Research Article

Assessment of Nutritional Status and Its Correlates among Adolescent Girls of Haryana, India

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Abstract

Assessment of nutritional status of a population using most appropriate growth chart is essential to establishitshealth status and for administering timely interventions. This study aimed to assess the nutritional status and its correlates among adolescent girls and to ascertain the suitable growth chart/reference to estimate undernutrition among them. The cross-sectional sample consisted of 1045 adolescent girls of scheduled caste category aged 9 to 17 years of District Yamunanagar, Haryana. Weight and height were measured to calculate Body Mass Index. Hemoglobin level of the girls was measured using Sahli's acid haematin technique. Dietary habits, socio-demographic and micro-environmental variables were recorded using structured questionnaire. Nutritional status was evaluated with the help of BMI using different standards. Anaemic status was assessed using WHO (1968) classification.Correlates of nutritional status were investigated using Chi-square test. According to CDC (2000), classification, 44.3% girls were underweight, 54.4% normal and 1.3% girls were overweight. Using IAP (2015), classification, 82.9% girls were normal; 14.5% thin; 2.3% overweight and 0.3% were obese. According to WHO (2007), reference data, 68.1% girls were stunted while 67.1% girls revealed wasting. 91.1% girls were found to be anaemic. Mother's educational status and consumption of homemade food by the girls showed significant association with the nutritional status of the girls. ROC analysis revealed IAP (2015), to be the most suitable for assessment of undernutrition among adolescent girls as compared to the other two criteria which overestimated the prevalence of thinness among them.

ABBREVIATIONS

WHO: World Health Organization; CDC: Centre for Disease Control and Prevention; IAP: Indian Academy of Pediatrics; ROC: Receiver Operating Characteristic Curve Analysis

INTRODUCTION

Assessment of nutritional status is highly intricate and individualized process, as it evaluates intake and expenditure of nutrients and other nutrition related health indicators. Adequate and balanced nutrition is required for overall normal growth of a child. An increase is witnessed in the nutritional requirements of an individual during the transitional phase of adolescence [1]. Good nutrition during adolescence is critical to cover the deficits suffered during childhood and should include nutrients required to meet the demands of physical, cognitive growth and development as well as provides adequate stores of energy to prevent adult onset of nutrition related diseases [2-4]. Adolescents constitute about 22.8% of total population of India [5]. A large number of adolescents suffer from chronic undernutrition; those belonging to the affluent segments of society may suffer from obesity. Both conditions, however, compromise adolescents' general health and performance. The rate of undernutrition among infants, children, adolescents and adults of India are among the highest in the world [6]. Poor nutritional status among adolescents may result in stunting and low lean body mass which may lead to concurrent and future adverse health outcomes especially in the poor reproductive performance among women [7]. In India, adolescent girls make the most vulnerable segment of the society as the rapid growth and development changes expose them to the detrimental effects of under nutrition and they face serious health problems due to low socio-economic conditions, inadequate nutrition and gender discrimination [8]. A national survey on children conducted by the Government of India and UNICEF in 2013-2014 revealed that the rate of stunting among children has declined significantly from 48% to 39% in many states of India between 2006 and 2014. Stunting among children of Haryana declined from 46% to 37% during this period. Among women of reproductive age, prevalence of thinness and stunting was found to be 40% and 12%, respectively [9]. In district Yamunanagar, the prevalence of stunting, wasting and underweight among children below 5 years has been reported to be 30%, 38.4% and 31.8%, respectively and the% prevalence of thinness among 15 to 49 years old women was 16.2% [10]. Undernutrition continues to be a common, social, and major public health problem in India today. Updated profile on physical growth and nutritional status of children and adolescents is necessary for formulation and implementation of appropriate nutrition intervention strategies at an early stage. Intensive studies assessing the multifarious factors affecting nutritional status during adolescence are meager in the state

of Haryana, India [11-14]. Therefore, the present study was undertaken to assess the nutritional status and its correlates among adolescent girls belonging to scheduled caste category residing in District Yamunanagar, Haryana. An attempt has been made to apply WHO (2007), reference data as well as growth charts given by Indian Academy of Pediatrics (2015), and Centre for Disease Control and Prevention (2000), to ascertain the most suitable growth chart/reference to assess malnutrition in an Indian population.

MATERIAL AND METHODS

District Yamunanagar is one of the 21 districts of Haryana State. The district is bounded by an area of 1756 km² and shares its border with Himachal Pradesh in the north, Uttar Pradesh in the east, District Karnal in the south, District Kurukshetra in the south-west and District Ambala in the west. It contains three tehsils (divisions), namely Jagadhri, Chhachhrauli, and Bilaspur and three sub-tehsils (sub-divisions), namely Radaur, Sadhaura and Mustafabad. Yamunanagar is the biggest district in terms of villages in Haryana, as it includes 475 Panchayats and 636 villages.

