Original Article

Computed tomography (CT)-based skeletal muscle vertebral-related index to assess low muscle mass in patients with non-small cell lung cancer

Yilong Huang[#], Feng Yuan[#], Lei Yang, Honglei Guo, Yuanming Jiang, Hanxue Cun, Zhanglin Mou, Jiaxin Chen, Chunli Li, Zhenguang Zhang, Bo He

Department of Medical Imaging, the First Affiliated Hospital of Kunming Medical University, Kunming, China

Contributions: (I) Conception and design: B He, Y Huang; (II) Administrative support: B He, Z Zhang; (III) Provision of study materials or patients: F Yuan, L Yang, H Guo, Y Jiang, H Cun, Z Mou, J Chen, C Li, Z Zhang; (IV) Collection and assembly of data: F Yuan, L Yang, H Cun, Z Mou, Z Zhang; (V) Data analysis and interpretation: B He, Y Huang; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work.

Correspondence to: Zhenguang Zhang, MM; Bo He, PhD. Department of Medical Imaging, the First Affiliated Hospital of Kunming Medical University, No. 295 Xichang Road, Kunming 650032, China. Email: 178546941@qq.com; kmmu_hb@163.com.

Background: Patients with lung cancer accompanied by sarcopenia may have a poor prognosis. Normally, low muscle mass associated with sarcopenia is assessed using the skeletal muscle index (SMI). It remains unclear whether the standardized skeletal muscle area (SMA) using 2-dimensional (2D) vertebral metrics (called the skeletal muscle vertebral related index, SMVI) could substitute for SMI when it is missing. The aim of this study was to investigate the feasibility of SMVI as an alternative to SMI, and their associations with overall survival (OS) in patients with non-small cell lung cancer (NSCLC).

Methods: In this single-center study, a retrospective analysis was conducted on 433 NSCLC patients who underwent computed tomography (CT) scans. At the third lumbar vertebra (L3) level, measurements were taken for SMA, vertebral body area, transverse vertebral diameter (TVD), longitudinal vertebral diameter (LVD), and vertebral height (VH). The 4 SMVIs were skeletal muscle vertebral ratio (SMVR) (SMA/vertebral body area), skeletal muscle transverse vertebral diameter index (SMTVDI) (SMA/TVD2), skeletal muscle longitudinal vertebral diameter index (SMLVDI) (SMA/LVD2), and skeletal muscle vertebral height index (SMVHI) (SMA/VH2). The patients were categorized into low and high muscle mass groups based on SMI, and the differences in SMVIs between the 2 groups were compared to assess their correlation with SMI. Receiver operating characteristic (ROC) curves and the area under the curve (AUC) were utilized to assess the discriminatory ability. Kaplan-Meier curves were employed to compare the survival disparity between the 2 groups.

Results: We included 191 male and 242 female patients in this study. Compared to the high muscle mass group, patients in the low muscle mass group exhibited significantly lower SMVR, SMTVDI, SMLVDI, and SMVHI (all $P<0.05$). All 4 SMVIs showed a positive correlation with SMI, with Spearman correlation coefficients of 0.83, 0.76, 0.75, and 0.67, respectively (all $P<0.001$). The AUC for diagnosing low muscle mass was higher than 0.8 for all 4 SMVI parameters. The Kaplan-Meier curve revealed that the low-risk group had a better survival probability than the high-risk group in the SMVR, SMTVDI, and SMLVDI.

Conclusions: The SMVI functions as an alternative metric for evaluating skeletal muscle mass in the assessment of NSCLC based on SMI.

Keywords: Lung cancer; sarcopenia; computed tomography (CT); overall survival (OS)

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Introduction

Skeletal muscles perform a critical function in numerous aspects of the human body, such as movement, posture maintenance, body support, regulation of temperature, and metabolic activities. Numerous studies have investigated the relationship between skeletal muscles and aspects of physical health, aging, the incidence of various diseases, and mortality rates (1,2). The European Working Group on Sarcopenia in Older People 2 (EWGSOP2) describes sarcopenia as a progressive and generalized skeletal muscle disorder associated with an increased likelihood of adverse outcomes including falls, fractures, physical disabilities, and mortality (3).

