Journal of Epidemiology and Global Health
Vol. **9**(**2**); June (2019), *pp.* 128–134
DOI: https://doi.org/10.2991/jegh.k.190513.001; ISSN 2210-6006; eISSN 2210-6014
https://www.atlantis-press.com/journals/jegh

Research Article

Prevalence and Determinants of Anemia among Adult Males in a Rural Area of Haryana, India

Shashi Kant, Rakesh Kumar*, Sumit Malhotra, Ravneet Kaur, Partha Haldar

Centre for Community Medicine, All India Institute of Medical Sciences, New Delhi 110029, India

ARTICLE INFO

Article History

Received 29 January 2019
Accepted 12 May 2019

Keywords

Anemia
prevalence
adult
male
India

ABSTRACT

Anemia is an under-recognized morbidity among adult males causing significant productivity loss. A study was done among adult males (≥18 years) in a rural area of Haryana, India to estimate the prevalence and determinants of anemia and to explore their attitude and beliefs about anemia. Mixed methods approach was adopted. A total of 1219 participants were selected by multistage simple random sampling for the cross-sectional study and were administered a questionnaire followed by hemoglobin measurement using HemoCue method. Six focus group discussions were conducted. Age adjusted prevalence of anemia was 27.9% [95% confidence interval (95% CI): 27.4–28.4%]. Anemia was found to be positively associated with age more than 50 years (OR: 2.7 (95% CI: 1.7–4.2) in age group 50–59 years and 3.6 (95% CI: 2.3–5.6) in age group ≥60 years as compared with age group 18–24 years) and presence of chronic co-morbidity (OR: 2.0; 95% CI: 1.2–3.2). There were misconceptions among study participants about the role of specific dietary factors in causation of anemia. Poor purchasing capacity was cited as main reason for not consuming iron rich diet. Anemia was a common morbidity in this study population.

1. INTRODUCTION

Anemia not only causes growth retardation of fetus, puts pregnant women at high risk of complications, causes poor growth and development among children, but also affects adults with a significant effect on productivity and economic growth [1]. A study that analyzed the cost of iron deficiency in 10 developing countries found that the median value of physical productivity losses per year due to iron deficiency was about US$2.32 per capita, or 0.57% of the gross domestic product and combining the effect of iron deficiency on cognition, total economic loss was estimated to be US$16.78 per capita or 4.05% of the GDP [2]. As per the World Health Organization's (WHO) estimates globally 12.7% of the adult males suffer from anemia [3]. In India, the fourth round of National Family Health Survey (NFHS-4) reported that 22.7% of the males in the age group 15–49 years had anemia [4]. The prevalence of anemia among males of Haryana in this age group had shown an increase from 17.6% in 2005–2006 to 20.1% in 2015–2016 [5]. Despite high burden and increasing trend of anemia, both in terms of prevalence and economic impact, there is paucity of information on anemia among adult males; and consequently, this age group is often not included in the anemia control programs.

Dietary deficiency plays a major role in causation of anemia. Dietary intake is influenced by cultural factors as well as perceived benefits of a particular diet. Studies on pregnant women and adolescent girls reported that though they were aware that poor quality or lack of diet causes anemia, their knowledge regarding specific dietary elements in preventing anemia was limited [6,7]. Economic constraints on dietary improvement were cited as the primary barrier to a food-based approach for alleviating symptoms of anemia. In many cases, respondents were also not aware of the serious consequences of anemia [7]. However, there is limited information about the attitude and beliefs of rural adult population, especially men, regarding anemia and the role of various dietary factors in its causation. Hence, this study was planned to estimate the prevalence of anemia among adult males (≥18 years) in a rural area of the Ballabgarh block of Haryana, India; its association with various sociodemographic, clinical, and dietary factors; and to explore the knowledge, attitude, and beliefs of adult males toward anemia.

2. MATERIALS AND METHODS

This study was conducted in Ballabgarh block of district Faridabad in the northern Indian state of Haryana. The total population of the study area was 98,000 in the year 2016. About 65% of the population in the study area was aged 18 years or above. A detailed description of the study area is available elsewhere [8]. The study was conducted between August 2016 and December 2016. Participants who refused to give consent for hemoglobin estimation were excluded from the study.

