International Journal of Sports Science and Performance
ISSN: 2583-2638
https://journal.kannuruniversity.ac.in/ijssp/

A Cross Sectional Study to Measure BMI and US Navy Method of Fat Percentage of Young Boys of Indore City

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Article Info

Key Words:
BMI, US Navy Method

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Article Received: 10.03.2021
Article Accepted: 25.05.2021
Article E-Published: 14.07.2021

Abstract

The purpose of the present study was to conduct a cross sectional study to measure BMI, and fat percentage of school going boys of Indore using US Navy method and to validate the US Navy method for young boys in Indian condition. The result indicated that obesity varies between age categories. US Navy method of fat percentage is found a valid method for estimating body fat for young children or students. Height is found as a suppressed variable and does not have direct relationship with US Navy fat method of percentage or newly developed modified fat percentage method but when combined with other variable it contributes in the estimation of body fat percentage. Modified Fat % method indicated four predictor variables i.e. Waist, height, neck and weight selected in a sequence for estimating body fat percentage. Model 3 and model 4 are found most suitable for predicting body fat percentage of young boys.

Introduction

In 2014 World Health Organization (WHO), estimated around 600 million obese adults worldwide. A Chinese nutrition survey shows that the prevalence of overweight and obesity was 19.2% and 15.0%, respectively. Obesity is a serious problem because of the increasing possibility of a wide range of health consequences, including hypertension, insulin insensitivity, diabetes mellitus, cardiovascular disease, and distinct types of cancers. The cost of medical care for obese patients is 30% higher than that of the normal weight peers.

Obesity is a medical condition in which excess body fat has accumulated to an extent that it may have a negative effect on health. People are generally considered obese when their body mass index (BMI), a measurement obtained by dividing a person's weight by the square of the person's height, is over 30 kg/m^2 the range 25–30 kg/m^2 is defined as overweight. Body composition (fat percentage) can be measured in several ways, the most appropriate method for measuring body fat percentage is under water weighing method. In this method, the direct body density is measured by underwater weighing. However, this method is restricted to laboratory testing.

Body mass index is perhaps the most common anthropometric measure used to predict relative overweight. It is specially recommended for young people from 2 year to 20 years. However,

 Cite this article: Yadav, Poonam & Kumar, Ajay: A Cross Sectional Study to Measure BMI and US Navy Method of Fat Percentage of Young Boys of Indore City. International Journal of Sports Science and Performance 2022; 2:1:1-5, July 2022, ISSN:2583-2638. Access this article online: https://journal.kannuruniversity.ac.in/ijssp/

the value of the measurement in children and adolescent is regularly questioned. The natural sequence of growth and maturation in children, as well as individual variation within the same period, indicate that indices of weight for height, such as the body mass index (W/H2), are extremely accurate measures of adiposity. BMI is not completely independent of height in children younger than 15 years of age and should be used with caution.

The body mass index (BMI) is another contentious statistical measurement that measures a person's weight and height. Though it does not assess body fat percentage, it may be a useful tool for estimating a healthy body weight based on a person's height.

It is the most extensively used diagnostic technique to diagnose weight disorders in the population, usually whether an individual is underweight, overweight, or obese, due to its ease of measurement and calculation. Body mass index can also be calculated using a Body Mass Chart, which shows the body mass index as a function of weight (horizontal axis) and height (vertical axis) with control lines for different body mass index values or colours for different body mass index categories.

Bioelectric impedance is one of the most popular methods to measure body fat and lean body mass, but it is not recommended for young children. The US Navy formula for fat percentage is another simple way of measuring body fat percentage which takes into account simple variables such as gender, weight, height, waist, hip (for female only) and neck circumference. This method directly measures the body fat percentage and this is the unique quality of this method.

The objective of this study was to find out the BMI, and fat percentage of young boys using US Navy method of fat percentage and the cross sectional comparison of BMI and fat percentage between various age category. The second objective of the study was to validate the US avy method of fat measurement for the young boys in Indian condition, Mand develop an equation to calculate the fat percentage of young boys, if the US Navy method has shown significant high correlation with BMI.

Methods

For the selection of subjects a single school was selected on convenience basis, whereas subjects from the school were selected randomly.

