ISSN- 0301-1216
Indian J. Prev. Soc. Med. Vol. 53, No.2, 2022

ORIGINAL ARTICLE

Dietary Diversity and its Association with Anaemia among Adolescents of Central India: Findings from Baseline Cross Sectional Study

Surya Bali[1], Shankar Vantepaka[2], Revadi G[3], Kriti Yadav[4]

ABSTRACT

Background: Anaemia continues to be a major public health concern in the country owing to varied dietary practices, socio-demographic and cultural influencers. Poor nutrition as a principal underlying factor is less explored among the adolescents among the high focus states in India. **Objectives:** To study the dietary diversity i.e., food habits, preferences, frequency of food consumption among adolescents and its association with anaemia. **Material and Methods:** This cross-sectional study, from a baseline adolescent health survey (November 2017 – March 2018) included 3213 adolescents (10-19 years). The participants were selected using multi-stage stratified random sampling technique from 6 districts of Madhya Pradesh. Data collection was done by filed investigators through paperless real time method that included socio-demographic details, anthropometric measurements, haemoglobin food frequency questionnaire. **Results:** The most common daily consumed food items were cereals, tea and pulses by adolescents. Overall prevalence of anaemia was 1715 (53.4%). Those consuming occasional fruits, green non leafy vegetables, red and yellow vegetables, roots and tubers and milk products were at higher risk of developing anaemia compared to other food items regularly. **Conclusion:** Although association exists between occasional consumption of certain food groups, their temporal relationship needs to be established.

Keywords: Adolescent, Malnutrition, Anaemia, Food Habits, Consumption

Introduction

Adolescence is an intermediary stage between puberty and adulthood. It stands as a transition time where nutrition habits are acquired and gradually built over the later stages of life.[1] This age group is a crucial time for physical and mental development. Adolescents are subjected to significant physiological (rapid growth changes during puberty, such as lean tissue accretion) and social changes (cultural and gender norms; acceptable work types, free time activities, early marriages, and physical activities; changes in access to processed & unhealthy food markets; food supply deficits at the household level), all of which necessitate an adequate and diverse diet.[2] Adolescents require a well-balanced diet, which includes all nutrients (carbohydrates, proteins, fats, vitamins, and minerals) in the proper amounts and proportions to maintain good health and well-being. [3,4]

1. Additional Professor, Department of Community and Family Medicine, All India Institute of Medical Sciences, Bhopal, India **Email:** surya.cfm@aiimsbhopal.edu.in
2. Junior Resident, Department of Community and Family Medicine, All India Institute of Medical Sciences, Bhopal, India **Email:** shankarvantepaka@gmail.com
3. Senior Resident, Department of Community and Family Medicine, All India Institute of Medical Sciences, Bhopal, India **Email:** revadi07081993@gmail.com
4. Senior Resident, Department of Community and Family Medicine, All India Institute of Medical Sciences, Bhopal, India, **Email:** drkritiyadav18@gmail.com

Corresponding author: Dr. G. Revadi, Senior Resident, Department of Community and Family Medicine, All India Institute of Medical Sciences (AIIMS Bhopal), Saket Nagar, Bhopal-462016; Mob – 7708584525; **Email –** revadi07081993@gmail.com

Submission	13.03.2022	Revision	22.03.2022	Accepted	12.05.2022	Printing	29.06.2022

Prior Publication*: Nil*; Conflicts of Interest*: None , *Article # 421/ 884

Over 80% of adolescents suffer from one or other forms of malnutrition like micronutrient deficiencies such as iron, folate, zinc, vitamin A, vitamin B12 and vitamin D. Anaemia continues to be a major public health concern in the country owing to varied dietary practices in different geographical settings. This vicious cycle of iron deficiency anaemia continues through the adolescence stage to the reproductive age group and to the new-borns as adolescents with low iron stores tends to give birth to premature low birth weight babies.[3] The prevalence of anaemia among Indian adolescent girls and boys accounts to 54% and 29% [5] amongst which half of them were found to be underweight.[6] The global school health survey conducted in one of the eight empowered action group states,[7] Madhya Pradesh revealed that 44.5% were involved in consuming junk food [8] and 58.4% of adolescent girls being anaemic.

