VOLUME-7, ISSUE-1, JANUARY-2018 • PRINT ISSN No 2277 - 8160

Original Research Paper

Medicine

VALIDITY OF MID UPPER ARM CIRCUMFERENCE MEASUREMENT AS A TOOL FOR NUTRITIONAL STATUS ASSESSMENT OF ADOLESCENTS FEMALES

Dr.Ruqaya Subhi Tawfeeq

Assistant professor M.B.CH.B – F.I.C.M.S (Community medicine). Al-Iraqia University Medical college-Community Medicine Department.

ABSTRACT

Back ground: Mid-upper arm circumference (MUAC) is widely used as an indicator of severe and moderately acute under nutrition

Aims of Study: To Identify the Role of Mid-Upper Arm Circumference as a Screening Tool of Nutritional Status in adolescent females.

Subject and method: A cross-sectional study which was conducted from first of October 2013to the end of March 20014 in Iraq -Tikrit city, a multi-stage stratified random sampling technique has been used to collect a (536) females12-19 years old students. The study includes two components: interviewer administration of questionnaire & anthropometric measurements (Weight, Height and mid-upper arm circumference). Diseased & married students had been excluded from the study.

Results: mean weight was (53.275±12.23)kg,height was (147.2±6.48)cm,BMI (24.46±4.72) (kg/m2) and MUAC (23.4±2.9) cm .Age has a significant relation with MUAC (r= 0.96,0.027), highly significant relation with BMI(r 0.147,0.001). MUAC to(35) underweight students was (19.43±1.119). MUAC to (290) normal weight students was (22.04±1.555). MUAC to (150) overweight students was (25.09±1.530). MUAC to(61) obese students was (28.57±2.642).

Conclusion: Anthropometric parameters showed a significant relation with MUAC

KEYWORDS : MUAC.BMI

Introduction:

Adolescent are tomorrow's adult population and It is estimated that adolescents will be expected to reach 1.13 billion by the year 2025.[1] Anthropometry is the measurement of certain parameters of human body, used to assess nutritional status in young children, adolescent & adults. Anthropometric indicators are useful tools for screening women at nutritional risk, monitoring nutritional status, predicting unfavourable infant outcomes related to pregnancy.[2,3]

Many developing countries currently affected by high rates of overweight that in some cases surpass underweight as a public health nutrition problem.[4] In adolescent chronic under nutrition delays normal maturation. Moreover, the distinction between acute & chronic under nutrition among adolescent & adult is not nearly as clear as in young children, since adults & adolescents no longer increase their height, they cannot become stunted & thinnest may result from either sudden or long standing food deficit.[5]

There is increasing evidence that children & adolescents of effluent families are overweight, possibly because of decreased physical activity, sedentary life styles, altered eating patterns & increase fat content of diet.[6] the Body Mass Index (BMI) is used widely as an indicator of the risk of overweight & of the presence of underweight, overweight & obesity because of relative ease & accuracy of the basic easy measurements.[7]

Mid-Upper Arm Circumference (MUAC) has recently emerged in the literature as a potential screening tool for poor nutritional status in adults & adolescents.[8]

MUAC may have potential as a clinical and surveillance indicator of obesity in children and adolescents[9].

MUAC may be a useful screening and diagnostic tool for undernutrition among school aged children and adolescents in situations of food insecurity, at health facilities, and in HIV programmes.[10]

Aim of Study

To Identify the Role of Mid-Upper Arm Circumference as a Screening Tool of Nutritional Status in adolescent female and to identify the validity of MUAC as a screening tool for nutritional status.

Subjects & Methods:

Official permission to carry out this study was obtained from the head masters of each school before the study. In addition approval permission & consent were obtained from all study students.

Design of study:

The current work represented an observational cross-sectional study which was conducted during the period extended from first of October 2013to the end of March 20014, with regular working hours.