Mixed methods approach was adopted. A community-based cross-sectional study was conducted to assess the prevalence of anemia and to collect information on various sociodemographic, clinical, and dietary factors. Participants were recruited through simple, multistage random sampling. The sample size was calculated to be

*Corresponding author. Email: dr.rakesh3105@gmail.com

1200 based on assumed prevalence of anemia as 20% [5], relative error of 20%, and a design effect of 3. Four of the 28 villages in the study area were selected randomly, and within each village an equal number of participants was selected by simple random sampling. Villages in the study area are similar in sociodemographic profile, and a sample was selected randomly within the village that was likely to be heterogeneous, an arbitrary design effect of 3 was taken as no information was available on the intracluster coefficient [9]. A Health Management Information System (HMIS) is maintained at Comprehensive Rural Health Services Project (CRHSP), Ballabhgarh with demographic and other details of all individuals in the area. A list of inhabitants and their details were obtained from HMIS. Trained graduate interviewers made home visits and interviewed the selected participants. Interviewers were trained for a day by one of the authors. However, no formal assessment of adequacy of training was undertaken. If the selected participants were not found at home in two visits, they were excluded from the study.

A pretested questionnaire in the local language, Hindi, was used to collect information on various sociodemographic, clinical, and dietary variables. Dietary history was assessed through a pretested questionnaire, which was adapted from the WHO Stepwise Approach to Surveillance tool for noncommunicable diseases, and included the frequency of consumption of green leafy vegetables, fruits, and dairy products. Dietary assessment could not be performed in one of the four villages due to logistic reasons. Current tobacco and alcohol users were defined as those who reported consuming any tobacco or alcoholic product during the last 7 days. The questionnaire was first prepared in English, which was then translated into the local language Hindi in which it was to be administered. The questionnaire was translated back into English to remove any error and to assess the quality of translation. Although there is no information on the prevalence of intestinal nematodes in the study area and among adult men in a similar setting, a study performed in a nearby area found the prevalence among school children to be 29.7% [10].

Focus Group Discussions (FGD) with adult male participants were conducted. Purposive sampling was performed to recruit participants for FGDs. Attempts were made to keep the groups homogeneous with regard to age and socioeconomic status. An FGD guide was used to elicit participant's knowledge, attitude, and beliefs regarding anemia and their dietary determinants. An FGD guide was prepared by the study investigators who facilitated the discussion. Domains for discussion included knowledge regarding anemia, its causes, symptoms, severity, role of diet and specific dietary elements in preventing anemia, and barriers and facilitators in dietary consumption of nutrients that may prevent anemia. FGD guide was pre-tested in the non-study area. A total of six FGDs were conducted and was facilitated by study investigators.

HemoCue® Hb 201 DM System (HemoCue AB, Sweden) was used to estimate the concentration of hemoglobin in capillary blood. Hemoglobin determined by the HemoCue method has been reported to be comparable with that determined by the other methods and has been recommended for on-the-spot estimation [11]. A single drop of blood was collected from a finger prick after removing the first two drops of blood to ensure that the sample was fresh capillary blood, and was placed into a cuvette for measurement. A hemoglobin level <13 g/dL was defined as anemia; that between 11 and 12.9 g/dL as mild anemia; between 8 and 10.9 g/dL as moderate anemia; and a hemoglobin level less than 8 g/dL as severe anemia [12]. All investigators were trained for a day in various aspects of the data collection. Data collection was performed under the supervision of a senior staff. Double data entry was done for 5% of the forms. Appropriate checks were performed in the data entry platform. All HemoCue instruments were recalibrated before the study.

