National Board of Examinations - Journal of Medical Sciences
Volume 2, Issue 10, Pages 1023–1031, October 2024
DOI 10.61770/NBEJMS.2024.v02.i10.007

**ORIGINAL ARTICLE**

# Sarcopenia Prevalence in Liver Cirrhosis Patients Using MRI and Handgrip Strength Measurements

Mukul Kansal,[1] Shikha Digra,[2] Navpreet Kaur Batth,[3] Pulkit Jindal,[4,*] Deeksha Singhal[5] and Nikhar Somani[6]

[1]*Senior Resident, Department of Medicine, Government Medical College, Patiala*
[2]*Specialist Medical Officer, District Hospital, Fatehgarh Sahib, Punjab*
[3]*Medical Officer, Department of Medicine, Hazrat Haleema Hospital, Malerkotla, Punjab*
[4]*Senior Resident, Department of Medicine, Adesh Medical College, Kurukshetra, Haryana*
[5]*Department of Medicine, Government Medical College, Patiala*
[6]*Senior Resident, Department of Pediatrics, Adesh Medical College, Kurukshetra*

Accepted: 01-August-2024 / Published Online: 11-October-2024

## Abstract

**Background:** Cirrhosis, a leading cause of mortality worldwide, is histologically represented as formation of regenerative nodules encircled by fibrous bands caused by chronic liver injury. Nutritional status in cirrhotic patients is challenging to assess due to fluid accumulation resulting from impaired protein synthesis. Factors such as reduced food intake, malabsorption, and altered macronutrient metabolism negatively impact the nutritional status, leading to sarcopenia. The development of sarcopenia is multifactorial and is linked to lower survival rates. **Aim:** To assess sarcopenia prevalence in liver cirrhosis patients using MRI and handgrip strength measurements. **Discussion:** Impaired food intake in liver cirrhosis results from a combination of factors including loss of appetite, hormonal changes, early satiety, ascites, nausea, taste disturbances, and functional dyspepsia. Malabsorption can also occur due to portosystemic shunting, reduced bile production, chronic pancreatitis, and small intestinal bacterial overgrowth, all of which contribute to sarcopenia. It also arises from complex interactions involving impaired glycogen synthesis, inadequate nutrition, disrupted skeletal muscle protein synthesis and underlying hypermetabolism. **Conclusion:** MRI-based assessments indicate there is a significant occurrence of sarcopenia in individuals with cirrhosis. Our findings reveal that handgrip strength, when correlated with MRI results, is a reliable predictor of sarcopenia in these patients.

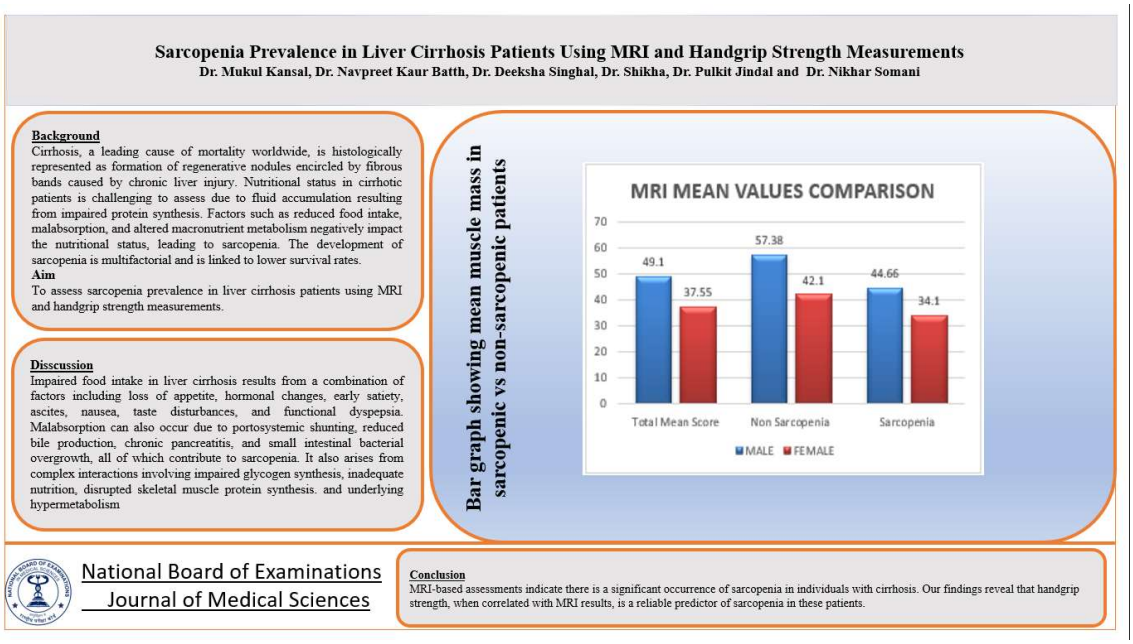
**Keywords:** cirrhosis, sarcopenia, MRI, handgrip strength

