Geographical Diversity in Prevalence and Associated Factors of Anaemia among Adolescents of India-A Systematic Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Systematic Review

ABSTRACT

Background: Anaemia is a global public health issue in India with anaemia prevalence of 56% among adolescent girls. While it affects all age groups, pregnant women and children are reported to be at risk. The study aims to understand the underlying factors of anaemia among adolescents.
Methods: The systematic review has included all studies from the time period, 2000 to 2020 which had anaemia prevalence among adolescent girls (10 to 19 years of age). Scopus and Web of Science databases were used to browse relevant articles within April-June, 2020. Study design, sample size, anaemia prevalence, and the method of Haemoglobin estimation, were some of the information recorded.
Results: A total of 88 articles were selected, out of which 20 were retained as per the inclusion

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criteria. Study from the east zone reported an anaemia prevalence of 36.4% and a significant association between serum ferreting levels and the severity of anaemia. The anaemia prevalence of different studies from the north, west and south zones ranged from 50-70%, 80-90%, and 30-79% respectively. Socio economic status, education of parents, prevalence of vitamin B12 deficiency was some of the important factors contributing to the prevalence were highlighted.
Conclusion: Anaemia prevails across and within the different zones, it is not comparable. However, strengthening of the existing level of effort is necessary to address the issue of anaemia among adolescents in India.

Keywords: Anaemia prevalence; adolescent girls; haemoglobin estimation; factors affecting anaemia.

1. INTRODUCTION

Anaemia is the global prevalence of the patients' health condition is estimated to be 24.8% with highest numbers in Africa and Southeast Asia. While there have been instances of the condition in almost all age groups, anaemia prevalence is particularly higher in young children and pregnant women (WHO, *Anaemia*). Globally, 47.4% pre-school children and 41.8% pregnant women are anaemic. For that matter, it is pivotal to address the issue during adolescence for the impending pregnancy and childbirth. Anaemia prevalence is marked worldwide, but nevertheless in girls of 10 to 19 years [1]. The National Family Health Survey (NFHS) of 2015-2016 documents 53% prevalence among females age of 15-49 years. Additionally, marked variations were observed according to region, gender, livelihood and many other attributes. According to a study done in Port Blair, 50.9% pregnant women in the age group 12 - 40 years was found to be anaemic [2]. Similarly, another study in Bangalore found that 33.9% women in a hospital were anaemic [3]. In another study by Didzun et al., the anaemia prevalence of men and women was found to be 23.2% and 53.2% respectively. Furthermore, in another study done 21% (Both male and female) [4]. Not only there were differences among the prevalence of anaemia but also the factors associated with it according to different studies.

A study done in Tamil Nadu found that, socioeconomic status, nutrition, and helminth control were significantly associated with anaemia [5]. Similarly, another study revealed that the education of the husband and awareness were important factors for anaemia. Similarly, the study in Bangalore found that prenatal depression and anxiety were key drivers of anaemia. Therefore, it can be assumed that there is an element of variability pertaining to the prevalence as well as the factors affecting anaemia in India. Also, there is a scarcity of rural level anaemia data in the country as well as in adolescents.

2. MATERIALS AND METHODS

2.1 Eligibility Criteria

The inclusion criteria for the selection of the study included

1. Studies reporting prevalence of anaemia in adolescents of 10-19 years
2. Articles are published in English only.
3. Studies documenting factors are associated with the prevalence of anaemia.
4. Content on National Iron plus Initiative (NIPI).
5. Studies from the period of 2000-2020 years.

Studies published before the year 2000, and on other age groups than adolescents, not identified through Scopus/Web of Science were excluded as well [6].

2.2 Information Sources

Studies were identified by searching the data base of Scopus, Web of Science. The search was performed in the months of April-June 2020. An open search on Google was done to identify content related to NIPI program.

2.3 Search Strings

(Adolescents of India or prevalence of anaemia or iron deficiency anaemia or anaemia in adolescents of India, NIPI) [7].

2.4 Study Selection

Two investigators (MG) and (AS) screened titles and abstracts to exclude obviously inappropriate papers and further examined the remaining section to determine whether it fits into the

inclusion criteria. One investigator (DK) performed the search related to the NIPI program.

2.6 Data Collection Process

In the second level screening; full text review was done, followed by data extraction that was done by (MG) and (AS) and (DK). Having excluded studies that did not meet the inclusion/exclusion criteria, a reduced number of possibly relevant studies were remaining that was read and critically appraised for inclusion in the analysis and discussion [8].