Recently, there has been considerable attention from numerous researchers on the relationship between sarcopenia and cancer. Several studies have investigated the relationship between lung cancer and sarcopenia, with consistent findings that sarcopenia is a poor prognostic factor for lung cancer (4,5). The presence of sarcopenia has been found to be a strong prognostic factor for a 2-fold increased risk of death in lung cancer patients, with some studies reporting a 3-fold increased risk in multivariate analysis (6). Sarcopenia is also associated with increased postoperative complications and decreased disease control rates with immune checkpoint inhibitors in patients with non-small cell lung cancer (NSCLC) (7). Overall, the evidence consistently suggests that sarcopenia is a significant factor in the prognosis and treatment of lung cancer, and further research is necessary to clarify the pathophysiology of sarcopenia and develop effective interventions for patients with lung cancer. Sarcopenia diagnosis is confirmed when low muscle strength and low muscle mass are present (3). Low muscle mass is considered an emerging biomarker for the prognosis of lung cancer patients (8), offering valuable prognostic information beyond traditional risk factors. With the growing recognition of muscle importance, various imaging methods have been introduced to assess muscle quantity.

Computed tomography (CT) is considered one of the gold standard non-invasive methods for assessing muscle mass (9,10). The measurement of skeletal muscle area (SMA) at the third lumbar vertebra (L3) level on a single axial CT image can provide an accurate estimation of the total skeletal muscle mass in patients (11). Muscle mass measurements based on CT imaging typically require standardization according to patient-specific body size parameters, such as height. This standardization is used, for instance, in calculations such as the skeletal muscle index (SMI) and the psoas muscle index (12,13). Typically, a patient's height should be recorded in the medical electronic record. However, the assessment of sarcopenia has only begun to receive clinical attention in recent years. Affected by the differences in the electronic medical records systems and the standardization of medical document records in various countries and medical institutions, some SMI data has inevitably been missing in retrospective studies (14). This makes their muscle mass difficult to assess, even though CT image-based SMA measurements are available. In the field of forensic medicine, various attempts have been made to estimate height from available alternative measurements and imaging, such as long bones and the sacrum (15-17). Additionally, methods based on spinal parameters derived from CT images have been proposed for height estimation (18,19), and studies have also used bone as a standardized reference (20). Fortunately, patients undergoing CT scans can conveniently acquire both SMA and multiple 2-dimensional (2D) vertebral parameters at the L3 level. However, the feasibility of using standardized SMA based on vertebral 2D parameters (called the skeletal muscle vertebral related index, SMVI) remains unclear, and it is also unknown which vertebral parameter performs optimally in this regard.

Therefore, the aim of this retrospective study was to explore the feasibility of SMVI in the assessment of low muscle mass and to observe the relationship between SMVI and the overall survival (OS) in patients with NSCLC. We present this article in accordance with the STARD reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-24-120/rc).

Methods

Participants

We performed a retrospective study of consecutive NSCLC patients who underwent CT between January 2010 and December 2019 at the First Affiliated Hospital of Kunming

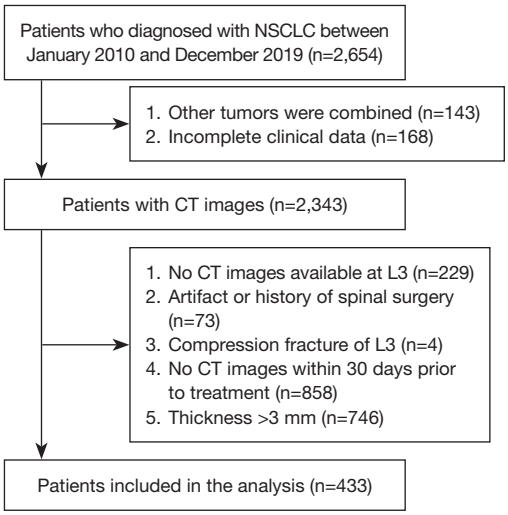

Figure 1 Flow diagram of patient enrollment. NSCLC, non-small cell lung cancer; CT, computed tomography; L3, third lumbar vertebra.

Medical University. We collected data on sex, age, height, weight, body mass index (BMI), smoking status, histological subtypes, and tumor-node-metastasis (TNM) stage. All patients received surgical treatment and had histologically confirmed NSCLC. The exclusion criteria were as follows: (I) incomplete clinical information; (II) history of spinal instrumentation surgery; (III) second primary tumor; (IV) spinal infection; (V) lack of available CT images at the L3; and (VI) inadequate image quality or inability to measurement. A total of 433 patients were included in the final analysis (*Figure 1*). Height data were unavailable for 165 patients. The study was conducted following the Declaration of Helsinki (as revised in 2013). Approval for this study was obtained from the Ethics Committee of the First Affiliated Hospital of Kunming Medical University (No. 2022L305) and the requirement for individual consent for this retrospective analysis was waived.