The study group & sampling:

This is a multi-stage stratified random sampling technique has been used to collect a (536) females students sample in three main stage. In first stage, all the schools have been divided according to its location in Tikrit district into urban & rural schools which were 18 schools. In the second stage, a more than 10% of students in each class have been examined according to the total number of the visited schools. In the third stage, a systemic random sampling has been applied by choosing every tenth students from each class to complete the sample size.

Development of questionnaire:

As the response of study sample was high & was suitable the possibility of skewing is not high since the required data are not critical to interviewing.Age: it include 3 age groups: Early adolescent (12-<15 years old), mid adolescent (15-<17 years old) & late adolescent (≥17 years old. Medical history: this includes acute, chronic & hereditary disease as well as congenital anomaly.

Data Collection:

The study includes two components: interviewer administration of questionnaire & anthropometric measurements.

Inclusion & Exclusion Criteria :

A female's student with the age of 12-19 years old had been included in the sample without any limitations for their presence in any class. Diseased & married students had been excluded from the study.

Examination:

1. **Weight:**

All student were weight wearing minimal clothing without shoes to the nearest of 100g using UNICEF Seca personal scale that are checked regularly & routinely before recording the weighment of each student & the pointer was adjusted to zero.

2. Height:
Height was measured with the student standing at ground level without footwear to the nearest of 0.1 cm against the wall as a vertical tape fixed perpendicular to the ground on the wall was used as scale. This tape was of non-stretchable fibreglass. It was fixed with transparent tape & care was taken to see that there were no folds or tilting to any side. Contact point include head, shoulder, buttock, knee & feet.

3. MUAC:
Using a non-stretchable tapes, MUAC were measured to the nearest of 0.1 to 0.5 millimetres. Left mid-upper arm was measured at the mid-point between the acromion process (in shoulder) & olecranon process of ulna (in elbow joint) with arm & forearm hanging loosely by the side. The tape was placed gently but firmly around the arm to avoid compression of the soft tissues.[11]

Data Interpretation:
BMI was calculated as weight (kg) divided by height squared (m^2). [12, 13] the classification of nutritional status depending on BMI cut-off points into four groups: underweight, normal, overweight & obesity following the recommendation cut-off point of WHO. [13] This cut-off point are:, BMI 18.5 for underweight, BMI 18.5 to 24.9 for normal weight, BMI 25 to 29.9 for overweight & BMI ≥ 30 for obesity. There is no specific cut-off point of MUAC as reported by WHO[13].

Validity of MUAC as a screening tool of nutritional status was calculated as sensitivity, specifity, positive predictive, negative predictive values, false positive percentage & false negative percentage.

Statistical analysis:
Data were analysed using Pearson correlation coefficient to examine the correlation between variables were expressed as r the regression coefficient. ANOVA system (f-test) & chi-square test was performed. the level of significant for this study is 0.05 for the sake of minimizing alpha error (rejecting the null hypothesis its true). The statistical analysis was done with the use of SSPS software, version 19.

Results
The total sample studied in this research was (536) .The age group was taken from 12-19 years, divided into three age groups ,early adolescent between 12-<15 years was 217 (40.5%) students ; mid adolescent between 15-<17 years was 164 (30.6%) students & late adolescent equal & more than 17 years was 155 (28.9%) students of the total sample in the research.

The anthropometric parameters that have been used to measure the nutritional status were mean weight (53.275±12.23) kg, the minimum weight was 28.0kg while the maximum weight was 118.0 kg, the mean height was (147.2±6.48)cm ,the minimum height was 128cm while the maximum height was 172cm.Regarding mean of BMI was (49.72)kg/m^2 , the minimum calculated BMI was (15.912) while the maximum (23.4±2.9) & calculation of mean . Measuring the MUAC has been showed that the mean was (23.4±2.9) minimum MUAC was 17cm while the maximum was 37cm (table 1).

Table1: Anthropometric parameters according to their general information.

