Original Article

Nutritional evaluation using different anthropometric variables in Nigerian school children

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Abstract

The anthropometric characteristics of 600 apparently healthy children of ages between 5 and 10 years of Gbagyi tribe of Abuja Nigeria, consisting of males (n = 300) with a mean age of 7.10 ± 1.98 and females (n = 300) with a mean age of 7.68 ± 1.86 were selected for the evaluation of their nutritional status using different anthropometric variables. The anthropometric characteristic of their height, age, weight, mid-upper arm circumference (MUAC), chest circumference and body mass index (BMI) was measured and analysed statistically for any significant difference, and correlation between the parameters studied. The results show some significant differences ($P \leq 0.05$) between the anthropometric parameters and a significant correlation (≤0.001) between the height and BMI, and other parameters in males and females. The study derived a linear regression and a multiple linear regression equations for Gbagyi children from which height, age, weight, MUAC, chest circumference and BMI could be predicted if one factor is known. The results from the present study provided an insight into the nutritional status of Nigerian school children of Gbagyi tribe of Abuja using the BMI and MUAC which showed if a child is malnourished, overweight or obese. The results from the present study show that there is a positive correlation between height and age, and other parameters indicating that height could be predicted using age, weight, BMI, chest circumference and MUAC, while BMI and mid upper arm circumference could be a useful tool in the estimation of nutritional status among Nigerian school children of Gbagyi tribe of Abuja.

Key words: Anthropometry, body mass index, Gbagyi tribe, mid-upper arm circumference, nutritional status, Nigeria

INTRODUCTION

Estimation of the body size such as height and weight are required for assessment of growth, nutritional status, calculating body surface area and predicting pulmonary function of children (Gauld *et al*., 2004). Measurement of height is important for the determination of basic energy requirement, standardisation and measures of physical capacity and for adjusting drug dosage (Jalzem and Gledhill, 1993).

However in some situations the exact height cannot be determined directly because the patients are unable to stand as a result of neuromuscular weakness, deformities of axial skeleton such as kyphosis, lordosis, scoliosis, lost of lower limbs or in patients who have undergone amputations. In such patients, height does not reflect the body size and the use of height measurements in prediction equation is likely to produce error. For example in scoliosis patients, the predicted spirometric values were underestimated when the measured body was used; under such circumstances, an estimate of height has to

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be computed based on other body parameters (Mitchell and Lipschitz, 1982; Hauser *et al*., 2005). Stature provides insight into various features of a population, including nutritional health and genetics. Stature is considered as one of the parameters for personal identification (Krishan and Sharma, 2007).

Protein Energy Malnutrition (PEM) is the most widespread form of malnutrition in the world today affecting over 500 million children (WHO, 1990). PEM and obesity are hazardous to health with high morbidity and mortality rates and the assessment of body composition and proportions are essential to prevent, diagnose and determine the severity of these disorders as well as their response to therapy (Tanphachitr and Leelahagul, 1995).

Body mass index (BMI) is a number calculated from a child's weight and height, and is a reliable indicator of body fatness and nutritional status for most children and teens (Orden *et al*., 2013). It has been shown that BMI and its derivatives namely weight and height are proxy indicators for the estimation of nutritional status in both children and adults (Petterson *et al*., 2000). Mid upper arm circumference (MUAC) is a rapid method of assessing nutritional status, without requiring extensive training, supervision, or materials (Goossens *et al*., 2012). With simple colour-coding and on-the-spot interpretation, MUAC is relatively easy to use and simple to understand for both community health workers and children's caretakers. Studies have shown that even for minimally trained health workers, intra- and inter-observer reliability of MUAC measurements are at least as good if not superior to other anthropometric indices and can offer considerable cost advantages as MUAC tapes are less expensive than height boards (Goossens *et al*., 2012). In therapeutic feeding programs, MUAC shows advantages over weight-for-height and is recommended by the World Health Organization (WHO) as an independent criterion for screening children using MUAC value from ≤ 115-118 mm as sole admission criteria for severe acute malnutrition (Velzeboer *et al*., 1983; Dale *et al*., 2013).

