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Triple Burden of Malnutrition among Adolescent School Girls in Puducherry

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ABSTRACT

Background: Malnutrition in adolescent girls causes alterations in growth, development, reproductive cycles, health and wellbeing. **Objectives:** To evaluate the dietary pattern, nutrient intake and nutritional status among adolescent school girls. **Methods:** Study was conducted among 386 girls (11-15years), purposively selected from government schools of Puducherry. Dietary intake was obtained using 24-hour food recalls, average nutrient intake per day was calculated using Nutrition Society of India diet calculator and compared with Recommended Dietary Allowances 2020. Food groups intake was compared with portions recommended by National Institute of Nutrition. The Food and Agriculture Organization's Minimum Dietary Diversity for Women was modified to determine the Dietary Diversity. Data was analyzed using SPSS 21.0. **Results:** The Body Mass Index of girls (12.88±1.11 years) revealed the prevalence of both under (28.8%) and over-nutrition (48.7%). Iron Deficiency Anaemia among (30%) of the underweight girls was ascertained by serum ferritin ≤15ng/ml. The average intake of food groups was less than guidelines and the Dietary Diversity Score was 5.93 ±1.18, showing minimum adequacy. The percentage of adolescents with low Dietary Diversity scores was 40.2%. Low socioeconomic status and parents' education were significant determinants. The average intake of energy, calcium, vitamin A, iron, zinc, folic acid was significantly lower, fat protein and vitamin C being higher than the recommendation. **Conclusion:** Improving food quality, diversity in consistent meal schedule and portion size in accordance with guidelines needs to be emphasized to prevent triple malnutrition.

Key words: Adolescence, Dietary Diversity Score, Iron deficiency Anaemia, Nutritional Status, Recommended Dietary Allowances, National Institute of Nutrition

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Introduction

Adolescence between the ages 10 and 19 years is transitory period where significant biological, cognitive, psychological and physical changes occur which have a significant impact on dietary requirements and are closely linked to nutritional status [1]. Adolescent nutrition is crucial especially in developing countries as there is a nutrition transition, and many youths' face malnutrition, including over nutrition, undernutrition and micronutrient deficiencies. Transitioning food environments promote energy dense, micronutrient-poor foods leading to unhealthy food choices among adolescents[2,3]. It is well known that inadequate or excessive nutrient intake can lead to detrimental effects on health, including nutrient deficits, elevated risk for type 2 diabetes, cardiovascular diseases and obesity. An individual's dietary pattern is determined by quantity, proportions, or combination of different foods and beverages in their diet, as well as the regularity with which they are typically consumed[4]. In addition to serving as a proxy for nutrient adequacy of the diet, individual's dietary diversity is a qualitative indicator of food consumption that represents household access to a variety of foods [5]. Micronutrient deficits and malnutrition are caused by a repetitious diet that is deficient in vital micronutrients[6].

Dietary Diversity Score (DDS) is the number of food groups consumed by household or an individual over a 24-hour period. It predicts dietary diversity, nutrient adequacy of the diet, and reflects individual's nutritional status[7]. The quality and diversity of an adolescent's diet, in addition to meal frequency and quantity are significant factors. Nutritional imbalance due to unhealthy eating habits among adolescents especially among girls, can lead to susceptibility to illness, nutritional deficiencies, reduced attention span, academic performance, and lowered potential and productivity, thus having long-term health implications[8,9]. Incorporating various plant-based ingredients, decreasing the intake of highly processed foods, avoiding sugar, consuming proteins with high biological value and choosing food alternatives like fruits and vegetables could all improve health of an individual[10]. It has been demonstrated that eating a balanced diet not only can lower the risk of certain chronic non-communicable diseases but contributes to the treatment of individual risk factors[11]. The main nutritional problem among adolescents is that their diets are inadequately diversified which may have detrimental effects on their physical growth, social skills and intellectual development and thus the health[12].