The present study was conducted on scheduled caste adolescent girls belonging to District Yamunanagar, Haryana. Scheduled castes are the Indian population groupings that are explicitly recognized by the Constitution of India, earlier called the "depressed classes" by the British. Thirty-nine groups of Haryana were notified as scheduled castes under the Article 341 of the constitution. In terms of scheduled caste population, Yamunanagar holds 4th position amongst various districts of Haryana. As per the 2011 census, scheduled caste population constitutes 25.26% of the total population of District Yamunanagar.Balmiki, Chamar and Deha are the primary scheduled caste populations residing in the area.

Cross-sectional sample of apparently healthy 1045 scheduled caste adolescent girls aged 9 to 17 years was collected using purposive sampling from 21 government schools located in three tehsils namely Jagadhri, Chhachhrauli, and Bilaspur of District Yamunanagar.

Date of birth of each girl was recorded from the school registers and all doubtful cases were excluded. The ages were converted to decimal age using 'Decimal Age Calendar' [15]. The data were divided into nine age groups each of the magnitude of one year. Height and weight were taken on each subject using standardized anthropometric techniques [16]. There was no inter-observer technical error of measurement as all the measurements were taken by the same investigator, the first author. Checks were made to find out intra observer technical error of measurement which was found to be less than 1%. Body mass index (BMI), was computed from height and weight [BMI= Wt (kg)/Ht (m²)]. The nutritional status was assessed with help of BMI using three criteria namely, Growth Charts by Centre for Disease Control and Prevention (CDC) [17]; Reference data by World Health Organization (WHO), 2007 based on z-scores [18]; and Growth charts by Indian Academy of Pediatrics (IAP) [19]). CDC (2000) growth charts classified children with ≥ 95th percentile BMI-for-age as obese; children with BMI levels between the 85th and 94th percentile as overweight and under the 5th percentile as

underweight. Following the recommendations of WHO [15], the nutritional status of each individual was calculated as z-score or S.D. scores for Height-for-age and BMI-for-age indices using WHO AnthroPlus Software. The cut-off points for mild, moderate and severe malnutrition for z-scores of this index was -1.1 to -2.0 S.D, -2.0 to -3.0 S.D. and less than -3.1 S.D., respectively. Following the revised growth charts given by IAP (2015), the 3rd percentile was used to define thinness and the adult equivalent of 23 and 27 cut-offs presented in BMI charts was used to define overweight and obesity.

Haemoglobin level of each subject was estimated following Sahli's Acid Haematin Method to assess the prevalence of anaemia in them. The blood sample was taken by a trained technician. Anaemia, as defined by World Health Organization is haemoglobin value below 13 g/dl in men over 15 years of age, below 12 g/dl in non-pregnant women over 15 years, and below 11 g/dl in pregnant women [20]. The prevalence of anaemia among scheduled caste adolescent girls was estimated by using the reference standards recommended by World Health Organization (1968).

Information on socio-economic, demographic (family type, family size, type of house, number of rooms in the house, birth order of participants), and micro-environmental (location of kitchen and toilet, fuel and stove type used in kitchen, flush type used, drainage facility, source of drinking water, use of water filters), variables along with ⦿dietary habits (number of meals consumed per day, food habits, intake of milk and fruit), was obtained using structured questionnaire. The socio-economic status of the families was assessed using modified Kuppuswamy's socio-economic status scale [21].

To evaluate the most suitable criteria to estimate under nutrition ROC curve analysis was performed using SPSS v. 16. Pearson's chi-square test was used to investigate various correlates of nutritional status.

RESULTS

As per Kuppuswamy's socioeconomic status scale [21], majority of the subjects under study (74%), belonged to upper-lower socio-economic class; 19.4% to lower-middle class. Out of remaining 6.6%, 3.3% belonged to lower class and 3.3% to upper-middle class. Majority of the parents were illiterate (32.7% fathers and 49.7% mothers), while 64.8% fathers and 49.5% mothers had education between primary to higher secondary level. Only 2.5% fathers and 0.8% mothers were educated upto graduate and post graduate level. Majority of the fathers were daily wagers/laborers (68.2%), and mothers were housewives (70.1%). Some of the parents worked as skilled workers as masons/carpenters/drivers/factory workers (12.1% fathers and 0.6% mothers), while few had their own business (12.3% fathers and 1.1% mothers). Most of the subjects were living in their own houses (81.3%), and only 18.7%occupied rented accommodation.76.7%subjects belonged to nuclear families and 23.3%to joint families. Most of these girls were living in poor environmental conditions.