Intact long limb bones have been used in the derivation of regression equations for stature assessment in different population groups (Petterson *et al*., 2000). Anthropologists have observed and compared the relationship between the body, segments and nutritional status to highlight variations between groups, races and sexual dimorphism (Hauser *et al*., 2005; Krishan and Sharma, 2007). The determination of nutritional status and stature is a major area of interest in forensic medicine, forensic anthropology and biological anthropology as it is useful in the area of medico-legal identification and hospital admission (Hauser *et al*., 2005). The bone area values at different sites strongly relate to muscle strength and parameters related to body size: height, weight, lean mass, fat mass and BMI (Petterson *et al*., 2000). It is commonly accepted that standards for nutritional assessment and skeletal identification vary among different populations, tribes, and the standard for one population may not be used for another (Iscan and Steyn, 1997). The present study was aimed at determining the nutritional status of Children using different anthropometric measurements in Gbagyi tribe of Abuja Nigeria.

MATERIALS AND METHODS

The study was carried out from three different Local Authority Primary Schools, namely Byazhin, Aziyapi, Kubwa II all in Bwari Local Government Area of Abuja-Nigeria, belonging to the Gbagyi ethnic group in June 2011. The sample consists of 300 males and 300 females with each school having 100 males and 100 females with no known physical deformities between the ages of 5 and 10 years and of Gbagyi tribe from both parents and grandparents within Abuja Area of Nigeria.

Ethical approval was obtained from the Ahmadu Bello University Ethical Committee and Informed consent was obtained from the Schools involved and the parents of the children used for the study after explaining the rudiments of the research to them. The parents of the children were assured of confidentiality in the study and that the children can withdraw from the study at any time in the study if they so wish.

The demographic data collected from the subjects include age in years, name, place of birth, parental and grandparental origin was completed in a questionnaire. Standing height, weight and mid-upper arm circumfluence (MUAC) measurements were taken. Standing height was measured to the nearest centimetres (cm) using a Stadiometer with subject standing erect on a horizontal resting plane bare footed having the palms of the hands facing forward and the finger pointing downward. The height was measured with each subject's head in the Frankfort plane. The measurements were taken from the sole of the feet to the vertex of the head as recommended by International Biological Program (Weine *et al*., 1969).

The weights of the subjects were taken using the weighing balance to the nearest kg according to the standard procedures (Whitney *et al*., 1998). BMI was then calculated by dividing weight by converted height in meters squared (Marks *et al*., 1985). BMI is a number calculated from a child's weight and height, and is a reliable indicator of nutritional status and body fatness for most children and teens. The MUAC was measured

to the nearest cm using a calibrated non-stretch tape with the left arm hanging relaxed (Taylor *et al*., 1996) and was taken midway between the tip of acromion and olecranon process as described by Amirsheybani *et al*. (2001). Nutritional evaluation was done using PEM assessment in each child with the UNICEF Brasilia arm circumference strip (1989) which has an age-specific cut-off for malnutrition. The International cut-off points for BMI for overweight and obesity used for the present study of ages between 5 and 10 years was calculated according to Cole *et al*. (2000). Chest circumfluence was measured with tape to the nearest cm from the level of the middle of the sternum, at the highest point of the thoracic cage with the tape passing under the arms with the arms relaxed by the side, and the measurement was taken at the end of a normal expiration (Vincent *et al*., 2012).

The measurements and readings from each subject were taken twice and recorded and if the two measurements and readings for each parameter agreed within 0.4 ranges the average was taken as the best estimate for the true value. When the two initial measures did not satisfy the 0.4 range criteria, two additional measurements and readings were made and the mean of the closest records was used as the best estimate (Reeves, 1996).

Statistical Analysis

Data was expressed as mean ± standard deviation (±SD). Pearson's correlation analysis was used to determine the strength of the relationship between the parameters studied. Students' T-test was used to test the significant levels between the body proportions studied both in males and females. Differences were declared significant when a *P* value is less than 0.05 ($P \leq 0.05$) and correlation exist when $P \leq 0.001$. To investigate the utility of weight, age, BMI and height in nutritional estimation, linear and multiple linear regression analysis were used.

RESULTS

The results from the present study show the mean ± SD of height, age, weight, BMI and MUAC in male and female children are as shown in Table 1. The result showed a significant difference ($P \leq 0.05$) between the male and female Nigerian school children in the age and weight but there was no significant difference ($P \leq 0.05$) in the height between the male and female Nigerian school children of Gbagyi tribe of Abuja.

