International Journal of Community Medicine and Public Health
Reddy SUK et al. Int J Community Med Public Health. 2019 Sep;6(9):4034-4042
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20194013

Original Research Article

Nutritional status and dietary intake among unmarried adolescent girls in rural area of Chittoor district: a community based survey

S. Uday Kumar Reddy, Sirshendu Chaudhuri*, Syeda Fathima Amrin, Gunasekaran Rabeka

Department of Community Medicine, Apollo Institute of Medical Sciences and Research, Chittoor, AP, India

Received: 25 June 2019
Accepted: 12 August 2019

***Correspondence:**
Dr. Sirshendu Chaudhuri,
E-mail: sirshendusisu@gmail.com

ABSTRACT

Background: Nutritional status and dietary intake during adolescent period play a crucial role in their mental and physical development. Objectives of the present study were to estimate the prevalence of undernutrition, as defined by the World Health Organization (WHO), among unmarried adolescent girls in rural area of Chittoor district; to estimate the average daily intake of different macro and micro-nutrients, i.e., calorie, protein and iron, by the same group by 24-hour dietary recall method; and to identify individual and family level determinants for undernutrition and decreased intake of nutrients.
Methods: In this cross-sectional community-based survey anthropometric measurements were done, and dietary intake of unmarried adolescent girls was assessed by 24-hour recall method.
Results: Majority is suffering from poor nutrient intake. This is more prominent for calcium [25.1-40.9% of the recommended daily allowance (RDA)] and energy intake (68.6-88.9% of RDA). Only 55% of the adolescents get iron supplementation; rests consume minimal iron (8.5gm) on average. Prevalence of thinness and stunting was 29.4% (95% CI: 20.4%, 38.4%) and 21.4% (95% CI: 13.3, 29.5%) respectively. Economic and housing conditions were associated with low dietary intake and poor nutritional status. Considerable cluster-wise variation exists for both the conditions.
Conclusions: High prevalence of stunting and thinness together with substantial macro and micro-nutrient deficiency exist among adolescent girls. Existing national programs for this age group needs adequate supervision. Awareness development regarding locally available low-cost nutritious food together with periodic anthropometric measurements is required.

Keywords: Adolescent, Determinants, Dietary intake, Nutritional status, Stunting, Thinness

INTRODUCTION

Appropriate growth and development in adolescence (10-19 years) plays a critical role in the human life cycle. This period is considered as a bridge between childhood and adulthood. A child enters the adolescent stage with various major factors which control his/her future adulthood like biological, physical social and mental factors. The biological factors include genetics, epigenetics, and natural endowment. Social factors include local and state level policies, the influence of community, peer group, school environment, and family.[1] Most importantly, adult productivity depends upon the physical and neuro-cognitive development that is attained during the adolescent period.

Amongst such factors, adequate nutrition probably plays a pivotal role in attaining such changes in adolescents.

Optimum nutritional intake is essential to meet the increasing demand of the growing body and the neuro-cognitive performance which is eventually related to adult productivity of the individual.[2] Additionally, adolescent girls are considered future mothers. Victoria et al[3], in one of the Lancet series, have elicited how the health and nutritional status of women and children are intimately linked. The United Nations has also expressed its concern towards the importance of adequate nutrition among adolescents in the Millennium Development Goals and later in Sustainable development goals.[4]

In India, almost 22% of the population belong to this age group.[5] Due to such a big population, the reported burden of under-nutrition and anemia among adolescent girls are considerably high in the country.[6,7] Although, there have been efforts from the state and the national government towards reducing the same, the effects are not obvious.[8] The reason could be existence of multiple factors at the household level. However, studies looking for such factors behind adolescent undernutrition in rural India are lacking. With the changing socio-cultural and political scenario, such studies are needed to develop sound policies to achieve the SDG goals. In this background, objectives of the present study were included to estimate the prevalence of undernutrition, as defined by the World Health Organization (WHO), among unmarried adolescent girls in rural area of Chittoor district; to estimate the average daily intake of different macro and micro-nutrients, i.e., energy, protein and iron, by the same group by 24-hour dietary recall method; and to identify individual and family level determinants for undernutrition and decreased intake of nutrients.

METHODS

Study design

Community based cross sectional study.