*Corresponding Author: Pulkit Jindal
Email: jindalpulkit768@gmail.com

**Abbreviations:**

| | | |
|---|---|---|
| BIA | : | Bioelectrical Impedance Analysis |
| CTP | : | Child-Turcotte-Pugh |
| CT/MRI | : | Magnetic Resonance Imaging/ Computed Tomography |
| SPPB | : | Short Physical Performance Battery |
| MELD | : | Model for End-Stage Liver Disease |
| IVNAA | : | In-Vivo Neutron Activation Analysis |
| HGS | : | Hand Grip Strength |
| DXA | : | Dual Energy X-ray Absorptiometry |

**Graphical Abstract**




## Introduction

Liver cirrhosis is histologically represented as formation of regenerative nodules encircled by fibrous bands caused by chronic liver injury leading to portal hypertension and end-stage liver disease [1]. The CTP and MELD scores are currently the best tools for mortality prediction in cirrhosis patients. However, these scores do not evaluate the patients' nutritional and functional status [2]. Nutritional status in cirrhosis is negatively impacted by impaired food intake, malabsorption, and altered macronutrient metabolism. Malnutrition plays a major role in the onset of sarcopenia among patients with cirrhosis [3]. Sarcopenia, a progressive and generalized skeletal muscle disorder, results from impaired glycogen synthesis, impaired skeletal muscle protein synthesis, inadequate nutrition, and underlying hypermetabolism because of the portosystemic shunting present in a cirrhotic liver [4].

## Pathophysiology

Multiple factors play a role in the initiation and advancement of sarcopenia. Impaired protein synthesis, neuromuscular integrity, proteolysis, and muscle fat content are few to name. Due to reduced glycogen reserves, lipid and protein

metabolism shifts towards a catabolic pathway, feeding gluconeogenesis. The phosphoinositide 3-kinase/mammalian target of rapamycin signalling pathway plays a significant role in sarcopenia via myostatin and insulin-like growth factor-1. Other hormonal factors may also contribute to the loss of skeletal muscle mass [5]. In patients with cirrhosis, limited functional capacity makes exercising difficult, and gastrointestinal tract alterations reduce food intake, resulting in suboptimal nutrient availability [6]. Additionally, the systemic pro-inflammatory status, triggered by altered gut microbiota and increased intestinal permeability, may further contribute to the development of cirrhosis-associated sarcopenia as shown in Figure 1 [7].

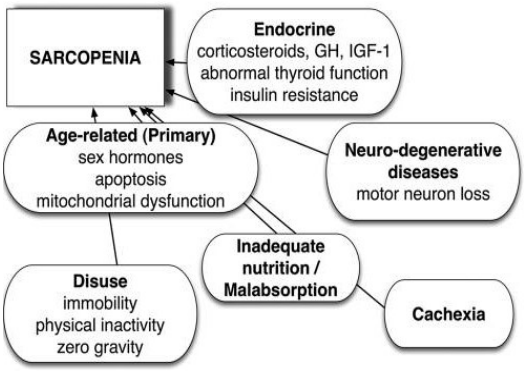



Figure 1. Sarcopenia: Multifactorial causation

**Stages of sarcopenia**

Sarcopenia can be classified into two types: primary and secondary. Primary sarcopenia, also known as age-related sarcopenia, occurs when aging is the sole apparent cause. In contrast, secondary sarcopenia arises when there are additional contributing factors.[8]

Sarcopenia can be divided into 3 stages: presarcopenia, sarcopenia, and severe sarcopenia. This classification is given by European Working Group on Sarcopenia in Older People as shown in Figure 2.

| Stage | Muscle mass | Muscle strength | Performance |
|---|---|---|---|
| Presarcopenia | ↓ | | |
| Sarcopenia | ↓ | ↓ | N or ↓ |
| Severe Sarcopenia | ↓ | ↓ | ↓ |

Figure 2. Stages of Sarcopenia

**Presarcopenia** is the first stage in which the loss of muscle mass has started but it still not has put a significant impact on physical performance or muscle strength. Diagnosis of this stage requires help of techniques that accurately measures muscle mass and then by comparing it to standard population norms.

