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Correlation Between Body Mass Index and Middle Upper Arm Circumferences in Liver Cirrhotic Patients

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Abstract: People who are suffering from the liver cirrhosis are more vulnerable to deficiency of nutrition. Body mass index (BMI) is considered as a good marker for assessing the malnutrition in patients ($<18.5 \text{ kg/m}^2$), but sometimes it is not possible to weigh and measure height of the patients, so it is necessary to find out the indicators of nutritional measured in patients. This study is aimed to analyze the relationship between BMI and another indicator, middle upper arm circumference (MUAC) for evaluation of nutrition in patients. This study included 50 cirrhotic patients and BMI and MUAC were calculated and then Pearson correlation was applied to analyze the correlation between BMI and MUAC, which showed the positive significant correlation between these two variables and then a simple linear regression model was applied with MUAC as predictor of BMI. The results showed that MUAC is a significant positive predictor of the BMI, it means MUAC can be used as a substitute of BMI when patients cannot be weighed and measured.

Keywords: Nutrition, Liver cirrhosis, Body mass index, Middle upper arm circumference, Correlation

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Introduction

Liver is very important organ of the human body and play vital role in metabolism by detoxification of harmful products and also functions as clotting factor and other proteins and excretion of bile. But when there is progressive distortion in the liver function then it became a chronic liver disease. This is a continued process of inflammation resulted in replacement of the healthy liver parenchyma with fibrotic tissue and regenerative

nodules, that is called liver cirrhosis and it is last stage of chronic liver disease. This is consequences of different cause such as non-alcoholic fatty liver disease, high alcohol consumption, liver injury, autoimmune disease, hepatitis B or C infection. Nutrition is the main concern in the liver cirrhosis as its deficiency is common in patients with end stage of liver cirrhosis because malnutrition is an independent predictor of mortality and is

associated with the some complication such as, ascites, encephalopathy and hepatorenal syndrome. Nutritional deficiency is common in patients with end stage liver disease (cirrhosis) and is often associated with a poor prognosis (Norman *et al.*, 2008). There is not any universally accepted diagnosis of malnutrition, but is commonly associated with the weight loss, poor dietary intake, low body mass index and low muscle mass strength. This study is aimed to analyse the relationship between BMI and another indicator, middle upper arm circumference (MUAC) for evaluation of nutrition in patients.

Body mass index (BMI) in relation to weight (kg/height in m²) is a good measure to detect the malnutrition. BMI of 18.5 kg/m² is indicator of the malnutrition in patients. But sometimes it is not possible to weigh and measure height of the patients. So another method is middle upper arm circumference (MUAC), which is the indicator of protein and energy reserves of the individual and has been used for many years for evaluation of nutrition in patients (Sultana *et al.*, 2015). MUAC can represent a useful measurement of malnutrition, especially in the absence of weight and height measurements, which constitute BMI (Eleraky *et al.*, 2021). Rahman *et al.* (2025) reported the positive association between BMI and MUAC (R=0.69, P<0.001) and the association was stronger in females (R= 0.75, P<0.001). The present study was aimed to measure the national status of the liver cirrhosis patients and find out the relation between BMI and MUAC.

Materials and Methods

The study was carried out in clinic of dietician. Randomly 50 patients of liver cirrhosis were evaluated who received the nutritional assessment by dietician and staff with anthropometric data (height, weight, BMI and MUAC). The data included age, sex and BMI and MUAC. MUAC of the patients were measured by inelastic measuring tape model Seca 201. Measurement was taken just at the midpoint between acromion and the olecranon in sitting and standing posture. MUAC was measured twice for every patients and

average of MUAC was recorded in centimetres. Weight and height of all liver cirrhosis patients were measured by using the model Seca 220 scale and BMI was calculated by analysis software using the formula weight (kg)/height (m)². Informed written consent was obtained from the patients participating in the research study.

Statistical analysis

The data of qualitative variables is presented with their frequency distribution and summarised by mean and standard deviation (SD). The simple linear regression coefficient of equation and Pearson linear correlation coefficient were applied to analyse the linear relationship between MUAC and BMI. Goodness of fit index was applied for determination of coefficient (R²). IBM SPSS (30.0 Version) was used to analyse the data.

Results and Discussion

The present study assessed 50 cirrhotic patients. Physical characteristics were assessed by measuring the height, weight, BMI and MUAC. The mean height of cirrhotic patients was 1.67 m (SD = 0.13), and mean weight was 75.44 kg (SD = 13.80) (Table 1). BMI was calculated from weight and height by applying formula and mean of total BMI of patients was 27.04 (SD = 4.16). The mean of MUAC of cirrhotic patients was 31.22 (SD = 4.91). It was assessed that 3 (6%) cirrhotic patients were underweight (Table 2). According to BMI standard followed by normal weight, only 8 (16%) patients were under the normal range category. Maximum number of patients 26 (52%) were under the overweight category and 13 (26%) patients were suffering from obese.