Study settings

The study was carried in the villages under 'Aragonda' sub-center in Chittoor district. It is situated approximately 20 kilometers away from Chittoor town with a total population of 8,000 and is the service area of Apollo Institute of Medical Sciences (AIMSR), Chittoor. The community medicine department of AIMSR closely works with the government system in this sub-center.

Study duration

The study was conducted between May 2018 and September 2018.

Ethical Committee clearance

Institutional ethical committee clearance of AIMSR (Ref No: IEC04/AIMSR/02/2018) has been obtained.

Study participants

Adolescents unmarried girls between 10-19 years from the villages from Aragonda sub-centre.

Inclusion criteria

The adolescent girls between 10-19 years and permanent resident (at least 6 months) of the area.

Exclusion criteria

Any acute or chronic medical condition which restricts the subject to stand and thereby compromising the anthropometric measurements, staying at home irregularly (<4 days in a week on average) and not willing to participate.

Sample size

As there was no study available before from this region, we assumed 50% of the adolescent girls have thinness. Based on the assumption and with a 20% of relative precision, we intended to examine 100 adolescents. The final sample size was 102.

Tools and data collection process

Initially, all the households from the study area having at least one eligible subject, was identified from the enumeration list, as prepared by the community medicine department. The households were selected by simple random sampling from the list. If any household had more than one eligible subject, then only one of them was selected randomly to avoid family level clustering effect.

A door to door survey was conducted at the selected households for conducting an interview of the mother or the primary caregiver of the adolescent through a pre-tested, semi-structured questionnaire in the local language. Appropriate consent from either of the parents and assent (if <18 years) were taken from and the subject. Data was collected in electronic case report forms (e-CRF) in 'KoBoToolBox' android applications.[9] However, subject's dietary intake in previous 24 hours was collected in paper forms through 24-hours dietary recall method with standard bowls. The information was also verified from the subject. Anthropometric measurements were done with standard calibrated instruments.

Definition of the outcome and predictor variables

Undernutrition was defined as 'Z' scores of age-standardised body mass index (BAZ) <-1SD.[10] The term undernutrition has been used interchangeably with thinness in this paper. Stunting was defined as 'Z' scores of age-standardised height-for-age (HAZ) <-2SD.[10] Daily intake of energy, protein, calcium, and iron from diet was calculated by the guidelines provided by the National

Institute of Nutrition (NIN), Hyderabad. All the nutrients have been expressed in terms of standard units.

Socio-economic status (SES) was assessed by BG Prasad's socio-economic scale for August 2018.[11] The scale considers per-capita monthly income for assessing SES.

Overcrowding was present when on average; more than two persons were living in a household. Presence of an alcohol user was assessed based on the reported history of alcohol use in past one month for recreational purpose by any of the family members. Similarly, smoking history was collected for a period of past one month. The term 'public distribution system' (PDS) was used interchangeably with ration shop in the villages.

Data entry and analysis

Socio-demographic and anthropometric data was downloaded directly from the 'KoBoToolBx' server which is password protected. Daily intake of the various nutrients was entered in Microsoft Excel. Final data were analyzed by SPSS version 20 for Windows (IBM Corp., Armonk, New York, 2010). Anthropometry portion will be analyzed by 'WHO AnthroPlus' software.[12] All the proportions have been expressed with 95% confidence interval (CI). The nutrient values have been expressed in terms of mean with standard deviation (SD) or median values with inter-quartile range (IQR) depending on the distribution pattern. 'Kruskal-Wallis' test was applied to detect the difference between median estimates across the clusters. Univariate followed by multivariate logistic regression was done to identify the predictors and was considered as significant if 'α'<0.05.

RESULTS

We interviewed 102 subjects for the study. Table 1 depicts the socio-demographic variables of the study population. Majority of the subjects (n=55; 53.9%) were from families belonged to poor SES (Table 1).

Dietary intake

Majority of the participants (n=97; 95.1%) preferred a mixed diet (combination of vegetarian and non-vegetarian). Dietary intake of different nutrients (energy, protein, and calcium) was substantially low among the study participants (Table 2) when compared with the recommended value for Indian standard.[13]

Fifty-five percent (n=56) participants were on regular iron supplementation of 100 mg/day. The daily median intake of iron for those who didn't get iron supplement was 8.5gm (IQR 6.6-11.9 gm). Percent RDA for iron intake of these participants varies between 31.5% to 40.5%.

Table 1: Socio-demographic variables of the study participants.

