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EFFICACY OF DIETARY ASSESSMENT AND ANTHROPOMETRY PARAMETERS TO EVALUATE NUTRITIONAL STATUS OF SCHOOL GOING ADOLESCENTS IN LUCKNOW, UTTAR PRADESH, INDIA.

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ABSTRACT

Adolescence is an important phase in the life of human being with rapid changes in their physical, cognitive and psychological areas. Nutrition status of adolescent is a significant factor to determine the health of a country. Nutrition plays an important role in the growth and development in adolescent girls and boys both. According to National Family Health Survey-5 the prevalence of anemia among adolescent girls was 57% and boys about 33.8%. Various assessment techniques have been used to assess malnutrition by adopting anthropometric measurements in terms of overweight and underweight such as BMI, MUAC and 24-hour dietary recall method.In present study, diet consumption pattern significantly reflected on the population anthropometric indices such as BMI and MUAC. In this study adoption of two assessment tools like anthropometric measurements and Dietary recall method were found to be effective in indicating malnutrition prevalence. For instance, weight was found to be increased in late adolescents as compared to early adolescents similarly their dietary pattern also indicated that late adolescent group consumed high carbohydrate -loaded diet and with high fat consumption pattern. The present research has tried to make nutritional assessment better by adopting anthropometric and dietary assessment parameters in compounded form rather than using them separately.

Keywords: adolescent; anthropometry measurements; dietary intake; nutritional status

INTRODUCTION

Nutrition status of adolescent is a significant factor to determine the health of a country. Adolescence is an important phase in the life of human being with rapid changes in their physical, cognitive and psychological areas. Person's age falling between 10 to 19 years is studied for adolescents *(1)*.16% of the total global population comprises of adolescents which equals to 1.2 billion across the countries, streaming it down in India, the prevalence rates for underweight of adolescent girls was 33.40% and the prevalence rate amongst adolescent boys was 32.50% *(2)*. Nutrition plays an important role in the growth and development of adolescents *(3)*. The National Family Health Survey-5 showed that the prevalence of anemia among adolescent girls was 57% and boys about 33.8% *(4)*. The report of Recommended Dietary Allowances- Indian Council of Medical Research (RDA-ICMR) 2024, stated that the average weight of adolescent girls in the age group 13 to 15 years should be 49.6 kg (on average) and for 16 to 18 years should be 55.7 kg, (on average) similarly, as per the report adolescent boys of age group between 13 to 15 years should weigh 50.5kg (on an average) and boys between 16 to 18 years should weigh around 64.4 kg *(5)*. In order to indicate the prevalence of malnutrition, various assessment techniques have been adopted and practiced worldwide. Amongst the most commonly used under

the category of anthropometric measurements are measurements of height (in cm), weight (in kg), Mid Upper Arm Circumference (MUAC) (cm), Body Mass Index (BMI). Ranges of BMI as defined by ICMR, Indian Academy of Pediatrics (IAP) and World Health organization (WHO) are widely used measurements to assess malnutrition in terms of overweight and underweight. MUAC helps to assess muscle mass wasting and is used very frequently to assess protein energy malnutrition during community's surveys. Shakir's tape is commonly used in Indian population by community health workers *(6)*. Apart from anthropometric assessment dietary consumption pattern is also important tool to assess the adequacy of nutritionally balanced food intake across the population. Dietary consumption pattern can be observed through various assessment tools such as 24-hours dietary recall method, food diary method, food weighment method etc. For gross and large sample size 24 hours dietary recall method is a quick and easily adopted method. This method helps interviewer to record the responses of even illiterate population *(7)*. During the entire human life cycle growth spurts occur at infanthood and adolescent's period which should be carefully monitored and taken care of. Failing to which deficit of nourishment occurs, this also adversely affect the achievement of milestones of various age groups *(8)*. Therefore, during these two phases food choices, frequency of meals, eating pattern, socio-economic factors should all be considered if malnutrition is a rampant problem across the population *(9)*. Recent studies highlighted the fact that adolescents are getting more inclined towards carbohydrate loaded foods, processed foods and excess consumption of fast food not only this, they are also in the practice of erratic food habits such as skipping of meals, irregular eating times, less consumption of water and seasonal foods and vegetables *(10)*.Thus, adolescent population is becoming more venerable towards developing macronutrient deficiencies such as adolescent obesity, anorexia nervosa as well as micronutrient deficiencies such as iron deficiency Anaemia, Calcium and Vitamin D deficiency etc. *(11)*. Therefore, present study aims to assess the prevalence of malnutrition by adopting anthropometric measurement such BMI and MUAC and also 24-hours dietary recall method amongst school going adolescents in Lucknow city, India. This study also tries to establish relationship between anthropometric as well as dietary assessment in order to assess prevalence of malnutrition if present.

