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Community Medicine

"A STUDY ON COMPARISON BETWEEN BODY MASS INDEX AND MID UPPER ARM CIRCUMFERENCE TO ASSESS NUTRITIONAL STATUS AMONG ADOLESCENT SCHOOL CHILDREN"

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ABSTRACT **BACKGROUND:** Adolescent is a period of transition between childhood and adulthood, aged between 10 to 19 years, constitutes 19.6% of total population according to 2011 census of India. Nutritional assessment among adolescents are important as they are the future parent and constitute a potentially susceptible group.

OBJECTIVES:

1. To find out the magnitude of nutritional status among the adolescents of an urban slum of Ballari.
2. To compare the middle upper arm circumference (MUAC) with that of body mass index (BMI) for determination of nutritional status of the study group.

MATERIAL AND METHODS: It was a school-based descriptive epidemiological study done among adolescent students aged 12.5– 16.5 years of four Government aided schools in the urban slum areas of Ballari. Anthropometric measurements of the students of one section selected from each class i.e. class VIII to X from all four schools. The nutritional status was assessed in terms of overnutrition (BMI for age) under nutrition (weight-for-age below 3rd percentile), stunting (Height-for-age below 3rd percentile) and thinness (BMI-for-age below 5th percentile), according to WHO standards.

RESULTS: This study was a school-based descriptive analytical study of cross-sectional design done among 648 adolescent students aged between 12.5 and 16.5 years. The mean BMI of boy and girl students was 17.69±3.25 and 18.48±3.11 respectively. Results showed 21.2% of study population as per BMI and 74.2% as per MUAC were malnourished. Evaluation of screening test showed MUAC as a marker was 28.6% sensitive and 84.7% specific. A correlation between measurements of MUAC and BMI was demonstrated (r=0.097; 95% CI; P=0.006; r2=0.009).

KEYWORDS : adolescent age group, nutritional status, BMI, MUAC

INTRODUCTION:

Poor nutrition starts before birth, and generally continues throughout adolescence and adult life and can extend to generations. Chronically malnourished girls are likely to remain undernourished during adolescence and adulthood, and when pregnant, are more likely to deliver low birth-weight babies.(1) Malnutrition denotes impairment of health due to either from deficiency or excess or imbalance of nutrients in the body(2). Adolescents represent around 20% of the global world's population and around 84% of them are found in developing countries.(2)

Recent reports of the World Health Organization (WHO) suggest that in South East Asian Region adolescents suffer from malnutrition and anaemia, which adversely impacts their health and development. Several factors affect the nutritional status of adolescents.(1) Among these, socio-economic and demographic factors are associated with worldwide patterns of stunting and thinness.(3) In India, one of the important aims of nutritional research is to focus on the prevalence of under nutrition among adolescents. The problem of malnutrition received recognition of planners and policy makers right from inception of five-year planning; a large number of national nutritional programs were implemented to combat the menace of malnutrition. However, malnutrition still persists.(4)

The World Health Organization recommends using body mass index to assess malnutrition in school aged children, adolescents, and adults. In 2007, WHO published growth references for weight, height, and body mass index for 5-19 year olds using historical data from the United States merged with prospective data from the 2006 WHO Multicentre Growth Reference Study of under 5, and growth curves modelled using the statistical methods developed for that study.(5) One study done in USA, concluded that the MUAC-for-age z score is at least as effective as the body mass index-for-age z score for assessing mortality risks associated with undernutrition among African school aged children and adolescents. Another study from Kolkata concluded that the mid upper arm circumference measurement is a reliable and a feasible method of assessment of nutritional status of adolescents and MUAC can provide simplified screening and diagnosis within nutrition, and in research. It was felt that assessment of nutritional status by middle upper arm circumference (MUAC) was easier, more convenient requiring less expertise than assessment with body mass index (BMI). The aim of this study is to compare the middle upper arm circumference (MUAC) with that of body mass index (BMI) for determination of nutritional status of the study population.

Materials And Methods:

A cross sectional analytical study was conducted among the Adolescent students of urban schools in Ballari city for the duration of six months- 1st January to 30th June 2018. It was a cross

We obtained list of all high schools (8th to 10th) of Ballari urban was collected from block education officer, which showed 68 high schools. Out of which we selected 5 aided and 5 unaided high schools by simple random sampling technique. Detailed methodology was explained to all the principals of selected schools by the investigator. Among them 2 aided 2 unaided Schools who had given consent were included in the study. One section each was selected from Students of 8, 9 & 10th class in each school by systemic random sampling. A total of 648(350 girls and 298 boys) students were interviewed for the study. Ethical clearance was obtained from the Institution. Written INFORMED consent was obtained from Principal of respective school as well as from each study participant.