Variables	Frequency (%)
Mean age in years (SD)	14.35 (2.7; 12.1-16.7)
Median number of family members (SD; IQR)	5 (1.5; 4-6)
Type of family (%)	
Nuclear	57 (55.9)
Extended	37 (36.3)
Joint	8 (7.8)
Religion	
Hindu	93 (91.2)
Muslim	9 (8.8)
Median number of children <18 years in the family (range)	2 (0-5)
Present education status	
Currently studying	89 (87.25)
Currently not studying	13 (12.75)
BG Prasad SES for August 2018 (All figures in INR)	
Class I (>=6871)	0 (0)
Class II (3435-6870)	8 (7.8)
Class III (2061-3434)	39 (38.2)
Class IV (1031-2060)	42 (41.2)
Class V (<=1030)	13 (12.7)
Public distribution system users	
Yes	97 (95.1)
No	5 (4.9)

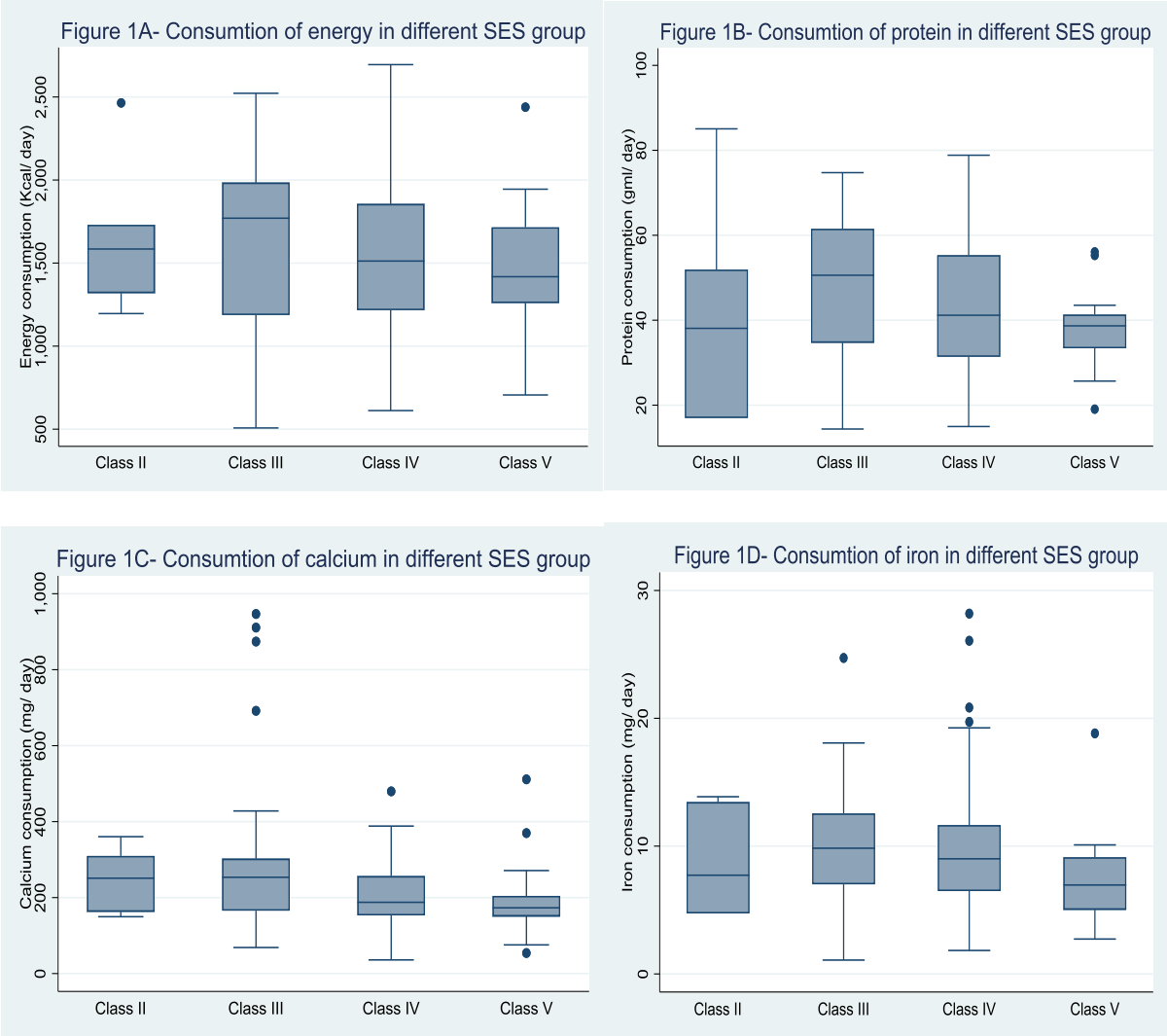

Figure 1 (A-D): Box and Whisker plots showing distribution of nutrient intake in different SES category.