**Sarcopenia** is the second stage in which muscle mass loss has already started but there is reduction of one of the two factors: physical performance or muscle strength.

**Severe sarcopenia** is the third stage and is diagnosed when all three factors are present including low muscle mass, decreased physical performance and reduced muscle strength [9].

**Assessment techniques**

Contemporary methods for identifying and diagnosing sarcopenia prioritize physical performance measures as the initial step. Evaluating muscle mass follows as the second diagnostic stage [10]. Muscle mass can be measured at various levels of body composition, with the complexity ranging from atomic detection to anatomical measurement as shown in Figure 3 [11]. The research databases were thoroughly searched, resulting in the identification of sixty-two eligible publications that included tools for

assessing physical performance, muscle strength and muscle mass [12].

MRI was employed as the gold standard for assessment of muscle mass due to its excellent resolutions, which allow for detailed evaluation of morphological as well as biochemical properties of muscles. One significant advantage of MRI over other imaging techniques is its ability to detect changes in muscle structure associated with aging and disease progression. MRI also provides accurate insights into intramuscular water and fat content non-invasively [13]. However, due to its high cost and limited accessibility, Cin anthropometric parameters such as handheld dynamometry and gait speed are commonly used to diagnose sarcopenia. The studies found that SPPB or handheld dynamometry with gait speed offer valid and reliable measurements of muscle strength and physical performance, respectively [14]. Muscle depletion and low handgrip strength were defined as <26 kg and SMI <52.4 $cm^2/m^2$ for men and <18 kg and SMI <38.5 $cm^2/m^2$ for women [15]. In this study, we aimed to assess sarcopenia prevalence in patients with cirrhosis using two methods: MRI and handgrip dynamometry. We compared the effectiveness of both techniques in determining the prevalence of sarcopenia.

## Materials and Methods

The study was conducted on 50 patients with liver cirrhosis, both outpatients and inpatients, who were admitted to the medical wards of the Department of Medicine at Rajindra Hospital. The investigation included patients regardless of the underlying cause of their cirrhosis.

| Criteria | Clinical practice | Research |
|---|---|---|
| Muscle mass | BIA<br>DXA<br>Anthropometry | IVNAA<br>CT/MRI<br>DXA<br>BIA<br>Total body potassium<br>Ultrasound |
| Muscle mass | Handgrip strength | Handgrip strength<br>Knee flexion/extension<br>Peak expiratory flow |
| Physical performance | SPPB<br>Gait speed test<br>Get-up-and-go test<br>Stair climb power test<br>Six-minute walk distance | SPPB<br>Gait speed test<br>Get-up-and-go test<br>Sit-to-stand test<br>Six-minute walk distance |

Figure 3. Assessment Techniques for muscle mass and physical performance

**Inclusion criteria:**

- Age between 18 to 65 years.
- Diagnosed cases of liver cirrhosis
- Patients who gave Informed consent.

**Exclusion criteria:**

- Patients below 18 or above 65 years.
- Diagnosed HIV or malignancy cases
- Advanced heart, lung, kidney failure patients
- Known cases of malabsorption syndrome
- Known cases of any neuromuscular disease
- Known case of any endocrinal disorder.

**Sarcopenia assessment: MRI**

Using the available MRI (1.5 Tesla Siemens Magneton Aera) images, the study identified the 3rd lumbar vertebral (L3) level to measure the cross-sectional area of the surrounding muscles. At this site, various muscles which show signs of sarcopenia including the psoas, paraspinals, transversus abdominis, rectus abdominis, internal and external obliques can be measured easily. This level is chosen also because cross sectional area of these muscles' correlates well with whole-body muscle mass. The L3 skeletal muscle area was then normalized to stature by dividing the muscle area by the height squared. Sarcopenia was defined as an L3 muscle area of 52.4 $cm^2/m^2$ in males and 38.5 $cm^2/m^2$ in females [16].