Techniques and tools: All the students thus included were subjected to anthropometric measurements as per the WHO standards. Exact age of students taken from the school records as anthropometric cutoffs relay on age.

1) Middle upper arm circumference was measured in centi-meter with a non-stretched measuring tape with the right arm hanging relaxed. The measurement was taken midway between the tip of the acromion and olecranon process. The tape was placed gently but firmly round the arm to avoid compression of soft tissue. Measurement was taken nearest to 0.1 cm.
2) The weight was measured in kilogram without shoes using a standing weighing machine having precision of 0.5 kg. Checks on the scale were made routinely before recording the weight of each student and the pointer was adjusted to zero using the screw provided.
3) The height was taken barefooted in centi-meter using standard stadimeter. Height was recorded to the nearest 1 cm.

4) The body mass index was calculated as weight in kg/ (height in meter)^2.

METHOD OF ANALYSIS:

The data so collected were compiled in MS Excel sheet and analysed using SPSS version 20.0 and Epi-info software. Student's 't' test was done for comparing means of BMI and MUAC for normal and study population at each age point. A correlation between BMI and MUAC measurement was demonstrated.

RESULTS AND DISCUSSION:

This study was a school-based descriptive analytical study of cross-sectional design done among 648 adolescent students aged between 12.5 and 16.5 years. Majority (86.6%) were Hindu by religion. Table 1 shows most (66.6%) student's both parents were working. Junk food consumption was more among 88% of students, and 84% students did not take any nutritional supplements.

Table 1. Demographic profile dietary variables of the study participants

Variables	Number (648)	Percentage (100)
Religion		
Hindu	561	86.6
Muslim	48	7.4
Christian	31	4.8
Others	8	1.2
Class		
8th	268	41.4
9th	156	24.1
10th	224	34.6
Parents working		
Either one	217	33.5
Both	431	66.5
Dietary pattern		
Vegetarian	237	36.6
Mixed	411	63.4
Intake of Nutritional supplements		
Yes	104	16.0
No	544	84.0
Junk food consumption		
Yes	571	88.1
No	77	11.9

Adolescents need proper food and good nutrition for survival, physical growth, mental development, performance and productivity, health and wellbeing. Almost half of the adolescents of both sexes are not getting even 70% of their daily requirements of energy and a quarter of them are getting less than 70% of RDA of proteins. (4)

Table 2. MUAC And BMI According To Gender

	Male (298)	Female (350)	p value
Age (mean±SD)	14.43±1.02	13.75±1.11	0.00001
MUAC (mean±SD)	21.97±2.95	22.14±3.18	0.485
MUAC			
Normal	31(10.4)	136(38.9)	
MUN (P5- P3)	18(6.0)	46(13.1)	0.00001
SUN (<P3)	249(83.6)	168(48.0)	
BMI (mean±SD)	17.69±3.25	18.48±3.11	0.0059
BMI			
Normal	209(70.1)	302(86.3)	
MUN (P10- P5)	56(18.8)	34(9.7)	0.00001
SUN (<P5)	25(8.4)	12(3.4)	
ON(>P90)	8(2.7)	2(0.6)	

This study shows that there is significant difference between mean BMI and MUAC of males and females according to malnutrition classification (p value <0.001). According to this table 89.6% boys and 61.1% girls are undernourished according to MUAC where as 29.9% boys and 13.7% girls are undernourished according to BMI.

A similar study was carried out in Gujarat(2), which showed that there is difference between means of BMI and MUAC.

As per the NCHS norms, the prevalence of thinness is more marked in Indian adolescents especially among boys. They have a lower BMI when compared with girls. This observation is similar to the observations of Onis, et al.(5) and Venkaiah, et al.(6) Thinness is more prevalent in the age group of 15-16 years old. This may be because of the growth spurt and sudden increase in height in adolescent age group. Jyekumar A, et al.(7) showed less prevalence of undernutrition both by BMI and MUAC.