Quantitative data were entered in Epi Info version 7.2 (CDC Atalanta, Georgia). Forms were reviewed for completeness before data entry. Data analysis was done using Stata version 12 (StataCorp, Texas, USA). Prevalence of anemia was reported as its proportion along with 95% CI. Age standardization of the prevalence of anemia was performed using the age structure of rural population of district Faridabad from the year 2011 [13]. Prevalences of mild, moderate, and severe anemia were reported for various subgroups. Possession of household consumable items, land and house ownership, source of drinking water, type of toilet facility, type of cooking fuel used, and type of electricity connection were combined into a composite wealth score using principal component analysis. It was transformed into wealth scores by computing the scores of the first component, which explained 41% variance. Wealth index constructed from these variables has been used in large-scale demographic and health surveys in India such as NFHS-4 [14]. Data from earlier NFHSs with similar variance from the first factor have been used to construct the socioeconomic indicator [15]. The study sample was divided into five wealth quintiles. Association of anemia with various sociodemographic, clinical, and dietary factors was assessed by logistic regression. In dietary factors and comorbidities, different categories were merged to improve the statistical power. Factors that had p-value <0.3 in bivariate logistic regression were adjusted through multiple logistic regression to assess the association between various factors and anemia. P-values of linear predicted value and squared linear predicted value were estimated to assess model assumptions. Pseudo R^2 and Hosmer–Lameshow test was used to test the goodness-of-fit. The level of significance for all analysis was set at 0.05. All FGDs were tape recorded. Recorded information was transcribed using standardized transcription forms. Qualitative data were categorized in relevant domains and themes were identified from the transcribed information.

Written informed consent was obtained from each subject. Information collected was kept confidential. Analyses were performed after removing identifiers. The result of hemoglobin testing was provided to the participant on the spot. Those found anemic or with other morbidity were offered treatment through local primary health centers. Ethical approval for the study was obtained from the Institute Ethics Committee of All India Institute of Medical Sciences, New Delhi (web address: https://www.aiims.edu/en/about-us.html, http://14.139.245.45:8082 approval No: IEC-378 dated August 1st, 2016).

3. RESULTS

A total of 1226 participants were approached, of which nine (0.7%) refused to give blood for hemoglobin estimation. The mean age of study participants was 39 years (SD: 15.6 years); most of the participants (53.9%) were in the age group 25–49 years. Elderly participants (aged ≥60 years) constituted 14.3% of the total study population. More than one-third of the study participants were educated for 11 or more years, and 38.8% were employed in

a government or private organization Table 1. About 4% of the participants reported ever being diagnosed with anemia. About 27.2% reported presence of a comorbidity, 6.5% of which had renal disorder, liver disorder, malignancy, or external bleeding. More than half of the study participants (51.2%) were currently using tobacco whereas 39.3% reported using alcohol. Washing hands after defecation and before having food was reported by 92.2% and 89.7% of the participants, respectively. Whereas 82% of the participants consumed milk or other dairy products daily or more than once weekly, only 43% consumed fruits daily or more than once weekly.

Unadjusted prevalence of anemia among study participants was 28.8% (95% CI: 26.3–31.4%); 22% had mild, 6.6% had moderate, and only 0.2% had severe anemia. Age adjusted prevalence of anemia was 27.9% (95% CI: 27.4–28.4%); age adjusted prevalences of mild, moderate, and severe anemia were 21.3%, 6.4%, and 0.2%, respectively. Prevalence of anemia was 46.8% (95% CI: 39.4–54.3%) in participants of age 60 years or more and was 23.7% (95% CI: 20.9–26.5%) in participants aged 18–49 years. It was found to be 22.1%, the lowest among those who were 11 years or more educated and 25.5% in participants who were self-employed Table 1. About 45% of the participants who reported being diagnosed either with renal disorders, liver disorders, malignancy, or bleeding per rectum were found to be anemic. One-quarter of the study participants who consumed milk daily or more than once weekly were found to be anemic Table 2.