**Sarcopenia assessment: Handgrip strength**

A mechanical handgrip dynamometer was utilized to measure handgrip strength. Patients were seated comfortably in a chair, and the handle of the dynamometer was adjusted accordingly. They were instructed to hold the device away from their body and table. Using their non-dominant hand, patients were asked to grasp and squeeze the handle of the dynamometer with maximum effort. Three measurements were taken, each separated by a gap of more than 30 seconds. The average of these three readings was then calculated. All measurements were recorded in kilograms [17].

**Results**

The study was conducted on 50 outdoor and indoor patients of liver cirrhosis. The mean age of the patients was 47.22 ± 10.845 years. Maximum patients were observed in age group 41-50 years i.e. 20. There was total 18 (36%) patients without sarcopenia and 32 (64%) patients with sarcopenia. Total 7 females (3 (42.9) without sarcopenia and 4 (57.1) with sarcopenia) and 43 males (15 (34.9) without and 28 (65.1) with sarcopenia were present in the study.

Muscle mass in MRI was measured, analysed and distributed into 2 groups: sarcopenic patients vs non sarcopenic patients. Mean was calculated for both groups as shown in Figure 4 and plotted on graph in Figure 6. It showed negative correlation and implied that sarcopenic patients has decreased muscle mass and vice versa.

| GENDER | TOTAL | SARCOPENIA | NON-SARCOPENIA | P- VALUE |
|---|---|---|---|---|
| MALE | 49.10±7.20 | 44.66±4.26 | 57.38±2.76 | .001** |
| FEMALE | 37.55±4.75 | 34.10±2.19 | 42.1±2.21 | .005* |
| TOTAL | 47.48±7.97 | 43.34±5.37 | 54.84±6.3 | .001** |

Figure 4. Mean muscle mass in sarcopenic vs non-sarcopenic patients

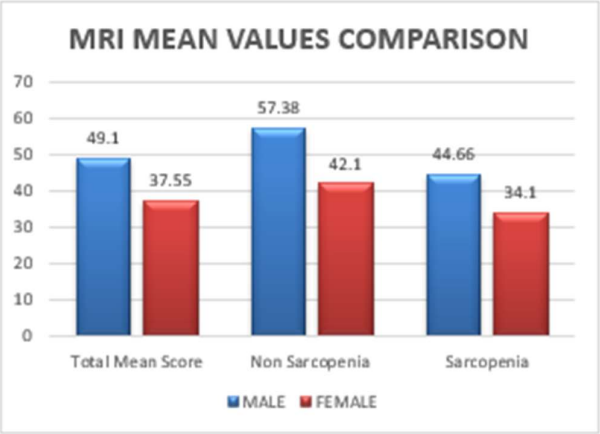



Figure 5. Bar graph showing mean muscle mass in sarcopenic vs non-sarcopenic patients

| METHOD | TOTAL | SARCOPENIA | NON-SARCOPENIA | P VALUE |
|---|---|---|---|---|
| DYNAMOMETER | 19.43±3.72 | 18.39±3.39 | 21.29±3.64 | .007* |

Figure 6. Mean HGS in sarcopenic vs non-sarcopenic patients

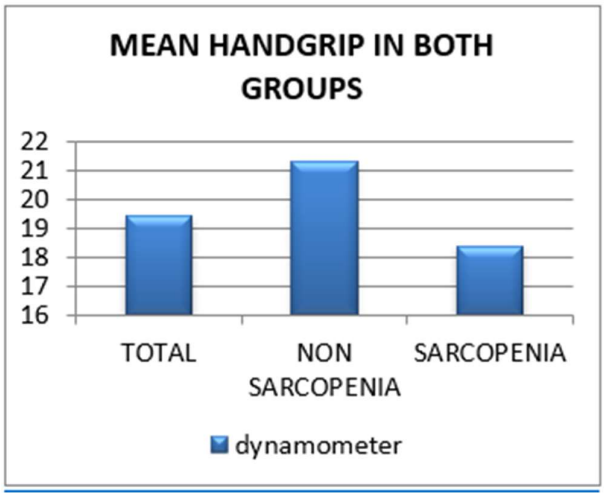



Figure 7. Bar graph showing mean HGS in sarcopenic vs non-sarcopenic patients

Handgrip strength was measured, analysed and distributed into 2 groups: sarcopenic patients vs non sarcopenic patients. Mean was calculated for both groups as shown in Figure 6 and plotted on graph in Figure 7. It showed negative correlation and implied that sarcopenic patients has decreased handgrip strength and vice versa.