Table 1: Anthropometric measurements in both male and female school children

	Male children	Range	Female children	Range
Variables	*n*=300	Min-Max	*n*=300	Min-Max
Age (years)	7.10±1.98	5.0-10.0	7.68±1.86*	5.0-10.0
Height (m)	1.20±0.12	1.0±1.51	1.21±0.12	0.99-1.50
Weight (kg)	22.53±6.14	11.0-39.0	3.77±5.91*	11.0-37.0
MUAC (cm)	17.84±2.07	13.0-24.0	18.31±2.35*	13.0-37.0
BMI (kg/m^2)	15.49±2.45	8.77-26.63	16.11±2.59	8.61-26.93

*$P \leq 0.05$: shows there was a significant difference, BMI - Body mass index

The result showed the mean and standard deviation of the anthropometric characteristics of height, age, weight, BMI and MUAC according to age groups in male children as shown in Table 2. The results in Table 3 show the mean and standard deviation of the anthropometric characteristics of height, age, weight, BMI and MUAC according to age groups in female Children. The results show that height, weight and BMI were significantly increased with age in Gbagyi school children of Nigeria in both males and females ($P \leq 0.05$). The results show that there was a proportional relationship between age and the parameters studied and an age-dependent increase in height and an age-dependent significant increase in weight and BMI in males ($P \leq 0.05$) except for BMI in which there was a decrease in ages 8 and 9 years which was not statistically significant. The females show an age-dependent significant increase in height, weight and BMI, except for the age 9 years in which BMI was not significantly decreased ($P \leq 0.05$).

Table 4 shows the level of significant between parameters studied in school children of Gbagyi tribe of Abuja Nigeria. $P < 0.001$**shows a high correlation between the parameters and *shows low correlation between the parameters.

The result in Table 4 shows the correlation matrix of the anthropometric parameters studied. The result shows a two-tailed correlation ($P \leq 0.001$) between height and age (r = 0.820; 0.738), weight (r = 0.827; 0.805) and BMI (r = 0.164; 0.030) in males and females, respectively. There was a two-tailed correlation ($P \leq 0.001$) between height and age (r = 0.778), weight (r = 0.705) and BMI (r = 0.894) in both male and female Nigerian school children of Gbagyi tribe of Abuja.

The results in Table 5 show linear regression of height (m) from age (years), weight (kg) and BMI (kg/m^2) of the male and female Nigerian school children of Gbagyi tribe of Abuja. The table show the standard error of estimate (SEE) not more than 0.099 m and 0.091 m for the prediction of height in males and females respectively, and for the total not more than 0.095 m. The linear regression equation for estimation of height from age (years), weight and BMI shows that there was a positive correlation ($P \leq 0.001$) between the gender and other parameters studied.

The result in Table 6 shows the multiple regression equation for estimation of height from age (years), weight, chest circumference, MUAC and BMI. The multiple linear

Table 2: Anthropometric parameters according to the age groups in male children

	Male school children					
Age group (years)	5	6	7	8	9	10
N	96	60	26	22	32	65
Height (m)	1.09±0.06	1.16±0.06	1.20±0.05	1.23±0.07	1.29±0.08	1.34±0.09*
Weight (kg)	17.07±2.7	19.77±3.39	24.62±3.75	24.96±4.45	26.88±4.38	29.25±4.78*
MUAC (cm)	17.06±1.8	16.87±1.50	17.58±1.53	18.27±2.59	18.22±1.45	19.63±1.99*
BMI (kg/m^2)	14.50±2.0	14.73±2.28	17.04±2.48	16.47±2.40	16.17±2.64	16.37±2.38*

*$P \leq 0.05$: Shows there was a significant difference, BMI - Body mass index

Table 3: Anthropometric parameters used according to age groups in female children

Female school children						
Age group (years)	5	6	7	8	9	10
N	55	48	30	35	48	74
Height (m)	1.08±0.05	1.14±0.07	1.17±0.07	1.21±0.08	1.27±0.07	1.32±0.11*
Weight (kg)	17.27±3.4	19.94±3.98	22.57±4.57	23.98±3.71	25.75±3.21	30.16±3.99*
MUAC (cm)	16.55±1.41	17.00±1.79	17.77±1.98	18.24±1.60	18.92±1.84	20.35±1.84*
BMI (kg/m^2)	14.75±2.81	15.25±1.84	16.37±2.81	16.58±2.53	15.99±1.52	17.37±2.70*

*$P \leq 0.05$: Shows there was a significant difference, BMI - Body mass index

Table 4: Correlation matrix of the anthropometric parameters used among Nigeria school children of Gbagyi tribe

Variables	Ages	Weight	Height	MUAC	BMI
Boys (*N*=300)					
Ages			0.820**		
Weight			0.827**		0.682**
Height	0.820**	0.827**		0.545**	0.164*
MUAC		0.545**			
BMI		0.682**	0.164*		
Girls (*N*=300)					
Ages			0.738**		
Weight			0.805**		0.607**
Height				0.649**	0.30**
MUAC			0.649**		
BMI		0.607**			

BMI - Body mass index, MUAC - Mid-upper arm circumference

regressions show a positive correlation ($P < 0.001$) of height with the other parameters used, but regression equation for estimation of height from BMI and chest circumference shows that there is no positive correlation of BMI with height ($P < 0.001$) in Nigerian children of Gbagyi tribe of Abuja.