An iron-rich diet, along with vitamins and minerals involved in iron absorption and RBC/Haemoglobin production, are evidenced to be the first line of defence against anaemia. [3] Thus, micronutrient deficiencies indirectly attribute to the development of anaemia through its significant contribution to dietary diversity.[9] Micronutrient deficiencies in a long run could potentially delay the growth spurt and ultimately affects the mental development of adolescents leading to chronic illness.[1] Indeed WHO has attributed the rise of NCD epidemic to unhealthy diet along with the other behavioural risk factors. [10] Dietary diversity is defined as increase in the variety of foods consumed over a specific reference period.[11] Dietary diversity is a mere qualitative measure of food consumption that shows household's access to a variety of food groups and serves as a proxy for an individual's nutrient sufficiency. [12,13]

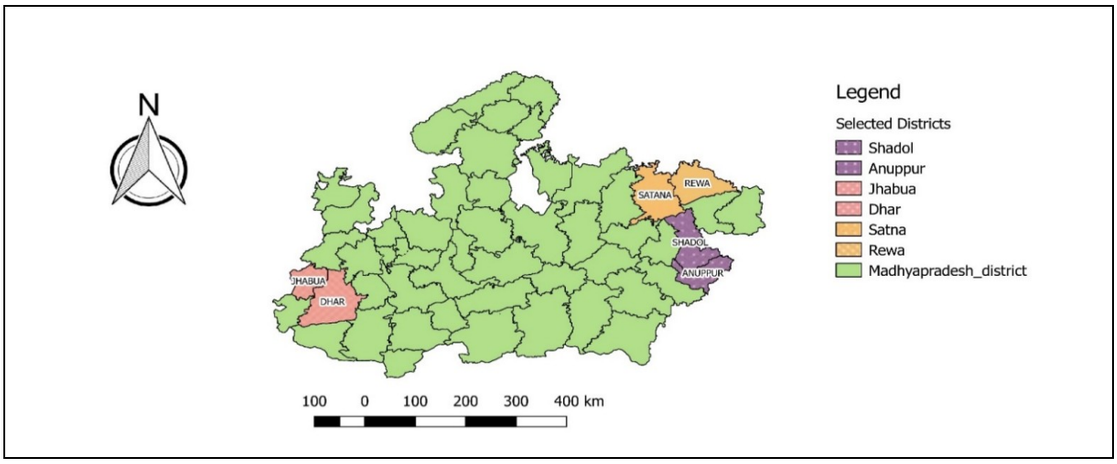
It is essential to study the adolescent food habits, their preferences and frequency of food consumption in association with anaemia which has not been explored much in adolescent context. This information serves as the basis to propose effective health promotion strategies targeting the adolescents and their key stakeholders. However, obtaining complex information on household's dietary accessibility or individual's dietary consumption can be limited by time and cost necessitating a high level technical skill of data collection and processing. [12] So, this study aimed at studying the dietary diversity i.e., food habits, preferences and frequency of food consumption among adolescents and its association with anaemia.

Materials and Methods

This was a cross-sectional study, from a baseline adolescent health survey comprising of 3276 adolescents conducted during November 2017 – March 2018. Sample size was calculated using Open epi.com [14] taking minimal prevalence of hypertension as 8% [15] with 95% Confidence interval and 15% relative error i.e., 1.23 absolute precision error with a design effect of 1.5. Total sample size was found to be 2862 and considering the non-response rate as 15% and available resources, a sample size of 3213 was finalized. The participants were selected using multi-stage stratified random sampling technique from 6 districts of Madhya Pradesh i.e., 2 districts each from East (Shahdol and Anuppur), West (Jhabua and Dhar) and North zones (Satna and Rewa) which formed the first stage of stratification as shown in Figure 1. The second stages of stratification were the selection of administrative blocks where 3 blocks were randomly selected from each of these 6 districts (total -18 blocks). The third stage of stratification was selection of 7 villages/wards from each of these 18 blocks based on the sampling frame of villages(rural) and wards(urban) made from (Census 2011 list) through probability proportionate to size sampling. The adolescents formed the final sampling unit of this study where 26 adolescents (13 males and 13 females) were randomly chosen for interview and examination from each of these villages and wards. Adolescents between 10-19 years who gave consent and were interviewed were included in the study and those adolescents enrolled in SAATHIYA program (program for generating demand for adolescent health services through peer education) were excluded. If one adolescent from a household has already been interviewed, then the other adolescents from the same household were excluded. Field investigators approached households and any one adolescent

person (boy or girl) from each house, if present were asked to voluntarily participate in the study. Parental consent was obtained for those adolescents less than 14 years. Face to face interviews were conducted.

Figure- 1: Selected districts from first stage stratification



Operational definitions: Operational definition of different food groups (Table 1), the severity of anaemia and pattern of consumption like occasional and frequent consumption are given below.