Table 2: Daily average intake of nutrients for adolescent girls*.

Nutrients	Age group in years (n)	Recommended daily allowances (RDA)[13] (A)	Daily mean intake (B)	Intake in % (C=A*100/B) of RDA (95% CI)	Deficiency in % (D=100-C) of RDA	P value
Energy (Kcal) [1 kcal= 4.18 kj]	10-12 (28)	2010	1431.3	71.2 (61.0, 81.40	28.8	<0.001
	13-15 (36)	2330	1598.3	68.6 (63.0, 74.2)	31.4	<0.001
	16-17 (20)	2440	1688.9	69.2 (58.8, 79.6)	30.8	<0.001
	>=18# (15)	1900	1689	88.9 (72.1, 105.7)	11.1	0.19
Protein (gm/day)	10-12 (28)	40.4	40.63	100.6 (84.4, 114.40	-0.6	0.9
	13-15 (36)	51.9	45.1	86.9 (71.0, 96.6)	13.1	0.009
	16-17 (20)	55.5	45.57	82.1 (67.0, 97.2)	17.9	0.02
	>=18# (15)	55.0	51.06	90.7 (71.2, 114.5)	9.3	0.5
Calcium (mg/day)	10-12 (28)	800	250.1	31.3 (21.7, 40.8)	68.7	<0.001
	13-15 (36)	800	260.7	32.6 (25.8, 39.3)	67.4	<0.001
	16-17 (20)	800	201.1	25.1 (20.3, 29.9)	74.9	<0.001
	>=18# (15)	600	245.5	40.9 (26.5, 50.2)	59.1	<0.001

*Based on 95 subjects-7 excluded due to unusually high or low intake than average daily intake.
#For sedentary work only.

Table 3: Univariate and multivariate analysis for poor nutrient intake.

Variables	Frequency (%) in low-intake group	Frequency (%) in adequate-intake group	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	P value
1. Energy intake					
Family size					
More (>4)	34 (58.6)	24 (41.4)	2.46 (1.08, 5.59)	1.92 (0.81, 4.56)	0.14
Less (≤4)	15 (36.6)	26 (63.4)			
Total number of children in the household					
>2	11 (68.8)	5 (31.2)	2.68 (0.85, 8.39)	2.02 (0.59-6.96)	0.27
≤2	37 (45.1)	45 (54.9)			
Presence of at least one male child in the family					
Present	33 (50.9)	26 (44.1)	1.9 (0.84, 4.3)	1.85 (0.75, 4.58)	0.18
Absent	16 (40.0)	24 (60)			
Per capita income					
<2000 INR	28 (59.6)	19 (40.4)	2.18 (0.97, 4.86)	2.25 (0.97-5.19)	0.06
≥2000 INR	21 (40.4)	31 (59.6)			
Overcrowding					
Present	25 (64.1)	14 (35.9)	2.60 (1.13, 6.0)	2.19 (0.92, 5.22)	0.08
Absent	24 (40.7)	35 (59.3)			
2. Protein intake					
Overcrowding					
Present	24 (61.5)	15 (38.5)	2.33 (1.02, 5.34)	2.03 (0.87, 4.76)	0.1
Absent	24 (40.7)	35 (59.3)			
Sanitation					
Open field	23 (62.2)	14 (37.8)	2.43 (1.05, 5.61)	2.06 (0.87, 4.87)	0.1
Toilet at home	25 (40.3)	37 (59.7)			

Table 4: Univariate and multivariate analysis for thinness and stunting.