The NFHS data (2019-2020) for Puducherry state states that 7.6% of urban and 12% of rural women in the age group 15-49 years have Body Mass Index less than 18.5 kg/m^2.Also 47.6% of urban and 43.2% of rural women are overweight or obese with the BMI of 25.0kg/m^2. High- risk Waist Hip ratio (<0.85) is prevalent among 55.4% of urban and 52.0% of rural women. It also states that 61.1% of urban and 53.0% of rural women in the age group 15-19 years are anaemic thus depicting the triple burden of malnutrition which could be associated with their dietary pattern and lifestyle[13]. Establishing healthy eating habits as early in the stages of the lifecycle can prevent nutrition -related disorders and promote health. So, the study is intended to assess the dietary intake and nutritional status of the adolescent school girls in the age of 11-15 years, so as to provide the possibility to develop good dietary habits before their transition into adult. The specific objectives were to ascertain the socioeconomic background, anthropometric parameters, dietary pattern, dietary diversity and adequacy of nutrient intake to interpret in relation to their nutritional status.

Methods

A descriptive research methodology was employed in this study. The selected population for this study is adolescent school girls in the ages between 11 and 15, with the understanding that this may be their final chance to apply lifestyle and nutrition education before developing more stable habits. The inclusion criteria were those who attained puberty and willingness to participate in the study. A total of 386 adolescent girls between 11 and 15 years were selected by purposive random sampling from government schools of Puducherry from classes 6 to 10. Of the total population size of 11836 girls, at a 5% margin of error with a confidence level of 95%, the required sample size was computed as 372 and the actual number invited was 410 (10 % excess as allowance for dropouts) and final was 386 after drop outs. Permission was obtained from the Directorate of School Education, Government of Puducherry, and approval by the Institutional Human Ethics Committee after protocol review (reference AUW/IHEC/FSN- 21-22/FHP-35 dated 21/06/2022). Written informed consent for participation was obtained from the girls and their parents. Pre-validated interviewer-administered structured questionnaire was used to collect data through interview technique.

Data Collection

Socio-economic status and demographic details: Socioeconomic status is consistently associated with health outcomes, and was evaluated according to the updated modified Kuppuswamy Socio Economic Status Scale[14]. The socioeconomic status of the family was determined based on the cumulative points derived from income of the family, education level and the occupation of the family's head. Age, age at menarche, parents' education and occupation, type of family, physical activity and adequacy of sleep were the factors assessed.

Assessment of Nutritional Status: Anthropometric measurements were done for height, weight, waist hip circumference. A digital weighing scale was used to measure body weight with a 0.05 kg precision, and a short board with tape affixed to the wall was used to measure the height precisely to the tune of 0.1 cm. Body Mass Index (BMI) was computed as the square of height (meters) divided by weight (kg/m^2). Nutritional status was interpreted based on IAP (Indian Academy of Paediatrics)[15] standards.

By estimating blood haemoglobin (Cyanmethemoglobin method) interpretation of anemia was made as per the WHO cut-off point for haemoglobin (Hb) <12g/dL [mild (10 to <12g/dL), moderate (8 to <10g/dL), and severe (< 8g/dL) and serum ferritin ≤15ng/ml[16] for identifying Iron Deficiency Anaemia (IDA).

Dietary Assessment: Three non-consecutive 24-hour food recalls including two weekdays and one weekend day was used to measure the dietary intake. Standard spoons and cups were used to help the respondents in estimating the quantity of cooked food intake from which the quantity of raw food items was calculated. Picture guides with coloured photographs of different portion sizes were shown to them. The quantity of the food and beverage items consumed in a day, was then entered into the Nutrition Society of India diet calculator software. Nutritional information for few specific foods based on the nutrition facts given from the book Indian Composition Tables 2017 were manually added to the software. By using the Nutrition Society of India diet calculator, the nutrient intake for the 3 days was calculated, and an average of that was taken as nutrient intake per day and was compared to Recommended Dietary Allowances (ICMR-RDA 2020)[17] for 11-12 years and 13-15 years old adolescent girls to check whether nutrient requirements are met. The average intake of foods from various food groups in a day was also derived.