Table-1: Indian Council of Medical Research (ICMR) Five Food Groups[16]

Food Group	Examples
Cereals, Grains and Products	Rice, Wheat, Ragi, Bajra, Maize, Jowar, Barley, Rice flakes, Wheat Flour.
Pulses and Legumes	Bengal gram, Black gram, green gram, red gram, Lentil (whole as well as dhals) Cowpea, Peas, Rajmah, Soyabeans, Beans
Milk	Milk, Curd, Skimmed milk, Cheese
Meat products	Meat: Chicken, Liver, Fish, Egg, Meat.
Fruits	Mango, Guava, Tomato Ripe, Papaya, Orange. Sweet Lime, Watermelon.
Vegetables (Green Leafy)	Amaranth, Spinach, Drumstick leaves, Coriander leaves, Mustard leaves, fenugreek leaves
Other Vegetables	Carrots, Brinjal, Ladies fingers, Capsicum, Beans, Onion, Drumstick, Cauliflower.
Fats	Butter, Ghee, Hydrogenated oils, cooking oils like Groundnut, Mustard, Coconut.
Sugars	Sugar, Jaggery

1. **Anaemia: Classification as per WHO:** [17]
   - Those with Hb 12 gm/dL or higher is considered non-anaemic.
   - Mild anaemia: Those with Hb 11-11.9 gm/dL
   - Moderate anaemia: Hb- 8-10.9 gm/dL
   - Severe anaemia: Hb -less than 8 gm/dL

3. **Frequent consumers-** Those who had self-reported to consume food groups like e.g., pulses, as 4-6 times/week and daily/week were categorized as frequent consumers 1.

4. **Occasional consumers:** Those who had never consumed, or consumed food groups 1-3 times/week were categorized as 0 (occasional consumers). While those who never consumed meat, eggs, tea and coffee were grouped as 0 and others as 1.

Data collection tool: Data collection was hosted through digital cloud server which is a form of paperless method of real time data collection and field investigators were asked to download the tool. The data obtained contains information of socio-demographic details, food habits, history of smoking, alcohol and physical activity obtained. Socio-demographic details of participants include Age, Gender, Marital status, Household headship, Location (Rural, Urban), Type of family (Nuclear, Non-nuclear), Level of education, Socioeconomic status (Above poverty line, below poverty line), Availed services from AFHC (Adolescent Friendly Health Clinic), skip meals (Never, occasionally, frequently), Physical activity (Regular, Occasional, No), Smoking habit (Yes, No), Alcohol consumption (Yes, No), level of haemoglobin (gm%). Data for Consumption rate of food items were collected under the headings of Never, 1-3/week, 4-6/week, daily/week. Each participant was tested of level of haemoglobin using Hemocue machine. Anaemia was categorized into presence or absence of anaemia according to Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity, as world health organization (WHO) document. [17]

Ethical considerations: Ethical approval was obtained from the Institutional Human Ethics Committee (IHEC), AIIMS Bhopal. Written consent/consent from parents for participants below 14 years was obtained from each adolescent before including them in the survey.

Statistical analysis: Data sheet was downloaded in Microsoft excel version and data was screened following which certain modifications were made and analyzed using IBM SPSS version 24. Nominal or categorical variables were summarized as proportion and continuous variables were summarized as Mean and Standard deviation. Association between two or more categorical variables were done using Chi square test. Unadjusted Odd's ratios (OR) were calculated to find the strength of association between P value < 0.05 was considered as statistically significant.

Results

The mean (SD) age of adolescent population in our study was (14.97± 2.35) years ranging from 10-19 years. Amongst 3213 adolescents, 1613 (50.2%) were females and 1600 (49.8%) were males with 2539 (87.1%) adolescents from rural areas and 674 (20.9%) adolescents from urban areas. Also, it was found that 1037 (32.3%) adolescents were above poverty line and 2176 (67.7%) were below poverty line.

In table-2 displayed below summarizes the overall food frequencies into occasional group (which includes those who never consumed or those who consumed 1-3 times the listed food items in a week) and regular group (Those who consumed food items 4-6 times or daily in a week). Among the listed food items: carbonated soft drinks, coffee, meat, and egg were never consumed by more than 50% of the adolescents. The most common daily consumed food items were cereals 3083 (94.6%), tea 2083 (64.8%) and pulses by 1249 (38.9%) adolescents.

Amongst 3213 adolescents in our study, haemoglobin measurement revealed that 1715 (53.4%) adolescents were anaemic out of which majority of 911 (53.1%) were girls. Among which the severity of anaemia ranged from mild in 1070 (62.4%), moderate in 608 (35.5%) and severe in 37(2.2%) adolescents.