Variables	Frequency (%) in under nutrition group	Frequency (%) in normal nutrition group	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	P value
1. Stunting					
Overcrowding					
Present	26 (65)	14 (35.0)	1.8 (0.8, 4.08)	2.6 (0.91,7.42)	0.07
Absent	31 (50.8)	30 (49.2)			
Alcohol user					
Present	29 (69)	13 (31.0)	2.55 (1.11, 5.83)	2.04 (0.64, 6.54)	0.23
Absent	28 (46.7)	32 (53.3)			
Menarche					
Achieved	43 (62.3)	26 (37.7)	2.24 (0.96, 5.26)	3.76 (1.33, 10.64)	0.01
Not achieved	14 (42.4)	19 (57.6)			
Smoker					
Present	32 (66.7)	16 (33.3)	2.32 (1.03, 5.18)	1.24 (0.39, 3.92)	0.7
Absent	25 (46.3)	29 (53.7)			
Education expenditure to total monthly income (EEI) ratio					
Low EEI (>=10%)	48 (68.6)	22 (31.2)	6.29 (2.43, 16.12)	9.07 (3.06, 26.91)	<0.001
High EEI (<10%)	8 (25.8)	23 (74.2)			
2. Thinness					
Diet pattern					
Purely veg	3 (60)	2 (40)	3.89 (0.62, 24.57)	4.97 (0.67, 36.85)	0.12
Mixed	27 (27.8)	70 (72.2)			

Continued.

Variables	Frequency (%) in under nutrition group	Frequency (%) in normal nutrition group	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	P value
PDS user					
No	3 (60)	2 (40)	3.89 (0.62-24.57)	4.46 (0.61, 32.9)	0.14
Yes	27 (27.8)	70 (72.2)			
Place of cooking					
Within living room	9 (40.9)	13 (59.1)	1.95 (0.73-5.21)	1.8 (0.62, 5.28)	0.28
Separate kitchen/ courtyard	21 (26.3)	59 (73.7)			
Presence of at least one male child in the family					
Present	21 (35.6)	38 (64.4)	2.09 (0.84-5.17)	2.45 (0.87, 6.85)	0.08
Absent	9 (20.9)	34 (79.1)			
Education expenditure to income ratio					
Low EEI (>=10%)	24 (34.3)	46 (65.7)	2.17 (0.78-6.02)	2.74 (0.89, 8.44)	0.08
High EEI (<10%)	6 (19.4)	25 (80.6)			

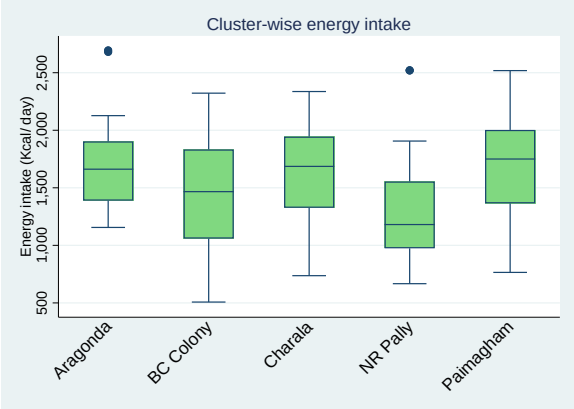

Figure 2: Box and Whisker plots showing distribution of energy intake in different clusters.

When classified into different SES category, we noticed a decreasing trend (statistically significant; $p<0.05$) of nutrient intake as the SES moves to lower class. (Figure 1 A-D). When divided into clusters, the variation was significant ($p<0.05$) for energy intake (Figure 2); but not significant for the other nutrients.

Anthropometric measurement

The z-scores of age-standardized mean body mass index (BAZ) was -0.25 (SD 1.3). Prevalence of thinness (BAZ <-2SD) was 29.4% (95% CI: 20.4%, 38.4%). Stunting (HAZ <-1SD) was found in 57 (55.9%) participants (95% CI: 13.3, 29.5%). Figure 3A and 3B depicts the distribution of BAZ and HAZ scores (red coloured) in respect to the WHO standard (green coloured).