2.7 Data Items

Adolescents are the characteristics participants, method of haemoglobin estimation, prevalence of anaemia, factors contributors [9].

3. RESULTS

The initial phase of screening identified a total of 88 articles, out of which 54 were selected and 34 were excluded as they were not fitting in the inclusion criteria. The final selection included 20 articles, 34 were not selected as they were, adult men, published before 2000. All articles are of the original except two, one is a systematic review and other is a letter to the editor [10]. The selected articles aimed to assess elaborated in the following sections. Please find below the details of selected articles is given in Table 1.

1. East Zone

Only one study was selected from this geographic region. A Community based cross-sectional study on 382 female adolescents from rural schools of Raipur; Chhattisgarh studied the prevalence and associated demographic factors and nutritional status [11]. The study found that a total of 36.4% were anaemic with the mild form being most prevalent (84.9%). Also, deficiency of Vitamin B12 was observed in 58% of the participants. A significant correlation was found between the grades of anaemia and serum ferreting levels.

2. North Zone

Six studies were selected from the North zone of India; all were cross-sectional and four on adolescent girls and two included girls and boys

from Delhi, Chandigarh, Himachal Pradesh, Uttarakhand, Punjab, and Bihar respectively.

In Haldwani, Uttarakhand, 770 adolescent method. Haemoglobin was estimated with haemoglobin colour scale. A prevalence of 48% was recorded; out of which 43.11% in rural and 55% in urban girls. In Amritsar, Punjab a research on 265 adolescent girls belonging to the scheduled caste community of Punjab found that 70.57% participants were suffering from multiple grades of anaemia; above 12% were severely anaemic [12]. The aim of the study conducted in Delhi was to understand. A total of 250 adolescent girls aged 10 to 17 years from a government senior secondary school were included in the study. Assessments of their haemoglobin levels, fluoride levels, and diet were done. The study found a prevalence of 56% at the baseline. Also it was observed that the status of anaemia changed from anaemic to non-anaemic on the intervention [13]. The study found that 50% of the adolescent girls were anaemic with a majority having mild form of the condition.

The research adolescents in Himachal Pradesh state of India. The sample constituted 885 participants (Hb estimation and BMI were calculated) selected from 30 random cluster villages in 2 areas [14]. Haemoglobin estimation was done using IMMULITE 1000 method. Estimation found to be 12.2 g/dL. Further, the prevalence of anaemia was found to be 87.2% in boys and 96.7% in girls. Also all the adolescents were found to be Vitamin B12 deficient, at the same time it was observed that nobody had deficiency of folic acid. In similar study among 1120 adolescents from eleven cities and two rural schools of Chandigarh assessed the prevalence of anaemia and levels of serum ferritin, cyanmethemoglobin method and ELISA methods were used for the same.

3. West Zone

A total of four studies on female adolescents were selected from Maharashtra in the west zone.

Setting of Maharashtra, studied 1010 34 villages in the Omarabad district of Maharashtra. Data on individual health, diet, socio-demography, and anthropometry was collected. Haemoglobin estimation was done using Sahil's haemoglobin meter. Logistic and regression analysis were

Table 1. Details of the selected articles

SL No.	Type of Article	Highlight	Zone	Population	Author	Year	Total Sample	Method used
1.	Original	Severity of anaemia associated with Serum Ferritin	East	Adolescent girls	Patel et al.	2017	382	Estimation of Iron profile and Vit B12
2.	Original	anaemia with VIT B12 was a major problem	North	Adolescent girls	Bhardwaj et al.	2013	885	Whatman filter paper No.1, IMMULITE 1000
3.	Original	Half of the school going adolescent girls were anaemic	North	Adolescent girls	Goyal et al.	2018	770	Haemoglobin colour scale to estimate Hb
4.	Original	81.66% prevalence in SC	North	Adolescent girls	Sidhu et al.	2005	265	Cyanmethemoglobin method to estimate Hb
5.	Original	Iron stores deficient	North	Adolescents	Basu et al.	2004	1120	Cyanmethemoglobin to estimate Hb, ELISA to estimate Serum Ferritin
6.	Original	Higher prevalence of mild anaemia	North	Adolescent girls	Kumari et al.	2017	200	Hb estimation by Sahil's method, TIBC estimation by Ferrozine method, Ferritin estimation by Access 2
7.	Original	Inverse relationship b/w urinary fluoride and Hb	North	Adolescent girls	Susheela et al.	2016	250	Hb estimation by Haemoglobinometer, Fluoride estimation by Ionmeter
8.	Original	Association b/w anaemia and MUAC, Rice	West	Adolescent girls	Ahankari et al.	2009	1010	Capillary HB investigation
9.	Original	Less educated parents and anaemic girl	West	Adolescent girls	Upadhye et al.	2016	300	Sahil's Haemoglobinometer to estimate Hb
10.	Original	Mean height and weight lower in anaemic cases	West	Adolescent girls	Chaudhary et al.	2012	296	Hb estimation using Cyanmethemoglobinometer
11.	Original	Low awareness about Govt. programs	West	Unmarried Adolescent girls	Kulkarni et al.	2019	240	Stadiometer for Anthropometric measurements
12.	Original	Worm infestation a RF	South	Adolescent girls	Siva et al.	2016	257	Hb estimation using Auto-