Anthropometric Parameters	Minimum No.	Maximum No.	Mean& SD
Weight	28	118	53.275±12.23
Height	128	172	147.2±6.48
BMI	15.912	49.72	24.46±4.72
MUAC	17	37	23.4±2.9

The anthropometric parameters were significantly correlated with each other and with age as a total. Studying the correlation of age with anthropometric parameters showed a significant relation with MUAC ®= 0.96, 0.027), highly significant relation with BMI(r 0.147,0.001). Studying the correlation of MUAC has been showed a highly significant correlation with BMI (0.896, 0.000). Studying the correlation of BMI has been showed a highly significant correlation with the three variables as explained in Table (2).

Table2: Correlation between ages, MUAC& BMI

Measurement	Correlation	Age	MUAC	BMI
Age	r	1	0.96*	0.147**
	p		0.027	0.001
MUAC	r		1	0.896**
	p			0.000
BMI	r			1
	p			

*correlation is significant at the 0.05 level (2-tailed) ,**correlation is significant at the 0.01 level (2-tailed)

A simple linear regression has been applied on the same variable by entering the BMI as dependant variable & the age, MUAC as independent variables. This test shows a significant relation between BMI & MUAC (44.823, <0.0001), while no significant relation between BMI, age (1.391, 1.391) .table (3).

Table 3: Simple linear regression test between BMI & age& MUAC.

Variables	Standardized Coefficient(Beta)	t	Sig.
Age	.051	1.391	.165
MUAC	.889	44.823	.000

Note: dependant Variable: BMI.

By ANOVA system (f-test) has been applied on each measures to examine its significant relation with each age groups(early ,mid and late adolescents) For the weight, early adolescent was (49.8±4.8) while mid adolescent was (54.8±12.3) & late adolescent was (56.4±11.4). The weight was highly correlated with age (16.038, 0.000). For the height, early adolescent was (144.1±6.5) while mid adolescent was (148.5±5.8) & late adolescent was (150.1±5.0). The height was highly significant correlated with the three age groups (51.894, 0.000). For the MUAC, early adolescent was (23.2±3.0) while mid adolescent was (23.5±2.9) & late adolescent was (23.6±2.7). There was no significant relation between MUAC & the three age groups (0.749,0.474). For the BMI, early adolescent was (23.8±4.7) while mid adolescent was (24.8±4.9) & late adolescent was (25,0±4.4). There was highly significant correlation between BMI & the three age groups (3.536, 0.030). Table (4).

Table 4: Mean & SD of anthropometric parameters to 536 female adolescent students according to the age groups.

Anthropometric parameters	Age			f-test (ANOVA)	Sig.
	Early	Mid	Late		
Weight	49.8±11.8	54.8±12.3	56.4±11.4	16.038	0.000
Height	144.1±6.5	148.5±5.8	150.1±5.0	51.894	0.000
MUAC	23.2±3.0	23.5±2.9	23.6±2.7	0.749	0.474
BMI	23.8±4.7	24.8±4.9	25.0±4.4	3.536	0.030

The nutritional status had different distribution at the three age groups. For early adolescent students 24 (68.6%) of them were underweight, 118 (40.7%) students were normal weight, 55 (36.7%) students were overweight & 20 (32.8%) were obese. For mid adolescent 6 (17.1%) of them were underweight, 90(31%) students were normal weight, 48 (32%) were overweight & 20 (32.8%) were obese. For late adolescent 5 (14.3%) of them were underweight, 82 (28.3%) were normal weight, 47 (31.3%) were overweight & 21 (34.4%) were obese. There was significant association between different nutritional status & the three age groups (14.112), (P value=0.028). Table (5).

Table 5: Distribution of different nutritional status according to the age groups.