Anemia was found to be positively associated with age [OR: 3.7 (2.4–5.8)] in the age group 60 or more as compared with 18–24 years), and self-reported history of renal disorder [OR: 3.2 (1.2–8.7)], and malignancy [OR: 2.5 (1.0–6.3)] on bivariate analysis. However, on multiple logistic regression, age was found to be significantly associated with anemia with odds ratio of 1.6 (1.1–2.3) in the age group 25–49 years, 3.1 (1.8–5.3) in the age group 50–59 years, and 4.1 (2.5–6.7) in age group ≥60 years as compared with age group 18–24 years and presence of one of the four chronic morbidities – renal disorder, liver disorder, malignancy, or bleeding per rectum [OR: 1.9 (1.2–3.2)]. *p*-values for linear predicted value and squared linear predicted value were found to be <0.01 and 0.41, respectively, suggesting that there was no specification error in the model. Pseudo R^2 for the model was 0.056 and *p*-value for Hosmer–Lemeshow test was 0.55. Anemia was also found to be significantly associated with age when age was used as a continuous variable; odds ratio in the bivariate analysis was 1.03 (1.02–1.04) and when adjusted using variables in the above model odds ratio remained the same, i.e., 1.03 (1.02–1.04) Table 3.

3.1. Focus Group Discussions

For most of the FGD participants, the vernacular equivalent of "anemia" was "*shareer mein khoon ki kami*," which translates as lack of blood in the body. The symptoms reported for anemia were tiredness, leg pains, fever, headache, and joint pains. Some of the participants also suggested that anemia may lead to "*patla sa dikhna*" (thinness). Participants felt that anemia was common among both males and females. The FGD participants listed eating adulterated food items such as pesticide-treated fruits and vegetables, adulterated milk, fast foods, and not eating foods such as "*lauki, kaddu, aur hari sabzian*" (bottle guard, pumpkin, and green leafy vegetables) as the prime reason for developing anemia. "*Pet me keeda hona*" (worm infestation) and "*saaf suthra na rahna*" (lack of personal hygiene) were some of the other causes of anemia that were cited by study participants.

Table 1 | Distribution of anemia status by sociodemographic characteristics

Variable	No anemia (%)[a] (*n* = 867)	Prevalence of anemia			*p*-value for trend[b]
		Mild (%)[a] (*n* = 268)	Moderate (%)[a] (*n* = 81)	Severe (%)[a] (*n* = 3)	
Age (years)					<0.01
18–24	199 (80.9)	40 (16.3)	7 (2.8)	0	
25–49	490 (74.5)	127 (19.3)	40 (6.1)	0	
50–59	85 (60.3)	43 (30.5)	11 (7.8)	2 (1.4)	
60 and above	93 (53.2)	58 (33.1)	23 (13.1)	1 (0.6)	
Completed years of schooling					<0.01
0	68 (68.7)	20 (20.2)	10 (10.1)	1 (1.0)	
1–5	57 (61.9)	26 (28.3)	9 (9.8)	0	
6–10	396 (68.1)	143 (24.6)	41 (7.0)	2 (0.3)	
11 and above	346 (77.6)	79 (17.7)	21 (4.7)	0	
Occupational status					0.46
Unemployed/student/retired	158 (68.1)	59 (25.4)	15 (6.5)	0	
Non-government/government employee	342 (72.3)	96 (20.3)	34 (7.2)	1 (0.2)	
Farming	230 (69.7)	75 (22.7)	23 (7.0)	2 (0.6)	
Self-employed	137 (74.5)	38 (20.6)	9 (4.9)	0	
Wealth quintile					0.02
First (Poorest)	168 (68.9)	52 (21.3)	22 (9.0)	2 (0.8)	
Second	164 (67.2)	57 (23.4)	23 (9.4)	0	
Third	170 (69.4)	62 (25.3)	12 (4.9)	1 (0.4)	
Fourth	186 (76.5)	49 (20.2)	8 (3.3)	0	
Fifth (Richest)	179 (73.7)	48 (19.7)	16 (6.6)	0	

[a]All the percentages are row percentages; [b]*p*-value for trend was assessed using Cuzick's test.