Table- 2: Distribution of food frequencies of the adolescents (N=3213)

Food Group		Occasional				Regular			
		Never		1-3 Times		4-6 times		Daily	
		No.	%	No.	%	No.	%	No.	%
Carbohydrate rich foods	Cereals	9	0.3	67	2.1	99	3.1	3038	94.6
	Puffed rice	1516	47.2	1282	39.9	228	7.1	187	5.8
	Roots & tubers	588	18.3	1341	41.7	792	24.6	996	3.1
Protein rich foods									
(a) Plant Origin	Pulse	209	6.5	1341	41.7	892	27.8	1249	38.9
(b) Animal Origin	Meat	2736	85.2	432	13.4	39	1.2	6	0.2
	Egg	1848	57.5	1105	34.4	183	5.7	77	2.4
Vegetables	Green-Leafy	227	7.1	1449	45.1	1195	37.2	342	10.6
	Green-Non Leafy	252	77.8	1408	43.8	1197	37.3	356	11.1
	Red & yellow-coloured	588	18.3	1341	41.7	790	24.6	494	15.4
Fruits & Variants	Fruits	732	22.8	1342	41.8	772	24.0	367	11.4
	Fatty or dried fruits	2600	80.9	368	11.5	136	4.2	109	3.4
Milk products & variants	Milk and Milk products	1568	48.8	737	22.9	291	9.1	617	19.2
	Tea	585	18.2	278	8.7	267	8.3	2083	64.8
	Coffee	3082	95.9	100	3.1	15	0.5	16	0.5
Sugar sweetened beverages	Carbonated soft drinks	3086	96.0	104	3.2	16	0.5	7	0.2
	Fruit juices	3067	95.5	115	3.6	23	0.7	8	0.2
Other food groups	Fast food	986	30.7	1595	49.6	482	15.0	150	4.7
	Salty food	659	20.5	1307	40.7	860	26.8	387	12.0

Table- 3 displayed below shows the association of anaemia across various socio demographic variables. Anaemia was predominantly present among the adolescents from rural areas 1359 (79.2%) with the highest prevalence of anaemia from Anuppur 324 (18.9%) and Jhabua 297 (17.3%) districts. Also, majority of those below poverty line 1173 (68.4%) and adolescents with education up to high school level 1323 (77.1%) were found to be anaemic when compared to above poverty line and other education status. Variable like gender, district and educational status were found to be significantly associated with anaemia ($P < 0.001$).

Table- 3: Socio demographic distribution of anaemia among adolescents (N=3213)

Variables		Anaemia				P value*
		Present (N=1715)		Absent (N=1498)		
Gender	Male	804	46.9	796	53.1	<0.001
	Female	911	53.1	702	46.9	
Location	Rural	1359	79.2	1180	78.8	0.744
	Urban	356	20.8	318	21.2	
District	Anuppur	324	18.9	229	15.3	<0.001
	Dhar	271	15.8	256	17.1	
	Jhabua	297	17.3	231	15.4	
	Satna	287	16.7	243	16.2	
	Rewa	249	14.5	279	18.6	
	Shadol	287	16.7	260	17.4	
Socio economic status	Above poverty Line	542	31.6	495	33.0	0.251
	Below poverty line	1173	68.4	1003	67.0	
Educational Status	Up to Primary	177	10.3	89	5.9	<0.001
	Up to High school	1323	77.1	1080	72.9	
	Intermediate & above	215	12.6	329	22.2	

***Chi square test**

As districts were found to be significantly associated with anaemia, a sub group analysis was done to understand the heterogeneity in the food frequencies of different food groups amongst various districts as shown in **Table 4.** Majority of the adolescents had regular cereals i.e, 3137 (97.6%), pulses i.e, 2141(66%) and tea consumption i.e, 2628 (81.8%) of which the latter was preferred regularly in almost all the districts. Occasional roots and tubers consumption was seen in Anuppur 187(13.1%), while occasional fruit consumption was observed in Shadol 29 (14.1%), occasional GNLV 236(14.2%) consumption was observed in Dhar district, occasional RYCV was seen in Jhabua 296(15.3%) and occasional pulses consumption was seen in Satna 128 (11.9%). While Jhabua recorded highest regular meat consumption 140 (29.4%), it also had the least regular egg consumption of 136 (10%) **(Table-4)**.