Students from class 6^{th} to 10^{th} were selected for this study and randomly 525 School going boys were selected for this study from Sanmati Public School, Indore. The ages of the subjects were range from 9 years to 15 years.

Height and weight were recorded from the school record as school periodically measured these data of the students. The neck circumference, waist circumference and hip circumference were measured by the researcher with the help of her colleague. Data were analysed on IBM statistical package for the social sciences (SPSS).

For validating US Navy method of fat percentage for young boys, BMI was considered the criterion measure of obesity in younger boys. BMI is an approximate measure of weather someone is over or under weight, calculated by using body weight in kg / height in $meters^{2.}$ and is considered suitable measure of fatness for young boys. The metric formula for BMI and Fat % by US Navy method are:

- BMI = Weight (kg) / [Height (m)] ^{2}
- Fat % = {86.01x Log10 (Waist Circumference - Neck Circumference)} – {70.041x Log10 (Height)} + 30.3

Descriptive statistics was applied to describe the characteristics of BMI, and fat percentage (US Navy method). Product moment correlation was used to validate the US Navy method of fat percentage for young boys and step wise regression was used to construct the regression equation for calculating fat as per US Navy method for young boys. Modified fat percentage method was developed and regression equation was given for the same.

Findings

The descriptive statistics, frequencies of subjects in various categories of classification and ANOVA between various age categories for BMI, and fat percentage are presented through tables and figures. Correlation matrix and regression analysis are used to validate US Navy fat percentage as a valid test in Indian condition and modified fat percentage regression equation is developed for school going boys.

Table 1
Frequencies of Subjects Under Various BMI Categories of Various Age Group of School

Age in Years	Under Weight	Healthy Weight	Over Weight	Obese Category 1	Obese Category 2	Obese Category 3	Total Subjects
9	51	13	0	0	0	0	64
10	58	27	6	0	0	0	91
11	41	27	5	4	0	0	77
12	48	37	4	1	0	0	90
13	61	39	15	2	0	0	117
14	36	25	6	1	0	0	68
15	9	9	0	0	0	0	18
Total	304	163	36	8	0	0	525

Table 2
Frequencies of Subjects Under Various Fat % Categories of Various Age Group of School Going Boys of Indore

Age in Years	Under fat	Healthy fat	Over fat	Obese	Total
9	5	40	14	5	64
10	13	43	27	8	91
11	4	45	10	18	77
12	17	45	15	13	90
13	16	62	21	18	117
14	12	39	12	5	68
15	2	12	3	1	18
Total	69	286	102	68	525

For analysing the second objective of the study that is "to validate or modified the US Navy method of fat measurement for the young boys in Indian condition, and to develop an equation to calculate the fat percentage of young boys, the correlation matrix was developed between various body measurements like height weight neck waist hip and with BMI and various ratio of the body i.e. Waist-hip ratio, neck-waist ratio, waist-height ratio, neck height ratio hip height ratio and BMI fat percentage method. Out of the large correlation matrix the correlations found significant and high are below in table 3.

Table 3
Pearson Correlation between Various Anthropometric Variable, BMI and Fat Percentage for Young Children

Variables	Height	Weight	Neck	Waist	Hip	BMI	Navy Fat
Height	1	.721**	.606**	.473**	.578**	.272**	0.023
Weight	.721**	1	.848**	.869**	.922**	.854**	.556**
Neck	.606**	.848**	1	.786**	.838**	.737**	.437**
Waist	.473**	.869**	.786**	1	.938**	.863**	.863**
Hip	.578**	.922**	.838**	.938**	1	.864**	.713**
BMI	.272**	.854**	.737**	.863**	.864**	1	.763**
Navy Fat	0.023	.556**	.437**	.863**	.713**	.763**	1

The researcher has found that all the other variables except height are statistically significant with US Navy fat % method and BMI having high correlation value. Height may be here as a suppressed variable which might considered in equation when regression is applied. The following findings support the reason to apply regression analysis.