Table 1 presents the age-wise percentage prevalence of underweight, normal and overweight scheduled caste girls according to classification by CDC [17]. The total sample revealed

44.3% girls as underweight, 54.4% as normal and 1.3%as overweight. Age-wise percentage distribution of adolescent girls in different z-score categories according to height-for-age index is presented in Table 2. Majority of girls had z-scores -1 S.D. or more below the reference median. 68.1%girls were stunted and remaining 31.9% were classified as normal.Out of 68.1% stunted girls, 39.4% suffered from mild stunting; 23.2% from moderate stunting and 5.4% from severe stunting. Table 3 presents the percentage prevalence of different grades of wasting in sample girls for BMI-for-age z-score. 67.1% girls were grouped under various levels of wasting. The percentage prevalence of mildly, moderately and severely wasted girls was 34%, 23.7% and 9.4%, respectively. According to classification by IAP [19], the age-wise prevalence of thinness, normal, overweight and obese categories among girls of District Yamunanagar has been presented in Table 4. 82.9% girls were found to be normal; 14.5% girls fell in the category of thinness; 2.3%girls were overweight and 0.3%girls were obese.

The prevalence of undernourished girls of District Yamunanagar varied according to the criteria used. ROC analysis showed that all the three criteria were significantly determining undernutrition, but growth charts by IAP (2015) had largest area under the curve (AURC=0.923), making it the most suitable criterion to predict undernutrition in the scheduled caste

adolescent girls of the present study; followed by CDC (2000) growth charts (AURC= 0.905) and WHO (2007) reference (AUC=0.896).

Figure 1 shows the prevalence of anaemia among the adolescent girls. As per WHO (1968), classification for prevalence of anameia, 91.1% adolescent girls were found to be anaemic while only 8.9% were non-anaemic.

Correlates of Nutritional Status

Association of socio-economic, demographic and micro-environmental parameters with the nutritional status of the girls was studied. Educational status of mothers showed significant association with the nutritional status of the girls (χ^2= 20.568, p-value=0.024*). Chi-Square revealed non-significant relationship between the nutritional status of the girls and their father's educational status, parent's occupational status and monthly family income as evident from Table 5. The girls who were residing in nuclear families; had a family size of ≤ 4 members; lived in their own houses; had a sib-ship size of two; and were of first birth order showed better nutritional status. However, Chi-square test revealed non-significant relationship between these demographic factors and nutritional status of the subjects (Table 6).

Table 1: Number and percentage Prevalence of Underweight, Normal, Overweight and Obese subjects according to CDC (2000) Classification.

Age (Years)	Number of Subjects	Underweight		Normal		Overweight	
		N	%	N	%	N	%
9	119	62	52.1	57	47.9	0	0.0
10	113	65	57.5	48	42.5	0	0.0
11	115	67	58.3	48	41.7	0	0.0
12	114	49	43.0	61	53.5	4	3.5
13	113	42	37.2	68	60.2	3	2.7
14	116	34	29.2	80	69.0	2	1.7
15	125	47	37.6	76	60.8	2	1.6
16	116	51	44.0	64	55.2	1	0.9
17	114	46	40.4	66	57.9	2	1.8
Total	1045	463	44.3	568	54.4	14	1.3

Table 2: Number and percentage Prevalence of Stunting (Height-for-age z-score) in Scheduled Caste Girls according to WHO, 2007.

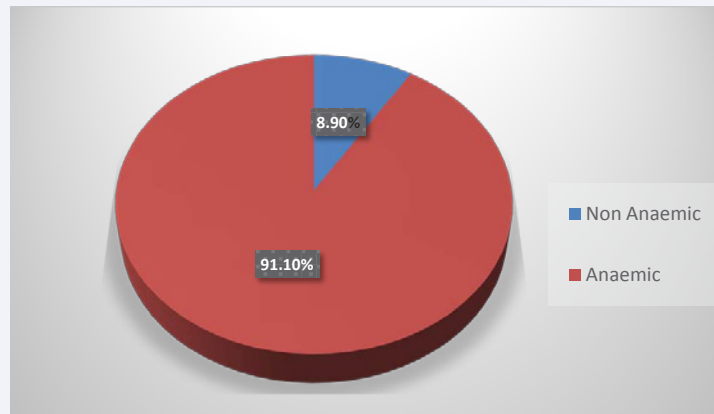| Age (Years)	Number of Subjects	Normal >-1 SD		Mild -1 to -1.9 SD		Moderate -2 to -2.9 SD		Severe -3 and less	
		N	%	N	%	N	%	N	%
9	119	57	47.9	36	30.3	23	19.3	3	2.5
10	113	40	35.4	34	30.1	27	23.9	12	10.6
11	115	42	36.5	41	35.7	20	17.4	12	10.4
12	114	33	28.9	47	41.2	28	24.6	6	5.3
13	113	49	43.4	35	31.0	23	20.4	6	5.3
14	116	32	27.6	52	44.8	30	25.9	2	1.7
15	125	34	27.2	55	44.0	27	21.6	9	7.2
16	116	24	20.7	57	49.1	32	27.6	3	2.6
17	114	22	19.3	55	48.2	33	28.9	4	3.5
Total	1045	333	31.9	412	39.4	243	23.2	57	5.4