MATERIALS AND METHODS

Census data from 2011 show that the total population of children, below the age of eighteen years is 472 million. India has the largest adolescent population in the world, which is 253 million*,* and one fifth of the subjects are between 10 to 19 years *(12)*. The total adolescent population of Lucknow city, in Uttar Pradesh, India is approximately 4.38 million. The total number of government schools in Lucknow (Nagar Skshetra) are 41 which are educating approximately 75,463 children. We selected 5 schools randomly one from each region (North, South, East, West and

Central region of Lucknow City), for selection of the sample for this study. We randomly selected 122 adolescents between 13-19 years of age from each school, by using computer generated random numbers, which came out to be approximately 17 students from each class, based on numbering given to students, in the various classes of the government schools. If a student refused to participate in the study, the student of the next number was included in the study to complete the sample size.

$$n = \hat{p} \times (1 - \hat{p}) \times z^2/MOE^2$$

Where, n: Sample size, $\hat{p}$: sample proportion (50%in case of unknown prevalence)

z= 95% confidence interval (1.96), MOE: margin of error (to be divided to get a decimal)

n= 384.16=385 With a margin of error of ±0.05% and an expected sample proportion of 0.5, the sample size would need to be 385.If consider the design effect is 1.5, then the total sample size will be n=385X1.5=578. Further, we consider 5% sample will be washed out. Therefore, total sample size should be, above 607. Adolescents between 13-19 years of age of both genders, (n=649) without any chronic illness were selected, from various government schools from urban areas of Lucknow city. Adolescents suffering from diseases like celiac disease (n=4), lactose intolerance (n=3), type 1 diabetes (n= 6), thalassemia (n=1), chronic diarrhoea and dysentery (n= 9) or on any medications (n=2), and those who refused to be part of the study (n=17) were excluded. Thus, after excluding all these adolescents (total number n=42), 607 subjects formed the material for this study. Data were collected using a case record form by the registered dietitians via interviews and a using a validated pretested structured questionnaire among subjects. The questionnaire was prepared in both English and Hindi Language which is also the regional language. The questionnaire gathered all the information about socio-demographic profile, anthropometric measures, dietary pattern (24-hour dietary recall) *(13)*. Nutrient intakes were calculated based on Indian food composition tables *(14)*. Anthropometric measurements; such as height, weight and MUAC were recorded through standard procedures. The height was measured to the closest 0.1 cm, after removing shoes, by a certified and reliable Stadiometer B0849JRVRN /Thermocare height measurement scale/ /Thermo Plast Industries/India *(15)*.The weight was recorded in light underclothes, using a calibrated electronic weighing scale Omron HN 300T Digital Weighing Machine/ Omron Healthcare/ China .Two readings of weight were recorded simultaneously and then the average weight was recorded to the nearest 0.1kg. Body mass index (BMI) was calculated after obtaining the values of height in meters and weight in Kg, by dividing weight in Kg with height in meter square (Kg/ m^2) *(16)*. We used Shakir's tape B01650G458/ Ibis Medical/ India to measure the MUAC *(17)*. The median MUAC was computed after readings for the upper arms of the left and right were obtained. The dependent variable was over-nutrition, which is a composite indicator calculated from WHO-BMI ranges based upon weight and height measurements at appropriate cut off points. Therefore, the major independent

variables of this research were anthropometric assessment (height, weight, median of MUAC and diet consumption pattern (24-hours dietary recall method) so as to establish association between consumption pattern and risk of overweight among school-going adolescents. The study has been approved by Institutional Ethical committee of Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow.

RESULTS

To assess the physical health parameters in presence study BMI, an average MUAC methods were used. (Table 1)

Table 1. Description of Anthropometric measurements in Early and Late Adolescents groups boys and Girls.