SL No.	Type of Article	Highlight	Zone	Population	Author	Year	Total Sample	Method used
		for anaemia						analyser SYSMAX 800i
13.	Original	Low BMI a RF for anaemia	South	Adolescent girls	Premalatha et al.	2012	400	Cyanmethemoglobin method
14.	Original	Lower SEC and anaemia	South	Adolescent girls	Biradar et al.	2012	840	Automated cell counter method
15.	Systematic Review	Insufficient availability of data in Kerala	South		Rakesh P S	2017	10 Studies	PubMed and Google Scholar searches, NFHS and DLHS
17.	Original	Helminth control and anaemia	South	Adolescent girls	Chandrakumari et al.	2019	255	Automated haematology analyzer
18.	Original	necessity of BCC	South	School students	Rakesh et al.	2019	880	Hb estimation by HaemoCue 201 photometer
19.	Letter to the Editor	Literacy of subjects and anaemia status	South	Adolescent girls	Kokiwar P R, Saiprasad G S	2007	224	Sahil's method
20	Original	Haemoglobin concentration and the girls' education and her mother's educational status	South	Adolescent girls	Rajaratnam J. et. al	2000	316	Cyanmethemoglobin method.

performed to find the associations of risk factors. The mean Hb level was found to be 10.1 g/dL and 87% of the participants were anaemic [15]. Another cross-sectional study in the tribal areas of two blocks of Palghar districts of Maharashtra assessed the nutritional status, hygiene practices and awareness regarding adolescent programs. A total of 240 unmarried adolescent girls from 10 villages were selected. Haemoglobin estimation was done Sahil's method. Majority of participants 79.2% belonged to scheduled tribes and 92.5% were from the lower socio-economic class. The mean haemoglobin was found to be 9.57 g/dL. More than three fourth 81.6% had moderate anaemia. The study showed that anemia affects the nutritional status of females. In Nagpur 300 girls between 12-16 years of age were screened for anaemia by Sahli's haemoglobin meter. Modified Kuppuswamy scale was used to assess the socioeconomic status of the family. Out of 300 girls, 270 girls (90%) were found to be anaemic.

4. South Zone

A total of eight studies were selected from the south zone, three each from Kerala and Tamil Nadu, and one each from Andhra Pradesh and Belgaum respectively.

Among 257 girls Ettumanoor panchayat of central Kerala. The sample as selected using simple random sampling from the list of 2600 adolescents obtained from anganwadis. Data was collected on socio-demographic profile and associated factors. Clinical examination of Majority (62%) belonged to nuclear family and from middle socio economic class as per the 'Kuppusamy Classification'. Logistic regression analysis showed risk factors significantly associated with anaemia were presence of ova/cyst in stool and number of pads used per day during menstruation. Protective factors included handwashing before food intake and after toilet, usage of foot wear and jiggery intake. A systematic review using PRISMA guidelines and a review protocol was established including a search strategy and a data collection method. Population, Intervention, Comparison, Outcomes, and Setting (PICOS) framework was applied to formulate research question and to facilitate literature of review. The study reported prevalence of anaemia in Kerala, and discussed the trend in last 25 years. Search engines; PubMed and Google scholar were used to identify studies. Community based research on anaemia from Kerala, regardless of its designs

and published during 1990 to 2015 were included. There was a variation in the techniques for estimation therefore pooled prevalence was not calculated. Anaemia was defined as per WHO criteria of levels of heamoglobin.