The result from the present study show that some male and female Nigerian school children of Gbagyi tribe of Abuja have PEM which was assessed in each child using the UNICEF Brasilia arm circumference strip (1989), which have age-specific cut-off points for defining malnutrition. The MUAC value of a well-nourished child is above 13.5 cm, between 12 and 13.5 cm indicates malnutrition and below 12 indicates severe malnutrition according to WHO (1995). The results from the present study show that one male child (5 years) of the 300 males (0.33%) has PEM with MUAC value of 13 cm, and also one female child (6 years) of the 300 females (0.33%) has PEM with

Table 5: Linear regression of height (m) in male (*n* = 300) and female (*n* = 300) from the parameters used among the school children of Gbagyi tribe of Abuja

Sample population parameters predictive equation for height SEE R R² P
Males (*N* = 300)
Ht and Age Height = 0.849 + 0.0490age 0.068 0.820 0.672 < 0.001
Ht and Wt Height = 0.838 + 0.0159Wt 0.067 0.827 0.683 < 0.001
Ht and Hl Height = 0.545 + 0.0464Hl 0.084 0.706 0.498 < 0.001
Htand BMI Height = 1.07 + 0.00791BMI 0.012 0.164 0.027 < 0.001
Females (*N* = 300)
Ht and Age Height = 0.848 + 0.0469Age 0.080 0.738 0.545 < 0.001
Ht and Wt Height = 0826 + 0.0161Wt 0.070 0.805 0.648 < 0.001
Ht and Hl Height = 0.568 + 0.0448Hl 0.084 0.703 0.494 < 0.001
Ht and BMI Height = 1.19 + 0.00136BMI 0.012 0.30 0.09 < 0.001
Total sample (*N* = 600)
Ht and Age Height = 0.852261 + 0.0473903Age 0.074 0.778 0.604 < 0.001
Ht and Wt Height = 0.833852 + 0.0159312Wt 0.069 0.705 0.497 < 0.001
Ht and Hl Height = 0.556396 + 0.0455739Hl 0.084 0.816 0.665 < 0.001
Ht and BMI Height = 1.12888 + 0.0046667BMI 0.012 0.894 0.8 < 0.001

Table shows the predictive equation of height from the parameters used. Ht - Height, Wt - Weight, Hl - Hand length, Cc - Chest circumference, MUAC - Mid upper arm circumference, BMI - Body mass index.

Table 6: Multiple linear regression of height (m) from the dimensions used in male and female children of Gbagyi tribe of Abuja

Multiple parameters	Predictive equation for height	SEE	*P* value
Males (N=300) Wt and Age	Ht=0.800+0.00919wt+0.0267age	0.058	< 0.001
Hl and MUAC	Ht=0.445+0.0386Hl+0.0118MUAC	0.076	< 0.001
Cc and BMI	Ht=0.216+0.0182Cc-0.00729BMI	0.084	< 0.001
Females (N=300) Wt and Age	Ht=0.790+0.0116wt+0.0186age	0.067	< 0.001
Hl and MUAC	Ht=0.471+0.0310Hl+0.0161MUAC	0.080	< 0.001
Cc and BMI	Ht=0.378+0.0162Cc-0.00883BMI	0.089	< 0.001

Table shows the predictive equation of height from the parameters used. Ht - Height, Wt - Weight, Hl - Hand length, Cc - Chest circumference, MUAC - Mid upper arm circumference, BMI - Body mass index, SEE - Standard error of estimate

MUAC value of 13 cm as shown in Table 7. A MUAC value above 13.5 cm is normal for children from ages 2 to 5 years of age (WHO, 1995). This shows that PEM was uncommon in Gbagyi school children of Abuja.