Anthropometry Measures	Early Adolescent (Mean ± SD)	Early Adolescent		Late Adolescent (Mean ± SD)	Late Adolescent	
		Boys (44)	Girls (69)		Boys (301)	Girls (193)
Age	13.69±0.46	13.66±0.48	13.71±0.46	16.37±1.24	16.47±1.24	16.21±1.24
Height (CM)	155.63±8.76	160.99±9.61	152.21±6.12	162.17±9.44	166.93±7.77	154.75±6.62
Weight (Kg)	41.74±7.62	43.89±8.56	40.37±6.67	48.96±9.57	51.83±9.77	44.50±7.28
BMI	17.20±2.59	16.92±2.89	17.38±2.39	18.64±3.14	18.67±3.75	18.58±2.81
Left MUAC	21.97±2.40	21.81±2.91	22.08±2.02	23.81 ± 2.87	24.07±3.08	23.40±2.45
Right MUAC	22.07±2.33	21.91±2.92	22.17±1.89	23.89 ±2.87	24.16±3.08	23.47±2.47
Average MUAC	22.02±2.34	21.86±2.90	22.12±1.92	23.85 ±2.85	24.11±3.06	23.43±2.44

In Table 1. As expected, sudden spurt in height and weight was found in late adolescence. Average MUAC also increased from 6% to 10% in adolescents. An increment of 7% in the BMI of girls and 10% in boys was observed. The body weight of boys was higher than girls in both categories of Adolescent. The difference in the body weight between boys and girls was greater for late adolescents than early adolescents (p<0.01). Average gain in body weight for girls was 4.13 kg. The average increase of weight of boys was about 1.9 fold higher than girls. 10% higher BMI in boys was observed in late adolescents as compare to boys of early adolescence. Similarly, 7% higher BMI in late adolescence girls was observed as compare to early adolescence girls. Change of average MUAC of boys belonging to early adolescents as compare to late adolescents boys was 10.3% higher while change of average MUAC in late adolescents girls was 7% higher as compare to early adolescents girls. To assess the impact of adequate food consumption on physical growth of both adolescents group, 24-hours dietary recall method was used in present study.

Table 2. Description of Macro and Micro Nutrients consumption in Late and Early Adolescent Boys and Girls.

Nutritional Parameters	Early Adolescent (Mean±SD)	Early Adolescents		Late Adolescent (Mean±SD)	Late Adolescent	
		Boys (44)	Girls (69)		Boys (301)	Girls (193)
Protein [g]	39.64±13.58	44.07±13.43	36.82±13.0	43.14±14.59	44.97±15.59	40.28±12.36
Fat [g]	28.71±12.33	31.47±13.06	26.95±11.59	26.79±10.92	26.77±10.90	26.82±10.99
Carbohydrate [g]	203.40±71.59	224.72±78.19	189.80±63.78	222.75±73.44	230.25±74.94	204.04±69.62
Energy in Kcal	1445.69±393.58	1473.50±372.01	1427.96±408.42	1502.49±398.63	1534.33±406.78	1452.84±381.83
Calcium (Ca) [mg]	182.14±135.86	206.99±129.85	166.29±138.14	168.16±2.34	240.50±181.42	192.51±140.62
Iron (FE) [mg]	10.03±4.32	76.20±33.47	55.97±26.39	4.34±1.95	75.03±29.56	58.65±29.33
Magnesium (Mg) [mg]	256.04±64.30	266.45±65.04	249.40±63.41	63.54±1.83	272.11±63.91	262.16±62.66

Phosphorous (P) [mg]	675.24±103.21	686.47±103.46	668.08±103.17	104.07±1.00	689.48±105.71	680.73±101.49
Potassium (K) [mg]	2408.38±513.24	2489.62±436.56	2356.58±553.49	497.05±0.18	2408.94±500.55	2383.74±492.46
Sodium (Na) [mg]	2379.64±431.28	2379.34±367.46	2379.83±470.09	414.16±0.10	2377.53±406.10	2371.82±427.48

(Table 2) Through 24-hours dietary recall method, nutritional intake in terms of macro as well as micronutrients was assessed on daily basis. it was observed that intake of macronutrients such as Carbohydrate, Fat, Energy and of micronutrients such as Iron, Magnesium, Phosphorus, Potassium and Sodium were low in both early and late adolescent when compared to recommended dietary allowances as suggested by ICMR-RDA-2024. The difference in macronutrients such as Protein, Carbohydrate, Energy and micronutrients such as Calcium, Iron, Magnesium, and Phosphorus was higher for late adolescents compared to early adolescents. The average gain in macronutrients for late adolescents was about 0.2, 2.57, 2.4, 7.29, 2.2, 2.25 and12.65 fold greater than early adolescents. While the average of macronutrient Fat content for boys and girls of late adolescent was lower than early adolescents by 1.02 fold lower than girls of early adolescents. In micronutrients, average of Potassium and Sodium for boys and girls of late adolescents was decreased to 0.33 and 3.10 fold as compared to early adolescents of boys and girls respectively.

