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INTERVENTIONAL RADIOLOGY

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# Correlation between computed tomography-based body composition parameters and hepatic venous pressure gradient in patients with cirrhosis: a systematic review and meta-analysis

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**PURPOSE**

Computed tomography (CT)-based body composition parameters and the hepatic venous pressure gradient (HVPG) are key characteristics in patients with liver cirrhosis. The present study aims to explore the correlation between CT-based body composition parameters and HVPG, as well as the difference in HVPG between patients with and patients without sarcopenia.

**METHODS**

A literature search for studies reporting the correlation between HVPG and CT-based body composition parameters published in English up to August 2023 in four databases, Embase, MEDLINE (via PubMed), Web of Science, and Cochrane Library, was conducted. The correlation coefficient between HVPG and CT-based body composition parameters was the primary outcome, and the difference in the HVPG value between the sarcopenia and non-sarcopenia groups was the secondary outcome. A meta-analysis was conducted using a random-effects models. The methodologic quality was assessed using the Quality Assessment of Diagnostic Studies instrument.

**RESULTS**

A total of 652 articles were identified, of which nine studies (n = 1,569) met the eligibility criteria. Among them, seven studies reported the primary outcome via the muscle index, five via the skeletal muscle index (SMI), two via the psoas-muscle-related index (PRI), and three via two adipose tissue indexes. A total of five studies reported the secondary outcome: four via SMI and one via PRI. No evidence of a significant correlation was determined between the various body composition parameters and the HVPG value, either in the muscle index or the adipose tissue index. Higher HVPG values were observed in patients with sarcopenia than in patients without sarcopenia [pooled standardized mean difference (SMD): 0.628 (−0.350, 1.606), $P < 0.001$; $I^2 = 92.8\%$; $P < 0.001$] when an Asian sarcopenia definition was adopted. In contrast, when a Western cut-off value was applied, the HVPG value was higher in patients without sarcopenia than in patients with sarcopenia [pooled SMD: −0.201 (−0.366, −0.037), $P = 0.016$; $I^2 = 0.00\%$; $P = 0.785$].

**CONCLUSION**

No sufficient evidence regarding a correlation between the CT-based body composition and HVPG value was discovered. The difference in the HVPG value between the sarcopenia and non-sarcopenia groups was likely dependent on the sarcopenic cut-off value.

**KEYWORDS**

Liver cirrhosis, portal hypertension, sarcopenia, body composition, meta-analysis

**This study was registered prospectively on the International Prospective Register of Systematic Reviews (PROSPERO) in 2023 (registration number: CRD42023392942).**

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Sarcopenia, a disease entity representing a progressive and generalized skeletal muscle disorder, is a prevalent morbidity of liver cirrhosis (LC).[1] Due to the concomitant altered catabolic state, insulin resistance, chronic systemic inflammation and physical inactivity, sarcopenia exists in different LC stages and is closely related with decompensation risk and postoperative complications, as well as mortality independent of commonly used tools, such as Child–Pugh score or the model for end-stage liver disease (MELD) score.[2-4] Furthermore, the role of adipose quantity or distribution as a precipitating event for poor prognosis in patients with LC has also been proposed.[5,6] Importantly, as two body phenotypes, the muscle and adipose quantity may interact with each other instead of acting as two independent pathophysiological conditions.[7]

Computed tomography (CT) is considered the gold standard for assessing muscle or adipose quantity, and CT-based muscle quantity is recommended for defining sarcopenia.[8,9] In patients with LC, CT is routinely performed with the aim of monitoring portal-systemic collaterals and tumor development or recurrence; thus, CT-based body composition parameters are accessible and reproducible. In addition, the hepatic venous pressure gradient (HVPG) is recognized as the gold standard for evaluating portal hypertension (PH).[10] To stratify the risk of decompensation with intent for early intervention, HVPG measurement has also been encouraged in patients with LC in real-life practice.[11]

Body composition, especially muscle quantity, and HVPG have been characterized as important characteristics in patients with LC. With the progress of LC, clinically significant PH is concomitant. Muscle depletion and fat accumulation or redistribution also likely occur in this course.[1,12] Specifically, the metabolism changes of such a population are characterized by insulin resistance, dysregulated muscle protein turnover, and altered lipid redistribution.[13] Furthermore, some clinical events, such as loss of appetite, fluid retention, and sedentary behavior, contribute to alterations of the body phenotype. A large sample cross-sectional study revealed that muscle mass depletion was independently associated with the liver fibrosis stage.[14] In addition, a preclinical study showed that ammonia-lowering therapy could result in an increase of skeletal muscle mass.[15] Nevertheless, the evidence on the correlation between HVPG and body composition is still weak. The number of existing studies is too limited to provide relevant data. Discrepant results were yielded among these studies. The study by Matsui et al.[16] showed that the HVPG value was inversely correlated with the skeletal muscle index (SMI). In contrast, other published data showed a null association.[5,17-19] Similarly inconsistent results have also been observed regarding the adipose tissue index and HVPG. Rodrigues et al.[5] concluded that there was a significant negative correlation between the subcutaneous adipose tissue index (SATI) and the HVPG value, but Cho et al.[18] and Zeng et al.[19] did not.

Whether the HVPG value is correlated with a certain body composition parameter, and to what extent the HVPG value differs between patients with sarcopenia and patients without sarcopenia remains unknown. Knowledge of the impact of PH on muscle or adipose tissue is highly desirable, guiding nutrition support and tailoring individualized therapy. The additional value of HVPG, known as a validated index mirroring PH, would be detected for association with body tissue alternations in patients with LC. Hence, a meta-analysis was conducted to overview the current evidence and address this issue.

**Main points**

- The present study is deemed to be the first meta-analysis to quantify evidence of a correlation between the hepatic venous pressure gradient (HVPG) and the body composition parameters.
- The association between portal hypertension (PH) and body composition parameters as two characteristics in patients with cirrhosis was revealed, with the goal of exploring the impact of PH on skeletal muscle loss or adipose tissue change.
- No evidence of significant correlation was determined between various body composition parameters and HVPG.
- The difference in the HVPG value between patients with sarcopenia and patients without sarcopenia is likely dependent on the sarcopenic definition.

## Methods

### Protocol registration

The present review was performed following the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[20] The PRISMA checklist is shown in Online Resource 1. This study was registered prospectively in the International Prospective Register of Systematic Reviews in 2023 (registration number: CRD42023392942). The requirement for informed consent and ethical approval from the Institutional Review Board were waived because the study quantified all existing publicly available data instead of involving specific patients.

### Eligibility criteria

Population, interventions, comparisons, outcomes: the population of interest was patients with LC. The interventions of interest included CT scanning and HVPG within an acceptable interval. The outcomes of interest included: (1) the correlation analysis between various body composition parameters and HVPG; and (2) the HVPG value reported in patients with or without sarcopenia. The comparison and study of interest were not applicable or limited.

The abstract of a conference poster containing relevant information was also eligible. The authors contacted the corresponding author for detailed information. References cited in the text of selected articles were also further searched to minimize publication bias.

### Search strategy

Peer-reviewed articles written in English and published up to August 2023 were searched in Embase, MEDLINE (via PubMed), Web of Science, and Cochrane Library. The retrieval protocol combined medical subject headings and text, which were mostly derived from entry terms in the PubMed and Embase databases. The search strategy is available in Online Resource 2.