Age	Underweight		Normal		Overweight		Obesity	
	No	%	No.	%	No.	%	No.	%
Early	24	68.6	118	40.7	55	36.7	20	32.8
Mid	6	17.1	90	31	48	32	20	32.8
Late	5	14.3	82	28.3	47	31.3	21	34.4
Total	35	100.0	290	100.0	150	100.0	61	100.0

Chi square=14.112 Degree of freedom =6 P value =0.028

The mean & SD of MUAC was calculated according to the four types of nutritional status at 95% confidence interval. MUAC to(35) underweight students was (19.43±1.119). MUAC to (290) normal weight students was (22.04±1.555). MUAC to (150) overweight students was (25.09±1.530). MUAC to(61) obese students was (28.57±2.642). Table 6.

Table 6: The mean & SD of MUAC accorning to the four types of nutritional status.

Nutritional status	Number	Mean &SD	Std.Error	95% confidence interval for Mean	
				Lower Bound	Upper Bound
Underweight	35	19.43±1.119	.186	19.04	19.81
Normal weight	290	22.04±1.555	.091	21.86	22.22
Overweight	150	25.09±1.530	.125	24.85	25.34
Obesity	61	28.57±2.642	.338	27.90	29.25

Applying a least significant test (LSD) to measure the significant association between the MUAC & the four nutritional status through entering the MUAC as a dependent variable & the nutritional status as independent to make a multiple comparison between the mean of MUAC of the four nutritional status has been shows that the there was a highly significant association (0.000) at the 0.05 level. Table 7

Table 7: Significant association between MUAC & nutritional status by Least Significant Association Test (LSD).

Nutritional Status(I)	Nutritional status(J)	Mean Difference	Std. Error	Sig.
Underweight	Normal	-2.61*	.301	0.000
	Overweight	-5.66*	.316	0.000
	Obesity	-9.15*	.357	0.000
Normal	Underweight	2.61*	.301	0.000
	Overweight	-3.06*	.169	0.000
	Obesity	-6.54*	.237	0.000
Overweight	Normal	5.66*	.316	0.000
	Overweight	3.06*	.169	0.000
	Obesity	-3.48*	.256	0.000

According to the significant association between the mean of MUAC & nutritional status that has been mentioned above, the cut-off points of MUAC has been determined & the validity of them for each nutritional status has been assessed as a screening instrument. Using an MUAC cut-off point ≤19cm for detecting underweight the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), false positive percentage(FP%), false negative percentage (FN%) were (51.4%), (97.4%), (58.1%), (96.6%), (2.6%) & (48.5%) respectively. Using an MUAC cut-off point ≤23cm for detecting normal weight the sensitivity, specificity, PPV,NPV, FP% & FN% were (90.6%), (92.7%), (95.4%), (64.2%), (7.3%) & (9.3%) respectively. Using an MUAC cut-off point ≤27cm for detecting overweight the sensitivity, specificity, PPV, NPV, FP% &FN% were (83.3%), (83.4%), (66.1%), (92.8%), (16.6%) & (16.6%). Using an MUAC cut-off point ≥28cm for detecting obesity the sensitivity, specificity, PPV, NPV, FP% &FN% were (60.7%), (97.9%), (78.7%), (95.1%), (2.1%) &(39.3%). Table (8).

Table 8: Validity of MUAC cut-off points for detecting different nutritional status in female adolescent students.

Validity	MUAC			
	Underweight ≤19cm	Normal weight ≤23cm	Overweight ≤27cm	Obesity ≥28cm
Sensitivity	51.4%	90.6%	83.3%	60.7%
Specificity	97.4%	92.7%	83.4%	97.9%
PPV	58.1%	95.4%	66.1%	78.7%
NPV	96.6%	64.2%	92.8%	95.1%
FP%	2.6%	7.3%	16.6%	2.1%
FN%	48.5%	9.3%	16.6%	39.3%

the significant relation between MUAC cut-off points with BMI was examined after calculating the mean &SD of it to each group. For underweight (18.45±1.7), normal weight (21.81±2.14), overweight (26.9±2.6) & obesity (33.74±4.9). The relation between MUAC cut-off points was highly significant (386.390), P value <0.0001by ANOVA system(f-test) at 95% confidence. Table (9).