Table- 4: Displayed below shows the distribution and association of food frequencies of various food groups amongst various districts

	Consumption pattern	Anuppur	Dhar	Jhabua	Rewa	Satna	Shadol	Total	P value
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	No.	
Fruits	Occasional	306 (14.8)	372 (17.9)	378 (18.2)	325 (15.7)	400 (19.3)	292 (14.1)	2073	0.001
	Regular	247 (21.7)	155 (13.6)	150 (13.2)	203 (17.8)	130 (11.4)	255 (22.4)	1140	
Green Leafy Veg.	Occasional	176 (16.7)	204 (19.4)	165 (15.7)	173 (16.4)	162 (15.4)	173 (16.4)	1053	0.057
	Regular	377 (17.5)	323 (15.0)	363 (16.8)	355 (16.4)	368 (17.0)	374 (17.3)	2160	
Green Non-Leafy Veg.	Occasional	295 (17.8)	236 (14.2)	312 (18.8)	261 (15.7)	292 (17.6)	264 (15.9)	1660	**0.001**
	Regular	258 (16.6)	291 (18.7)	216 (13.9)	267 (17.2)	238 (15.3)	283 (18.2)	1553	
Red & Yellow Coloured Veg	Occasional	304 (15.8)	354 (18.4)	296 (15.3)	330 (17.1)	315 (16.3)	330 (17.1)	1929	**0.001**
	Regular	249 (19.4)	173 (13.5)	232 (18.1)	198 (15.4)	215 (16.7)	217 (16.9)	1284	
Roots & Tubers	Occasional	187 (13.1)	247 (17.3)	261 (18.3)	240 (16.8)	292 (20.5)	198 (13.9)	1425	0.001
	Regular	366 (20.5)	280 (15.7)	267 (14.9)	288 (16.1)	238 (13.3)	349 (19.5)	1788	
Cereal	Occasional	11 (14.5)	5 (6.6)	7 (9.2)	19 (25.0)	17 (22.4)	17 (22.4)	76	**0.017**
	Regular	542 (17.3)	522 (16.6)	521 (16.6)	509 (16.2)	513 (16.4)	530 (16.9)	3137	
Pulses	Occasional	151 (14.1)	271 (25.3)	231 (21.5)	143 (13.3)	128 (11.9)	148 (13.8)	1072	0.001
	Regular	402 (18.8)	256 (12.0)	297 (13.9)	385 (18.0)	402 (18.8)	399 (18.6)	2141	
Milk Products	Occasional	426 (18.5)	392 (17.0)	401 (17.4)	363 (15.7)	336 (14.6)	387 (16.8)	2305	0.001
	Regular	127 (14.0)	135 (14.9)	127 (14.0)	165 (18.2)	194 (21.4)	160 (17.6)	908	
Meat	Occasional	467 (17.1)	439 (16.0)	388 (14.2)	493 (18.0)	470 (17.2)	479 (17.5)	2736	0.001
	Regular	86 (18.0)	88 (18.4)	140 (29.4)	35 (7.3)	60 (12.6)	68 (14.3)	477	
Egg	Occasional	308 (16.7)	358 (19.4)	392 (21.2)	256 (13.9)	278 (15.0)	256 (13.9)	1848	0.001
	Regular	245 (17.9)	169 (12.4)	136 (10.0)	272 (19.9)	252 (18.5)	291 (21.3)	1365	
Tea	Occasional	148 (25.3)	43 (7.4)	70 (12.0)	108 (18.5)	89 (15.2)	127 (21.7)	585	0.001
	Regular	405 (15.4)	484 (18.4)	458 (17.4)	420 (16.0)	441 (16.8)	420 (16.0)	2628	

Table- 5 below shows the Univariate analysis between different food groups and anaemia. The Odds of anaemia in occasional consumption of a particular food group was calculated with reference to regular consumption of the same food group. Those consuming occasional fruits (OR:1.38, 95% CI: 1.19-1.60, p<0.001), Green Non leafy vegetables (OR:1.34,95% CI: 1.17-1.54, p<0.001), Red and yellow vegetables (OR:1.32, 95% CI: 1.15-1.53, p<0.001), Roots and Tubers (OR:1.31, 95% CI: 1.14-1.51, p<0.001) and Milk products (OR:1.45, 95% CI: 1.23-1.69, p<0.001) were higher risk of developing anaemia compared to those who consume the above food items regularly.

Table- 5: Univariate analysis between food groups and anaemia

Food groups	Consumption pattern	Anaemia				Odd's ratio	95% CI	P value
		Yes (N=1715)		No (N=1498)				
		No.	%	No.	%			
Fruits	Occasional	1166	68	907	60.5	1.38	1.19-1.60	<0.001
	Regular (ref)	549	32	591	39.5			
Green non leafy vegetables	Occasional	945	55.1	715	47.7	1.34	1.17- 1.54	<0.001
	Regular (ref)	770	44.9	783	52.3			
Red & yellow vegetables	Occasional	1084	63.2	845	56.4	1.32	1.15-1.53	<0.001
	Regular (ref)	631	36.8	653	43.6			
Roots & Tubers	Occasional	814	47.5	611	40.8	1.31	1.14 -1.51	<0.001
	Regular (ref)	901	52.5	887	59.2			
Milk Products	Occasional	1291	75.3	1014	67.7	1.45	1.23-1.69	<0.001
	Regular (ref)	424	24.7	484	32.3			
Pulses	Occasional	598	34.9	474	31.6	1.15	0.99-1.34	0.053
	Regular (ref)	1117	65.1	1024	68.3			

Similarly, univariate analysis was done with anaemia as dependant variable and each of the socio demographic variables as independent. From Table 6 it is evident that adolescent girls have higher odds of developing anaemia (OR: 1.28, 95CI: 1.12-1.47, P <0.001) when compared to boys.