### Study selection

The exclusion criteria were as follows: (1) duplicate and irrelevant articles; (2) cell-line studies; (3) review articles; (4) case reports; (5) letters; (6) comments and editorials; (7) subjects from pediatric and non-human sources; and (8) cadavers.

The further exclusion criteria in a full-text assessment were as follows: patients with (1) LC with non-intrahepatic causes; (2) presence of evident intrahepatic vessel communication in measuring HVPG; and (3) a history of transjugular intrahepatic portosystemic shunt.

The HVPG value and body composition parameter on a continuous scale were eligible for analysis.

The correlation analysis should be performed using Pearson's (*r*) or Spearman's rho analysis according to the normality of the raw data. Presently, the impact of tumors

not involving an intra- or extra-hepatic great vessel on the HVPG value remains unclear. Measurements of HVPG were performed in selected patients with hepatocellular carcinoma (HCC) and LC in real-life practice; thus, patients with HCC with a Barcelona Clinic Liver Cancer stage of 0, A, or B would not have been excluded in this meta-analysis. In addition, this potential effect could be further eliminated in the subgroup analysis.

### Definitions

Transversal-psoas muscle thickness and psoas muscle thickness by height are the same measurement with different names, referring to the transversal diameter of the psoas muscle perpendicular to the largest axial psoas muscle diameter at the L3 plane normalized by height. Therefore, these two indexes were replaced with the psoas-muscle-related index (PRI) for analysis. All muscle and adipose indexes are defined and illustrated in Supplementary Figure 1.

### Outcomes

The primary outcome was the correlation coefficient between various body composition parameters and HVPG. The difference in HVPG value between the sarcopenia group and the non-sarcopenia group was the secondary outcome. Due to a lack of a validated cut-off value to define adipopenia, the secondary outcome analysis was not performed in adipose indexes.

### Data extraction

Two review authors (S.Y. and Q.C.) blindly and independently extracted the following items from each article: the first co-author, year of publication, country, study design, sample size, body mass index (BMI), sex, cause of liver disease, albumin, decompensation proportion, Child–Pugh score, MELD score, the interval between CT scan and HVPG measurement, sarcopenia definition, sarcopenia cut-off value, sarcopenia proportion, HVPG value in the sarcopenia and non-sarcopenia groups, correlation coefficient between body composition parameters and the HVPG value, and details of the HVPG measurement technique.

All data were respectfully recorded by two review authors using Microsoft Excel. Any inconsistency was resolved by reviewing the original article to achieve a consensus.

### Risk of bias and certainty of evidence assessment

Two review authors independently assessed the methodological quality with regard to risk of bias and applicability concern using the Quality Assessment of Diagnostic Studies instrument. The Grading of Recommendations Assessment, Development and Evaluation (GRADE) system and online tool (GRADE Pro GDT, https://gdt.gradepro.org/) were used to rate the outcome if possible. The certainty of evidence was classified into four levels based on the five domains (https://training.cochrane.org/resource/grade-handbook) high, moderate, low, and very low.

### Statistical analysis

The HVPG values in the sarcopenia and non-sarcopenia groups presenting as mean ± standard deviation were summarized. Values presenting as the median (interquartile range) would have been converted using an established fashion if necessary.[21]

The difference in the HVPG values was compared using the standardized mean difference (SMD) with a 95% confidence interval (CI). The Pearson correlation coefficient was collected and converted to the Fisher-*Z* value according to the following equation: $Z = 0.5\ [\ln(1 + r) - \ln(1 - r)]$; the corresponding standard error was calculated according to the following equation: $SEz = \frac{1}{\sqrt{n-3}}$, and summary *r* was recovered using the following equation: $r = (e^{2Z} - 1) / (e^{2Z} + 1)$.[22]

A Fisher transformation was used to convert the Spearman coefficient into an approximately normal distribution and further calculate the 95% CI. Subsequently, the same summary process was conducted as a Pearson analysis. Fisher's *Z* value was used in the meta-analysis and shown in the plots, and the correlation coefficient derived from the inverse Fisher's transformation was presented as the summary result. The heterogeneity was identified using Cochran's Q test and further quantified using the $I^2$ statistic among the studies. When the *P* value was <0.05 or the $I^2$ value was >50%, the heterogeneity was considered high, and the source of bias was explored. Publication bias was assessed if the number of included studies was >10.[23] In the prespecified sensitivity analysis, pooled correlation coefficient estimates were further stratified as per presence of HCC and different sarcopenic cut-off values.

A *P* value of <0.05 was indicative of a significant difference. Considering the heterogeneity and sample size, a random effects model was selected to calculate the pooled effect size. The Stata MP (version 16.0, Stata Corp, College Station, USA) package was used for meta-analysis, and Review Manager (version 5.3) was used to evaluate the methodological quality.

## Results

### Study characteristics

Of the 652 studies screened initially, nine involving a total of 1,569 patients with LC were included for meta-analysis.[5,16-19,24-27] A corresponding flow diagram is shown in Figure 1.

One poster including relevant data was excluded because it had not been published officially, and the request for raw data or effect size had not been answered.[28] The characteristics of the included studies are shown in Table 1.

Regarding the characteristics of the included patients, the sarcopenia proportion ranged from 34.7% to 71% across the eligible studies. The most common cause of liver disease was alcohol in six studies, followed by