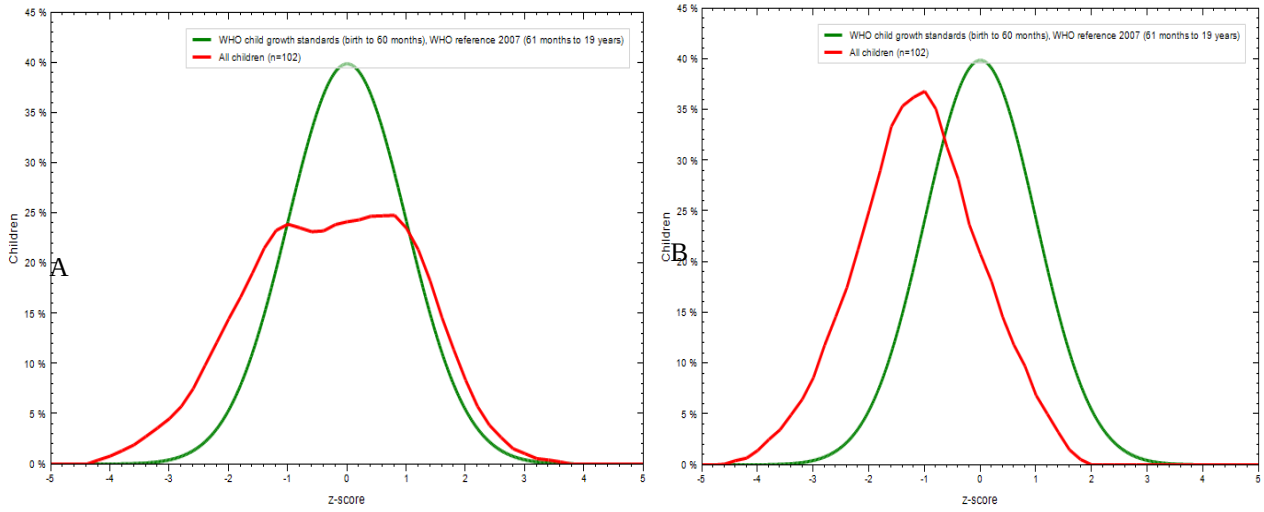

Figure 3: (A) Distribution of z-scores of age-standardized body mass index (BAZ); (B): distribution of z-scores of height-for-age (HAZ).

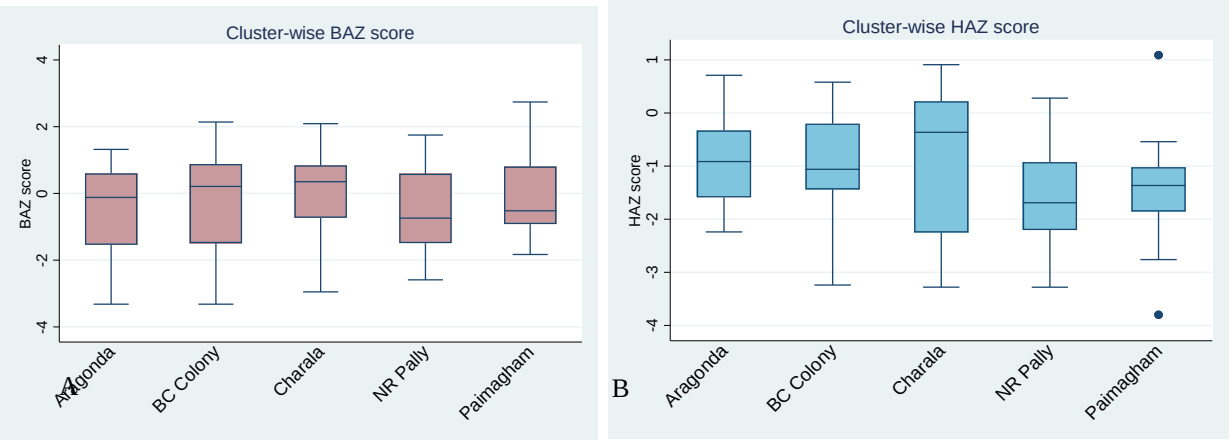

Figure 4: Distribution of BAZ (A) and HAZ (B) scores in different clusters.

The median differences of BAZ and HAZ scores across different clusters were statistically significant ($p<0.05$). (Figure 4).

Both low nutrient intake and poor nutritional outcomes tend to show more association with social and housing factors like overcrowding, more family members and a greater number of children (>2) in a family (Table 3 and 4). Social issues like the presence of alcohol user or smoker in a family showed a tendency to have a stunted adolescent in the family (Table 4).