Figure 1 Percentage Prevalence of Anaemia in adolescent girls of present study.

Table 3: Number and percentage Prevalence of Wasting (BMI-for-age z-score) in Scheduled Caste Girls according to WHO, 2007.

Age (Years)	Number of Subjects	Normal >-1 SD		Mild -1 to -1.9 SD		Moderate -2 to -2.9 SD		Severe -3 and less	
		N	%	N	%	N	%	N	%
9	119	31	26.0	51	42.9	24	20.2	13	10.9
10	113	28	24.8	39	34.5	34	30.1	12	10.6
11	115	34	29.6	27	23.5	36	31.3	18	15.6
12	114	43	37.7	31	27.2	24	21.1	16	14.0
13	113	44	38.9	32	28.4	20	17.7	17	15.0
14	116	43	37.1	43	37.1	26	22.4	4	3.4
15	125	46	36.8	40	32.0	32	25.6	7	5.6
16	116	34	29.3	45	38.8	31	26.7	6	5.2
17	114	41	36.0	47	41.2	21	18.4	5	4.4
Total	1045	344	32.9	355	34.0	248	23.7	98	9.4

Table 4: Number and percentage Prevalence of Thinness, Normal, Overweight and Obese subjects according to IAP (2015) classification.

Age (Years)	Number of Subjects	Thinness		Normal		Overweight		Obese	
		N	(%)	N	(%)	N	(%)	N	(%)
9	119	19	16.0	100	84.0	0	0.0	0	0.0
10	113	21	18.6	89	78.8	3	2.7	0	0.0
11	115	23	20.0	90	78.3	2	1.7	0	0.0
12	114	21	18.4	88	77.2	5	4.4	0	0.0
13	113	21	18.6	87	77.0	4	3.5	1	0.9
14	116	9	7.8	104	89.7	3	2.6	0	0.0
15	125	14	11.2	107	85.6	4	3.2	0	0.0
16	116	11	9.5	103	88.8	1	0.9	1	0.9
17	114	12	10.5	99	86.8	2	1.8	1	0.9
Total	1045	151	14.45	867	82.96	24	2.29	3	0.29

Table 7 shows the association of micro-environmental factors with the nutritional status of the girls. Majority of the families of the subjects used traditional mud type chulah (hearth), and firewood as fuel type for cooking purposes. Chi-square revealed non-significant association between the nutritional status and location of the kitchen as well as stove/fuel type used by the respondents. Data on sanitation facilities revealed that toilet was located outside the residence of 72.9% subjects while 27.1% subjects had toilet inside their houses. 58.6% girls used boreholes and 22% has access to flush system. Open defecation was reported by 19.4% girls. No significant association was found between sanitation facilities and nutritional status of the girls. The drinking water requirements of the subjects were met by water taps (97.3%), and hand pumps (2.7%). Only 3.7% girls

Table 5: Distribution of socio-economic variables based on nutritional status of adolescent girls of District Yamunanagar, Haryana, India.