Table -6: Shows univariate logistic regression of the selected socio demographic variables

Particulars		Unadjusted Odd's ratio	95% Confidence interval	P value
Gender	Males (ref)	---	---	---
	Females	1.28	1.12-1.47	<0.001
District	Anuppur	1.28	1.01-1.62	0.041
	Dhar	0.96	0.75-1.22	0.732
	Jhabua	1.17	0.92-1.48	0.213
	Rewa	0.81	0.64-1.03	0.082
	Satna	1.07	0.84-1.36	0.580
	Shadol (ref)	---	---	---
Educational status	Up to Primary	3.04	2.24-4.14	<0.001
	Up to High school	1.88	1.55-2.27	<0.001
	Intermediate and above (ref)	---	---	---

Also, those adolescents residing in Anuppur are 1.28 times higher odds of developing anaemia (95CI: 1.01-1.62, P 0.041)) as compared to those residing in Shadol. Similarly, those adolescents who had studied up to primary education had 3.04 times higher odds (95CI: 2.24-4.14, P <0.001) and those up to high school education had 1.88 times higher odds (95CI : 1.55-2.27, P <0.001) of developing anaemia as compared to those with higher educational status.

Discussion

The findings of our study are discussed under following heading below:

Food frequencies: Firstly, among the 18 listed food items the most common daily consumed food items were tea, pulses and cereals. A descriptive study on Food Consumption Pattern and Body Mass Index of Adolescents girls in a school from South India stated that the daily consumption of Cereals and cereal products was 95.85%, which was similar to our study. Whereas the consumption of other food items like pulses, vegetables, fruits, milk and milk products, fried foods, fast foods, and Cold drinks were less when compared to our study. [18] Another study by Halala Handiso et.al[4] on dietary diversity determinants in Ethiopian adolescents showed less frequent consumption of meat, poultry and dark green vegetables as compared to cereals, grains and pulses. Bukelo et al [19] showed that only one fourth of rural adolescents consume fruits and vegetables more than 2 days a week which was far lower than our findings of nearly 50% consumption of at least 1-3 times/week.

The dietary assessment in our study employed consumption frequency of 18 listed food items rather than the routine estimation of total energy of the consumed food items unlike articles.[20,21] Ruel MT[13] had mentioned dietary diversity as a measure that employs number of different groupings, classification systems and reference periods as per the heterogeneous population. This indeed limits the comparability of our study findings as we had not used dietary diversity scores. However, our findings could be explained in context with the socio-cultural differences between the rural and urban communities, education and poverty status that could have critically determined the food choices of the adolescents.

Prevalence of anaemia: Overall prevalence of anaemia in our study was almost half the study population, predominantly more in adolescent girls as compared to boys. However in the global context, prevalence of anaemia among adolescents were low as compared to the Indian context. [23,24] This finding on higher prevalence in adolescent girls could be compared with the National Anaemia Mukt Bharat Programme report.[5] Smaller iron stores and the onset of menstruation in girls tends to impose additional iron requirement to compensate for menstrual blood loss [3] compared to boys. Also, adolescent girls have lower total food intake or energy intake [3] as compared to boys thereby predisposing to greater risk of anaemia. This higher prevalence is of significant public health concern as per the reports of WHO. [17]

Demographic factors and anaemia: Anaemia prevalence was largely evident among the rural adolescents, belonging to below poverty group with high school education in our study. The bio availability of iron in animal-based foods (poultry, meat, eggs and fish) is comparatively better than plant-based foods [24] which could be critically determined by the economic status due to family size, purchasing power, small meal frequency and hunger. These findings were concordant with the other studies conducted in Uttar Pradesh, Tamil Nadu, and Chandigarh states [25-27] of India and findings of Mexican study where lower socio economic status adolescents [22] showed higher prevalence of anaemia.

District wise consumption: The prevalence of anaemia was higher in Anuppur and Jhabua when compared to the other districts. Although Jhabua had regular meat-eating population still the burden was high, and this could be attributed to the study participants where majority were girls with less than high school education and below

poverty line. Also, they were predominantly residents of rural areas with practices of regular tea consumption which acts as inhibitor of iron absorption leading to anaemia.