Table 2 | Distribution of anemia status by clinical and dietary characteristics

Variable	No anemia (%)[a] (*n* = 867)	Prevalence of anemia			*p*-value for trend[b]
		Mild (%)[a] (*n* = 268)	Moderate (%)[a] (*n* = 81)	Severe (%)[a] (*n* = 3)	
History of anemia					0.02
Ever diagnosed with anemia					
Yes	25 (51.0)	19 (38.8)	5 (10.2)	0	
No	842 (71.9)	249 (21.3)	76 (6.5)	3 (0.3)	
Ever treated for anemia					0.25
Yes	20 (48.7)	17 (41.5)	4 (9.8)	0	
No	847 (71.9)	251 (21.3)	77 (6.5)	3 (0.3)	
Presence of self-reported co-morbidities (renal disorder, liver disorder, malignancy, external bleeding)					<0.01
Yes	44 (55.0)	25 (31.3)	11 (13.7)	0	
No	823 (72.3)	243 (21.3)	70 (6.2)	3 (0.3)	
Alcohol use					0.54
Yes	346 (72.2)	99 (20.7)	34 (7.1)	0	
No	521 (70.4)	169 (22.8)	47 (6.4)	3 (0.4)	
Tobacco use					0.23
Yes	434 (69.6)	146 (23.4)	42 (6.7)	2 (0.3)	
No	433 (72.7)	122 (20.5)	39 (6.6)	1 (0.2)	
Washing hands with soap after defecation					0.98
Yes	67 (70.5)	23 (24.2)	5 (5.3)	0	
No	800 (71.1)	245 (21.8)	76 (6.8)	3 (0.3)	
Washing hands with soap before eating					0.41
Yes	92 (73.6)	28 (22.4)	5 (4.0)	0	
No	875 (70.8)	240 (21.9)	76 (7.0)	3 (0.3)	
Dietary factors (*n* = 838)					
Consumption of fruits					0.32
Daily or more than once weekly	272 (75.1)	65 (18.0)	25 (6.9)	0	
Occasionally/never	343 (72.1)	97 (20.4)	33 (6.9)	3 (0.6)	
Consumption of green leafy vegetables					0.56
Daily or more than once weekly	506 (73.0)	135 (19.5)	49 (7.1)	3 (0.4)	
Occasionally/never	109 (75.2)	27 (18.6)	9 (6.2)	0	
Consumption of milk/dairy products					0.68
Daily or more than once weekly	507 (73.8)	128 (18.7)	49 (7.1)	3 (0.4)	
Occasionally/never	108 (71.5)	34 (22.5)	9 (6.0)	0	

[a]All the percentages are row percentages; [b]*p*-value for trend was assessed using Cuzick's test.

Intake of good diet consisting of dairy products such as clarified butter and cottage cheese, green leafy vegetables, and fruits were reported by most of the participants as the primary measure to prevent anemia. Consuming nonvegetarian diet was cited by nonvegetarian participants as a measure to prevent anemia. However, none of the participants consumed green leafy vegetables and a nonvegetarian diet regularly. Participants added they preferred a diet rich in dairy products as it is easily available ("*Aram se mil jaata hai*") and they have been taking this since childhood ("*bachpan se yahi khate aaye hain*"). Inability to afford green leafy vegetables and fruits were cited as other reasons for not consuming them regularly. FGD participants were aware about the iron tablets for treating anemia, but thought that it was provided only to pregnant women by the health system.

4. DISCUSSION

This was one of the few studies that attempted to assess the prevalence of anemia and its association with selected sociodemographic, clinical, and dietary factors among adult males. Data on the burden of anemia among adult population is limited and conflicting. A study conducted by the National Nutrition Monitoring Bureau in 2006 in rural areas of nine states of the country with a much larger sample size reported a comparatively higher prevalence of anemia, i.e., 54.8% among men aged 20 years or more [16]. This study used cyanmethemoglobin method for estimating anemia. This study also found a positive association between various sociodemographic constructs such as type of house, electrification status, source of drinking water, and type of cooking fuel used. We combined all these constructs as well as other measures of wealth such as household possession of consumer items, type of toilet used, and land ownership in a composite wealth index. However, we did not find statistically significant association of wealth index with anemia despite prevalence being higher among participants in the lower wealth quintiles. One of the reasons could be the limitation of the wealth index in this case to accurately decipher household inequalities as the first factor explained only 41% variance. Another study in a rural area in Haryana among men aged 16–70 years conducted almost two decades back in the year 1994–1995, wherein hemoglobin was estimated using the cyanmethemoglobin method, reported the prevalence of anemia to be 44.3% [17]. The study also reported anemia prevalence to be higher among people with lower educational status, smokers, and of a lower socioeconomic status. Another study that assessed anemia among adult males aged 15–45 years in