SOCIO-ECONOMIC VARIABLES	NUMBER OF ADOLESCENT GIRLS	THINNESS		NORMAL		OVERWEIGHT+OBESE		χ², df, p-value
	N	N	%	N	%	N	%	
FATHER'S EDUCATION								
Illiterate	342	61	17.80	276	80.70	5	1.50	12.391, 10, 0.260
Primary (Class V)	206	28	13.60	173	84.00	5	2.40	
Middle (Class VIII)	182	26	14.30	153	84.10	3	1.60	
Matriculate (Class X)	201	22	10.90	170	84.60	9	4.50	
Higher Secondary (Class XII)	88	12	13.60	72	81.80	4	4.50	
Graduate and above	26	2	7.70	23	88.50	1	3.80	
MOTHER'S EDUCATION								
Illiterate	519	76	14.60	433	83.40	10	1.90	20.568,10,0.024*
Primary (Class V)	242	28	11.60	208	86.00	6	2.50	
Middle (Class VIII)	168	28	16.70	129	76.80	11	6.50	
Matriculate (Class X)	80	10	12.50	70	87.50	0	0.00	
Higher Secondary (Class XII)	28	7	25	21	75.00	0	0.00	
Graduate and above	8	2	25	6	75.00	0	0.00	
FATHER'S OCCUPATION								
Daily Wager	713	102	14.3	593	83.20	18	2.50	2.593,6,0.858
Skilled Worker	126	19	15.1	104	82.50	3	2.40	
Service	77	15	19.5	60	77.90	2	2.60	
Business	129	15	11.6	110	85.30	4	3.10	
MOTHER'S OCCUAPATION								
Daily Wager	263	46	17.5	207	78.70	10	3.80	10.028,8,0.263
Skilled Worker	6	1	16.7	5	82.30	0	0.00	
Service	32	7	21.9	25	78.10	0	0.00	
Business	11	2	18.2	8	72.70	1	9.10	
Housewife	733	95	13.0	622	84.90	16	2.20	
MONTHLY FAMILY INCOME (In Rupees)								
<5000	59	10	16.9	46	78.00	3	5.10	5.069,6,0.535
5000-10000	751	102	13.6	629	83.80	20	2.70	
10000-15000	172	27	15.7	143	83.10	2	1.20	
15000 and above	63	12	19.0	49	77.80	2	3.20	
*p < 0.05, **< 0.01								

Table 6: Distribution of demographic variables based on nutritional status of adolescent girls of District Yamunanagar, Haryana, India.

DEMOGRAPHIC VARIABLES	NUMBER OF ADOLESCENT GIRLS	THINNESS		NORMAL		OVERWEIGHT+OBESE		χ², df, p-value
	N	N	%	N	%	N	%	
FAMILY TYPE								
Nuclear Family	802	110	13.70	668	83.30	24	3.00	3.561,2,0.169
Joint Family	243	41	16.90	199	81.90	3	1.20	
FAMILY SIZE								
≤ 4 members	120	10	8.30	105	87.50	5	4.20	5.160,2,0.076
>4 members	925	141	15.20	762	82.40	22	2.40	
TYPE OF HOUSE								

Self Owned	850	118	13.90	713	83.90	19	2.20	3.616,2,0.164
Rented	195	33	16.90	154	79.00	8	4.10	
DURATION OF STAY								
Since Birth	838	123	14.70	694	82.80	21	2.50	0.475,4,0.976
Less than 5 years	171	24	14.00	142	83.00	5	2.90	
More than 5 years	36	4	11.10	31	86.10	1	2.80	
NUMBER OF ROOMS								
Kaccha House (Temporary Structure)	25	2	8.00	23	92.00	0	0.00	5.639,8,0.688
One room	308	47	15.30	249	80.80	12	3.90	
Two rooms	426	57	13.40	360	84.50	9	2.10	
Three rooms	180	27	15.00	149	82.80	4	2.20	
>3 rooms	106	18	17.00	86	81.10	2	1.90	
BIRTH ORDER								
First Born	327	42	12.80	274	83.80	11	3.40	2.010,2,0.366
Later Born	718	109	15.20	593	82.60	16	2.20	
SIBSHIP SIZE								
2	138	16	11.60	115	83.30	7	5.10	4.711,2,0.095
>2	907	135	14.90	752	82.90	20	2.20	

Table 7: Relationship of Microenvironmental factors with Nutritional Status of adolescentgirls of District Yamunanagar, Haryana, India.