Assessment of Dietary Diversity: The adolescent girls' dietary diversity was determined by the Food and Agriculture Organization's (FAO) Minimum Dietary Diversity for Women (MDD-W)[18] with needed modification. It included all [1] Cereals and Nutricereals, [2] Pulses and Legumes, [3] Milk and milk products, [4] Nuts and Oil seeds, [5] Flesh foods (which includes organ meat, meat and fish), [6] Eggs,]7] Roots and Tubers, [8] Dark green leafy vegetables, [9] Other vitamin A rich fruits and vegetables,[10] Other Vegetables and [11] Other fruits. This has been taken as it aligns with National Institute of Nutrition- Indian Council of Medical Research's dietary guidelines for Indians. Thus, the dietary diversity was made up of 11 food groups, and the maximum score was 11. The adolescent school girls were asked to report anything they had eaten or drunk before the survey, with a minimum of 10 g/day. The answer options 'yes' for consuming a minimum of one food item from the food group and 'no' for not consuming any. The number of food groups an individual consumed over 24 -hour period was added together to obtain DDS score which ranged from 0 to 11. The results were divided into two categories: adequate (6-11) (a score greater than or equal to 6 (≥6), indicated they consumed food groups from 6 or more and inadequate (1-5) (a score equal to or less than 5 (≤5) indicated they consumed food groups from 5 or fewer[5,19].

Data analysis: SPSS version 21.0 was used to analyze and verify the completeness of the data. Arithmetic mean, standard deviation, percent distribution, chi square test, student t-test and ANOVA were used for statistical analysis. A p-value of 0.05 was considered as the cutoff point for statistical significance.

Results

Socio- economic and demographic characteristics of adolescent girls:

Comprehensive overview of the characteristics of the respondents is provided in **table-1.** A total of 386 adolescent girls (11 to 15 years old) participated in the study, and the mean (± SD) age of the respondents was 12.88±1.11 years and 61.4% of the adolescent girls were in the age range of 13-15 years old. An average of 11.63±1.03 years is the age at menarche. Sixty four percent (63.5%) lives as a joint family. Out of all the respondents, half (51.6%) of their mothers had education up to only high school and were home makers. Nearly half of them (49.5%) belonged to upper middle income as per the updated modified Kuppuswamy SES stratification. When daily lifestyle was analyzed, 64% were did not participate in sports or physical activities, and 72.3% slept 7-10 hours daily.

Table -1: Socio-economic and demographic characteristics of the adolescent girls

Socio demographic variables		No	%
Age Group in years	10-12	149	38.6
	13-15	237	61.4
Religion	Hindu	346	89.6
	Christian	25	6.5
	Muslim	15	3.9
Region	Rural	84	21.8
	Urban	302	78.2
Mother's Education	Illiterate	31	8.0
	Primary	104	26.9
	High School	199	51.6
	Higher Secondary	35	9.1
	Graduate and above	17	4.4
Mother's Occupation	Govt/Private Employee	77	19.9
	Self Employed	39	10.1
	Home maker	194	50.3
	Others	76	19.7
Father's Education	Illiterate	46	11.9
	Primary	111	28.8
	High School	158	40.9
	Higher secondary	42	10.9
	Graduate and above	29	7.5
Father's Occupation	Govt/Private Employee	87	22.5
	Business	17	4.4
	Self Employed	86	22.3
	Others	196	50.8
Size of family	2-3 members	39	10.1
	4-5 members	255	66.1
	6 & above	92	23.8
Socio Economic Status (using updated modified Kuppuswamy SES stratification)	16-25 Upper middle (II)	191	49.5
	11-15 Lower middle (III)	111	28.8
	5-10 Upper lower (IV)	84	21.8
Age at menarche	8 - 11 yrs	64	16.6
	11.01-12.0 yrs	143	37.0
	12.01-13.0 yrs	132	34.2
	13.01-15 yrs	47	12.2
Total		**386**	**100.0**

Nutritional Status of the Adolescent Girls

The mean height of the girls was 152.48 ± 6.33 cm, the mean weight was 45.52 ±10.83 kg, and the mean BMI was19.55 ± 4.25 kg/m^2. The important findings of the study are that 28.8% of them underweight, 22.5% of them were with optimal weight 17.9% of them were overweight, and 30.8 % of them were obese based on BMI for age classifications and comparison with IAP standards.