DISCUSSION

Our study comprehensively examined the diet and nutritional status of adolescent unmarried girls in the rural areas of southern India. Anthropometric measurements revealed that almost a third (29.4%) of the study population is suffering from acute malnutrition as indicated by poor BMI for age. In contrary, the prevalence of stunting (55.3%) is alarmingly high in this population. Prevalence of thinness, as estimated by other community and school-based studies, showed high prevalence. On an average, thinness varied from 35.7% to 40.9%.[6,14-16] However, evaluation of thinness from different studies should be done very cautiously as the reference standard used for detecting thinness varied and thereby the estimate is likely to change due to this. The earlier studies used IAP or NCHS standard in Indian setting while most of the present studies including our finding are based on WHO reference.[14]

Poor nutritional status is mostly related to several socio-economic factors as indicated by multi-variate analysis. Poor living condition like overcrowded families, minimal expenditure towards education are found to have strong relationship. Younger adolescents who are yet to achieve their menarche showed a high tendency to have a poor nutritional outcome. Additionally, factors like presence of alcohol user and smoker in the family; cooking practice within living room; the presence of at least one male child in the family make the adolescent girls more prone to have poor nutritional status. Although existence of gender discrimination is difficult to identify from the present study, literature from other parts of the country showed that undernutrition among adolescent girls has a clear relationship with biased intra-household allocation of food.[17] Similar to our finding, two large studies from India identified that economic factor and family size is the strong determinant factor for undernutrition.[6,7] In the present study, we found a high association of undernutrition among the girls who have achieved menarche. To maintain the post-pubertal rapid growth, there is a high demand of the macro and the micro-nutrients. In this setting, the households probably failed to meet such increased demand due to compromised economic status. Lack of knowledge, a higher rate of bulimia and anorexia nervosa at this age could be the other reasons behind such finding.[18]

We found most of the study population lack dietary intake of all the macro and micro-nutrients. Energy consumption is considerably low among the younger adolescents when compared with the RDA for the same age group. However, the deficiency pattern is reduced in older adolescents (>18 years). Unlike energy, protein intake is only marginally less when compared to the RDA. A large study[6] from tribal and rural population showed a little more than one-third of the adolescents consume <70% of RDA for energy. The same study showed a much higher proportion (57.4%) of adolescents consumed less protein than recommended. Most of the large studies showed a similar pattern of deficiency among adolescent girls when compared to the recommended allowance of that age group.[6,7]

In our study, we found a low intake of macronutrients is present in the study population irrespective of the socio-economic and cultural differences. There is a prominent tendency of poor intake of energy and protein as we go down from the upper to lower classes. The multi-variate analysis in the present study also supports the same. However, the exception we noticed that uppermost class consumes low nutrients could be due to fewer sample in that group. A similar tendency has been noticed for

protein intake as well. We observed a weak relationship between poor nutrient intake and factors like 'large family size', 'overcrowded households', and 'open field defecation' practice. Large community-based studies also indicate a strong relationship between poor food intake and low per-capita income.[6,7] As discussed earlier, gender discrimination could play a crucial role in nutrient intake as well but beyond the scope of the present paper to conclude on such issue. Nevertheless, we got a weak relationship with inadequate intake by the adolescent girls in presence of at least one male child in the family.

The deficiency for both micro-nutrients was clearly high. However, as half of the study population gets regular iron supplementation, it is expected they will meet the daily need. Unlike iron supplementation, no national-level program supplements calcium for this age group. The mean calcium intake per day in the present study is considerably low than the mean intake estimated by Khadilker et al in Pune in the year 2006.[19] Nonetheless, studies from other parts of India and similar settings in Bangladesh showed similar low intake of calcium and iron.[6,7,20,21] Micronutrients like calcium and iron often depend upon the type of food available locally as well as the knowledge of nutrients. Poor knowledge could be one of the important factors contributing to low intake of the micro-nutrients.

To conclude, our results from the community-based assessment of nutritional status and nutritional intake of the adolescent girls showed a high prevalence of stunting and thinness together with a sizeable deficiency in macro and micro-nutrient intake. The variation in nutritional deficiencies and poor nutritional outcome varies markedly in different SES group and in clusters. Educating children and parents regarding locally available low-cost nutritious food could be helpful. The study also reveals that different services recommended by the national programs are not implemented or followed adequately. We strongly recommend regular assessment of the nutritional status of the adolescents. Simultaneously, we need appropriate supervision in implementing the ongoing components of the national health programs related to adolescent health. Based on the result, we recommend exploring on the same research question to have a pooled analysis within the country before we move towards a systematic intervention in this age group.