Table 9: Relation between BMI & MUAC cut-off points.

MUAC cut-off points	Mean &SD	Std. Error
Underweight ≤19cm	18.45±1.7	.3058
Normal weight ≤23cm	21.81±2.14	.1306
Overweight ≤27cm	26.91±2.6	.1912
Obesity ≥28cm	33.74±4.98	.7274

F-test (ANOVA system) = 386.390 Degree of freedom = 3 P value =<0.0001

Discussion:

The present study was describing the nutritional status among female adolescent students. Therefore the methods & results developed would be useful as basic information in further studies among adolescents. The present study had several strengths including a validated MUAC cut-off points, accurate & simple anthropometric measurements in addition the results has been adjusted for age.

Anthropometric measurements in our sample were: MUAC (23.4±2.9cm) weight (53.27±12.23kg), height (147.2±6.48cm), BMI (24.46±4.72kg/m^2). This result agreed with (Khadizaeh T.) [14]; in MUAC(23.9±2.8) but disagreed with weight, height & BMI which were (52.3±8.2kg), (158±5.6cm) & (20.9±3.1kg/m^2) respectively in **Iran**[14]; while disagreed with **Egypt** which shows higher weight (54.7±7kg),higher height (155.8±7.4cm) & lower BMI (22.5±5.2kg/m^2), & with **Lebanon** which shows lower weight & BMI were (49.1±11.9kg) & (20.5kg/m^2) & higher height (154.7±10.7cm) & also with **Kuwait** which shows higher weight & height were (57.2±15.1kg) & (155.9±5,6cm) & lower BMI (23.5±5.9kg/m^2).[14] Also disagreed with (James et al.) in **Bangladesh** which were higher height (149±6.1cm) & lower weight, BMI & MUAC were (41.3±6.1kg), (18.5±2.4kg/m^2) & (22.6±2.28cm) respectively.[16] This difference in anthropometric measurements may occur due to many genetic & environmental condition that are specific to each country such diet, physical activity & parental anthropometric measures.

A highly significant relation of MUAC with BMI this result agreed with (Khadizadeh T.) who showed a significant relation between MUAC & BMI, weight, height, age & calf circumference[14],

Simple linear regression analysis revealed significant association between MUAC & BMI this was agreed with (Khadizadeh T.) in which a multiple linear regression revealed an independent association between MUAC &BMI but not between age & BMI.[14] From this result; MUAC can be derived either to substitute for BMI measurements or to combine with it as a more selective indicator of peripheral wasting and subcutaneous adipose tissue.

MUAC was mainly depend on distribution of adipose tissue, physical activity & pubertal changes & not depend on the growth & development so there was very slight increase of it with age & there was no significant relation of MUAC with age so it can be used at any age group such as children, adolescent & adult.

The nutritional status of the sample in this research has been re-assessed depending on the new MUAC cut-off point that has been detected in this study, the correlation between the new classification of nutritional status & the other anthropometric measurements was calculated to see if the MUAC can be used significantly in measuring the nutritional status alone or in combination with them. The new classification of nutritional status was highly significant correlated with BMI (P value 0.0001). This result was agreed with (Tawfeek H. et al)[17] which show that there was a highly significant correlation of about +o.88 between weight & height (P 0.001). Weight, height & MUAC were positively correlated (r= 0.61; P 0.05). also agreed with (Collin`s S) which demonstrate a correlation between MUAC cut point & BMI (0.82-0.92, P value 0.001).[18,19]

Conclusion:

Anthropometric parameters showed a significant relation with MUAC, the MUAC as a dependent variable & the nutritional status as independent to make a multiple comparison there was a highly significant association between the mean of MUAC and the nutritional status .