DISCUSSION

Prevalence of malnutrition in adolescent age group is not only limited to individual concern but also calls for amendments in National Health Policies and other regulatory policies. As undernourished adolescents cannot secure a healthy future for the nation *(18)*. Adolescents group constitutes major part of Indian population. Therefore, their overall health is of significant importance for country's growth. Various indices have been worldwide used to assess the health of adolescents. Assessment tools such as Anthropometric, Biochemical, Clinical and Dietary are important yardsticks to find out rate of prevalence of malnutrition in said population. Nutritional and physical health are the fore frontiers. In order to evaluate nutritional and physical health as per the guidelines given by international regulatory bodies like WHO, IAP and national bodies like ICMR RDA-2024, NIN, etc., anthropometric and dietary assessment tools are frequently used. In our study, inadequate nutritional intake increases the dual burden of malnutrition that is overnutrition in terms of fat, energy, protein and carbohydrate and undernutrition in terms of protein and various

vital micronutrients. In the major findings of the study, girls belonging to adolescent age group either early or late are nutritionally deprived as compared with the boys. Therefore, findings of this study are analogous to the findings in studies done by *(19)*. Their studies also revealed that inadequate dietary intake was significant indicator of stunting and anemia amongst adolescent in India. Inadequate nutrition intake was observed when compared with recommended dietary allowances as given by national body ICMR RDA-2024, this also reflects on anthropometric measurements in directly proportional manner. An anthropometric measurement helps to reinforced the findings of nutritional assessment *(20)*. In present study, strong correlation between both the assessment techniques was established.

CONCLUSIONS

Therefore, conclusion may be drawn that present study highlighted that in order to determine the prevalence of malnutrition amongst the adolescent age group adoption of one or two assessment techniques helps to derived more accurate findings. In present study, diet consumption pattern significantly reflected on the population anthropometric indices such as BMI and MUAC. In this study adoption of two assessment tools like anthropometric measurements and Dietary recall method were found to be effective in indicating malnutrition prevalence. For instance, weight was found to be increased in late adolescents as compared to early adolescents similarly their dietary pattern also indicated that late adolescent group consumed high carbohydrate -loaded diet and with high fat consumption pattern.

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CONFLICT OF INTEREST

The authors have no conflicts of interest relevant to this article.

AUTHORS' CONTRIBUTION

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REFERENCES

1. World Health Organization. Adolescent Health. Available online at: https://www.who.int/westernpacific/health-topics/adolescent-health (accessed November 9, 2021). https://doi.org/10.3389/fpubh.2022.877073

2. UNICEF. Adolescent Development and Participation. Available online at: https://www.unicef.org/india/what-we-do/adolescent-developmentparticipation (accessed November 9, 2021).

3. Estecha Querol S, Iqbal R, Kudrna L, Al-Khudairy L, Gill P. The double burden of malnutrition and associated factors among south Asian adolescents: Findings from the global school-based student health survey. Nutrients. 2021 Aug 20;13(8):2867. **https://doi.org/10.3390/nu13082867**

4. Das P, Roy R, Das T, Roy TB. Prevalence and change detection of child growth failure phenomena among under-5 children: a comparative scrutiny from NFHS-4 and NFHS-5 in West Bengal, India. Clinical Epidemiology and Global Health. 2021 Oct 1;12:100857. https://doi.org/10.1016/j.cegh.2021.100857

5. Mohapatra D, Pemde HK, Kataria D. Disordered eating behaviors, body dissatisfaction and their determinants in Indian adolescents: A cross-sectional observational study. Indian Journal of Psychiatry. 2024 Feb 1;66(2):165-70. 10.4103/indianjpsychiatry.indianjpsychiatry_717_23

