
Very good	(4)	
Excellent	(5)	

Menarche

Q. At what age did you have your first period?

.....Year.....Months

Q. When did you experienced the last periods?

.....Date.....Month

Q. When do you expect the next period?

.....Date.....Month

Q. Do you get the period at regular interval?

Yes	(1)
No	(2)

Q. How many days the periods last

- Three days
- Four days
- Five days
- Six days
- Seven days
- Other, specify..... (89)

Q. In your opinion how would you describe the flow?

Scanty	(1)
Normal	(2)
Heavy	(3)

Annexure. 2

Data collection format on Knowledge about Anemia among class and science teachers in the respective school of District Shimla HP

I. Identification information

1. ID. No ☐

2. Area

Rural	(1)	☐
Urban	(2)	

3. Name

4. Sex

Male	(1)	☐
Female	(2)	

5. Age (calculated in years)

.....Years

6. Religion:

Hindu	(1)	☐
Christian	(2)	
Muslim	(3)	
Buddhist	(4)	
Punjabi	(5)	
Other, specify.....	(89)	

7. Caste:

SC	(1)	☐
ST	(2)	
OBC	(3)	
GC	(4)	
Other, specify.....	(89)	

II. Knowledge about anaemia:

Q. What type of food do you eat?

Vegetarian	(1)	☐
Non-vegetarian	(2)	

Q. What do you understand by anaemia?

Paleness (1)
Tiresomeness (2)
Palpitations (3)
Breathlessness (4)
Others, specify..... (89)
Do not know (99)

Q. What are the reasons for developing anemia?

Inadequate diet (1)
Deficiency of iron (2)
Worm infestations (3)
Infections (4)
Loss of blood (5)
Others, specify..... (89)
Do not know (99)

Q. What do you think are the adverse health consequences of anemia?

Q. Do you think anemia can be prevented by dietary modifications?

Yes (1)
No (2)
Do not know (89)

Q. If yes type of foods to be consumed

Green leafy vegetables (1)
Fresh fruits (2)
Animal foods (3)
Nutritious foods (4)
Others specify..... (89)
Do not know (99)

Q. What is the source of your knowledge?

Friends..... (1)
Newspaper..... (2)
Radio..... (3)
TV ..... (4)
Books ..... (5)
Medical Officers..... (6)
Multi Purpose Health Worker..... (7)
Other specify..... (89)