Food groups and anaemia: Predisposition of anaemia due to occasional consumption of fruits and green vegetables could be explained as:

Plant based foods like green leafy vegetables and non-leafy vegetables (cucumber, bottle guard, bitter guard etc), legumes, dry foods, pulses and cereals like wheat, jowar and bajra [25] are rich in iron. However, red yellow vegetables (tomatoes, pumpkin, carrots etc) and roots and tubers (potatoes, radish, beetroot etc) contain relatively less amount of iron as compared to green leafy vegetables. Similarly, Vitamin C - rich fruits [25] like gooseberries (Amla), guava and citrus improves iron absorption from plant foods and must be taken together. Beverages like tea contains tannin that tends to bind dietary iron and inhibits iron absorption.

Strengths: The strengths of this study were it was community-based study with large sample size and the results could be generalized to the larger population.

Limitations: Being a cross sectional study, a temporal relationship between frequency of different food items, anaemia and other independent predictors cannot be established. The various determinants of dietary diversity were not studied in detail. Also, as data was collected through recall of the past one week, the chances of recall bias cannot be excluded. The information obtained were self-reported by adolescents and were likely to underestimate or overestimate the parameters studied.

Conclusion

The causes of anaemia are multi-factorial and the contribution of each of the factors may vary with dietary practice, geographical setting, and sociodemographic influences. The present study evaluated the dietary diversity pattern among the adolescents and its association with anaemia.

Acknowledgements: The Adolescent Health (AH) Baseline Study was conducted jointly by the National Health Mission (NHM), Madhya Pradesh under Ministry of Health and Family Welfare (MoHFW), All India Institute of Medical Science (AIIMS), and both UNICEF and UNFPA being the technical support for the study. We acknowledge the support from the Mission Director and Director, NHM (M.P), Deputy Director, Adolescent Health, NHM (M.P). The team was also grateful to District Health Society teams of the sampled districts for providing support. We acknowledge the great work done by field investigators team for data collection and the project staff for supporting at various levels. The team expands the at most gratitude to the various adolescents and their families who participated in the study, shared their lives, gave valuable inputs, and spared their precious time

Funding:

- National Health Mission (NHM), Madhya Pradesh (M.P)
- UNICEF (United Nations Children's Fund) and
- UNFPA (United Nations Populations Fund).

References

1. Nutrition in Middle Childhood and Adolescence - Child and Adolescent Health and Development -NCBI Bookshelf [Internet]. [cited 2021 Jun 2]. Available www.ncbi.nlm.nih. gov/ books/ NBK525242.

2. Christian P, Smith ER. Adolescent Under nutrition: Global Burden, Physiology, and Nutritional Risks. Ann Nutr Metab [Internet]. 2018 [cited 2021 Sep 23];72(4):316–28. Available from: https://www.karger.com/ Article/FullText/488865

3. Technical Handbook on Anaemia in Adolescents: 16.

4. Halala Handiso Y, Belachew T, Abuye C, Workicho A. Low dietary diversity and its determinants among adolescent girls in Southern Ethiopia. Yildiz F, editor. Cogent Food & Agriculture. 2020 Jan 1;6(1):1832824.

5. Anemia Mukt Bharat | A programme by Ministry of Health and UNICEF [Internet]. Anemia Mukt Bharat Dashboard. [cited 2021 Jun 3]. Available from: https://anemiamuktbharat.info.

6. Puwar T, Saxena D, Yasobant S, Savaliya S. Noncommunicable Diseases among School-going Adolescents: A Case Study on Prevalence of Risk Factors from Sabarkantha District of Gujarat, India. Indian J Community Med. 2018 Dec;43(Suppl 1):S33–7.

7. AHSpr.pdf [Internet]. [cited 2021 Jun 5]. Available from: https://www.censusindia.gov.in/ vital_statistics/AHS Bulletins/ files/AHSpr.

8. Sharma DP, Mandliya DJC, Dhaneria DM, Diwan DV. Assessment of prevalence of risk factors for non-communicable diseases in early adolescent age group using Global School Health Survey in Ujjain, Madhya Pradesh, India. Pediatric Review: International Journal of Pediatric Research. 2020 Aug 28;7(6):228–36.

9. Jugha VT, Anchang-Kimbi JK, Anchang JA, Mbeng KA, Kimbi HK. Dietary Diversity and Its Contribution in the Etiology of Maternal Anemia in Conflict Hit Mount Cameroon Area: A Cross-Sectional Study. Front Nutr. 2021 Feb 4;7:625178.

10. Noncommunicable diseases [Internet]. [cited 2021 Jun 2]. Available from: https://www.who.int/ westernpacific/ health-topics/ noncommunicable-diseases.