In Kerala, prevalence of anaemia was assessed in school going children of Ernakulum district; factors associated with it were also studied. The total sample selected was 880 students from 11 schools. HemoCue 201 photometer was used to estimate haemoglobin. The prevalence of anaemia was found to be 44%, 0.8% with severe anaemia, 3.5% with moderate anaemia and around 39.7% with mild anaemia. A total of 21.3% and 52.6% were not consuming green leafy vegetables and citrus fruits. The factors associated were female gender, higher age group, and routine consumption of tea/coffee with meals.

In Chennai a cross sectional survey found 78.75% of anaemia (using cyan method) among female school students from private and public school adolescents. The prevalence was found to be higher in public than private schools. A significant association of anaemia was highlighted in Haemoglobin with age as a factor if same dietary pattern is followed over the years. A community trial assessed the prevalence of anaemia among 155 and 161 adolescents' girls (13-19 years) from the two blocks in Vellore district using a multi stage sampling method; selection of panchayats from the two blocks followed by number of girls from each panchayat. Socio economic status was identified; nutritional status was assessed using anthropometric measurements.

A cross sectional study conducted among 840 adolescents in rural area of Belgaum identified prevalence of anemia using automated cell counter.

Nalgonda town of Andhra Pradesh identified a prevalence of 67.9%, significantly higher in early adolescents.

3.1 National Iron Plus Initiative (NIPI)

3.1.1 Historical perspective

This got incorporated into the Maternal and child health (MCH) programme. The programme nomenclature was changed in 1991 to 'National Nutritional Anaemia Control Programme

(NNACP)' and was a part of Child survival and safe motherhood (CSSM) programme started in 1992. The programme implemented through the Primary health centres and ICDS programme and now in RMNCH+A Programme under the National Health Mission.

3.1.2 National Iron Plus Initiative (NIPI)

Table 2 shows the NIPI is described in detail 2013. These guidelines also give emphasis on the importance of Food based strategies. The guidelines detail the different approaches for implementation of NIPI with a special focus on therapeutic Life cycle approach describing the appropriate management at different levels of health care. It outlines the roles and responsibilities of the different health care staff.

3.2 Studies with Discussion on National Iron plus Initiative (NIPI)

A study conducted on the NIPI guidelines, reiterates that life cycles approach has been used covering all age groups for effective anaemia control in India [4].

A review was conducted by Mondal Ankita et al 2018 to compare NIPI with the existing WHO guidelines. The review is presented in three sections for Infants & Pregnant women. The study concludes that WHO guidelines suggest daily iron supplementation for 3 months in a year whereas India follows a bi-weekly (6 – 59 months) or weekly supplementation (5 years and above) for entire year. The total dosage however for a year is higher as per NIPI in children and same. The study describes the meta-analysis of various studies performed in India to understand the basis for deciding the strategies of NIPI especially the bi-weekly and weekly regimen of IFA supplementation. An increased compliance was seen with bi-weekly or weekly administration as against the daily administration of IFA.

The reason for low compliance of IFA consumption is nausea, vomiting, gastric irritation, epigastric pain, constipation. Also, high dose of iron in pregnancy has been associated with gestational diabetes.

Further, a study conducted in 2018, compares the burden of anaemia.

Table 2. Under NIPI the and service delivery is as follows

Age groups	Intervention' Dose	Regime	Service delivery
6-60 months	1 ml of IFA syrup containing 20 mg of elemental iron and 100 meg of folic acid	Biweekly throughout the period 6-60 months of age and de-worming for children 12 months and above.	Inclusion in MCP card Through ASHA/ANM
5-10 years	Tablets of 45 mg elemental iron and 400 meg of folic acid	Weekly throughout the period 5-10 years of age and biannual de-worming	In school through teachers and for out of school children through Anganwadi centre (AWC)
10-19 years	100mgelemental iron and 500 meg of the folic acid	Weekly throughout the period 10-19 years of age and biannual de-worming	In school through teachers and those for out of school children through (AWC)
Pregnant and lactating women	100mg elemental iron and 500 meg of folic acid	1 tablet daily for 100 days, starting after the first trimester, at 14-16 weeks of gestation. To be repeated for 100 days postpartum.	ANC/ANM/ASHA Inclusion In MCP card
Women in reproductive age (WRA) group	100 mg elemental iron and 500 meg of| folic acid	Weekly throughout the reproductive period	Through FHW during house visit for Contraceptive distribution

3.3 Intensified National Iron plus Initiative (I-NIPI)

In April 2018, target set under the programme is to reduce the burden by 3% per annum (with a total of 18% reduction) from baseline of NFHS 4 amongst each beneficiary. The strategy used will be 6 beneficiaries x 6 Interventions x 6 institutional mechanisms.