MICRO-ENVIRONMENTAL FACTORS	NUMBER OF ADOLESCENT GIRLS	THINNESS		NORMAL		OVERWEIGHT +OBESE		χ^2, df, p-value
	N	N	%	N	%	N	%	
LOCATION OF KITCHEN								
Inside house	531	72	13.6	443	83.4	16	3.0	1.391,2,0.499
Outside house	514	79	15.4	424	82.5	11	2.1	
FUEL TYPE								
Firewood	278	41	14.7	229	82.4	8	2.9	4.189,6,0.651
L.P.G.	468	69	14.7	384	82.1	15	3.2	
Cowdung Cakes	276	37	13.4	236	85.5	3	1.1	
Kerosene	23	4	17.4	18	78.3	1	4.3	
STOVE TYPE								
Traditional Mud Type Chulah (Hearth)	554	78	14.1	465	83.9	11	2.0	2.133,4,0.711
Gas Burner	468	69	14.7	384	82.1	15	3.2	
Kerosene stove	23	4	17.4	18	78.3	1	4.3	
PROVISION OF CHIMNEY								
Yes	220	28	12.7	190	86.4	2	0.9	3.984,2,0.136
No	825	123	14.9	677	82.1	25	3.0	
LOCATION OF TOILET								
Inside	283	39	13.8	239	84.5	5	1.8	1.226,2,0.546
Outside	762	112	14.7	628	82.6	22	2.9	
FLUSH TYPE								
Permanent Flush	230	28	12.2	197	85.7	5	2.2	2.298,4,0.681
Borehole	612	96	15.7	499	81.5	17	2.8	
Field (open)	203	27	13.3	171	84.2	5	2.5	
DRAINAGE FACILITY								

Open	923	140	15.2	759	82.2	24	2.6	3.345,2,0.188
Closed	122	11	9.0	108	88.5	3	2.5	
SOURCE OF DRINKING WATER								
Handpump	28	5	17.9	23	82.1	0	0.0	0.977,2,0.614
Piped	1017	146	14.4	844	83.0	27	2.7	
ADEQUECY OF WATER								
Yes	948	135	14.2	790	83.3	23	2.4	1.457,2,0.483
No	97	16	16.5	77	79.4	4	4.1	
WATER FILTER								
Yes	39	5	12.8	32	82.1	2	5.1	1.094,2,0.579
No	1006	146	14.6	835	83.0	25	2.5	

had access to water filters. Nutritional status of subjects showed non-significant association with the source of drinking water and use of water filters.

Data on dietary habits shown in Table 8 revealed that majority of the girls (94.2%), had ≤ three meals per day, out of which 14.3% belonged to thinness category, 82.9% were normal and 2.7% belonged to overweight +obese category while 5.8% girls consumed 5 meals a day out of which 16.4% girls were thin and 83.6% were normal. Out of the total sample, 75% girls followed non-vegetarian diet; 23.4% drank milk on daily basis and 50.6%girls consumed fruit on regular basis. There was no significant association between dietary habits and nutritional status of the girls. Maximum number of girls belonging to normal category were those who brought home cooked food for lunch as compared to girls who had mid-day meal provided by the school. Chi-square test reported significant association between consumption of home cooked food and nutritional status of the girls (χ^2= 20.758, p-value=0.002**).

Table 9 shows the relationship of nutritional status with anaemic status of the adolescent girls. It was found that out of 151 thin girls 135 (89.4%), girls were anaemic and out of 867 normal girls 795 (91.50%), girls were suffering from anaemia. The prevalence of anaemia in overweight + obese girls was found to be lowest (81.5%), than other two categories. However, chi-test did not reveal any significant association between nutritional status and anaemic status of the girls.

DISCUSSION

National Family Health Survey (2015-16), stated that the problem of malnutrition in children especially in the state of Haryana is critical with the prevalence of wasting, stunting and underweight among children amounting to be 30.2%, 34% and 29.4%respectively. In the present study we assessed nutritional status of scheduled caste girls belonging to lower and middle class families using three criteria. According to CDC classification, 44.3% girls were underweight, 54.4% normal and 1.3% girls were overweight. Using IAP classification, 82.9% girls were normal; 14.5% thin; 2.3% overweight and 0.3% were obese. According to WHO standards, 68.1% girls were found to be stunted while 67.1% girls revealed wasting. The results of the present study have been compared with the prevalence of undernutrition among girls reported by several studies conducted in various Indian states **(**Table 10**)**, as this will show the existence of

regional variations, if any. The comparative profile of these studies showed that prevalence of underweight/thinness among scheduled caste girls of District Yamunanagar is lower than scheduled caste girls of Ropar, Punjab [22]; Naraingarh, Haryana [11]; school going girls of District Barnala & Mansa, Punjab [23]; Shimla [24]; Patiala [25]; Varanasi [26-27]; rural areas of Rohtak, Haryana [12]; Hisar [13]; Assam [28]; Urban slum of Bareilly, Uttar Pradesh [29]; and Urban Lucknow [30] and higher than girls of urban areas of Rohtak, Haryana [12]; Rural Lucknow [30], and District Palwal, Haryana [14], and school going girls of District Rajgarh, Chhattisgarh [31]. The prevalence of stunting and wasting among the subjects is higher than the girls of compared population groups. These differences in prevalence rates of various grades of malnutrition may be attributed to different genetic and environmental correlates along with the different dietary habits, socio-economic levels and cut-off points used to define undernutrition.