CT imaging and skeletal muscle measurement

All CT scans were obtained within 1 month before treatment (Somatom Definition AS; Siemens, Erlangen, Germany) in this study (21). The scanning parameters were as follows: slice thickness, 1 or 3 mm; section spacing, 1 or 3 mm; tube voltage, 100 kVp; tube current, 500 mAs. For each participant, a single axial CT image at the L3 level was analyzed to measure the area of skeletal muscle and vertebral body. The CT images were analyzed using a commercially available body composition analysis software platform (Slice-O-Matic V5.0; TomoVision, Magog, Canada). CT values ranging from –29 to +150 Hounsfield units (HU) were used to identify muscle and –29 to 1,000 HU for vertebral body (22). To account for variations in SM due to differences in patient size, including the SMI, which was obtained by dividing the SMA by the square of height in meters, as per the following calculation formula: SMI = SMA/h^2. The SMI threshold for diagnosing low muscle mass in sarcopenia varies across gender. Male patients with an SMI <40.3 cm^2/m^2 and female patients with an SMI <30.8 cm^2/m^2 were diagnosed with low muscle mass (23).

Assessment of SMVI

CT images were transferred to a picture archiving and communication system (PACS; Neusoft, Shenyang, China) and were measured in this workstation. The transverse vertebral diameter (TVD), longitudinal vertebral diameter (LVD), and area of vertebral body (VBA) at the center cross-section were measured at the L3 level. Besides, the vertebral height (VH) of L3 was measured at the central sagittal level of lumbar vertebrae. Additionally, standardization of SMA was performed using 2D vertebral parameters (SMVI), calculated by the following formulas: skeletal muscle vertebral ratio (SMVR) = SMA/VBA; skeletal muscle transverse vertebral diameter index (SMTVDI) = SMA/TVD^2; skeletal muscle longitudinal vertebral diameter index (SMLVDI) = SMA/LVD^2; and skeletal muscle vertebral height index (SMVHI) = SMA/VH^2. All measurements were performed by a trained radiology researcher (FY) and reviewed by a musculoskeletal radiologist (ZGZ) with more than 13 years of experience, who were blinded to the patients' clinical data, SMI, and outcomes. The CT image segmentation process of SMA, VBA, TVD, LVD, and VH is shown in *Figure 2*.

Patient outcomes

The primary outcome was OS, defined as the time from the date of first surgery to the date of death. The date of death was determined through telephone follow-up and electronic medical record system searches.

Statistical analysis

Continuous variables were reported as mean ± standard deviation (SD), and categorical variables were presented

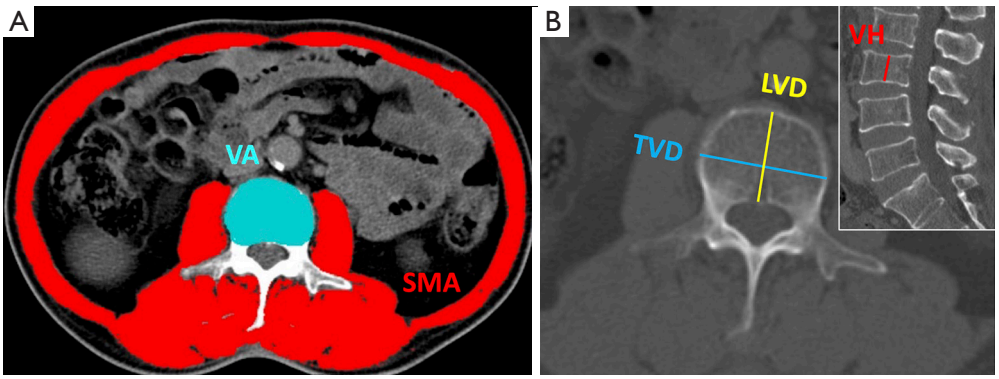

Figure 2 Measurement of the muscle and vertebral body at L3 level. (A) Skeletal muscle area (red) and vertebral area (cyan). (B) Transverse vertebral diameter (bule line); longitudinal vertebral diameter (yellow line); vertebral height (red line). SMA, skeletal muscle area; VA, vertebral area; TVD, transverse vertebral diameter; LVD, longitudinal vertebral diameter; VH, vertebral height.

as frequencies with percentages. Normality of continuous variables was assessed by the Shapiro-Wilk test. A sample size was calculated using GPower 3.1. The estimated sample size was 48 per group with total sample size of 96. Continuous variables with normal distribution were analyzed usingindependent *t*-test, continuous variables with non-normal distribution subjected to Mann-Whitney U test. Categorical variables were compared using the chi-square test. Correlation between SMI and SMVI were analyzed by Pearson's coefficient. Diagnostic performance of SMVI was measured by receiver operating characteristic (ROC) curve and area under ROC curve (AUC). Kaplan-Meier curves and log rank test were used for survival analysis. Statistical analyzes were calculated using R software (version 4.2.2; R Foundation for Statistical Computing, Vienna, Austria). A P value of less than 0.05 (P<0.05) was considered significant.