Relationship between BMI and MUAC

There was positive correlation between BMI and MUAC among the patients as correlation was statistically significant (r = 0.606; p <0.001) (Table 3). A simple linear regression was applied with the MUAC as predictor and BMI as dependent variable. Overall results showed a significant regression equation F (1, 49) = 28.39; p <0.001) (Table 4) with a r² is 0.36 (Fig. 1), which showed that MUAC

Table 1: Physical characteristic of subjects

Characteristics	Mean	Standard deviation
Height (m)	1.67	0.13
Weight (kg)	75.44	13.80
BMI	27.04	4.16
MUAC	31.22	4.91

Table 2: Assessment of weight according to standard of BMI

BMI standard	Frequency	Percentage
Underweight	3	6
Normal weight	8	16
Overweight	26	52
Obese	13	26

Table 3: Model Summary

Model	R	R square	Adjusted R
1	0.606	0.367	0.354

Table 4: ANOVA

Model	Sum of Squares	df	F	Sig.
Regression	318.475	1	28.390	<0.001
Residual	549.671	49		
Total	868.146	50		

Table 5: Coefficients

Model		Standardized Coefficients Beta	t	Sig.
1	MUAC	0.606	5.328	<0.001

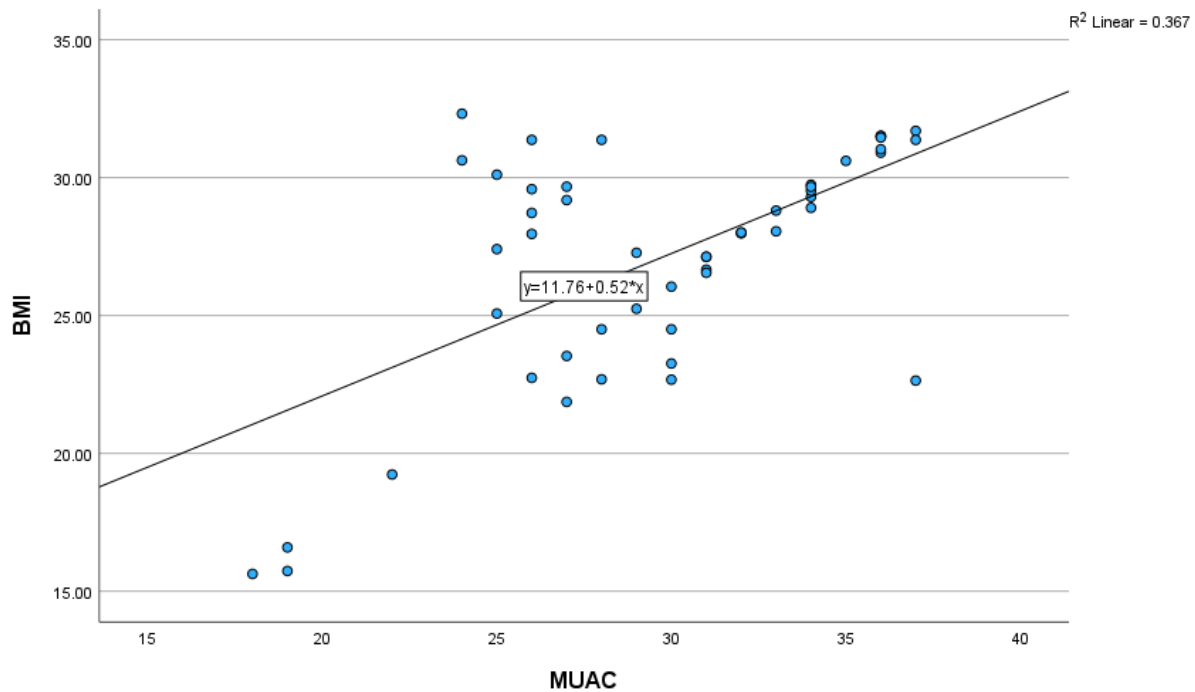


Fig. 1: Scatter plot of correlation between MUAC and BMI

can explain the 36% variations in the BMI among the patients. Table 5 showed that MUAC was a significant positive predictor of the BMI ($\beta = 0.606$; $t = 5.32$; $p < 0.001$).

The present study was aimed to assess the relationship between MUAC and BMI among 50 cirrhotic patients who are assessed by dietician. The findings of this study showed the positive correlation between the BMI and MUAC and correlation was statistically significant. There was a close relation between muscle mass strength and absolute quantity of muscle (Norman *et al.*, 2008). Result of this study is also in agreement with the many earlier studies which showed the positive correlation between BMI and MUAC. BMI has been used an indicator for measurement of under-weight and obesity, however, quite recently MUAC has also been used. The studies carried out in

India and Bangladesh fixed the cut off values for both male and female adults (Sultana *et al.*, 2015; Das *et al.*, 2018). The correlation between MUAC and BMI is positive regardless of sex or rural/urban residence. Therefore, the MUAC can be used as a clinical test to predict BMI (Thokozani *et al.*, 2024).

This study was also aimed to analyze the MUAC as predictor of BMI. Results showed that MUAC was a significant positive predictor of the BMI ($\beta = 0.606$; $t = 5.32$; $p < 0.001$). as similar result was observed in the previous studies. The study of MUAC can explain approximately 69.9% of the variation in BMI. MUAC was a strong predictor of BMI ($r = 0.836$, $p < 0.001$) (Thokozani *et al.*, 2024). MUAC is strongly correlated with BMI in adults in Nepal. For simplicity, a MUAC of 24.5 cm is the optimal statistically and setting

based cut off in both women and men to identify underweight (BMI < 18.5 kg/m²) (Lene *et al.*, 2020). Findings of this study showed that BMI and MUAC are positively correlated to each other and MUAC is good predictor of BMI, which indicates that MUAC can be used to estimate the underweight and malnutrition among the patients. It can be good substitute of BMI in some situation where patient cannot be weighed or measured.

Conclusion

This study concludes that BMI and MUAC, both are used to assess the nutrition status of the patients. BMI is used to classify the weight of person as categories of underweight, normal, overweight and obese. Findings of this study showed the positive significant correlation between BMI and MUAC. This study also showed MUAC as good predictor of BMI which means now MUAC can be used in the place of BMI as low source nutritional screening tools among the patients.

Ethical Statement

No animal or microbes have been used or sacrificed for this study, hence Ethical Approval not required.

Author Contributions

Each author has contributed equally in designing the research, conducting thorough analysis, drafting the manuscript, and refining its content. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

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