The six beneficiaries mentioned are:

1. Children (6 – 59 months)
2. Adolescent girls (15 -19 years)
3. Adolescent boys (15 -19 years)
4. Women of reproductive age group
5. Pregnant women
6. Lactating women

However, corrections deemed necessary in these guidelines for inclusion of school going children. in mention of reproductive age as 20 – 24 years.

The six speeches have been:

1. Addition of iron folic acid
2. Deworming
3. Intensified BCC year-round and late cord tightening 3 minutes after birth
4. Use of digital tools to evaluate care for anaemia
5. Obligatory supply in all nutrition programmes of fortified food
6. Work on alternative causes of endemic pocket anaemia

For their I-NIPI training, modules must be designed for grass root health workers

The six mechanisms of the institutions are:

1. Coordination between ministers
2. The Mukt Bharat National Anaemia Unit
3. National Excellence Center and advanced anaemia control research

4. DISCUSSION

4.1 Summary of Findings

In the East zone, 36.4% adolescents were found to be anaemic, with the mild form being most prevalent among 84.9% girls and more than half with vitamin B 12 deficiencies in Raipur. In northern zone, a prevalence of 50-70% was found except one that showed a higher percentage of above 90%. Vitamin B12 deficiencies, high prevalence in girls and in rural areas as compare to boys and in urban areas were reported. Maharashtra reported high prevalence of 80-90% among adolescent girls, significant association of socio economic status with anaemia was confirmed in two of the study and one identified an association with literacy status of the parent. In the south; the prevalence was found to be 30-40% in Kerala and was associated with female gender, higher age group.

4.2 Discussion In The Light Of Other Studies

Anaemia- A important Public Health problem globally and in India. While it affects men and women of several age groups, children under 5 and pregnant women are most susceptible for the condition. It is a notable fact that adolescence period precedes pregnancy and childbirth. Therefore, associated with anaemia among adolescents as an attempt to prevent the development of anaemia in pregnancy and the new-born. The prevalence of anaemia, mean Hb concentration, method of estimation, and the associated factors were critically reviewed in the study.

The study in Chhattisgarh attributed anaemia (IDA) to vitamin B12 deficiency anaemia. A few researches have evaluated deficiency of iron, vitamin B12 and folate in adolescents with nutritional anaemia and its association with severity of the diseases. Free iron and folic acid is supplemented but not vitamin B12 as per the guidelines of the NIPI program.

To understand the effect of fluoride on haemoglobin status and anaemia was the objective of another study. Likewise, another such study in Himachal Pradesh aimed to assess the prevalence of iron, folic acid, and vitamin B-12 deficiency among young adolescent females. Anaemia was found in the range of 23.9% to 57% in adolescent girls from the above mentioned studies. Likewise, a majority of studies found out that, mild anaemia was most common and most cases belonged to rural belts of the country. Similarly, the mean haemoglobin level as reported by the studies ranged from 7 g/dL to 9.4 g/dL. The factors to cure anaemia is the consumption of cereal and fruits. Another study in East Delhi stressed on the inverse relationship between urinary fluoride levels and mean haemoglobin level. In the same

study intervention helped in improving the Hb level.

A total of four studies, depending on the inclusion criteria, have been selected from the West Zone. Along with the three studies aimed at determining the prevalence of anaemia among adolescent girls and associated risk drivers, 2 studies examined the nutritional status of different populations and 1 study examined the effect on haematological, biologically-chemical indexes and peripheral nervous function of vitamin B-12 on oral vitamin B-12 treatment in psychological doses. Most studies have revealed that most anaemic teens have mild anaemia. Anaemia in teenage girls was most common cause of low haemoglobin level due to low nutritional diet.

The prevalence of anaemia ranged from 30% to 67.9% among the different studies. Similarly, the factors associated with anaemia also varied according to studies. The factors ranged from Menstruation, hand washing before food, mother's education, diet, nutrition, socio-economic class, health control, to supplementations. In a study in Andhra Pradesh, association between anaemia and family size and socio-economic status were also highlighted. Significant statistical association was not observed between anaemia and literacy of subjects, literacy of mothers and fathers. Similarly, in another study in Tamil Nadu, linear trends haemoglobin level low.