1. US Navy fat percentage and height- .023, BMI and Height - .272**

2. US Navy fat percentage and weight-.556**, BMI and Weight - .854**
3. US Navy fat percentage and neck-.437**, BMI and neck - .737**
4. US Navy fat percentage and waist-.863**, BMI and waist - .863**
5. US Navy fat percentage and hip-.731**, BMI and hip - .864**

Table 4
Regression Analysis for Predicting Body Fat % through Anthropometric Variables for Young Children

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	Df2	Sig. F Change
1	.863[a]	0.745	0.745	3.23	0.745	1527.91	1	523	0
2	.968[b]	0.936	0.936	1.61	0.191	1562.14	1	522	0
3	.993[c]	0.986	0.986	0.76	0.05	1801.88	1	521	0
4	.993[d]	0.987	0.987	0.73	0.001	48.181	1	520	0

a. Predictors (Constant), Waist, b. Predictors (Constant), Wasit, Height, c. Predictors (Constant) Wasit, Height, Neck, d. Predictors (Constant) Wasit, Height, Neck, weight, e. Dependent Variable: US Navy Fat %

Table 4 reveals that the four variables i.e. waist, height, neck and weight have been selected as predictor variables for body fat percentage. Total four models were extracted for body predicting body fat percentage in which model 3 is found most suitable as its multiple correlation (R) is reached .993 and the value of R^2 is .986. This model has selected first variable as waist, second variable as height, and third variable as neck. The fourth model has added one more variable i.e. Weight as fourth variable but there is no increase in R whereas a negligible increase in R^2 from .986 to .987, so both the 3rd and 4th model can be used to develop regression equation to estimate the fat percentage. Significant difference found in the experimental group and control group in the pre-test and post-test as the cal. F value i.e., 40.57 for pertest was found to be greater than the tabulated f value 4.54 with (1,7) df at 0.05 level of significance.

Table 5
Beta Coefficients of Models Selected for Estimating Body Fat Percentage

Model		Unstandardized Coefficients		Standardized	Correlations		
		B	Std.	Beta	Zero	Partial	Part
1	Constant	-23.414	1.04				
	Waist	0.542	0.04	0.863	0.863	0.863	0.863
2	Constant	2.922	0.84				
	Wasit	0.689	0.008	1.098	0.863	0.968	0.967
	Height	-0.245	0.006	-0.496	0.023	-0.866	-0.437
3	Constant	10.28	0.437				
	Wasit	0.85	0.005	1.354	0.863	0.99	0.837
	Height	-0.186	0.003	-0.376	0.023	-0.928	-0.299
	Neck	-0.887	0.21	-0.399	0.437	-0.881	-0.223
4	Constant	5.438	0.814				
	Wasit	0.886	0.007	1.411	0.863	0.983	0.613
	Height	-0.168	0.005	-0.34	0.023	-0.878	-0.21
	Neck	-0.832	0.022	-0.374	0.437	-0.861	-0.194
	Weight	-0.051	0.007	-0.108	0.556	-0.291	-0.035

Conclusion

The regression equation for all the four models is developed using table 7 i.e., beta coefficient of constant and weighted variables for predicting body fat percentage. The researcher suggests using model 3 when you are only a measuring tape but don't have a weighing machine and model 4 can also be used if weighing machine is also available.

Regression Equation for Estimating Body Fat Percentage

Equation 1. (Model 1)

Body Fat % = Waist X 0.542 – 23.414

Equation 2. (Model 2)

Body Fat % = Waist x 0.689 – Height X 0.245 + 2.922

Equation 3. (Model 3)

Body Fat % = Waist X 0.850 – Height X 0.186 – Neck X 0.887 + 10.286

Equation 4. (Model 4)

Body Fat % = Waist X 0.886 – Height X 0.168 – Neck X 0.832 – Weight X 0.051 + 5.438

The finding of this study has conclude that:

1. The obesity varies between age categories in young boys.
2. US Navy Fat Percentage method is found a valid method for estimating body fat for young boys.
3. Height is found as a suppressed variable and does not have direct relationship with US Navy fat percentage methods or newly developed modified fat percentage method but when combined with other variable it contributes in the estimation of body fat percentage.
4. Total four models were extracted for predicting body fat percentage in which model 3 is found most suitable as its multiple correlation (R) is reached .993 and the value of R^2 is .986. and selected predictable variables as waist, height and neck. Also the model three has advantage that it requires only a measuring tape and weighing machine is not required.
5. The fourth model has added one more variable i.e. Weight as fourth variable but there is no increase in R whereas a negligible increase in R^2 from .986 to .987, so both the 3rd and 4th model can be used to develop regression equation to estimate the fat percentage.

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