Results

Demographic and clinical characteristics of the study sample

A total of 433 patients (191 male and 242 female) with available CT images were enrolled in the study, with a mean age of 59.74±11.04 years and a mean BMI of 22.76±3.15 kg/m^2. The comparison of the baseline characteristics between different muscle mass groups is shown in *Table 1*. There was a significant difference between the high and low muscle mass groups for the age, male proportion, weight, BMI, OS, and histological subtypes (all P<0.05). SMI, SMVR, SMTVDI, SMLDVI, and SMVHI in the low muscle mass group were significantly lower than those in the high muscle mass group (all P<0.001). As shown in *Table 2*, significant differences in the SMI, SMVR, SMTVDI, SMLDVI, and SMVHI across the high and low muscle mass groups were detected in a subgroup analysis based on gender. Regardless of the high or low muscle mass groups, the SMI, SMVR, SMTVDI, SMLDVI, and SMVHI were higher in male patients than in female patients (all P<0.001).

Correlation between SMI and SMVI

The heatmap shows the correlation analysis between SMI, SMVR, SMTVDI, SMLDVI, and SMVHI (*Figure 3*). The SMVR was highly positively correlated with the SMI, and the Pearson correlation coefficient was 0.83 (P<0.001; *Figure 3A*). Besides, SMTVDI, SMLDVI, and SMVHI had moderately positive correlation with the SMI (r=0.76, 0.75, and 0.67, respectively; all P<0.001) (*Figure 3B-3D*). In addition, highly and moderately positive correlations were observed in different SMVI parameters (P<0.001).

SMVI and low muscle mass

Under the diagnostic criteria by SMI, in the male and female patients, the AUC of the SMVR for the diagnosis of low muscle mass was 0.902 and 0.892, the cutoff value was 8.86 and 8.10 cm^2/cm^2, the specificity was 89.4% and 77.7%, and the sensitivity was 75.0% and 87.3%, respectively. A similar diagnostic performance was observed for the SMTVDI and SMLDVI in both males and females. The DeLong test indicated an insignificant difference between AUCs of SMVR, SMTVDI, and SMLDVI

Table 1 Baseline characteristics of study participants

Characteristic	Total (n=433)	High muscle mass (n=302)	Low muscle mass (n=131)	P value
Age, years	59.74±11.04	58.57±10.31	62.44±12.18	0.002*
Height, m	1.62±0.07	1.62±0.07	1.63±0.07	0.301
Weight, kg	60.10±10.46	61.61±10.52	56.60±9.46	<0.001*
BMI, kg/m^2	22.76±3.15	23.47±3.09	21.12±2.63	<0.001*
SMI, cm^2/m^2	38.65±8.38	41.75±7.47	31.51±5.53	<0.001*
SMVR, cm^2/cm^2	9.16±1.91	9.84±1.69	7.60±1.40	<0.001*
SMTVDI, cm^2/cm^2	5.61±1.18	6.03±1.06	4.64±0.82	<0.001*
SMLVDI, cm^2/cm^2	10.64±2.45	11.44±2.26	8.80±1.77	<0.001*
SMVHI, cm^2/cm^2	21.17±7.16	22.94±7.24	17.10±4.98	<0.001*
Overall survival, days	1,270.98±840.24	1,357.44±870.92	1,071.66±729.72	0.001*
Sex, n (%)				0.031*
Male	191 (44.11)	123 (40.73)	68 (51.91)	
Female	242 (55.89)	179 (59.27)	63 (48.09)	
Smoking status, n (%)				0.169
No	357 (82.45)	254 (84.11)	103 (78.63)	
Yes	76 (17.55)	48 (15.89)	28 (21.37)	
Histological subtypes, n (%)				<0.001*
Adenocarcinoma	355 (81.99)	253 (83.77)	102 (77.86)	
Squamous cell carcinoma	18 (4.16)	5 (1.66)	13 (9.92)	
NSCLC	60 (13.86)	44 (14.57)	16 (12.21)	
TNM stage, n (%)				0.883
I	325 (75.06)	228 (75.50)	97 (74.05)	
II	53 (12.24)	35 (11.59)	18 (13.74)	
III	28 (6.47)	19 (6.29)	9 (6.87)	
IV	27 (6.24)	20 (6.62)	7 (5.34)	

Continuous variables are presented as mean ± standard deviation. Categorical parameters are presented as number (frequency). *, P<0.05. BMI, body mass index; SMI, skeletal muscle index; SMVR, skeletal muscle vertebral ratio; SMTVDI, skeletal muscle transverse vertebral diameter index; SMLVDI, skeletal muscle longitudinal vertebral diameter index; SMVHI, skeletal muscle vertebral height index; NSCLC, non-small cell lung cancer; TNM, tumor-node-metastases.