REFERENCES

1. WHO. Nutrition in Adolescent: Issues & Challenge for Health Sector. WHO Discussion Paper on Adolescent. World Health Organization, Geneva, 2005: 1-17.
2. United Nation Sub-Committee on Nutrition (ACC/SCN). 4th report on the world nutrition situation: Nutrition throughout the life cycle. New York, United Nations, 2000: 1-21.
3. The Sphere Project. Humanitarian Chapter and Minimum Standards in Disaster Response. International Federation of Red Cross and Red Crescent Societies, Geneva; 1998: 5-8.
4. Mendez MA, Monteiro CA, Popkin BM. Overweight exceeds underweight among women in most developing countries. American Journal of Clinical Nutrition. 2005; 81: 714-21.
5. WHO. Management of severe malnutrition: a manual for physicians and other senior health workers. World Health Organization, Geneva, 1999: 25-30.
6. International Life Science Institute. Preventing Childhood Obesity is a Current Research Focus: Initiatives Cooperate to Share Information and Stem Epidemic. The PAN Report: Physical Activity and Nutrition, USA, International Life Sciences Institute; 2000: 2-5.
7. Kapil U, Singh P, Pathak P, Dwivedi SN, Bhasin S. Prevalence of obesity amongst affluent adolescent school children in Delhi. Indian Paediatric. 2002; 39:445-9.
8. Fuller J, Schaller-Ayers J. Assessing nutrition and metabolism. Health assessment, a nursing approach.3rd edition. Philadelphia, Lippicott, Williams and Wilkins; 2000: 153-236.
9- Craig E , Bland R , Ndirangu J , and Reilly J J .Use of mid-upper arm circumference for determining overweight and overfatness in children and adolescents.BMJ Open Access ,PMC4112423:Arch Dis Child. 2014 Aug; 99(8): 763–766.
10- Mramba L, Ngari M, Mwangome,M , Muchai L, Bauni E, Sarah WalkerA :et al . A growth reference for mid upper arm circumference for age among school age children and adolescents, and validation for mortality: growth curve construction and longitudinal cohort study. BMJ 2017; 358 doi: https://doi.org/10.1136/bmj.j3423 (Published 03 August 2017)
11. Scott JR. The normal Pregnancy & Prenatal Care. In: Danforth DN. Danforths Obstetrics & Gynaecology. 8th edition. Philadelphia, Lippincott, Williams & Wilkins; 1999: 85-90.
12. Keys A, Fidanza F, Karvonen MJ, Kimura N, Taylor HL. Indices of relative weight and obesity. Journal of chronic Disease. 1992; 25: 329-43.
13. WHO. Physical Status: The Use and Interpretation of Anthropometry. Geneva, Switzerland: WHO; 1995: 24-8.
14. Khadivzadeh T. Mid upper arm circumference and calf circumference as indicator of nutritional status in women of reproductive age. Eastern Mediterranean Health Journal. 2002; 8(4/5): 612-18.
15. Jackson RT., Rashed M., Al-Hamad N., Hwalla N. & Al-Somaie M. Comparison of BMI-for-age in adolescent girls in 3 developing countries of Eastern Mediterranean Region. Eastern Mediterranean Health Journal. 2007; 13(2): 1-9.
16. Levinson JF. & Rohde EJ. Responses to: An evaluation of the impact of a US $ 60 million nutrition program in Bangladesh: NNP Basal survey 2004. London School of hygiene & tropical medicine. 2005; 3: 164-193.
17. Tawfeek H., Al-Mashikins S. & Salom A. The Iraqi national nutrition survey: correlation between various anthropometric measurements as indicators of severity of malnutrition .Available at http://www.unu.edu/unpress/food/v194/ch05.htm. Retrivereted on April 2008
18. Leiter LA, Marliss EB. Survival during fasting may depend upon fat as well as protein stores. The Journal of the American Medical Association. 1982; 248: 2306-7.
19- Dasgupta A, Butt A, Kanti Saha T, Basu G, Chattopadhyay A, Mukherjee A. Assessment of Malnutrition Among Adolescents: Can BMI be Replaced by MUAC. Indian J Community Med :v.35(2); 2010 Apr