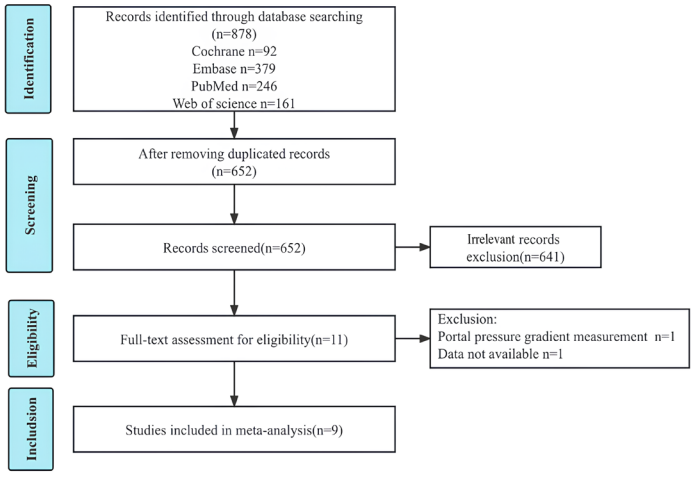


**Figure 1.** Flow diagram of the study selection process.

**Table 1.** Characteristics of included studies

| | | Participants | | | | | | Index | | Outcomes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Author and year | Country | Sample size | BMI | Male (%) | Decompensation proportion (%) | Child–Pugh score | MELD score | Interval between CT and HVPG | Measured index | Sarcopenia cut-off (men/women) | HVPG in sarcopenia group | HVPG in non-sarcopenia group | Correlation coefficient* | *P* |
| **Jeong et al.[24] (2018)** | Korea | 131 | 23.3 ± 4.1 | 71.8 | 87.8 | 7.6 ± 2.1 | 10.7 ± 4.4 | Within 2 months | SMI | 52.4 $cm^2/m^2$ and 38.5 $cm^2/m^2$ | 14.7 ± 5.0 | 15.6 ± 6.2 | NA | 0.357 |
| **Paternostro et al.[25] (2021)** | Australia | 203 | 24.6 (22.4–28.0) | 68.0 | 73.4 | NA | 12 (9–15) | ±200 days | TPMT | 12 mm/m and 8 mm/m | 18 (16–22.5) | 20 (16–23) | 0.031 | 0.211/0.66* |
| **Maruyama et al.[17] (2017)#** | Japan | 98 | 24.3 ± 4.8 | 65.3 | NA | NA | 9.6 ± 2.7 | <1 year | SMI | 42 $cm^2/m^2$ and 38 $cm^2/m^2$ | 15.2 ± 5.4 | 14.6 ± 4.8 | NA | 0.56 |
| **Non-sarcopenia group** | | 64 | 26.1 ± 4.6 | 70.3 | | | 9.8 ± 2.9 | | | | NA | NA | −0.096 | 0.45* |
| **Sarcopenia group** | | 34 | 20.8 ± 2.6 | 55.9 | | | 9.2 ± 2.2 | | | | NA | NA | 0.122 | 0.49* |
| **Kim et al.[26] (2014)** | Korea | 65 | NA | 63.1 | 100.0 | NA | 9.0 ± 1.7 | Within 2 months | PMTH | 14 mm/m | NA | NA | −0.127 | 0.313* |
| **Kang et al.[27] (2018)** | Korea | 452 | 23.1 (20.7, 24.8) | 83.8 | NA | NA | 10.4 ± 3.6 | Within 3 months | SMI | 52.4 $cm^2/m^2$ and ≤38.5 $cm^2/m^2$ | 14.0 (10.0, 17.0) | 14.0 (11.0, 17.25) | NA | 0.313 |
| **Matsui et al.[16] (2022)** | Japan | 202 | 23.8 ± 4.4 | 69.8 | NA | 7.5 ± 2.0 | 10.3 ± 6.2 | NA | SMI | 42 $cm^2/m^2$ and 38 $cm^2/m^2$ | 15.0 ± 6.2 | 8.4 ± 5.1 | −0.476 | <0.001/<0.001* |
| **Cho et al.[18] (2021)** | Korea | 166 | 23.3 ± 3.9 | 70.5 | 62.7 | 7.6 ± 2.1 | 10.8 ± 4.4 | Within 2 months | SMI | 50 $cm^2/m^2$ and ≤39 $cm^2/m^2$ | NA | NA | 0.111 | >0.05* |
| | | | | | | | | | SATI | | | | 0.03 | >0.05* |
| | | | | | | | | | VATI | | | | −0.057 | >0.05* |
| **Rodrigues et al.[5] (2019)** | Switzerland | 84 | 28.0 ± 5.0 | 60.7 | 54.8 | 7.0 ± 2.0 | 13.0 ± 8.0 | Within 12 weeks | SMI | 50 $cm^2/m^2$ and 39 $cm^2/m^2$ | | | −0.006 | 0.96* |
| | | | | | | | | | SATI | | | | −0.282 | 0.01* |
| | | | | | | | | | VATI | | | | −0.07 | 0.55* |
| **Zeng et al.[19] (2023)** | China | 168 | 23.0 ± 3.6 | 64.9 | NA | 6.9 ± 1.7 | 10.8 ± 3.4 | Within 1 month | SMI | 44.77 $cm^2/m^2$ and 32.50 $cm^2/m^2$ | NA | NA | −0.083 | 0.583 |
| | | | | | | | | | SATI | | | | 0.042 | 0.589 |
| | | | | | | | | | VATI | | | | 0.024 | 0.762 |

#This study reported the correlation coefficient separately in sarcopenia and non-sarcopenia groups. Results for continuous data are expressed as means ± standard deviations and for categorical data as n (%). The MELD score in Matsui et al.[16] (2022) was the MELD-Na score. *Indicates the *P* value of the correlation coefficient between a certain body composition parameter and the HVPG value. CT, computed tomography; BMI, body mass index; MELD, model for end-stage liver disease; HVPG: hepatic vein pressure gradient; SMI, skeletal muscle index; SATI, subcutaneous adipose tissue index; VATI, visceral adipose tissue index; TPMT, transversal-psoas muscle thickness; PMTH, psoas muscle thickness by height; NA, not available.

virus in the remaining three studies. There were 13 participants with HCC in the context of LC included in one study.[17]

A total of seven studies reported the primary outcome. Of these, five comprised 718 patients reported via SMI[5,16-19] (one reported the correlation coefficient separately in the sarcopenia and non-sarcopenia subgroups)[17] and two comprised 268 patients reported in PRI.[25,26] A total of three studies provided the primary outcome in SATI and the visceral adipose tissue index (VATI).[5,18,19]

In addition, five studies reported the secondary outcome: four reported via SMI and one reported via PRI.[25] Among the four studies reporting via SMI, the cut-off value was 42 $cm^2/m^2$ for men and 38 $cm^2/m^2$ for women in two studies[16,17] and 52.4 $cm^2/m^2$ in men and 38.5 $cm^2/m^2$ in women in the other two studies.[24,27] Considering that SMI was recommended for defining sarcopenia by most societies, the study reporting via PRI was not included for the secondary outcome.

For the publication nation, one study was conducted in Australia,[25] one in Switzerland,[5] and the remaining seven in Asian countries, including China,[19] Japan,[16,17] and the Republic of Korea.[18,24,26,27]

All included studies were retrospective studies published in the last 5 years.

### Quality assessment and risk of bias

All included studies were considered to be of low or moderate risk of bias, as illustrated in Figure 2. The detailed scales are shown in Online Resource 3. The GRADE summary of findings for the outcome is provided in Supplementary Table S1.

### Primary outcome

### Muscle index

Only Matsui et al.[16] reported a significantly negative correlation between SMI and HVPG in 202 patients; the remaining studies reported a null correlation.

The pooled correlation coefficient, regardless of muscle index, was −0.08 (−0.25, 0.09; $P = 0.368$), with significant heterogeneity observed (overall: $I^2 = 85.3\%$; $P < 0.001$); similar results were observed in the SMI and PRI subgroups [SMI: $r = -0.09$ (−0.31, 0.14); $P = 0.442$; $I^2 = 88.4\%$; $P < 0.001$; PRI: $r = -0.01$ (−0.15, 0.12); $P = 0.852$; $I^2 = 16.1\%$; $P = 0.275$] (Figure 3).

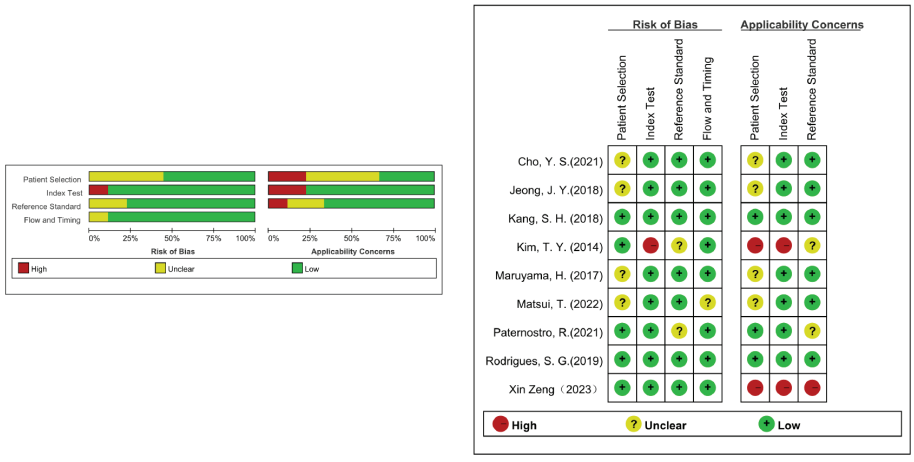


**Figure 2.** Methodological quality of all included studies. Left: methodological quality graph; right: methodological quality summary.