(P>0.05); the SMVHI had the lowest AUC in the male and female patients, and the differences with other SMVIs were statistically significant (P<0.05; *Table 3*, *Figure 4*).

SMVI and OS

We used the cutoff value of SMVR, SMTVDI, SMLDVI, and SMVHI to diagnose low muscle mass and observe differences in survival probability based on SMVIs classification. There was a significant difference in OS for patients with low SMI compared to high SMI (P=0.0082; *Figure 5A*). Patients in the low SMVR, SMTVDI, or SMLDVI groups had a shorter OS (P=0.0024, 0.003, 0.0018, respectively; *Figure 5B-5D*). There was no significant difference in OS between patients with low and high SMVHI using the cutoff value of SMVHI <23.12 cm^2/cm^2 in the male and SMVHI <18.51 cm^2/cm^2 in the female (P=0.28; *Figure 5E*).

Table 2 Skeletal muscle vertebral related index of study participants under different genders

Characteristic	Male				Female			
	Total (n=191)	High muscle mass (n=123)	Low muscle mass (n=68)	P	Total (n=242)	High muscle mass (n=179)	Low muscle mass (n=63)	P
SMI, cm^2/m^2	43.65±8.02	48.20±5.61	35.44±4.34	<0.001*	34.70±6.31	37.32±4.94	27.27±2.94	<0.001*
SMVR, cm^2/cm^2	9.89±2.02	10.87±1.60	8.12±1.38	<0.001*	8.59±1.62	9.14±1.37	7.03±1.19	<0.001*
SMTVDI, cm^2/cm^2	5.98±1.29	6.59±1.06	4.87±0.86	<0.001*	5.32±1.01	5.65±0.89	4.40±0.72	<0.001*
SMLVDI, cm^2/cm^2	11.45±2.68	12.66±2.25	9.25±1.86	<0.001*	10.01±2.04	10.61±1.86	8.31±1.54	<0.001*
SMVHI, cm^2/cm^2	23.73±8.29	26.57±8.19	18.59±5.56	<0.001*	19.15±5.33	20.44±5.22	15.49±3.69	<0.001*

Continuous variables are presented as mean ± standard deviation. *, P<0.05. SMI, skeletal muscle index; SMVR, skeletal muscle vertebral ratio; SMTVDI, skeletal muscle transverse vertebral diameter index; SMLVDI, skeletal muscle longitudinal vertebral diameter index; SMVHI, skeletal muscle vertebral height index.