Figure 8 shows MRI correlation with handgrip dynamometer in males. MRI was positively and significantly correlated with Handgrip strength showing linear correlation. Figure 9 shows MRI correlation with handgrip dynamometer in females. MRI was positively and significantly correlated with Handgrip strength showing linear correlation.

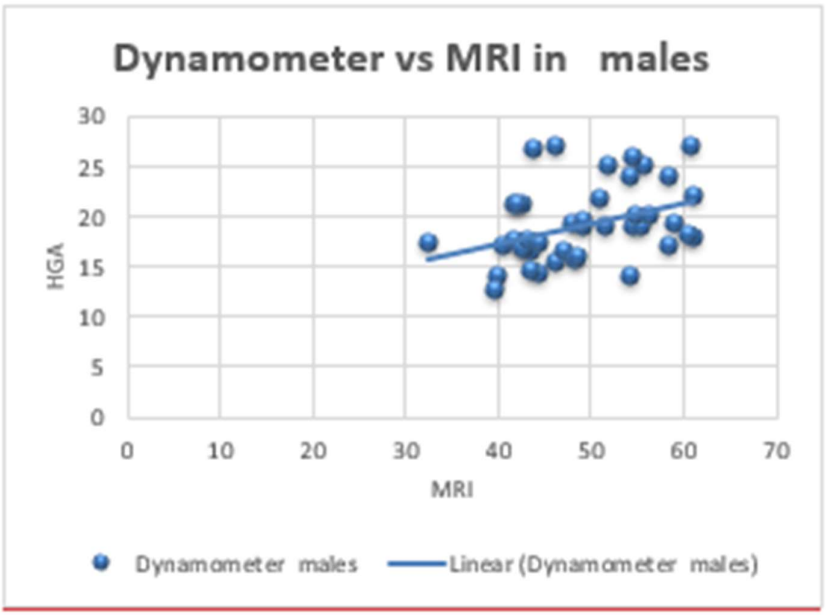



Figure 8. MRI vs handgrip strength in males

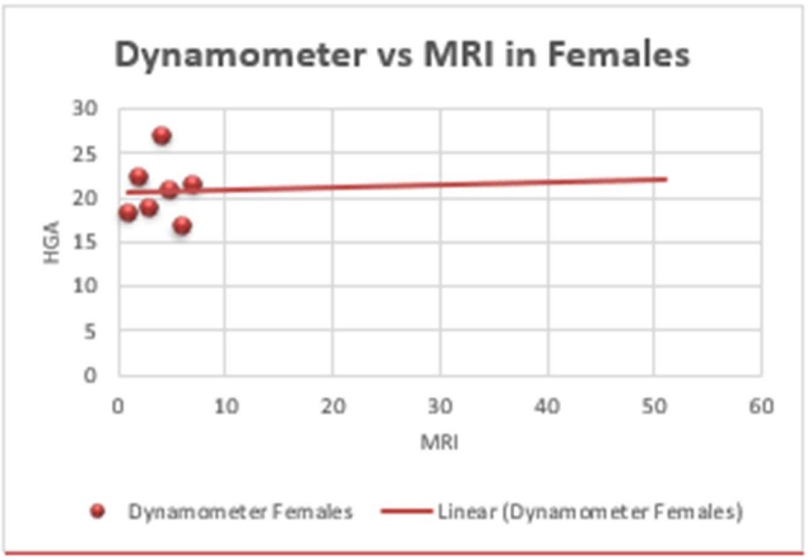



Figure 9. MRI vs handgrip strength in females

## Conclusion

The high prevalence of sarcopenia in patients with liver cirrhosis, as assessed by MRI, underscores the importance of accurate diagnostic methods. Our study explored the effectiveness of handgrip dynamometry (HGS) in predicting sarcopenia among these patients. The findings indicate that HGS, when correlated with MRI results, is a reliable predictor of sarcopenia in cirrhotic patients. Interestingly, the etiology of cirrhosis did not influence the occurrence of sarcopenia in our study. While both MRI and HGS are non-invasive assessment methods, HGS stands out for its ease of use.

## Future Scope

As the understanding of sarcopenia's impact on clinical outcomes in liver cirrhosis deepens, several key areas warrant further exploration. Firstly, developing standardized MRI protocols for assessing muscle mass can enhance diagnostic accuracy and comparability across studies. Secondly, integrating MRI findings with other biomarkers and clinical parameters can provide a more comprehensive understanding of sarcopenia's multifactorial nature. Additionally, longitudinal studies are essential to evaluate the progression of sarcopenia and its response to various treatments which can help establish the efficacy of interventions like nutritional support, physical exercise, and pharmacological agents. In conclusion, the future scope of researching sarcopenia in liver cirrhosis patients using MRI and handgrip strength is vast and promising.