ROC analysis revealed that the growth charts by IAP (2015), were found to be the most suitable for assessment of undernutrition among adolescent girls as compared to CDC growth charts and WHO reference data, both of which overestimated the prevalence of thinness among them. Venkatesh, Pachaiappan, & Ramalingam (2015), [32], also compared the prevalence of thinness, overweight and obesity among urban adolescent girls of Pondicherry using the WHO 2007 BMI-for-age z-scores and revised IAP (2015), growth charts and concluded that WHO (2007), reference data overestimated the prevalence of thinness significantly in comparison to IAP (2015), growth charts for Indian children.

Under-nutrition is a serious public-health problem which has direct bearing on increased risk of mortality and morbidity. The covariates of under-nutrition are intricate and include genetic, environmental, social and cultural factors. Environmental contamination (overpopulation, poor micro and macro-environmental conditions, poor sanitation facility) contributes to an increasing number of health hazards [33-37]. Identification of risk factors contributing to this epidemic is vital for its prevention and control. In the present study, educational, occupational status of parents and their monthly income was assessed. Mother's educational status showed significant association with nutritional status of the girls as is evident from the chi-square test. The nutritional status of the girls improved with the improvement in educational status of the mother (Table

Table 8: Number and percentage distribution of girls based on Dietary habits and Dietary pattern among thin, normal and overweight+obese categories.

DIETARY HABITS AND DIETARY PATTERN	NUMBER OF ADOLESCENT GIRLS	THINNESS		NORMAL		OVERWEIGHT +OBESE		χ^2, df, p-value
	N	N	%	N	%	N	%	
MEALS CONSUMED PER DAY								
≥ 3 meals	984	141	14.3	816	82.9	27	2.7	1.846,2,0.397
≥5 meals	61	10	16.4	51	83.6	0	0.0	
FOOD HABITS								
Vegetarian	168	24	14.3	139	82.7	5	3.0	0.376,4,0.984
Non-Vegetarian	784	113	14.4	652	83.2	19	2.4	
Egg Eaters	93	14	15.1	761	81.7	3	3.2	
MILK INTAKE								
Yes	323	51	15.8	269	83.3	3	0.9	5.542,2,0.063
No	722	100	13.9	598	82.8	24	3.3	
FREQUENCY OF MILK CONSUMPTION								
Never	722	98	13.6	600	83.1	24	3.3	6.332,4,0.176
Occasionally	78	12	15.4	65	83.3	1	1.3	
Daily	245	41	16.7	202	82.4	2	0.8	
FRUIT INTAKE								
Yes	529	76	14.4	443	83.7	10	1.9	2.076,2,0.354
No	516	75	14.5	424	82.2	17	3.3	
CANTEEN/LUNCH /MID-DAY MEAL								
Nothing	77	7	9.1	67	87.0	3	3.9	20.758,6,0.002**
Canteen	202	22	10.9	177	87.6	3	1.5	
Lunch	207	17	8.2	183	88.4	7	3.4	
Midday Meal	559	105	18.8	440	78.7	14	2.5	
*p < 0.05, **< 0.01								

Table 9: Prevalence of anaemia among Scheduled Caste adolescent girls of District Yamunanagar,Haryana, India according to their Nutritional Status.

	NUMBER OF ADOLESCENT GIRLS	NON ANAEMIC CASES		ANAEMIC CASES		χ^2, df, p-value
NUTRITIONAL STATUS		N	%	N	%	
Thin	151	16	10.60	135	89.40	*3.996,2,0.136*
Normal	867	72	8.30	795	91.50	
Overweight+Obese	27	5	18.50	22	81.50	

Table 10: Prevalence of different grades of malnutrition among various populations of India.

City/District/State/ Study	Studied Girls	Criteria Used	Age group	Sample Size	Underweight/ Thinness (%)	Stunting (%)	Wasting (%)
Kharar Tehsil, District-Ropar, Punjab (Gaur et al., 1995)	Punjabi Scheduled caste	NCHS	6-12	219	44.7	26.9	28.8
Naraingarh, Haryana (Talwar et al., 2007)	Scheduled caste	WHO, 1986	6-12	145	33.1	31.03	17.2
Rohtak, Haryana (Vashist et al., 2009)	Rural & Urban	NCHS	13-16	416 (Rural)	15.1	12.7	--
				444 (Urban)	13.73	10.8	--