The BMI for overweight and obesity by sex between age 2 and 18 years is shown in Table 8. The results from the present study found that 28 (9.33%) male Nigerian school children of Gbagyi tribe of Abuja were overweight and 6 (2%) were obese, while 38 (12.67%) female Nigerian school children of Gbagyi tribe of Abuja were overweight and 6 (2%) were obese as shown in Table 9 based on BMI guidelines (Cole *et al*., 2000) for defining obesity and overweight in children.

Table 7: The use of mid-upper arm circumference to determine the nutritional status among school children of Gbagyi tribe of Abuja-Nigeria

	Males			Females		
Age (yrs)	Above 13.5 cm	Between 12.5 and 13.5 cm	<12.5 cm	Above 13.5 cm	Between 12.5 and 13.5 cm	<12.5 cm
5	94	1*	Nil	55	Nil	Nil
6	60	Nil	Nil	47	1*	Nil
7	26	Nil	Nil	30	Nil	Nil
8	22	Nil	Nil	45	Nil	Nil
9	32	Nil	Nil	48	Nil	Nil
10	65	Nil	Nil	73	Nil	Nil

*The number of school children undergoing PEM in the age groups studied in Nigerian school children of Gbagyi tribe of Abuja. PEM - Protein energy malnutrition

Table 8: The International cut-off points for body mass index for overweight and obesity used for the present study of age between 5 and 10 years

	Body mass index 25 kg/m² Body mass index 30 kg/m²			
Age (yrs)	Overweight		Obese	
	Male	Female	Male	Female
5	17.42	17.15	19.30	19.17
6	17.55	17.34	19.78	19.65
7	17.92	17.75	20.63	20.51
8	18.44	18.35	21.60	20.57
9	19.10	19.07	22.77	22.81
10	19.84	19.86	24.00	24.11

DISCUSSION

The result of the present study showed that the dimension of height, age, weight, MUAC, chest circumference and BMI can successfully be used for the estimation of nutritional status and height in Nigerian school children of Gbagyi tribe. The parameters named above showed significant correlation with nutritional status and height in both male and female Nigerian school children of Gbagyi tribe of Abuja; hence these can be used by law enforcement agents and forensic scientists to identify fragmentary and dismembered human remains in Gbagyi school children of Abuja, since it is an established fact that long bones are the most appropriate specimen for height evaluation (Krogman and Iscan, 1986). It has been shown in this study that there is a two-tailed significant correlation between BMI and height, and also with other parameters: age, weight, MUAC, chest circumference, and nutritional status in both male and female Nigerian school children of Gbagyi tribe of Abuja.

The use of anthropometric methods have been shown to be very useful in the estimation of nutritional status in children and in athletes in which the bone area values at different sites of the body are strongly related to muscle strength and parameters related to body size such as height, weight, lean mass, fat mass and BMI (Ruff, 2000; Pettersson *et al*. 2000). Thus morphometric estimation of body mass from skeletal frame size appears to work reasonably well in both normal and highly athletic modern humans (Ruff, 2000; Pettersson *et al*., 2000). The present study shows that weight could be correlated with height and weight could be correlated with BMI which can be correlated with the nutritional status in

Table 9: Age-specific distribution of underweight and obese school children of Gbagyi tribe of Abuja based on BMI (kg/m²) sample of 300 male and 300 female children

Age (yrs)	Distribution of overweight male children	Distribution of obese male children	Distribution of overweight female children	Distribution of obese female children
5	(7) 17.65;18.06; 18.14; 17.65; 19.22; 17.86;17.57	Nil	(7) 17.57; 17.24, 17.47; 17.30; 17.30; 17.80; 18.85	(2) 22.71; 23.57
6	(1) 19.17	(3) 20.14, 20.45;20.86	(6) 18.06; 18.34; 17.36; 17.76; 17.64; 18.44	Nil
7	(8) 20.49; 20.45; 20.48; 19.07; 18.75; 18.15; 19.53; 18.14	(1) 24.11	(5) 19.81; 20.16; 18.63; 18.47;18.58	(1) 26.93
8	(6) 20.40; 20.83; 19.77; 19.81; 19.44; 18.93	Nil	(11) 20.58; 19.58, 18.80; 20.78; 21.55; 18.65; 18.86;18.67, 20.09; 19.95;19.93	Nil
9	(4) 19.48; 20.14; 19.12; 19 0.12.	(1) 23.12	(2) 19.07; 19.23	Nil
10	(2) 20.81; 23.08	(1) 26.63	(7) 20.86; 20.16, 21.36; 22.76; 20.20, 20.61; 23.44	(3) 26.01; 26.91; 26.20

BMI - Body mass index, The number in bracket shows the actual number of children with the condition above among the school children of Gbagyi tribe of Abuja.