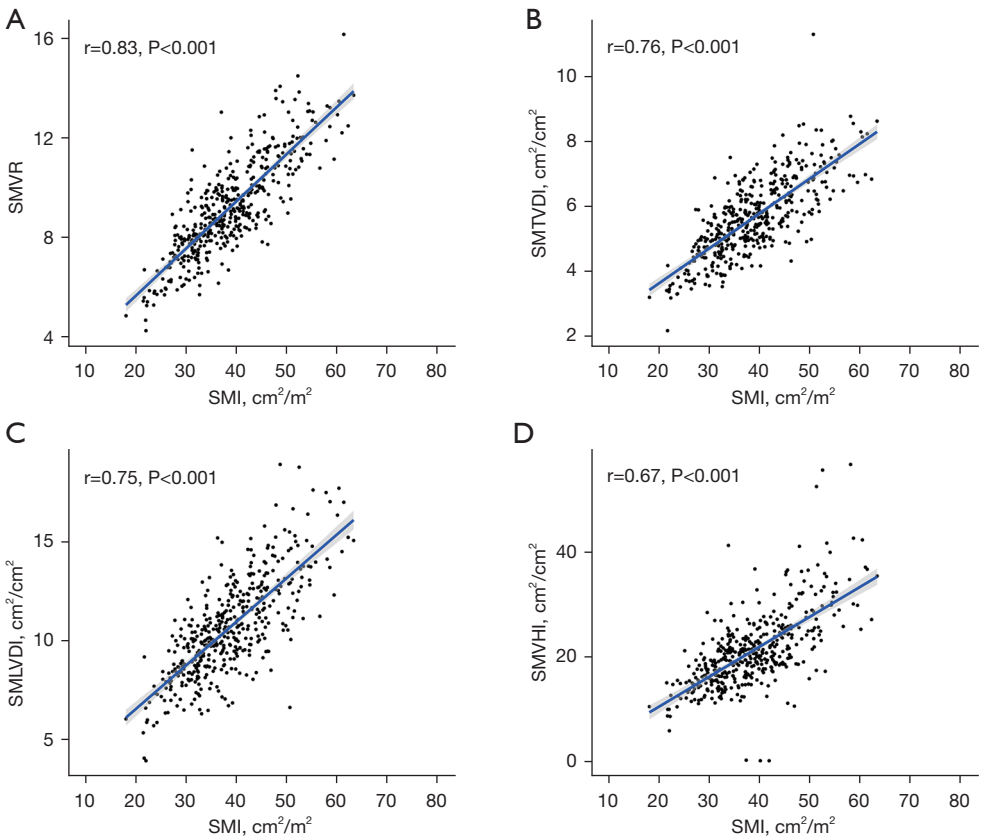

Figure 3 Correlation analyses between skeletal muscle index and 4 skeletal muscle vertebral related indexes. (A-D) The scatter plots between SMI and SMVI [(A) SMVR; (B) SMTVDI; (C) SMLVDI; (D) MSVHI]. SMI, skeletal muscle index; SMVR, skeletal muscle vertebral ratio; SMTVDI, skeletal muscle transverse vertebral diameter index; SMLVDI, skeletal muscle longitudinal vertebral diameter index; SMVHI, skeletal muscle vertebral height index; SMVI, skeletal muscle vertebral related index.

Table 3 Diagnostic efficacy of skeletal muscle vertebral related index in differentiating muscle loss

Characteristic	Cut-off value	Specificity	Sensitivity	AUC (95% CI)
Male				
SMVR, cm^2/cm^2	8.86	0.894	0.750	0.902 (0.856–0.947)
SMTVDI, cm^2/cm^2	5.78	0.756	0.882	0.905 (0.864–0.946)
SMLVDI, cm^2/cm^2	11.22	0.724	0.882	0.881 (0.834–0.928)
SMVHI, cm^2/cm^2	23.12	0.691	0.841	0.823* (0.763–0.88)
Female				
SMVR, cm^2/cm^2	8.10	0.777	0.873	0.892 (0.848–0.937)
SMTVDI, cm^2/cm^2	4.99	0.771	0.825	0.866 (0.816–0.916)
SMLVDI, cm^2/cm^2	9.00	0.816	0.730	0.837 (0.781–0.893)
SMVHI, cm^2/cm^2	18.51	0.670	0.841	0.803* (0.742–0.864)

*, P<0.05. AUC, area under the curve; CI, confidence interval; SMVR, skeletal muscle vertebral ratio; SMTVDI, skeletal muscle transverse vertebral diameter index; SMLVDI, skeletal muscle longitudinal vertebral diameter index; SMVHI, skeletal muscle vertebral height index.

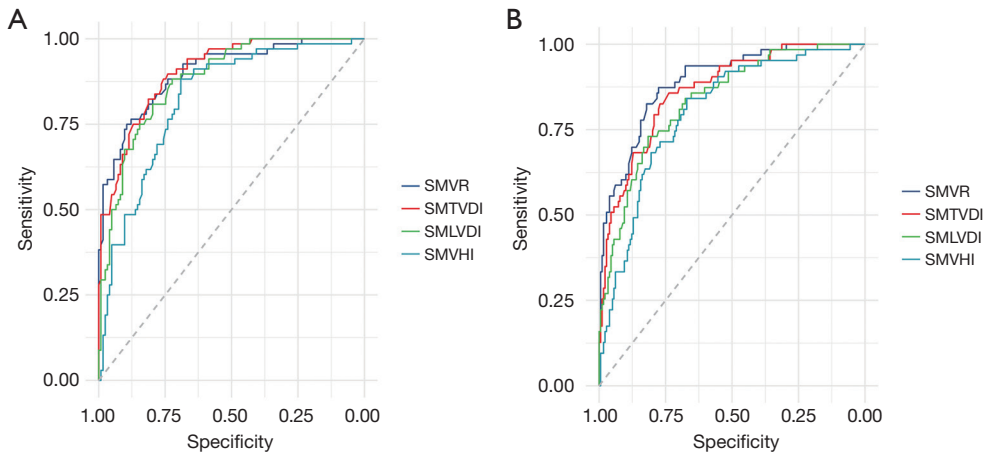

Figure 4 ROC curves of SMVI discriminate between low muscle mass and high muscle mass. (A) Male, cut-off value of SMI is 40.3 cm^2/m^2; (B) female, cut-off value of SMI is 30.8 cm^2/m^2. SMVR, skeletal muscle vertebral ratio; SMTVDI, skeletal muscle transverse vertebral diameter index; SMLVDI, skeletal muscle longitudinal vertebral diameter index; SMVHI, skeletal muscle vertebral height index; ROC, receiver operating characteristic; SMVI, skeletal muscle vertebral related index; SMI, skeletal muscle index.