Table 3 | Association between anemia and selected sociodemographic, clinical, and dietary factors

Variable	Unadjusted odds ratio	*p*-value	Adjusted odds ratio[a]	*p*-value
Age group (years)				
18–24	Reference		Reference	
25–49	1.4 (1.0–2.1)	0.05	1.6 (1.1–2.3)	0.02
50–59	2.8 (1.7–4.4)	<0.01	3.1 (1.8–5.3)	<0.01
60 and above	3.7 (2.4–5.8)	<0.01	4.1 (2.5–6.7)	<0.01
Completed years of schooling				
0	Reference		Reference	
1–5	1.3 (0.7–2.4)	0.32	1.3 (0.7–2.4)	0.43
6–10	1.0 (0.6–1.6)	0.89	1.4 (0.8–2.3)	0.18
11 and above	0.6 (0.4–1.0)	0.06	1.1 (0.6–1.9)	0.76
Occupational status				
Unemployed/student/retired	Reference		Reference	
Non-government/government employee	0.8 (0.6–1.1)	0.25	0.7 (0.4–1.0)	0.06
Farming	0.9 (0.6–1.3)	0.69	0.7 (0.5–1.1)	0.17
Self-employed	0.7 (0.5–1.1)	0.16	0.6 (0.4–0.9)	0.04
Presence of self-reported co-morbidities (renal disorder, liver disorder, malignancy, external bleeding)				<0.01
Yes	2.1 (1.3–3.4)	<0.01	1.9 (1.2–3.2)	
No	Reference		Reference	
Alcohol use				
No	Reference	0.49		
Yes	0.9 (0.7–1.2)			
Tobacco use				0.13
No	Reference	0.21	Reference	
Yes	1.2 (0.9–1.5)		0.8 (0.6–1.1)	
Washing hands after defecation				
Yes	Reference	0.89		
No	1.0 (0.6–1.6)			
Washing hands before eating				
Yes	Reference	0.52		
No	0.9 (0.6–1.3)			
Wealth quintile				0.39
First (Poorest)	1.3 (0.8–1.9)	0.24	1.2 (0.8–1.8)	
Second	1.4 (0.9–2.0)	0.12	1.3 (0.9–2.0)	0.20
Third	1.2 (0.8–1.8)	0.30	1.2 (0.8–1.8)	0.42
Fourth	0.8 (0.6–1.3)	0.46	0.8 (0.5–1.3)	0.40
Fifth (Richest)			Reference	
Dietary factors (*n* = 838)				
Consumption of fruits				
Daily or more than once weekly	Reference	0.32		
Occasionally/never	1.2 (0.8–1.6)			
Consumption of green leafy vegetables				
Daily or more than once weekly	Reference	0.59		
Occasionally/never	0.9 (0.6–1.3)			
Consumption of milk/dairy products				
Daily or more than once weekly	Reference	0.56		
Occasionally/never	1.1 (0.7–1.7)			

[a]Adjusted for age group, education, occupation, self-reported comorbidity, tobacco use, and wealth quintile (Pseudo R^2 = 0.056, Hosmer–Lemeshow *p*-value = 0.55).

the desert areas of Rajasthan, India reported anemia prevalence by way of clinical examination to be 43.9% [18]. However, another study in rural Andhra Pradesh in the year 2007 reported the prevalence of anemia among adult males to be only 14.8% using Hemo Control photometer, which measures hemoglobin using a similar principle as HemoCue [19]. This study also reported a higher prevalence of anemia among people engaged in farming and found a positive association between age and anemia. NFHS-4 reported the prevalence of anemia among males aged 15–49 years in Faridabad district to be 14.7% [20], which is lower than that found in our study that reported the age adjusted prevalence in age group 18–49 years to be 23.2%. This difference could be because of a lower prevalence of anemia in urban population, which was included in NFHS-4.