Study	Setting	Criterion	Age	N			
District Barnala& Mansa, Punjab (Goyal et al., 2012)	School going	WHO, 2007	11-16	417	64.5	66.7	--
Bareilly, Uttar Pradesh (Srivastava et al., 2012)	Urban Slum	CDC, 2000	5-15	219	45.2	22.4	37.4
Varanasi, Uttar Pradesh (Singh et al., 2012)	Rural	CDC, 2000	15-19	650	26.6	--	--
Lucknow, Uttar Pradesh (Sachan et al., 2012)	Rural and Urban	NCHS/CDC	10-19	593 (Urban)	17.0	--	--
				254 (Rural)	11.4	--	--
Shimla, Himachal Pradesh (Chadgal& Talwar, 2014)	Government School Going	WHO, 2007	12-18	201	17.83	--	--
Agroha, Hisar, Haryana (Choudhary et al., 2015)	Rural	Asian criterion	10-19	273	65.57	--	--
District Patiala, Punjab (Kaur et al., 2015)	School going	_	10-15	349	50.43	--	--
Varanasi, Uttar Pradesh (Krishna & Mishra, 2016)	Urban	NCHS	10-19	400	23.0	--	--
District Palwal, Haryana (Thakur & Gautam, 2016)	Rural	WHO, 1995	0-20	1274	4.6	6.3	3.5
District Fatehabad, Haryana (Rani and Rani, 2016)[60]	Rural	WHO, 1995	13-17	100	--	19	11
Assam (Konwar et al., 2019)	Rural	WHO, 2007	10-19	265	49.4	50.6	--
District Raigarh, Chhattisgarh (Pandey, 2019)	School going	WHO, 1995	11-16	400	44	--	--
Present Study	School going	WHO, 2007	9-17	1045	--	68.0	67.1
		CDC, 2000			44.3	--	--
		IAP, 2015			14.45	--	--

5). The results of the present study are in accordance with many studies with similar findings [38-41]. Proper dietary habits and adequate and balanced nutrition are essential to fulfill the energy requirements to sustain the rapid physical changes in adolescents. In the present study, dietary habits of the girls did not showed significant effect on their nutritional status. Nutritional status of the girls improved with the consumption of home-made food. These findings are in consensus with studies by [42-44]. The dietary habits of the girls revealed that balanced intake of both macro and micro nutrients is lacking in their diet. Globally, the most significant contributor to the onset of anaemia is iron deficiency [45]. Low bioavailability of iron from diets and infections that cause iron loss contribute towards iron deficiency. It is well known that during adolescence, iron requirement increase due to rapid growth and increase in blood volume [46]. Adolescent girls bear the direct burden of pernicious effects of under-nutrition which further propagate to future generations thus, contributing to the intergenerational cycle of malnutrition. Many studies have concluded that poor nutritional status significantly associates with higher prevalence of anaemia in the adolescents [47-52]. However, the results of the present study reveal non-significant association between nutritional status and anaemic status of the girls. These results are in consensus with earlier studies [53-59].

used. Although amount of exact calories consumed by the subjects were not calculated yet, on the basis of 24-hour dietary record it was observed that the girls did not consume required calories as recommended for adolescent girls. The poor nutritional status of subjects in the present study may be attributed to inadequate nutrition due to poverty, illiteracy and lack of awareness among the parents regarding nutritional requirements of their wards at specific ages. Adolescent girls should be sensitized about their dietary requirements with special reference to increased intake of macro and micronutrients which are essential for growth and development at this stage of life. It is also suggested to undertake regional studies on children and adolescents for regularly monitoring their nutritional status for timely interventions. The limitation of our study is that being a cross-sectional study it depicts the current status of nutritional status of adolescent girls and secondly the exact number of calories consumed by the subjects were not calculated to match up with the recommended calories .Moreover, the percentage of micronutrients present in the diet were also not estimated to record the particular deficiency. On the basis of 24 hour dietary record it was observed that the nutritional intake of girls was far lower than the recommended calories. Longitudinal studies are recommended for better insight of age effects on their nutritional status and its correlates.

CONCLUSION

In conclusion, it can be stated that to monitor the nutritional status of Indian children growth charts by IAP (2015), should be

ACKNOWLEDGEMENTS

permission to carry out data collection from various schools of the district and to the parents, principals and teachers of various schools for extending their cooperation to carry out the work. The authors are extremely thankful to all the participants for actively participating in the study and for providing required data and information.

FUNDING

ETHICAL APPROVAL

Ethical clearance for the collection of data on human subjects was obtained from the Ethical Review Committee of Panjab University, Chandigarh. A prior permission was obtained from the District Education Officer and Principals of schools along with the written consent of parents/legal guardians after explaining the objective and methodology of the study.

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