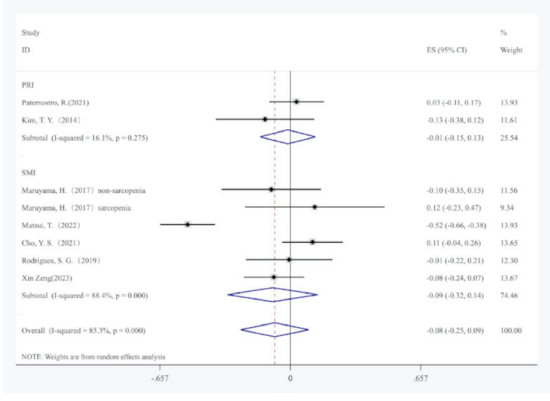


**Figure 3.** Pooled correlation coefficient for the muscle index in all eligible studies.

### Adipose tissue index

No significant correlation was pooled [$r = -0.03$ (−0.12, 0.05), $I^2 = 34.5\%$, $P = 0.177$] in either of the adipose index subgroups [SATI: $r = -0.06$ (−0.24, 0.13), $P = 0.545$; VATI: $r = -0.03$ (−0.12, 0.07), $P = 0.586$]. The high heterogeneity was detected in the SATI subgroup ($I^2 = 71.1\%$, $P = 0.032$) but not in the VATI subgroup ($I^2 = 0.0\%$, $P = 0.695$). The corresponding forest plot is shown in Figure 4.

### Secondary outcome

The summary difference of the HVPG value between the sarcopenia and non-sarcopenia groups indicated statistical significance, with unstable results due to different sarcopenia definitions. When using the cut-off value from the Japan Society of Hepatology guidelines for sarcopenia (SMI <42 $cm^2/m^2$ for men or <38 $cm^2/m^2$ for women), higher HVPG values were observed in patients with sarcopenia than in patients without sarcopenia [pooled SMD: 0.628 (−0.350, 1.606), $P < 0.001$; $I^2 = 92.8\%$; $P < 0.001$]. When a commonly used cut-off value in the Western population was applied (50 $cm^2/m^2$ for men and 39 $cm^2/m^2$ for women), the HVPG value was higher in patients without sarcopenia than in patients with sarcopenia [pooled SMD: −0.201 (−0.366, −0.037), $P = 0.016$; $I^2 = 0.00\%$; $P = 0.785$] (Figure 5).

### Sensitivity analysis

After exclusion of the study including 13 patients with HCC, the correlation between either PRI or SMI and HVPG was not significant [overall: $r = -0.10$ (−0.30, 0.11), $P = 0.341$; $I^2 = 89.1\%$, $P < 0.001$; SMI: $r = -0.13$ (−0.40, 0.17), $P = 0.401$; $I^2 = 92.6\%$; $P < 0.001$]. The corresponding forest plot is shown in Figure 6.

## Discussion

In the present review, a meta-analysis was performed to identify and quantify the current evidence regarding the correlation between body composition parameters and HVPG. The pooled results indicated that there was no significant correlation between muscle or adipose quantity and the HVPG value, regardless of muscle index. The results of the secondary outcome were unstable due to different sarcopenia definitions. With consideration of the statistical significance and ethnicity-specific cut-off value of sarco-

penia, the result appears to reveal that patients with lower muscle mass may have a higher HVPG value.

Body composition and HVPG are of paramount importance for patients with LC. Nevertheless, a knowledge gap remains in the correlation between them. To the best of the present authors' knowledge, this meta-analysis is the first to quantitatively combine current data to assess the correlation between body composition parameters and HVPG.

In fact, limited LC-related studies have reported both composition parameters and HVPG values at the same time, seldom exploring the association between them. Specifically, CT-based quantitative analysis and invasive operation hamper the acquisition of data in clinical practice. Despite the fact that the limited evidence grade leads to a cautious interpretation of the results, the findings of this meta-analysis could help explore the impact of PH on body composition parameters and might be instrumental in refining a comprehensive evaluation algorithm of patients with LC.

In this meta-analysis, several points merit attention. First, the HVPG value was used to evaluate the PH instead of the portosystemic pressure gradient, largely because the portosystemic pressure gradient was commonly collected in the transjugular intrahepatic portosystemic shunt procedure with a limited clinical application prospect. Second, to reduce the bias derived from different global cut-off values of sarcopenia, only the muscle or adipose tissue quantity as the continuous variable normalized to height or height$^2$ was extracted and comparable. In addition, other statistics would have been summarized if they could have been converted to the correlation coefficient using a validated statistical method, including the contingency coefficient and standardized beta value; however, such a study was not found in the study screening. Third, SMI is recognized as the gold standard for measuring muscle quantity in defining sarcopenia, and psoas-muscle-related parameters have been shown to be less strongly correlated with the total body protein or mortality risk compared with SMI.[29,30] Therefore, of the five studies reporting the secondary outcome, one study reporting via PRI was not included in the meta-analysis. Last, all included studies were published in the past 5 years, thereby enabling a standard care for patients with LC.

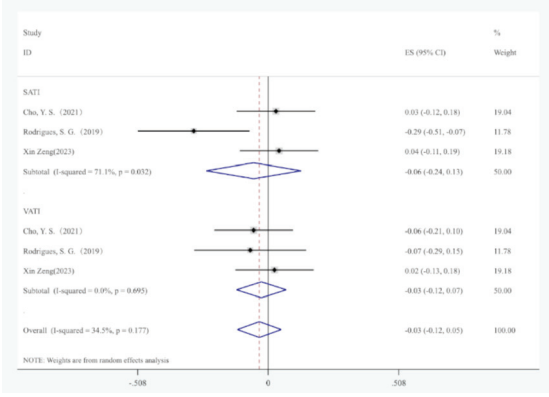


**Figure 4.** Pooled correlation coefficient for the adipose tissue index.

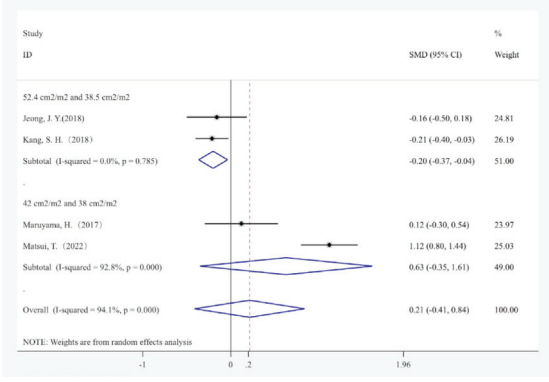


**Figure 5.** Summary difference of the hepatic venous pressure gradient value between the sarcopenia and non-sarcopenia groups.

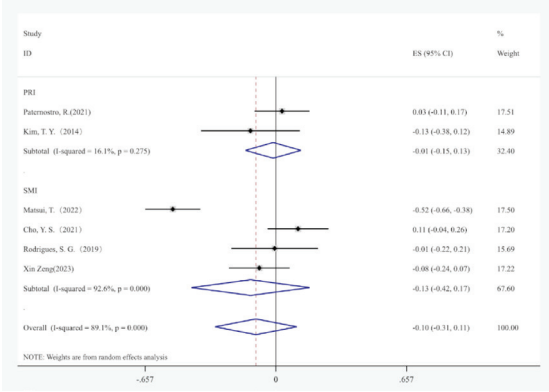


**Figure 6.** Sensitivity analysis. The pooled correlation coefficient for muscle index after the exclusion of patients with hepatocellular carcinoma.