Our study corroborated evidence from elsewhere regarding the association between chronic morbidities and anemia. Although hand-washing has been shown to reduce the prevalence of anemia among adolescents and children [21,22], we did not find any association between hand-washing and anemia, possibly as helminthiasis does not seem to play a major role in causation of anemia among adults. A diet rich in phytates and calcium, which slow down iron absorption and predispose humans to anemia [23]. However, we did not find any association between the intake of green leafy vegetables, fruits, and milk products and anemia. This is possibly because of the qualitative assessment of their intake, which was likely to be imprecise and was a major limitation in finding the association. We also did not consider gathering detailed information on dietary history, which

would have allowed more accurate assessment of their nutrient intake. Studies on pregnant women and adolescent girls have found lack of knowledge regarding specific dietary elements in preventing anemia [6,7]. Economic constraints to dietary improvement were cited as the primary barrier to a food-based approach to alleviating symptoms of anemia [7]. In our study also, the knowledge and attitude toward dietary factors of anemia were conflicting. Although study participants were aware of the importance of good diet and green leafy vegetables, they also said that a diet rich in dairy products is important to prevent anemia. Easy availability of dairy products and unaffordability of green leafy vegetables and fruits were cited as the main reasons for low consumption of green leafy vegetables. Qualitative assessment of dietary intake and assessment of morbidity by self-reporting were few of the major limitations of our study. Furthermore, dietary estimation could not be done in one of the villages that might affect the estimates. Definition used for current smoker and alcohol use might overestimate their prevalence.

5. CONCLUSION

Despite a decline in prevalence of anemia among rural population over the years, anemia remains a significant public health problem, as defined by the WHO [24]. Elderly population was found to be at a higher risk of anemia. There were misconceptions among the study participants about the role of specific dietary factors in causation of anemia and poor purchasing capacity was cited as the main reason for not adhering to iron-rich diet.

CONFLICTS OF INTEREST

None declared.

AUTHORSHIP DECLARATION

Shashi Kant, Sumit Malhotra, Ravneet Kaur, Partha Haldar declares conceptualization, protocol and tools development, writing and approval of the manuscript. Rakesh Kumar declares conceptualization, protocol and tools development, data analysis, writing and approval of the manuscript.

All authors are in agreement with the manuscript and declare that the content has not been published elsewhere.

FUNDING SOURCE

This study was not funded.

ACKNOWLEDGEMENT

We acknowledge the support of participants of this study and students and residents of CRHSP, Ballabgarh in conducting this study.

ETHICAL APPROVAL

Institute Ethics Committee, All India Institute of Medical Sciences, New Delhi, India.