5. CONCLUSION

The present study shows an overall high trend of prevalence of anaemia among adolescents with varying degree of severity. The prevalence across the four zones is not comparable as the timeline and haemoglobin estimation techniques used are different. Majority studies were found to be focused on adolescent girls, barring a few on boys. The fact that boys though relatively less vulnerable than girls for having low Hb levels, cannot be ignored. Designing holistic interventions (clinical and socio cultural dimensions), strengthening the existing GOI national program, are the recommended elucidations reduced. In this paper, the study conducted in 2019, discusses the merits and demerits of the NIPI and have pointed out various challenges like not identifying programme as a priority with minimal administrative commitment; supply chain issues; training of health workers and teachers;

additional responsibility on the frontline workers; poor inter sectoral coordination; and inadequate counselling and behaviour change communication. The study recommends for the changes in technical guidelines, orientation of frontline workers, awareness programmes, and collection of data for true estimates of anaemia.

CONSENT

It is not applicable.

ETHICAL APPROVAL

The paper is an output of a exploration and documentation of review of literature for a community health project to study the female adolescents of rural area of Mulshi taluka. The research project has received ethics approval from Independent Ethics Committee of SIU in the year 2018.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Adolescent Division, Ministry of health and family welfare, Government of India, Guidelines for control of Iron deficiency Anaemia;2013.
   [Accessed on August 30, 2020].
   Available:https://www.nhm.gov.in/images/pdf/programmes/child-health/guidelines/Control-of-Iron-Deficiency-Anaemia.pdf
2. Ahankari AS, Myles PR, Fogarty AW, Dixit JV, Tata LJ. Prevalence of iron-deficiency anaemia and risk factors in 1010 adolescent girls from rural Maharashtra, India: A cross-sectional survey. Public Health. 2017;142:159-166.
3. Basu S, Basu S, Hazarika R, Parmar V. Prevalence of anaemia among school going adolescents of Chandigarh. Indian Paediatrics. 2005;42(6):593.
4. Bellad A, Kapil R, Gupta A. National guidelines for prevention and control of iron deficiency anaemia in India. Indian Journal of Community Health. 2018;30.
5. Benoist B, McLean E, Egli I, Cogswell M. Worldwide prevalence of anaemia 1993–2005: World Health Organization; 2019.

6. Bhardwaj A, Kumar D, Raina S K, Bansal P, Bhushan S, Chander V. Rapid assessment for coexistence of vitamin B12 and iron deficiency anaemia among adolescent males and females in Northern Himalayan state of India. Anaemia; 2013.

7. Biradar S S, Biradar S P, Alatagi A C, Wantamutte A S, Malur P R. Prevalence of anaemia among adolescent girls: a one year cross-sectional study. Journal of Clinical and Diagnostic Research. 2012; 6(3):372-377.

8. Chaudhary S M, Dhage V R. A study of anaemia among adolescent females in the urban area of Nagpur. Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine. 2008;33(4):243.

9. Didzun O, De Neve J W, Awasthi A, Dubey M, Theilmann M, Bärnighausen T, ... Geldsetzer P. Anaemia among men in India: a nationally representative cross-sectional study. The Lancet Global Health. 2019;7(12):e1685-e1694.

10. Ford N D, Bichha R P, Parajuli K R, Paudyal N, Joshi N, Whitehead Jr, R D, ... Rijal S. Factors associated with anaemia among adolescent boys and girls 10–19 years old in Nepal. Maternal & Child Nutrition. 2020;e13013.

11. Goyal N, Rawat C M S, Jha S K. Prevalence of anaemia among school adolescent girls. Indian Journal of Community Health. 2015;27(3):398-401.

12. Jolly R, Rajaratnam A, Asokan J S, and Jonathan P. Prevalence of anaemia among adolescent girls of rural Tamilnadu. Indian Paediatrics. 2000;37(5):532-536.

13. Kapil U, Kapil R, Gupta A. National Iron plus Initiative: Current status & future strategy. The Indian Journal of Medical Research, 2019;150(3):239.

14. Kokiwar P R, Saiprasad G S. Anaemia among adolescent girls. Indian Journal of Public Health. 2007;51(4):252.

15. Kulkarni R, Surve S, Patil S, Sankhe L, Gupta P, Toteja G. Nutritional status of adolescent girls in tribal blocks of Maharashtra. Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine. 2019;44(3):281.