Table 3: Comparison of BMI and MUAC of study population according to age (boys n=298)

AGE IN YEARS	NUMBER (%)	OBSERVED BMI (kg/m2)	REF VALUE BMI (kg/m2)	DIFFERENCE IN BMI	OBSERVED MUAC (CMS)	REF VALUEMUAC (CMS)	DIFFERENCE IN MUAC
		MEAN± SD		MEAN± SD			
12.5-12.99	16	17.63±2.91	18.7±3.05	1.07 (NS)	21.0±2.36	23.69± 3.25	2.69(S)
13.0-13.5	38	17.45±2.11	19.11±3.14	1.66(S)	21.91±3.03	24.4±3.02	2.3(S)
13.5-13.99	31	18.94±4.16	19.89±3.73	0.95(NS)	22.13±2.42	25.14±2.4	3.01(S)
14.0-14.5	38	17.03±2.53	19.87±3.09	2.84(S)	22.25±3.19	25.82±2.45	3.57(S)
14.5-14.99	64	17.70±3.0	20.51±3.35	2.81(S)	22.12±3.18	26.46± 2.35	4.34(S)
15.0-15.5	75	17.91±3.92	20.5±3.12	2.59(S)	22.41±2.72	27.05 ±2.4	5.44(S)
15.5-15.99	18	17.11±3.58	21.01±3.24	3.9(S)	20.05±2.76	27.59±2.35	7.54(S)
16.0-16.5	18	17.17±2.33	21.48±3.25	4.31(S)	21.75±3.43	28.03±2.32	6.28(S)

***NS- not significant- p value > 0.05, S= significant – p value <0.05**

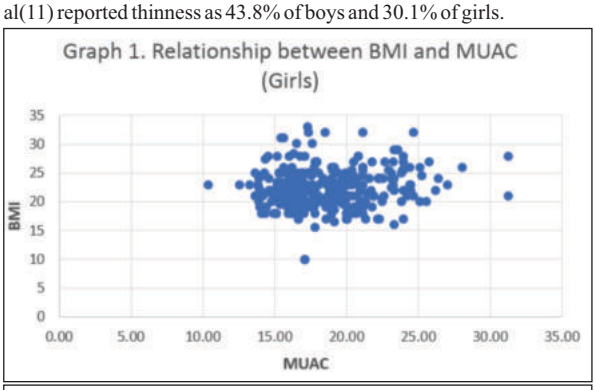
Table 4: Comparison of BMI and MUAC of study population according to age (girls n=350)

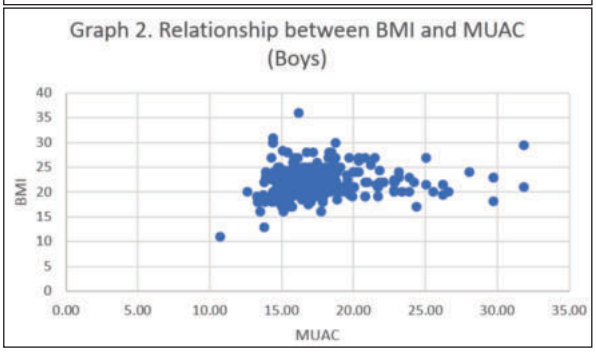
AGE IN YEARS	NUMBER	OBSERVED BMI (kg/m2)	REF VALUE BMI (kg/m2)	DIFFERENCE IN BMI	OBSERVED MUAC (CMS)	REF VALUEMUAV (CMS)	DIFFERENCE IN MUAC
		MEAN± SD		MEAN± SD	MEAN± SD		
12.51-12.99	71	18.92±3.96	19.6±3.59	0.68 (NS)	22.7±3.1	24±2.4	1.3(S)
13.0-13.5	93	18.68±3.26	19.96±3.8	1.28(S)	22.4±3.1	24.45±2.8	2.05(S)
13.51-13.99	38	18.26±2.47	20.37±3.95	2.11(S)	21.4±3.1	24.82±2.5	3.42(S)
14.0-14.5	41	18.76±2.74	20.75±3.95	1.99(S)	22.4±3.3	25.14±3.01	2.74(S)
14.51-14.99	39	18.02±2.12	21.17±3.68	3.15(S)	21.8±2.6	25.4±2.8	3.6(S)
15.0-15.5	48	17.98±2.85	20.9±3.63	2.92(S)	22.1±2.9	25.7±2.65	3.6(S)
15.5-15.99	12	18.04±3.74	21.19±3.55	3.15(S)	20.4±5.6	25.92±3.5	5.42(S)
16.0-16.5	8	18.11±2.12	21.66±3.87	3.55(S)	21.3±3.1	26.06±3.6	5.3(S)

***NS- not significant- p value > 0.05, S= significant – p value <0.05**

Table 3 and 4 shows that mean BMI and MUAC of study population at different age category compared with the corresponding reference value of National Health and Statistics report. An independent sample T test showed that under nutrition is present in almost all the age groups with respect to both BMI and MUAC and the mean BMI and MUAC was significantly higher in girls compared to boys. The results are similar to the study done in Kolkata (4), Tanzania(8) and West Bengal(9). Another study done by Sexena et al,(10) reported 43.47% of the adolescent girls were thin. As per the NCHS norms prevalence of thinness among boys varies between 31% to 52% without any clear trend where as in girls, it varies between 4% to 59%. Though, the number of boys is less in each age group, it appears that prevalence of

thinness in boys is more than in girls. Another study by Anand K et al(11) reported thinness as 43.8% of boys and 30.1% of girls.