Prevalence of anaemia among underweight adolescent girls (n=111) were demonstrated by the fact that 66.6% of the respondents were anaemic, with 9.0% being mildly anemic, 49.5% being moderately anaemic, and 8.1% being severely anaemic. Estimation of serum ferritin for every third sample among the mild anaemic (n=10) respondents (n=4) revealed that 25% of them have Iron deficiency by having serum ferritin ≤15 ng/ml. Iron intake of adolescents was associated with their haemoglobin level (r = 0.318: p-value <0.01) and serum ferritin (r=0.453; p value < 0.01).

Meal pattern of adolescent girls

Most adolescent girls were non-vegetarians (98.7%), and only 1.3% were vegetarians. Most of them (93.5% and 91.7%) consumed their lunch and dinner respectively and followed three meals a day, whereas 40.7 % skipped breakfast, and 61.7% consumed fast food as snack.

Table-2, provides factors related to food consumption and meal pattern. However, the majority of girls exhibited healthy behaviors like drinking adequate water, having breakfast regularly and eating three meals a day. Most of them have lunch provided by school feeding programme, which can reduce the risk of food insecurity and promote optimal growth and cognitive development in school adolescents, among other short-term and long-term benefits[20].

Nutrient intake of adolescent girls: Dietary details of the adolescent girl were obtained by 24 -hour recall for 3 non-consecutive days. The average nutrient intake was computed using the NSI diet calculator and compared with Recommended Dietary Allowances for 11-12 years and 13-15 years respectively. **Table-3** describes the recommended dietary allowances and the actual intake of nutrients by the girls and the differences.

Table-2: Frequency distribution of school girls based on factors related to food consumption and meal pattern.

Factors related to food consumption and meal pattern		No.	%
Appetite	Good	311	80.6
	Fair	65	16.8
	Poor	10	2.6
Digestion and Elimination	Good	249	64.5
	Fair	128	33.2
	Poor	9	2.3
Food intolerance	Yes	92	23.8
	No	294	76.2
Food allergies	Yes	26	6.7
	No	360	93.3
Intake/day	Morning Beverage	242	62.7
	Breakfast	299	77.5
	Mid-morning Bev/ snack	186	48.2
	Lunch	361	93.5
	Evening Snack/ Bev	181	46.9
	Dinner	354	91.7
	Bed time	68	17.6
Skipped meals	Breakfast	157	40.7
	Lunch	29	7.5
	Dinner	18	4.7

Table-3: Nutrient intake of adolescent girls in comparison with RDA(NIN-ICMR)

Nutrients	Girls (11-12 years)				Girls (13-15 years)			
	RDA	Actual intake Mean ± SD	Excess/ Deficiency	t value	RDA	Actual intake Mean ± SD	Excess/ Deficiency	t value
Energy (Kcal)	2060	1764.59 ± 162.40	- 295.41	22.20**	2400	1924.35 ± 217.55	- 475.65	33.66**
Protein (g)	33	42.64 ± 3.61	9.64	32.57**	43	45.00 ± .00	1.99	9.90**
Fat (g)	25	62.19 ± 9.41	37.19	48.26**	25	66.36 ± 12.09	41.36	52.65**
Zinc (mg)	8.5	5.21 ± 0.82	- 3.29	48.93**	12.8	5.39 ± 0.75	-7.41	153.02**
Calcium (mg)	850	439.25 ± 112.14	- 416.75	45.33**	1000	460.39 ± 103.92	- 539.61	79.94**
Vitamin A (µg)	790	266.63 ± 162.90	-523.67	39.24**	890	274.21 ± 160.94	- 615.79	58.90**
Vitamin C(mg)	50	63.28 ± 31.87	13.28	5.09**	65	65.91 ± 36.35	0.91	0.38 NS
Iron (mg)	28	11.28 ± 3.26	-16.72	62.62**	30	11.40 ± 3.02	-18.60	94.71**
Folic Acid (µg)	225	143.53 ± 24.90	- 81.47	39.94**	245	148.28 ± 22.85	- 96.72	65.16**

*RDA- Recommended Dietary Allowances, SD standard deviation, ** Significant at 1% level