11. FAO: Minimum dietary diversity for women: a guide- Google Scholar [Internet]. [cited 2021 Oct 3]. Available from: https://scholar.google.com/scholar_lookup?title= Minimum+Dietary+ Diversity+ for+Women:+A+ Guide+ for+ Measurement&author=F+FAO&publication_year=2016

12. FAO-Guidelines-For-Measuring-Household-And-Individual-Dietary-Diversity.pdf [Internet]. [cited 2022 Feb 19]. Available from: https://ngo.csd-i.org/wp-content/uploads/Elective-Courses/303/FAO-Guidelines-For-Measuring-Household-And-Individual-Dietary-Diversity.pdf

13. Ruel MT. Operationalizing dietary diversity: a review of measurement issues and research priorities. J Nutr. 2003 Nov;133 (11 Suppl 2):3911S-3926S.

14. OpenEpi Menu [Internet]. [cited 2021 Jun 8]. Available from: http://wwww.openepi.com/ Menu/OE_ Menu.htm.

15. Patel A, Bharani A, Sharma M, Bhagwat A, Ganguli N, Chouhan DS. Prevalence of hypertension and prehypertension in schoolchildren from Central India. Annals of Pediatric Cardiology. 2019 Jan 5; 12(2):90.

16. TNAU Agritech Portal :: Sustainable Agriculture [Internet]. [cited 2021 Oct 3]. https://agritech. tnau. ac.in/ nutrition/ nutri_food_diet_icmr%20food%20groups.htm.

17. WHO_NMH_NHD_MNM_11.1_eng.pdf [Internet]. [cited 2021 Jun 3]. Available from: https://apps.who.int/iris/ bitstream/handle/10665/85839/WHO_NMH_NHD_MNM_11.1_eng.pdf?sequence=22&isAllowed.

18. Lakshmi E. Food Consumption Pattern and Body Mass Index of Adolescents − A Descriptive Study. International Journal of Nutrition. 2021; 11(4):5.

19. ones AC, Kirkpatrick SI, Hammond D. Beverage consumption and energy intake among Canadians: analyses of 2004 and 2015 national dietary intake data. Nutrition Journal. 2019 Oct 18;18(1):60.

20. Bukelo MF, Kiran D, Ramakrishna GB, Bukelo MJ, Kiran PR, Kulkarni V, et al. Risk factors for Non-Communicable diseases among rural adolescents: A school-based cross-sectional study. Asian Journal of Pharmaceutical and Clinical Research. 2015 Mar 1;8(2):284–7.

21. Padrão P, Lunet N, Santos AC, Barros H. Smoking, alcohol, and dietary choices: evidence from the Portuguese National Health Survey. BMC Public Health. 2007 Jul 3;7(1):138.

22. Jain A, Dhanawat J, Kotian MS, Angeline R. Assessment of risk factors of non-communicable diseases among high school students in Mangalore, India. International Journal of Health & Allied Sciences. 2012 Oct 1;1(4):249.

23. De la Cruz-Góngora V, Villalpando S, Shamah-Levy T. Prevalence of anemia and consumption of iron-rich food groups in Mexican children and adolescents: Ensanut MC 2016. Salud Publica Mex. 2018 Jun;60(3):291–300.

24. Tura MR, Egata G, Fage SG, Roba KT. Prevalence of Anemia and Its Associated Factors among Female Adolescents in Ambo Town, West Shewa, Ethiopia. J Blood Med. 2020; 11: 279–87.

25. Dietary Guidelines for NIN website. pdf [Internet]. [cited 2022 Feb 18]. Available from: https://www.nin.res.in/ downloads/Dietary Guidelines for NINwebsite.pdf.

26. Rawat CMS, Garg SK, Singh JV, Bhatnagar M, Chopra H, Bajpai SK. Socio Demographic Correlates of Anaemia among Adolescent Girls in Rural Area of District Meerut (U.P.). Indian Journal of Community Medicine. 2001 Oct 1; 26(4):173.

27. Chandrakumari AS, Sinha P, Singaravelu S, Jaikumar S. Prevalence of Anemia Among Adolescent Girls in a Rural Area of Tamil Nadu, India. J Family Med Prim Care. 2019 Apr; 8 (4):1414–7.

28. Basu S, Basu S, Hazarika R, Parmar V. Prevalence of anemia among school going adolescents of Chandigarh. Indian Pediatr. 2005 Jun; 42 (6):593–7.

Citation: B Surya, V. Shankar, G Revadi, Yadav K. Dietary diversity and its association with anaemia among adolescents of central India: Findings from baseline cross sectional study. Indian J Prev Soc Med, **2022; 53 (2): 84-95**