Negative results of the primary outcome are partly explainable because of a considerable interindividual variation of the liver function reserve among the included patients. In the included studies, decompensated cirrhosis or clinical signs of PH, such as ascites, gastro-esophageal varices, and hepatic encephalopathy, were deemed indications of HVPG measurement. Among all the evaluable patients, the mean values of the MELD score were 9–13, the decompensation proportions were 54.8%–100%, and the baseline HVPG values were 14–19 mmHg. In fact, sarcopenia is relatively frequently found in advanced liver disease or the decompensated stage.[31,32] Furthermore, some characteristics of patients with LC, including the cause of liver disease, decompensated cirrhosis, or oral beta-blocker administration should have been used in the subgroup analyses with the aim of ruling out confounding factors and further identifying a potential association between the muscle quantity and the HVPG value in a certain subgroup of patients with LC. Likewise, adipose tissue change and re-distribution could be affected by BMI and sex.[33] Therefore, for the primary outcome of the adipose tissue, the non-significant summary result may indicate the likelihood of the correlation between adipose tissue indexes and HVPG depending on the baseline characteristics of the included patients.

In addition, the result of the secondary outcome was not robust. It is speculated that a lower cut-off value (42 $cm^2/m^2$ for men or <38 $cm^2/m^2$ for women) could identify more individuals with a low muscle quantity and further re-classify a proportion of patients as having sarcopenia; that is, a lower cut-off value of sarcopenia has more statistic power to differentiate patients with different PH stratifications. It is noted that all included studies on the secondary outcome were from Asian countries (Japan and the Republic of Korea). The Asian sarcopenia definition (42 $cm^2/m^2$ for men or <38 $cm^2/m^2$ for women) thus allows for better interpretability and practical applicability.[9]

As the present study is a pilot meta-analysis exploring the unknown relationship between two important characteristics of patients with LC, some limitations exist. First, a considerable interindividual variation of baseline characteristics among included patients, especially liver function status, leads to a cautious interpretation of the results. Second, some included studies only presented the effect size instead of analyzing it in the subgroups. The evidence grade is limited by the number of included studies and the data blank. Most importantly, the number of available studies that fulfilled the present study's inclusion criteria is low, precluding meta-regression to further identify the potential confounding factors. Hence, a prospective study dedicated to recording relevant information is required in the future.

In conclusion, overall, this meta-analysis showed a non-significant correlation between body composition parameters, including muscle and adipose tissue quantity, and the HVPG value. However, its current clinical usefulness is uncertain due to a lack of universal definition and limited research.

### Reporting checklist

This review was performed following the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.

### Conflict of interest disclosure

The authors declared no conflicts of interest.

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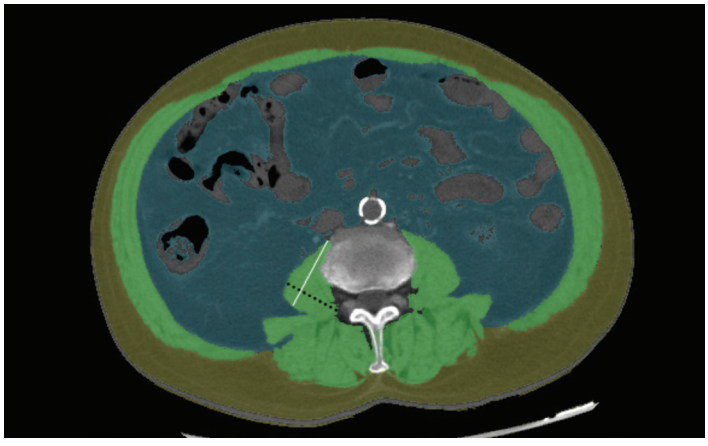

**Supplementary Figure 1.** The skeletal muscle index was the total skeletal muscle area normalized by height$^2$, including the psoas major, erector spinae, quadratus lumborum, transverse abdominis, internal and external oblique, and rectus abdominis (green mask). Transversal-psoas muscle thickness and psoas muscle thickness by height were named differently but measured in the same way; they were defined as the transversal diameter of the psoas muscle perpendicular to the largest axial psoas muscle diameter. Therefore, the psoas-muscle-related index replaced two aforementioned indexes for statistics (dotted line). The subcutaneous adipose tissue index and visceral adipose tissue index were estimated as the adipose area normalized by height$^2$ between the skin line and outer abdominal wall (yellow mask) and the adipose tissue within the abdominal wall, respectively (blue mask).

**Supplementary Table S1.** GRADE summary of findings of secondary outcome
**Patient or population:** Patients with HVPG value and CT-based body composition parameter
**Question:** HVPG of sarcopenia compared to HVPG of non-sarcopenia for liver cirrhosis patients
**Setting:** All
**Bibliography:**

| Certainty assessment | | | | | | | | No of patients | | Effect | | Certainty | Importance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No of studies | Study design | Risk of bias | Inconsistency | Indirectness | Imprecision | Other considerations | | HVPG of sarcopenia | HVPG of non-sarcopenia | Relative (95% CI) | Anticipated absolute effects (95% CI) | | |
| **SMD (Western cut-off)** | | | | | | | | | | | | | |
| 2 | Observational studies | Not serious | Not serious | Not serious | Serious[a] | Strong association all plausible residual confounding would reduce the demonstrated effect | | 254/583 (43.6%) | 329/583 (56.4%) | Not estimable | SMD -0.20 (-0.37 lower to -0.04 higher) | ⨁⨁⨁◯ Moderate | Important |
| **SMD (Eastern cut-off)** | | | | | | | | | | | | | |
| 2 | Observational studies | Not serious | Very serious[b] | Not serious | Serious[c] | Strong association all plausible residual confounding would reduce the demonstrated effect | | 177/300 (59.0%) | 123/300 (41.0%) | Not estimable | SMD 0.63 (-0.35 lower to 1.61 higher) | ⨁◯◯◯ Very low | Important |

[a], obvious benefit or damage; [b], $I^2$ value is more than 90% and a good explanation could not be given; [c], the 95% confidence interval contains 1 and is invalid, GRADE, Grading of Recommendations Assessment, Development and Evaluation; HVPG, hepatic venous pressure gradient; CT, computed tomography; SMD, standardized mean difference; CI, confidence interval.