Nigerian Children of Gbagyi tribe of Abuja as shown from the present study. This shows that the more the height, the lower the BMI then the higher the nutritional status and athletic performance (Ruff, 2000; Pettersson *et al*. 2000). Estimation of the nutritional status using various physical measurements has been attempted by many researchers but the variables that proved to be consistently reliable in estimating nutritional status are the MUAC and BMI (Kanchan *et al*., 2010). The results from the present study show that MUAC, BMI and age can be used to predict nutritional status, together with weight, chest circumference and height. From the present study, the parameters used to determine height can also be used to determine nutritional status because there was a two-tailed significant correlation between nutritional status and age, weight, height, chest circumference, MUAC and BMI in both male and female Nigerian school children of Gbagyi tribe of Abuja.

This study was designed to establish a relationship between the nutritional status, BMI and MUAC in Gbagyi primary school children aged between 5 and 10 years. The present study tried to derive regression equations which could help in the prediction of nutritional status in Nigerian school children of Gbagyi tribe of Abuja. The equation for the estimation of nutritional status from height, BMI and MUAC measurements of Nigerian school children of Gbagyi tribe of Abuja differs from those presented by Bhartnagar (1984), who carried out studies among the Punja male children with higher measurement values resulting in differences in the equation and invariably differences in the estimation of nutritional status. These differences could be due to the differences in the average values of the parameters studied. The differences could also be due to the different methods and parameters used in the present study.

MUAC is a measure of both energy deficiency in adult and children, and is a useful index of the efficacy of the nutritional therapy in PEM and obesity. The measurement of MUAC can be regarded as a screening method for underweight, normally assessed from BMI to identify the preferential loss of peripheral tissue stores of fat and protein (Ferro-Luzzi *et al*., 1996). BMI and MUAC are sometimes used in conjunction to classify adult nutritional status (James *et al*., 1994). A MUAC value < 18.5 cm may be indicative of acute under nutrition and MUAC value of 16.0 cm indicates severe nutrition (James *et al*.,1994). The results from the present study show that one male child of 300 males has PEM with MUAC value of 13 cm, and also one female child of 300 females has PEM with MUAC value of 13 cm. A MUAC value above 13.5 cm is normal for children from ages 2 to 5 years (WHO, 1995). This shows that PEM was uncommon in Nigerian school children of Gbagyi tribe of Abuja. The MUAC value of a well-nourished child is above 13.5 cm, between 12 and 13.5 cm indicates malnutrition and below 12 indicates more severe malnutrition (WHO, 1995).

BMI has been accepted as index of obesity or adiposity in adults (Garrow and Webster, 1985) while the usefulness of BMI for defining children is not clear hitherto. When an accurate determination of standing height cannot be obtained, weight could be used interchangeably in determining the nutritional status (Torres *et al*., 2003). The BMI value > 25 kg/m^2 indicates overweight and between 18.5 and 25.00 kg/m^2 indicates normal weight for healthy limit (WHO, 1990). Most studies show increased mortality in the leanest as well as the most obese individuals (Rissanen, *et al*. 1989; Goldstein, 1992). Cole *et al*. (2000) reported age-specific BMI standards or defining obesity and overweighed in children. The present study found that 28 male school children of Gbagyi tribe of Abuja were overweight and 6 were obese children, while 38 female school children of Gbagyi tribe of Abuja were overweight and 6 were obese children based on the WHO BMI guidelines (Cole *et al*., 2000) for defining obesity and overweight in children.

CONCLUSION

The results from the present study indicated that MUAC and BMI are proxy indicators for nutritional status when it is difficult to measure height directly, and also other variables stand as indicators for predicting nutritional status. Also the present study was able to establish the nutritional status of children in the study area showing that few children are malnourished (male: 0.33%; female: 0.33%), overweight (male: 9.33%; female: 12.67%) and obese (male: 2%; female: 2%) among Nigerian school children of Gbagyi tribe of Abuja. Thus height, weight, MUAC and BMI may be reliable indicators of nutritional status able to replace the more complicated anthropometric indices, based on their simplicity and predictive value to easily screen large numbers of children. This study was able to identify nourished, malnourished, overweight and obese children in school children of Gbagyi tribe of Abuja Nigeria and if applied earlier, the children can be treated easily and effectively.

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