The energy requirements recommended for adolescent girls aged between 11and 15 years range from 2060 kcal to 2400 kcal (RDA 2020), but the mean intakes of energy by the respondents were between 1764.59 ± 162.40 and 1924.35 ± 217.55 which was significantly less compared to RDA. The overweight and obesity were associated with their energy intake (*f = 63.35 and P = 0.000). Adequacy of protein intake, 42.64±3.61g/day by 11–12 years old girls and 45.00±0.00 g/day by 13-15-year-old girls is one of the significant findings. The average intake of Energy, Calcium, Vitamin A, Iron, Zinc, Folic acid was significantly lower, whereas fat, protein and vitamin C being higher than the recommendation. The average intake of iron 11.28 ± 3.26 mg/day

compared to the RDA of 28mg/day for 11–12-year-old girls and 11.40 ± 3.02 mg/day compared to 30mg/day for 13–15-year-old girls, depicts inadequate iron intake.

Dietary Diversity Score and intake of various food groups per day by the adolescent girls: The dietary intake of adolescent school girls was assessed through food recalls and the average intake of various food groups was computed using diet calculator of nutrition society of India. The comparison of average intake of food groups with recommended portion size is given in **Table-4.** The food groups which are consumed either above or below the recommended level is given as mean difference.

Table-4: Average intake of various food groups per day by the adolescent girls in comparison with recommended portion size by NIN-ICMR

Food groups	Girls (11-12 years)				Girls (13-15 years)			
	RPA	Actual intake Mean ±SD	Excess/ Deficiency Mean Difference	t value	RPA	Actual intake Mean ±SD	Excess/ Deficiency Mean difference	t value
Cereals Grains Products (g)	240	187.73± 28.67	- 52.27	22.26**	330	196.36±27.52	-133.64	74.76**
Pulses and Legumes(g)	60	50.60± 14.55	-9.40	7.89**	60	52.88± 13.29	-7.12	8.26**
Leafy Vegetables(g)	100	9.76± 45.87	-90.24	68.69**	100	8.39± 14.65	-91.61	96.30**
Roots and Tubers(g)	100	98.4143.31	-1.59	0.42	100	105.64±45.93	5.64	1.90
Other Vegetables(g)	200	20.07± 20.45	-179.93	107.40**	200	21.60± 20.24	-178.41	135.71**
Fruits(g)	100	51.23± 25.20	- 48.77	23.62**	100	56.80±33.55	-43.20	19.83**
Milk and Milk Products(ml)	500	89.12± 62.66	-410.88	80.04**	500	101.80±62.36	-398.20	98.30**
Meat, egg, poultry	50	11.70± 15.47	-38.30	30.21**	50	8.95± 12.38	-41.05	51.03**
Fats and Edible oils(g)	35	34.54± 7.10	0.46	0.79	40	33.96± 8.20	-6.04	11.33**
Sugars(g)	30	16.87± 11.02	-13.13	14.54**	25	20.25± 12.27	-4.75	5.96**

RPA- Recommended Portion allowance, SD- standard deviation, ** significant at 1% level

The intake of various food groups by the adolescent girls were less that the recommended portion allowances per day. They consumed staple cereals, roots and tubers adequately, whereas the other groups were not enough. Though the study participants' average dietary diversity score was 5.93 ±1.18, showing adequacy in diversity, the amount consumed did not meet the recommendations.

Discussion

The important findings of 28.8% of them being underweight, 22.5% of them with optimal weight 17.9% of them being overweight, and 30.8% of them being obese based on BMI for age reveals high prevalence and gradual decline of undernutrition and the increasing incidence of overweight and obesity among adolescent girls, thus showing the dual burden of malnutrition among school girls. A study[21] at Dharwad district among rural adolescent girls revealed that 14.9% were under-weight for their age, 25.2% of them were under nourished and 3.7 were over nourished based on their BMI. Our findings show higher prevalence of anaemia when compared to the multi–center cross-sectional study[22] conducted in ten major districts across India showed 17.6% participants were anaemic, of which 63.3% were mild, 34.4 moderate and 2.3% were severe anaemic. Anaemia among adolescent can impair productivity, reduce cognitive function and lead to susceptibility to infection.