There is weak correlation between BMI and MUAC of girls (r= 0.117, p value= 0.028) as well as boys (r= 0.091, p value = 0.119). but the correlation is statistically significant among girls. Many studies showed good correlation (r = 0.88(12), 0.822(4), 0.593(7), 0.849 in males, 0.459 in females(8)) between MUAC and BMI. In our study it was really difficult to say we can use MUAC as predictor of undernutrition as the results did not correlate with the BMI as compared to other studies. But we could definitely say we can classify severely malnourished easily.

Table 5: Screening Test Results

MUAC	BMI		
	NORMAL	MALNOURISHED	TOTAL
NORMAL	146	13	159
MALNOURISHED	365	114	479
TOTAL	511	127	638

Statistic	Value	95% CI
Sensitivity	28.57%	24.69% to 32.70%
Specificity	89.76%	83.13% to 94.44%
Positive Likelihood Ratio	2.79	1.64 to 4.76
Negative Likelihood Ratio	0.80	0.73 to 0.86
Disease prevalence	80.09%	76.78% to 83.13%
Positive Predictive Value	91.82%	86.83% to 95.03%
Negative Predictive Value	23.80%	22.37% to 25.29%
Accuracy	40.75%	36.91% to 44.68%

The results of screening test and evaluation (table 5) showed, 146 out of 511 identified as true positive or normally nourished (sensitivity 28.57%) and 114 out of 127 identified as true negative or malnourished (specificity 89.76%). The use of MUAC to assess nutritional status showed 28.57% sensitivity and 89.76% specificity, as represented in Table 6.

Similar results were reported among children using MUAC, with a sensitivity and specificity of 24.6% & 94.8% (13) and 28.57% & 96.28% (7) respectively.

The MUAC is very well identified as a screening tool for malnutrition in children, because the prevalence of mal nutrition (undernutrition and over nutrition), specifically severe acute malnutrition and moderate acute malnutrition, is high in developing countries. As the study took place in low prevalence of undernutrition area, lower sensitivity of malnutrition was observed when compared to a study done in Kolkatta observed 71.2% sensitive and 94.6% specific. (4) Because percentage of mal-nourished children in the present study is 11.1% or 83.6% as per BMI and MUAC, respectively, further studies are suggested among populations with a higher prevalence of undernutrition among adolescents. The sample being selected for this is from 2 aided 2 unaided Schools of urban area. However, the results of our study among adolescent children indicate a positive correlation between BMI and MUAC and among girls it was statistically significant. Similar studies among adolescents in Pune (7) and Tanzania showed correlation between BMI and MUAC, where-as Tanzania study suggested that the latter could be used as an assessment tool among adolescents. (14) Another study suggested MUAC can be used to identify severely malnourished children even before detection with BMI. (15)

CONCLUSION:

MUAC Measurement is a simple non-invasive method, has been adopted for screening undernutrition among children and adults in epidemiological and clinical studies and even WHO has given cutoff of 115cms in 6-60months. The results of the present study in Karnataka, India, observed that MUAC in adolescent children has a sensitivity and specificity similar to those in studies carried out among populations of children with low prevalence of undernutrition and which showed positive correlation with BMI among adolescent children in the age group of 12 to 18 years. When compared with other methods, it offers the advantages of easy carry of equipment, and even to geographically not accessible areas; requires minimum training; and is useful in the assessment of nutrition status when measured with care and precision. In spite of the convenience and ease of measurement of MUAC, it requires careful training and supervision to prevent wrapping the measuring tape too tight or too loose, which may result in some degree of observer variation. For these reasons, MUAC has to be studied further among different age groups to arrive at standard cutoffs in developing countries for appropriate interventions. It is felt that this is a small effort to identify a simple method of nutritional assessment of adolescents and therefore we suggest that more research is to be done to assess the MUAC for nutritional assessment in a larger sample and in many countries so that these methods are adapted by all, especially at the community level.

Source of Support: Nill

Conflict of Interest: None declared

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