6. Shakir A. Anthropometric field methods: simplified methods. InNutrition and Growth 1979 Aug 31 (pp. 389-398). Boston, MA: Springer US. https://link.springer.com/chapter/10.1007/978-1-4613-2916-9_19

7. Kirkpatrick SI, Dodd KW, Potischman N, Zimmerman TP, Douglass D, Guenther PM,et al. Healthy eating index-2015 scores among adults based on observed vs recalled dietary intake. Journal of the Academy of Nutrition and Dietetics. 2021 Nov 1;121(11):2233-41. https://doi.org/10.1016/j.jand.2021.06.009

8. Patil S, Patil N, Joglekar C, Yadav A, Nilawar A, Banavali U, et al. aDolescent and prEconception health peRspectiVe of Adult Non-communicable diseases (DERVAN): protocol for rural prospective adolescent girls cohort study in Ratnagiri district of Konkan region of India (DERVAN-1). BMJ Open. 2020 Sep 1;10(9):e035926. https://doi.org/10.1136/bmjopen-2019-035926

9. Nazri NS, Vanoh D, Leng SK. Malnutrition, low diet quality and its risk factors among older adults with low socio-economic status: a scoping review. Nutrition research reviews. 2021 Jun;34(1):107-16. https://doi.org/10.1017/S0954422420000189

10. Pal A, Pari AK, Sinha A, Dhara PC. Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West

Bengal, India. International Journal of Pediatrics and Adolescent Medicine. 2017 Mar 1;4(1):9-18. https://doi.org/10.1016/j.ijpam.2016.08.009

11. Locks LM, Shah M, Bhaise S, Hibberd PL, Patel A. Assessing the diets of young children and adolescents in India: challenges and opportunities. Frontiers in Pediatrics. 2022 May 17;10:725812. https://doi.org/10.3389/fped.2022.725812

12. Pandurangi R, Mummadi MK, Challa S, Reddy NS, Kaliaperumal V, Khadar Babu C, Telikicherla UR, et al., Burden and Predictors of Malnutrition Among Indian Adolescents (10-19 Years): Insights From Comprehensive National Nutrition Survey Data. Front Public Health. 2022 Jun 15;10:877073. doi: 10.3389/fpubh.2022.877073. PMID: 35784251; PMCID: PMC9240318. https://doi.org/10.3389/fpubh.2022.877073

13. Khadatkar A, Dubey UC, Saini N, Ramadas S. Assessment of nutritional status and habitual dietary intake of Indian farm women: Evidence from a case study in central India. Nutrition. 2024 Feb 1;118:112262. https://doi.org/10.1016/j.nut.2023.112262

14. Longvah, T., Ananthan, R., Bhaskarachary, K. and Venkaiah, K.(2017) Indian Food Composition Tables 2017, ICMR- National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, Telangana, India.

15. van Zadelhoff SJ, Haisma HH. How Is Context Addressed in Growth Monitoring? A Comparison of the Tanzanian, Indian, and Dutch Manuals. Current developments in nutrition. 2022 Apr 1;6(4):nzac023. https://doi.org/10.1093/cdn/nzac023

16. Mohajan D, Mohajan HK. Body mass index (BMI) is a popular anthropometric tool to measure obesity among adults. Journal of Innovations in Medical Research. 2023 May 5;2(4):25-33. https://www.paradigmpress.org/jimr/article/view/578

17. Ashtekar SV, Padhyegurjar MS, Powar JD, Padhyegurjar SB. Mid-upper-arm-circumference as a growth parameter and its correlation with body mass index and heights in ashram school students in Nashik district in Maharashtra, India. Indian Journal of Community Medicine. 2020 Oct 1;45(4):419-24 10.4103/ijcm.IJCM_446_19

18. Narayan J, John D, Ramadas N. Malnutrition in India: status and government initiatives. Journal of public health policy. 2019 Mar 6;40:126-41. https://link.springer.com/article/10.1057/s41271-018-0149-5

19. Kumar P, Patel SK, Debbarma S, Saggurti N. Determinants of school dropouts among adolescents: Evidence from a longitudinal study in India. PLoS one. 2023 Mar 2;18(3):e0282468. https://doi.org/10.1371/journal.pone.0282468

20. Nithya DJ, Bhavani RV. Dietary diversity and its relationship with nutritional status among adolescents and adults in rural India. Journal of biosocial

science. 2018 May;50(3):397-413. https://doi.org/10.1017/S0021932017000463