Breakfast is a most significant meal of the day, especially among school children and adolescents, as it helps to reduce hunger temporarily, which enhances shot-term memory, focus and cognitive function[23] and 40.7% of the adolescents skipping their breakfast is of real concern. The most bothering finding in our study was that the average intake of fat among adolescents was higher than the RDA ranging from 62.19±9.41 to 66.36±12.09g/day. The reason could be oil usage in cooking and the contribution of invisible fat from foods consumed.

Adolescent obesity must be prevented and controlled by emphasizing energy distribution from carbohydrate and fat intake, since higher intake of fat contributes to the overall intake of energy[24]. Large portions of rice, and other cereals, starchy roots, potatoes and pulses could be associated with increased carbohydrate intake[25] and adding to overall calorie intake. Regarding the intakes of macronutrients, interestingly the protein intake was more than RDA, but as the overall calorie intake is less, the protein may be utilized for energy purposes. Our results were consistent with the well documented iron deficits in developing countries. The average intake of iron 11.28 ± 3.26 mg/day compared to the RDA of 28mg/day for 11–12-year-old girls and 11.40 ± 3.02 mg/day compared to 30mg.day for 13–15-year-old girls, depicts inadequate iron intake. The mean intake of vitamin A was extremely low, similar to a study by Fiorentino *et al*.,[26] that found insufficient intakes of Vitamin A, among 79% of children and adolescents (11-17 years old).

The mean dietary score of 5.93 ±1.18 is consistent with the DDS of 4.70±1.21, as determined by Abebe et al. in 2021[27]. Study results showed that 41.10% had school girls had inadequate dietary diversity. Dietary diversity was significantly influenced by the frequency of meals consumed, household socioeconomic status, parent's education and food insecurity. Similarly, a review found that dietary diversity among school children and adolescents was positively correlated with the household socioeconomic status[28]. Overall, the quality of the diet was poor, indicating the existing consumption patterns are unlikely to satisfy micronutrients requirement. On an average, their daily consumption of the required quantity of foods from different food groups was inadequate. The reason could be poor economic status, lack of awareness of the smart selection of foods rich in micronutrients, thus affecting families' ability to access diverse and nutritious foods. Intake of starchy food items was reported in all recalls and thus the carbohydrates found in cereal grains, roots and tubers contributed to the majority of the energy that is consumed, which is similar to the report by Victor Aguayo and Kajali Paintal 2017[29] and Abebe *et al*.,2021, and consumption of foods rich in micronutrient was less common [30]. Diets consumed by these girls were also inadequate in terms of milk, fruit and green leafy vegetables and vegetables high in β-carotene as recommended NIN –ICMR. The mean intake of various food groups by the adolescent girls was significantly lower than recommendations by dietary guidelines. Dietary Diversity Score ranging from 6.23 in 1–7 years to 6.96 in 13–17 years age group, and consumption of foods high in carbohydrates like cereal and millets and roots and tubers and less consumption of dairy products, fruits, and nuts and oilseeds were reported in Manipur [31], as trend in food consumption. Adolescents (10–19 years) in low- and middle-income environments who eat diets low in fruits and vegetables are at risk for nutrient deficiencies. At the same time, processed foods that are high in energy, low in nutrients are contributing to the global obesity epidemic.[32]

Conclusion

This study described the dietary intake and nutritional status of adolescent girls of 11-15 years from government schools of Puducherry. Adolescent girls of lower middle socio-economic status had diets that were insufficient to provide the necessary nutrients for normal growth and development. Because they come from houses with few sources of income most adolescent girls cannot afford to consume a more varied diet. Due to their insufficient dietary intake, these adolescent girls might be at risk of poor nutritional status and represent a vulnerable group susceptible to triple burden of malnutrition. As food-based dietary guidelines to promote diversified food consumption, intervention strategies like nutrition education at school levels, supplementation of micronutrient enriched nutritious snacks or food products, etc., are needed to improve adolescent girls' dietary intake and meet their requirements of all micro and macronutrients. The results offer important insights about the food behaviour and dietary intake of adolescent girls, which could be used to formulate strategies for behaviour change or enhance existing nutrition programs.

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