Discussion

To address the potential absence of SMI in clinical practice and retrospective studies, this study standardized SMA using 2D vertebral measurements from CT images at the L3 level for the first time. We explored the feasibility of SMVIs as a reasonable substitute for SMI in NSCLC patients. Besides, we evaluated the diagnostic performance of the SMVIs in patients with low muscle mass and their relationship with patient prognosis. We found there was a positive correlation between SMI and SMVRs at the L3 level. The SMVIs effectively distinguished low muscle mass and were associated with the OS of NSCLC patients.

When SMI data derived from CT or magnetic resonance imaging (MRI) is unavailable, researchers may be able to refer to existing assessment of dual-energy X-ray absorptiometry and bioelectrical impedance analysis. This strategy still might not address all the issues when

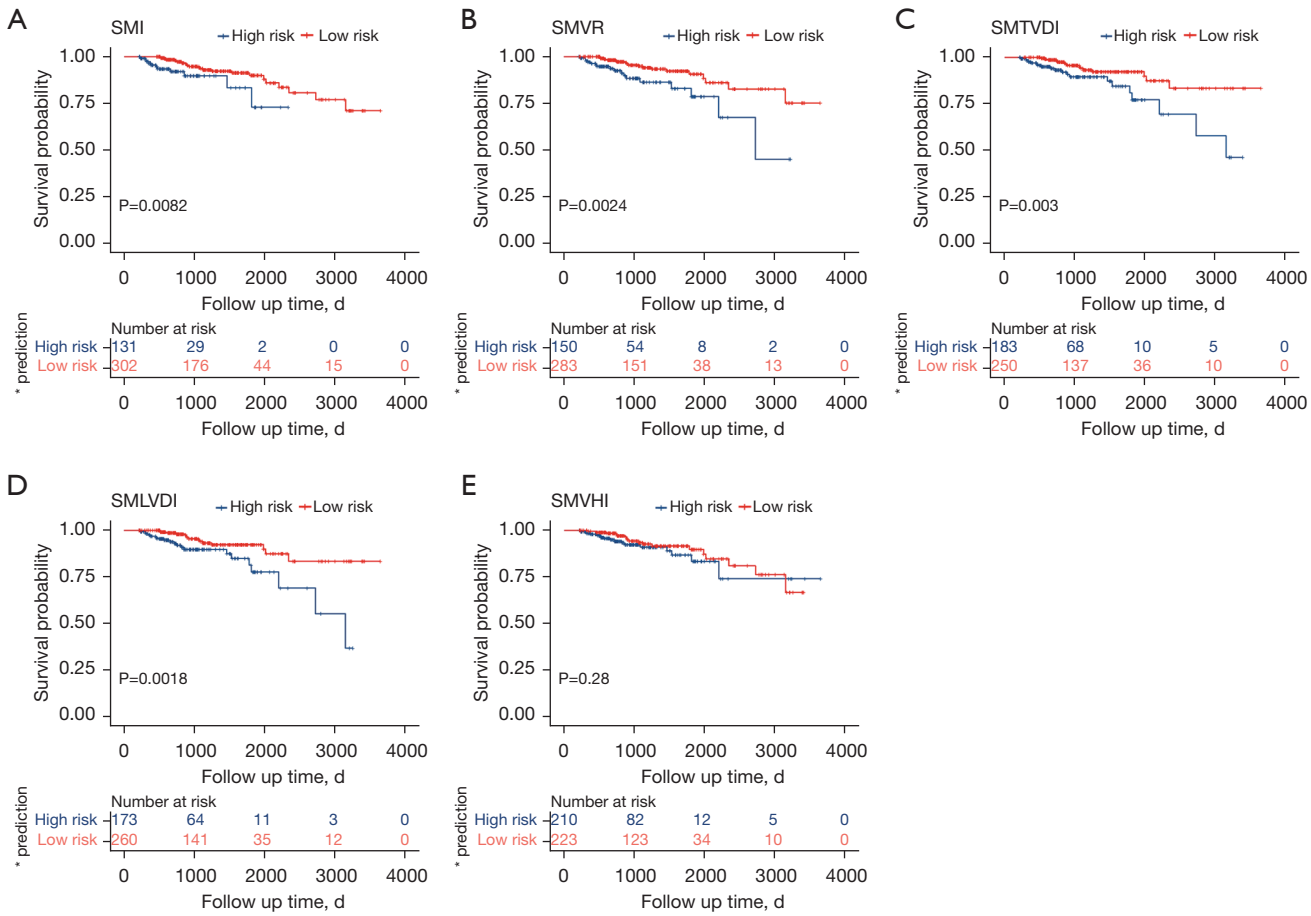

Figure 5 Kaplan-Meier curves of overall survival of NSCLC patients. (A) SMI; (B) SMVR; (C) SMTVDI; (D) SMLVDI; (E) SMVHI. NSCLC, non-small cell lung cancer; SMI, skeletal muscle index; SMVR, skeletal muscle vertebral ratio; SMTVDI, skeletal muscle transverse vertebral diameter index; SMLVDI, skeletal muscle longitudinal vertebral diameter index; SMVHI, skeletal muscle vertebral height index.