## Online Resource 1.

### PRISMA 2020 Checklist

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| **TITLE** | | | |
| Title | 1 | Identify the report as a systematic review. | LIne 1-2 |
| **ABSTRACT** | | | |
| Abstract | 2 | See the PRISMA 2020 for Abstracts checklist. | Line 3-28 |
| **INTRODUCTION** | | | |
| Rationale | 3 | Describe the rationale for the review in the context of existing knowledge. | Line 61-82 |
| Objectives | 4 | Provide an explicit statement of the objective(s) or question(s) the review addresses. | Line 83-88 |
| **METHODS** | | | |
| Eligibility criteria | 5 | Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses. | Line 98-105 |
| Information sources | 6 | Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted. | Line 107-110 |
| Search strategy | 7 | Present the full search strategies for all databases, registers and websites, including any filters and limits used. | Line 110 |
| Selection process | 8 | Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process. | Line 111-123 |
| Data collection process | 9 | Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process. | Line 143-151 |
| Data items | 10a | List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect. | Line 130-134 |
| | 10b | List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information. | Line 143-149 |
| Study risk of bias assessment | 11 | Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process. | Line 152-158 |
| Effect measures | 12 | Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results. | Line 130-134 |
| Synthesis methods | 13a | Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)). | Line 185-186 |
| | 13b | Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions. | Line 163-176 |
| | 13c | Describe any methods used to tabulate or visually display results of individual studies and syntheses. | Line 177-180 |
| | 13d | Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used. | Line 177 |
| | 13e | Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression). | Line 172-176 |
| | 13f | Describe any sensitivity analyses conducted to assess robustness of the synthesized results. | Line 175 |
| Reporting bias assessment | 14 | Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases). | not applicable |
| Certainty assessment | 15 | Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome. | Line 155-158 |

### PRISMA 2020 Checklist

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| **RESULTS** | | | |
| Study selection | 16a | Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram. | Line 175-179 |
| | 16b | Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded. | Line 177-179 |
| Study characteristics | 17 | Cite each included study and present its characteristics. | Line 180-200 |
| Risk of bias in studies | 18 | Present assessments of risk of bias for each included study. | Line201-203 |
| Results of individual studies | 19 | For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots. | Line 204-233 |
| Results of syntheses | 20a | For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies. | Line 204-233 |
| | 20b | Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect. | Line 204-233 |
| | 20c | Present results of all investigations of possible causes of heterogeneity among study results. | Line 204-233 |
| | 20d | Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results. | Line 204-233 |
| Reporting biases | 21 | Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed. | not applicable |
| Certainty of evidence | 22 | Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed. | Line 204-233 |
| **DISCUSSION** | | | |
| Discussion | 23a | Provide a general interpretation of the results in the context of other evidence. | Line 236-243 |
| | 23b | Discuss any limitations of the evidence included in the review. | Line 297-302 |
| | 23c | Discuss any limitations of the review processes used. | Line 297-302 |
| | 23d | Discuss implications of the results for practice, policy, and future research. | Line 303-307 |
| **OTHER INFORMATION** | | | |
| Registration and protocol | 24a | Provide registration information for the review, including register name and registration number, or state that the review was not registered. | Line 86-87 |
| | 24b | Indicate where the review protocol can be accessed, or state that a protocol was not prepared. | Line 86-87 |
| | 24c | Describe and explain any amendments to information provided at registration or in the protocol. | not applicable |
| Support | 25 | Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review. | not applicable |
| Competing interests | 26 | Declare any competing interests of review authors. | not applicable |
| Availability of data, code and other materials | 27 | Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review. | available |

*From:* Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

**Online Resource 2.**

## Pubmed searching strategy

| | | |
|---|---|---|
| #1 | ((((((("Body Composition"[Mesh]) OR ("Intra-Abdominal Fat"[Mesh])) OR ("Subcutaneous Fat"[Mesh])) OR ("Adiposity"[Mesh])) OR ("Sarcopenia"[Mesh])) OR ("Muscle, Skeletal"[Mesh])) AND ((((Hepatic venous pressure gradient[Title/Abstract]) OR ("Hypertension, Portal"[Mesh])) OR ("Hepatic Veins"[Mesh])) OR ("Portal Pressure"[Mesh])) | 156 |
| #2 | (((((((pressure, portal[Title/Abstract]) OR (portal venous pressure[Title/Abstract])) OR (pressure, portal venous[Title/Abstract])) OR (venous pressure, portal[Title/Abstract])) OR (((hepatic vein[Title/Abstract]) OR (vein, hepatic[Title/Abstract])) OR (veins, hepatic[Title/Abstract]))) OR ((((((((portal hypertension[Title/Abstract]) OR (portal hypertensions[Title/Abstract])) OR (cruveilhier-baumgarten syndrome[Title/Abstract])) OR (cruveilhier baumgarten syndrome[Title/Abstract])) OR (syndrome, cruveilhier-baumgarten[Title/Abstract])) OR (cruveilhier-baumgarten disease[Title/Abstract])) OR (cruveilhier baumgarten disease[Title/Abstract])) OR (disease, cruveilhier-baumgarten[Title/Abstract]))) OR (Hepatic venous pressure gradient[Title/Abstract])) AND ((((((((((((((((((((muscles, skeletal[Title/Abstract]) OR (skeletal muscles[Title/Abstract])) OR (muscle, voluntary[Title/Abstract])) OR (muscles, voluntary[Title/Abstract])) OR (voluntary muscle[Title/Abstract])) OR (voluntary muscles[Title/Abstract])) OR (skeletal muscle[Title/Abstract])) OR (soleus muscle[Title/Abstract])) OR (muscle, soleus[Title/Abstract])) OR (plantaris muscle[Title/Abstract])) OR (muscle, plantaris[Title/Abstract])) OR (anterior tibial muscle[Title/Abstract])) OR (muscle, anterior tibial[Title/Abstract])) OR (tibial muscle, anterior[Title/Abstract])) OR (gastrocnemius muscle[Title/Abstract])) OR (muscle, gastrocnemius[Title/Abstract])) OR (((((sarcopenias[Title/Abstract]) OR (presarcopenia[Title/Abstract])) OR (skeletal muscle index[Title/Abstract])) OR (SMI[Title/Abstract])) OR (muscle atrophy[Title/Abstract]))) OR (((((fats, subcutaneous[Title/Abstract]) OR (subcutaneous fats[Title/Abstract])) OR (adipose tissue, subcutaneous[Title/Abstract])) OR (fat, subcutaneous[Title/Abstract])) OR (subcutaneous adipose tissue[Title/Abstract]))) OR ((((((((((((((((((((((((fats, intra-abdominal[Title/Abstract]) OR (intra abdominal fat[Title/Abstract])) OR (intra-abdominal fats[Title/Abstract])) OR (fat, intra-abdominal[Title/Abstract])) OR (fat, intra abdominal[Title/Abstract])) OR (intra-abdominal adipose tissue[Title/Abstract])) OR (adipose tissue, intra-abdominal[Title/Abstract])) OR (intra abdominal adipose tissue[Title/Abstract])) OR (retroperitoneal fat[Title/Abstract])) OR (fat, retroperitoneal[Title/Abstract])) OR (fats, retroperitoneal[Title/Abstract])) OR (retroperitoneal fats[Title/Abstract])) OR (retroperitoneal adipose tissue[Title/Abstract])) OR (adipose tissue, retroperitoneal[Title/Abstract])) OR (visceral fat[Title/Abstract])) OR (fat, visceral[Title/Abstract])) OR (fats, visceral[Title/Abstract])) OR (visceral fats[Title/Abstract])) OR (abdominal visceral fat[Title/Abstract])) OR (abdominal visceral fats[Title/Abstract])) OR (fat, abdominal visceral[Title/Abstract])) OR (fats, abdominal visceral[Title/Abstract])) OR (visceral adipose tissue[Title/Abstract])) OR (adipose tissue, visceral[Title/Abstract]))) OR (((body compositions[Title/Abstract]) OR (composition, body[Title/Abstract])) OR (compositions, body[Title/Abstract])))) | 90 |
| #1: MeSH word search<br><br>#2: Text word search | | |