REFERENCES

[1] Zimmermann MB, Hurrell RF. Nutritional iron deficiency. Lancet 2007;370;511–20.
[2] Horton S, Ross J. The economics of iron deficiency. Food Policy 2003;28;51–75.
[3] World Health Organization. Worldwide Prevalence of anaemia 1993–2005: WHO global database on anaemia. In: de Benoist B, McLean E, Egli I, Cogswell M, editors. Geneva, Switzerland: WHO; 2008.
[4] International Institute for Population Sciences (IIPS). National Family Health Survey (NFHS-4), 2015-16, India Fact sheet. Mumbai: IIPS; 2016. http://rchiips.org/NFHS/pdf/NFHS4/India.pdf (accessed 27 April 2018).
[5] International Institute for Population Sciences (IIPS). National Family Health Survey (NFHS-4), 2015-16, Haryana-Key Indicators. Mumbai: IIPS; 2016. http://rchiips.org/nfhs/pdf/NFHS4/HR_FactSheet.pdf (accessed 27 April 2018).
[6] Diamond-Smith NG, Gupta M, Kaur M, Kumar R. Determinants of persistent anemia in poor, urban pregnant women of Chandigarh city, North India: a mixed method approach. Food Nutr Bull 2016;37;132–43.
[7] Galloway R, Dusch E, Elder L, Achadi E, Grajeda R, Hurtado E, et al. Women's perceptions of iron deficiency and anemia prevention and control in eight developing countries. Soc Sci Med 2002;55;529–44.
[8] Kant S, Misra P, Gupta S, Goswami K, Krishnan A, Nongkynrih B, et al. The Ballabgarh Health and Demographic Surveillance System (CRHSP-AIIMS). Int J Epidemiol 2013;42;758–68.
[9] Report of a Joint WHO/UNICEF/ICCIDD consultation. Indicators for assessing iodine deficiency disorders and their control programmes; 1992. https://apps.who.int/iris/bitstream/handle/10665/62614/WHO_NUT_93.1.pdf;jsessionid=71CC3687A3E89CA26864DBEDDC5AD825?sequence=1 (accessed 9 April 2019).
[10] Ranjan S, Passi SJ, Singh SN. Prevalence and risk factors associated with the presence of Soil-Transmitted Helminths in children studying in Municipal Corporation of Delhi Schools of Delhi, India. J Parasit Dis 2015;39;377–84.
[11] Nkrumah B, Nguah SB, Sarpong N, Dekker D, Idriss A, May J, et al. Hemoglobin estimation by the HemoCue® portable hemoglobin photometer in a resource poor setting. BMC Clin Pathol 2011;11;5.
[12] World Health Organization. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and Mineral Nutrition Information System. Geneva: World Health Organization; 2011 (WHO/NMH/NHD/MNM/11.1). http://www.who.int/vmnis/indicators/haemoglobin.pdf (accessed 4 May 2018).
[13] Registrar General of India. C14 five-year age group data by age and sex. Office of Registrar General of India, Ministry of Home Affairs, Government of India. http://www.censusindia.gov.in/2011census/C-series/C-14.html (accessed 12 May 2019).
[14] International Institute for Population Sciences (IIPS) and ICF. National Family Health Survey (NFHS-4), 2015-16: India. Mumbai: IIPS; 2017, p. 16. http://rchiips.org/Nfhs/NFHS-4Reports/India.pdf (accessed 12 May 2019).
[15] Bassani DG, Corsi DJ, Gaffey MF, Barros AJD. Local distributions of wealth to describe health inequalities in India: a new approach for analyzing nationally representative household survey data, 1992–2008. PLoS One 2014;9;e110694.

[16] National Nutrition Monitoring Bureau (NNMB). Diet & nutritional status of population and prevalence of hypertension among adults in rural areas. Technical Report No: 24. Hyderabad, India: National Institute of Nutrition, Indian Council of Medical Research; 2006.
[17] Malhotra P, Kumari S, Kumar R, Varma S. Prevalence of anemia in adult rural population of north India. J Assoc Physicians India 2004;52;18–20.
[18] Singh MB, Lakshminarayana J, Fotedar R. Chronic energy deficiency and its association with dietary factors in adults of drought affected desert areas of Western Rajasthan, India. Asia Pac J Clin Nutr 2008;17;580–5.
[19] Subasinghe AK, Walker KZ, Evans RG, Srikanth V, Arabshahi S, Kartik K, et al. Association between farming and chronic energy deficiency in rural South India. PLoS One 2014;9;e87423.
[20] International Institute for Population Sciences (IIPS). National Family Health Survey (NFHS-4), 2015-16, Faridabad, Haryana-Key Indicators. Mumbai: IIPS; 2016. http://rchiips.org/nfhs/FCTS/HR/HR_FactSheet_88_Faridabad.pdf (accessed 27 April 2018).
[21] Mahmud MA, Spigt M, Bezabih AM, Pavon IL, Dinant G-J, Velasco RB. Efficacy of handwashing with soap and nail clipping on intestinal parasitic infections in school-aged children: a factorial cluster randomized controlled trial. PLoS Med 2015;12;e1001837.
[22] Siva PM, Sobha A, Manjula VD. Prevalence of anaemia and its associated risk factors among adolescent girls of central Kerala. J Clin Diagn Res 2016;10;LC19–LC23.
[23] Gillespie S. Major issues in the control of iron deficiency. New York, USA: The Micronutrient Initiative/UNICEF; 1998.
[24] World Health Organization. Iron deficiency anaemia: assessment, prevention and control. A guide for programme managers. Geneva: World Health Organization; 2001 (WHO/NHD/01.3).