## Conflicts of interest

The authors declares that they do not have conflict of interest.

## Funding

No funding was received for conducting this study.

## References

1. L Schuppan D, Afdhal NH. Liver cirrhosis. Lancet. 2008 Mar 8;371(9615):838-51.
2. Zipprich A, Garcia-Tsao G, Rogowski S, Fleig WE, Seufferlein T, Dollinger MM. Prognostic indicators of survival in patients with compensated and decompensated cirrhosis. Liver Int. 2012 Oct;32(9):1407-14.
3. Merli M, Giusto M, Gentili F, Novelli G, Ferretti G, Riggio O, et al. Nutritional status: its influence on the outcome of patients undergoing liver transplantation. Liver Int. 2010 Feb;30(2):208-14.
4. Kim HY, Jang JW. Sarcopenia in the prognosis of cirrhosis: Going beyond the MELD score. World J Gastroenterol. 2015 Jul 7;21(25):7637-47.
5. Argilés JM, Busquets S, Stemmler B, López-Soriano FJ. Cachexia and sarcopenia: mechanisms and potential targets for intervention. Curr Opin Pharmacol. 2015 Jun;22:100-6.
6. Cheung K, Lee SS, Raman M. Prevalence and mechanisms of malnutrition in patients with advanced liver disease, and nutrition management strategies. Clin Gastroenterol Hepatol. 2012 Feb;10(2):117-25.
7. Quigley EM. Gastrointestinal dysfunction in liver disease and portal hypertension. Gut-liver interactions revisited. Dig Dis Sci. 1996 Mar;41(3):557-61.

8. Traub J, Bergheim I, Eibisberger M, Stadlbauer V. Sarcopenia and Liver Cirrhosis-Comparison of the European Working Group on Sarcopenia Criteria 2010 and 2019. Nutrients. 2020 Feb 20;12(2):547.
9. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, et al; Writing Group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the Extended Group for EWGSOP2. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019 Jan 1;48(1):16-31.
10. Rubbieri G, Mossello E, Di Bari M. Techniques for the diagnosis of sarcopenia. Clin Cases Miner Bone Metab. 2014 Sep;11(3):181-4.
11. Guerri S, Mercatelli D, Aparisi Gómez MP, Napoli A, Battista G, Guglielmi G, Bazzocchi A. Quantitative imaging techniques for the assessment of osteoporosis and sarcopenia. Quant Imaging Med Surg. 2018 Feb;8(1):60-85.
12. Mijnarends DM, Meijers JM, Halfens RJ, ter Borg S, Luiking YC, Verlaan S, et al . Validity and reliability of tools to measure muscle mass, strength, and physical performance in community-dwelling older people: a systematic review. J Am Med Dir Assoc. 2013 Mar;14(3):170-8.
13. Pahor M, Manini T, Cesari M. Sarcopenia: clinical evaluation, biological markers and other evaluation tools. J Nutr Health Aging. 2009 Oct;13(8):724-8
14. Bruyère O, Beaudart C, Reginster JY, Buckinx F, Schoene D, Hirani V, et al. Assessment of muscle mass, muscle strength and physical performance in clinical practice: an international survey. Eur Geriatr Med 2016 Jun 1;7(3):243-6.
15. Yoo JI, Choi H, Ha YC. Mean Hand Grip Strength and Cut-off Value for Sarcopenia in Korean Adults Using KNHANES VI. J Korean Med Sci. 2017 May;32(5):868-872.
16. Giusto M, Lattanzi B, Albanese C, Galtieri A, Farcomeni A, Giannelli V, et al. Sarcopenia in liver cirrhosis: the role of computed tomography scan for the assessment of muscle mass compared with dual-energy X-ray absorptiometry and anthropometry. Eur J Gastroenterol Hepatol. 2015 Mar;27(3):328-34.
17. Sinclair M, Chapman B, Hoermann R, Angus PW, Testro A, Scodellaro T, et al. Handgrip Strength Adds More Prognostic Value to the Model for End-Stage Liver Disease Score Than Imaging-Based Measures of Muscle Mass in Men With Cirrhosis. Liver Transpl. 2019 Oct;25(10):1480-1487.