**Embase searching strategy**

| | | |
|---|---|---|
| #1 | 'hepatic venous pressure gradient'/exp | 1,042 |
| #2 | 'portal vein blood pressure'/exp | 6,542 |
| #3 | 'portal hypertension'/exp | 41,132 |
| #4 | 'hepatic vein pressure gradient':ti,ab,kw OR 'porta pressure':ti,ab,kw OR 'porta vein pressure':ti,ab,kw OR 'portal blood pressure':ti,ab,kw OR 'portal pressure':ti,ab,kw OR 'portal vein pressure':ti,ab,kw OR 'portal venous pressure':ti,ab,kw OR 'pressure, portal vein':ti,ab,kw OR 'hypertension, portal':ti,ab,kw OR 'hypertension, portal vein':ti,ab,kw OR 'porta hypertension':ti,ab,kw OR 'portal congestion':ti,ab,kw OR 'portal vein hypertension':ti,ab,kw OR 'vena portae hypertension':ti,ab,kw | 6,933 |
| #5 | 'skeletal muscle'/exp | 432,889 |
| #6 | 'sarcopenia'/exp | 20,474 |
| #7 | 'subcutaneous fat'/exp | 25,911 |
| #8 | 'body composition'/exp | 128,357 |
| #9 | 'intra-abdominal fat'/exp | 25,745 |
| #10 | 'cross striated muscle':ab,ti OR 'cross striped muscle':ab,ti OR 'muscle, skeletal':ab,ti OR 'skeletal musculature':ab,ti OR 'skeleton muscle':ab,ti OR 'trunk muscle':ab,ti OR presarcopenia:ab,ti OR 'fat, subcutaneous':ab,ti OR 'panniculus adiposus':ab,ti OR 'subcutaneous adipose tissue':ab,ti OR 'subcutaneous fat tissue':ab,ti OR 'abdominal visceral adipose tissue':ab,ti OR 'abdominal visceral fat':ab,ti OR 'intra-abdominal adipose tissue':ab,ti OR 'intraabdominal adipose tissue':ab,ti OR 'intraabdominal fat':ab,ti OR 'organ adipose tissue':ab,ti OR 'organ fat':ab,ti OR 'visceral abdominal adipose tissue':ab,ti OR 'visceral abdominal fat':ab,ti OR 'visceral adipose tissue':ab,ti OR 'visceral fat':ab,ti OR 'composition, body':ab,ti | 36,031 |
| #11 | #1 OR #2 OR #3 OR #4 | 45,318 |
| #12 | #5 OR #6 OR #7 OR #8 OR #9 OR #10 | 596,687 |
| #13 | #11 AND #12 | 379 |

### Web of Science searching strategy

| | | |
|---|---|---|
| #1 | TS="Hepatic venous pressure gradient" OR "hepatic vein pressure gradient" OR "portal vein blood pressure" OR "porta pressure" OR "porta vein pressure" OR "portal blood pressure" OR "portal pressure" OR "portal vein pressure" OR "portal venous pressure" OR "pressure, portal vein" OR "portal hypertension" OR "hypertension, portal" OR "hypertension, portal vein" OR "porta hypertension" OR "portal congestion" OR "portal vein hypertension" OR "vena portae hypertension" | 23,028 |
| #2 | TS="skeletal muscle" OR "cross striated muscle" OR "cross striped muscle" OR "muscle, skeletal" OR "skeletal musculature" OR "skeleton muscle" OR "trunk muscle" OR "Sarcopenia" OR "presarcopenia" | 226,391 |
| #3 | TS="Subcutaneous Fat" OR "fat, subcutaneous" OR "panniculus adiposus" OR "subcutaneous adipose tissue" OR "subcutaneous fat tissue" OR "intra-abdominal fat" OR "abdominal visceral adipose tissue" OR "abdominal visceral fat" OR "intra-abdominal adipose tissue" OR "intraabdominal adipose tissue" OR "intraabdominal fat" OR "organ adipose tissue" OR "organ fat" OR "visceral abdominal adipose tissue" OR "visceral abdominal fat" OR "visceral adipose tissue" OR "visceral fat" OR "body composition" OR "composition, body" | 113,631 |
| #4 | #2 OR #3 | 325,823 |
| #5 | #1 AND #4 | 161 |

### Cochrane searching strategy

### Mesh word search

| | | |
|---|---|---|
| #1 | MeSH descriptor: [Muscle, Skeletal] explode all trees | 15,568 |
| #2 | MeSH descriptor: [Sarcopenia] explode all trees | 835 |
| #3 | MeSH descriptor: [Adiposity] explode all trees | 964 |
| #4 | MeSH descriptor: [Subcutaneous Fat] explode all trees | 407 |
| #5 | MeSH descriptor: [Intra-Abdominal Fat] explode all trees | 576 |
| #6 | MeSH descriptor: [Body Composition] explode all trees | 7120 |
| #7 | MeSH descriptor: [Portal Pressure] explode all trees | 71 |
| #8 | MeSH descriptor: [Hepatic Veins] explode all trees | 115 |
| #9 | MeSH descriptor: [Hypertension, Portal] explode all trees | 1374 |
| #10 | ("hepatic venous pressure gradient"):ti,ab,kw (Word variations have been searched) | 332 |
| #11 | ("hepatic vein pressure gradient"):ti,ab,kw (Word variations have been searched) | 26 |
| #12 | #10 or #11 | 353 |
| #13 | #1 or #2 or #3 or #4 or #5 or #6 | 22,925 |
| #14 | #7 or #8 or #9 or #12 | 1,663 |
| #15 | #13 and #14 | 6 |