ACKNOWLEDGEMENTS

The project was under the 'Short Term Studentship' grant under ICMR. We sincerely thank ICMR for supporting the project

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Blum RW, Bastos FI, Kabiru CW, Le LC. Adolescent health in the 21st century. Lancet. 2012;379(9826):15678.
2. Branca F, Piwoz E, Schultink W, Sullivan LM. Nutrition and health in women, children, and adolescent girls. BMJ. 2015;351:4173.
3. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and child undernutrition: consequences for adult health and human capital. Lancet. 2008;371(9609):340-57.
4. Food, 2015. Available at: http://www.un.org/en/sections/issues-depth/food/. Accessed on 9 October 2018.
5. Census of India: age structure and marital status. Available at: http://censusindia.gov.in/Census_And_You/age_structure_and_marital_status.aspx. Accessed on 10 October 2018.
6. Rao KM, Balakrishna N, Laxmaiah A, Venkaiah K, Brahmam GNV. Diet and nutritional status of adolescent tribal population in nine states of India. Asia Pac J Clin Nutr. 2006;15(1):64-71.
7. Venkaiah K, Damayanti K, Nayak MU, Vijayaraghavan K. Diet and nutritional status of rural adolescents in India. Eur J Clin Nutr. 2002;56(11):1119-25.
8. Haider R. Adolescent Nutrition: A Review of the Situation in Selected South-East Asian Countries. 2006: 96. Report No.: SEA-NUT-163.
9. KoBoToolbox. Data collection tools for challenging environments. Available at: https://www.kobotoolbox. org/. Accessed on 13 January 2019.
10. Christian P, Smith ER. Adolescent undernutrition: global burden, physiology, and nutritional risks. Ann Nutr Metab. 2018;72(4):316-28.
11. B. G. Prasad scale. Prasad social classification scale update. Available at: http://prasadscaleupdate.weebly.com/. Accessed on 23 January 2019.
12. WHO. Application tools WHO. Available at: http://www.who.int/growthref/tools/en/. Accessed on 13 January 2019.
13. Nutrient requirements and recommended dietary allowances for Indians (1990, Reprinted 2008) 2nd ed 2010). In: Rao BSN, Sivakumar B, eds. Indian Council of Medical Research. Available at: https://www.icmr.nic.in/content/nutrient-requirements-recommended-dietary-allowances-indians-1990-reprinted-2008-2nd-edition. Accessed on 24 January 2019.
14. Maiti S, De D, Chatterjee K, Jana K, Ghosh D, Paul S. Prevalence of stunting and thinness among early adolescent school girls of Paschim Medinipur district, West Bengal. Int J Biol Med Res. 2011;2(3):781-3.
15. Nair A, Doibale MK, Kuril BM, Domple VK. Study of nutritional status of adolescent girls in a rural area of a district of Maharashtra. Int J Community Med Public Health. 2017;4(12):4617-22.

16. Ali D, Shah RJ, Fazili AB, Rafiq MM, Mushtaq B, Iqbal QM, et al. A study on the prevalence of thinness and obesity in school going adolescent girls of Kashmir Valley. Int J Community Med Public Health. 2016;3(7):1884-93.
17. Berti PR. Intrahousehold distribution of food: a review of the literature and discussion of the implications for Food Fortification Programs. Food Nutr Bull. 2012;33(2):163-9.
18. Soliman A, De Sanctis V, Elalaily R. Nutrition and pubertal development. Indian J Endocrinol Metab. 2014;18(1):39-47.
19. Khadilkar A, Das G, Sayyad M, Sanwalka N, Bhandari D, Khadilkar V, et al. Low calcium intake and hypovitaminosis D in adolescent girls. Arch Dis Child. 2007;92(11):1045.
20. Ahmed F, Zareen M, Khan MR, Banu CP, Haq MN, Jackson AA. Dietary pattern, nutrient intake and growth of adolescent school girls in urban Bangladesh. Public Health Nutr. 1998;1(2):83-92.
21. Anand K, Kant S, Kapoor SK. Nutritional status of adolescent school children in rural North India. Indian Pediatr. 1999;36(8):810-5.

Cite this article as: Reddy SUK, Chaudhuri S, Amrin SF, Rabeka G. Nutritional status and dietary intake among unmarried adolescent girls in rural area of Chittoor district: a community based survey. Int J Community Med Public Health 2019;6:4034-42.