**Text word search**

| | | |
|---|---|---|
| #1 | (muscles, skeletal):ti,ab,kw OR (skeletal muscles):ti,ab,kw OR (muscle, voluntary):ti,ab,kw OR (muscles, voluntary):ti,ab,kw OR (voluntary muscle):ti,ab,kw (Word variations have been searched) | 18,384 |
| #2 | (voluntary muscles):ti,ab,kw OR (skeletal muscle):ti,ab,kw OR (soleus muscle):ti,ab,kw OR (muscle, soleus):ti,ab,kw OR (plantaris muscle):ti,ab,kw (Word variations have been searched) | 18,848 |
| #3 | (muscle, plantaris):ti,ab,kw OR (anterior tibial muscle):ti,ab,kw OR (muscle, anterior tibial):ti,ab,kw OR (tibial muscle, anterior):ti,ab,kw OR (gastrocnemius muscle):ti,ab,kw (Word variations have been searched) | 1,894 |
| #4 | (muscle, gastrocnemius):ti,ab,kw (Word variations have been searched) | 1,597 |
| #5 | #1 or #2 or #3 or #4 | 19,793 |
| #6 | (sarcopenias):ti,ab,kw OR (presarcopenia):ti,ab,kw OR (skeletal muscle index):ti,ab,kw OR (SMI):ti,ab,kw OR (muscle atrophy):ti,ab,kw (Word variations have been searched) | 8,939 |
| #7 | (fats, subcutaneous):ti,ab,kw OR (subcutaneous fats):ti,ab,kw OR (adipose tissue, subcutaneous):ti,ab,kw OR (fat, subcutaneous):ti,ab,kw OR (subcutaneous adipose tissue):ti,ab,kw (Word variations have been searched) | 3,239 |
| #8 | (fats, intra-abdominal):ti,ab,kw OR (intra abdominal fat):ti,ab,kw OR (intra-abdominal fats):ti,ab,kw OR (fat, intra-abdominal):ti,ab,kw OR (fat, intra abdominal):ti,ab,kw (Word variations have been searched) | 1,259 |
| #9 | (intra-abdominal adipose tissue):ti,ab,kw OR (adipose tissue, intra-abdominal):ti,ab,kw OR (intra abdominal adipose tissue):ti,ab,kw OR (retroperitoneal fat):ti,ab,kw OR (fat, retroperitoneal):ti,ab,kw (Word variations have been searched) | 594 |
| #10 | (fats, retroperitoneal):ti,ab,kw OR (retroperitoneal fats):ti,ab,kw OR (retroperitoneal adipose tissue):ti,ab,kw OR (adipose tissue, retroperitoneal):ti,ab,kw OR (visceral fat):ti,ab,kw (Word variations have been searched) | 3,087 |
| #11 | (fat, visceral):ti,ab,kw OR (fats, visceral):ti,ab,kw OR (visceral fats):ti,ab,kw OR (abdominal visceral fat):ti,ab,kw OR (abdominal visceral fats):ti,ab,kw (Word variations have been searched) | 3,066 |
| #12 | (fat, abdominal visceral):ti,ab,kw OR (fats, abdominal visceral):ti,ab,kw OR (visceral adipose tissue):ti,ab,kw OR (adipose tissue, visceral):ti,ab,kw (Word variations have been searched) | 2,301 |
| #13 | #8 or #9 or #10 or #11 or #12 | 3,486 |
| #14 | (body compositions):ti,ab,kw OR (composition, body):ti,ab,kw OR (compositions, body):ti,ab,kw (Word variations have been searched) | 23,051 |
| #15 | (pressure, portal):ti,ab,kw OR (portal venous pressure):ti,ab,kw OR (pressure, portal venous):ti,ab,kw OR (venous pressure, portal):ti,ab,kw (Word variations have been searched) | 1,133 |
| #16 | (hepatic vein):ti,ab,kw OR (vein, hepatic):ti,ab,kw OR (veins, hepatic):ti,ab,kw (Word variations have been searched) | 1,743 |
| #17 | (portal hypertension):ti,ab,kw OR (portal hypertensions):ti,ab,kw OR (cruveilhier-baumgarten syndrome):ti,ab,kw OR (cruveilhier baumgarten syndrome):ti,ab,kw OR (syndrome, cruveilhier-baumgarten):ti,ab,kw (Word variations have been searched) | 1,815 |
| #18 | (cruveilhier-baumgarten disease):ti,ab,kw OR (cruveilhier baumgarten disease):ti,ab,kw OR (disease, cruveilhier-baumgarten):ti,ab,kw (Word variations have been searched) | 0 |
| #19 | #17 or #18 | 1,815 |
| #20 | (Hepatic venous pressure gradient):ti,ab,kw OR (hepatic vein pressure gradient):ti,ab,kw OR (HVPG):ti,ab,kw (Word variations have been searched) | 497 |
| #21 | #5 or #6 or #7 or #13 or #14 | 47,332 |
| #22 | #15 or #16 or #19 or #20 | 3,731 |
| #23 | #21 and #22 | 86 |
| #23 includes two Cochrane reviews and 84 trials | | |

Online Resource 1.

**Quality assessment based on QUADAS-2**

| Study | Risk of bias | | | | Applicability concerns | | |
|---|---|---|---|---|---|---|---|
| | P | I | R | FT | P | I | R |
| Jeong, J. Y.(2018) | ? | ✓ | ✓ | ✓ | ? | ✓ | ✓ |
| Paternostro, R.(2021) | ✓ | ✓ | ? | ✓ | ✓ | ✓ | ? |
| Maruyama, H. (2017) | ? | ✓ | ✓ | ✓ | ? | ✓ | ✓ |
| Kim, T. Y. (2014) | ✓ | ✗ | ? | ✓ | ✗ | ✗ | ? |
| Kang, S. H. (2018) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Matsui, T. (2022) | ? | ✓ | ✓ | ? | ? | ✓ | ✓ |
| Cho, Y. S.(2021) | ? | ✓ | ✓ | ✓ | ? | ✓ | ✓ |
| Rodrigues, S. G.(2019) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Xin Zeng(2023) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Note:** P = Patient Selection; I = Index Test; R = Reference Standard; FT = Flow and Timing.

✓ indicates low risk; ✗ indicates high risk; ? indicates unclear risk.

**Detailed description of included studies**

| Study | Domain | Item | Description of decision |
|---|---|---|---|
| Jeong, J. Y.(2018) | Risk of bias | P | A consecutive or random sample was not described, but with a clear period |
| | | I | |
| | | R | |
| | | FT | |
| | Applicability concerns | P | A consecutive or random sample was not described, but with a clear period |
| | | I | |
| | | R | |
| Paternostro, R.(2021) | Risk of bias | P | |
| | | I | |
| | | R | The value of TPMT for sarcopenia definition compared with SMI was uncertain |
| | | FT | |
| | Applicability concerns | P | |
| | | I | |
| | | R | The value of TPMT for sarcopenia definition compared with SMI was uncertain |
| Maruyama, H. (2017) | Risk of bias | P | Of 98 patients, one with paraumbilical vein was excluded due to shunt-related increase of portal venous flow(proportion less than 20%) |
| | | I | |
| | | R | |
| | | FT | |
| | Applicability concerns | P | Thirteen patients with HCC at early stage were included, the impact of early HCC on muscle loss is uncertain |
| | | I | |
| | | R | |
| Kim, T. Y. (2014) | Risk of bias | P | |
| | | I | The threshold was derived from mortality with maximum |

| | | | |
|---|---|---|---|
| | | | log-rank statistic instead of a pre-specified value |
| | | R | The value of PMTH for sarcopenia definition compared with SMI is uncertain |
| | | FT | |
| | Applicability concerns | P | All included patients were non-critically-ill patients with decompensated cirrhosis |
| | | I | The threshold was derived from mortality with maximum log-rank statistic instead of a pre-specified value |
| | | R | The value of PMTH for sarcopenia definition compared with SMI is uncertain |
| Kang, S. H. (2018) | Risk of bias | P | |
| | | I | |
| | | R | |
| | | FT | |
| | Applicability concerns | P | |
| | | I | |
| | | R | |
| Matsui, T. (2022) | Risk of bias | P | A consecutive or random sample was not described, but with a clear period |
| | | I | |
| | | R | |
| | | FT | The interval was not described; liver fibrosis or cirrhosis is a chronic condition. |
| | Applicability concerns | P | A consecutive or random sample was not described, but with a clear period |
| | | I | |
| | | R | |
| Cho, Y. S.(2021) | Risk of bias | P | A consecutive or random sample was not described, but with a clear period |
| | | I | |
| | | R | |
| | | FT | |

| | | | |
|---|---|---|---|
| | | P | A consecutive or random sample was not described, but with a clear period |
| | Applicability concerns | I | |
| | | R | |
| | | P | |
| | | I | |
| | Risk of bias | R | |
| Rodrigues, S. G.(2019) | | FT | |
| | | P | |
| | Applicability concerns | I | |
| | | R | |
| | | P | |
| | | I | |
| | Risk of bias | R | |
| Xin Zeng(2023) | | FT | |
| | | P | |
| | Applicability concerns | I | |
| | | R | |

Note: hepatocellular carcinoma: HCC