the patient has only had a CT scan. This study was not aimed at highlighting the limitations of SMI and seeking new alternative indicators in the routine clinical practice. However, how to generate from existing CT images a new indicator that can assess low muscle mass is meaningful, especially in retrospective studies. Firstly, by adopting previously reported SMI cutoff values indicative of low muscle mass in Asian populations (23), all 4 SMVI parameters showed a significant decrease in patients classified within the low muscle mass group, mirroring the outcomes observed with SMI. Furthermore, this result remained consistent regardless of gender influence. In forensic studies, skeletal dimensions are closely associated with height, such as long bones and vertebrae (18,24). A study conducted on a Spanish population sample found that the femur was the most accurate predictor of stature in males (R=0.851), whereas the tibia was the best predictor in females (R=0.876) (24). In our study, we compared the correlation between SMVIs and SMI, revealing a moderate-to-strong positive correlation between SMVIs and SMI. The ROC curve analysis demonstrated that SMVIs exhibit good diagnostic performance for identifying low muscle mass, with all 4 parameters having an AUC greater than 0.75. In the assessment of survival risk, our findings indicated that NSCLC patients with low SMI have a shorter OS, which aligns with previous research outcomes (25). Furthermore, by employing diagnostic thresholds for SMVR, SMTVDI, SMLVDI, and SMVHI to categorize patients into high- and low-risk groups for diagnosing low muscle mass, Kaplan-Meier curves demonstrated a noticeable disparity in OS among NSCLC patients based on differing SMVR, SMTVDI, and SMLVDI

levels. Previous studies have suggested that sarcopenia can significantly impact survivability in NSCLC patients through multiple interconnected mechanisms, including reduced treatment tolerance, impaired immune function, metabolic dysregulation, functional decline, and increased risk of complications (26-28). Therefore, identifying and addressing sarcopenia early in the course of NSCLC management may improve treatment outcomes and OS.

It is worth noting that not all SMVIs exhibit consistent performance. Considering results across both male and female populations for identifying low muscle mass, SMVR demonstrated the optimal diagnostic efficacy, achieving the highest combined values for AUC, sensitivity, and specificity. Conversely, SMVHI exhibited the lowest correlation with SMI (r=0.67) and demonstrated the poorest performance in diagnosing low muscle mass (AUC in males =0.763, AUC in females =0.742). It provided insignificant assistance in predicting the OS for NSCLC patients with low muscle mass. This is attributed to the significant role of age in relation to height (29). Studies indicate that VH decreases with age, particularly in later stages of life, which is associated with age-related bone loss (30,31). Additionally, VH ratios are subject to age-related changes, often decreasing with advancing age, especially among postmenopausal women (32). Therefore, when not adjusted for age, SMVHI's ability to identify low muscle mass is less effective compared to other SMVIs.

In this study, we recommend using SMVIs as an alternative for assessing muscle mass when SMI data is unavailable. Cutoff values are provided for diagnosing low muscle mass using SMVIs. Recent research involving deep learning methods for fully automated muscle segmentation and the associated 2D vertebral parameters utilized may provide a relatively straightforward approach for quickly obtaining muscle mass assessments in clinical settings (33). However, if SMI data is available, we advocate for the use of this more widely accepted and recognized metric.

There are several limitations to this current study. Firstly, routinely obtaining CT images at the L3 level is not standard practice in thoracic examinations for lung cancer. In this study, in order to effectively evaluate the feasibility of SMVI, we chose the SMI measured at the L3 level recommended in the guideline as a reference. Whether the L3 level is the optimal choice remains unclear and requires further investigation in future studies. Secondly, in this study, we did not focus on the potential impact of SMVR on treatment. Thirdly, in this single-center retrospective study, the participants were limited to NSCLC patients. The generalization of the study findings to other populations remains to be investigated but can serve as a reference.

Conclusions

SMVI is derived from the standardization of SMA using 2D vertebral parameters, namely SMVR, SMTVDI, SMLDVI, and SMVHI. It exhibits a significant positive correlation with SMI at the L3 level. SMVI effectively identifies low muscle mass as defined by SMI. NSCLC patients with low SMVR, SMTVDI, or SMLDVI exhibit a notably reduced OS. For patients with missing SMI data, SMVI serves as a feasible alternative method for assessing skeletal muscle mass.

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Footnote

Reporting Checklist: The authors have completed the STARD reporting checklist. Available at https://qims.amegroups.com/article/view/10.21037/qims-24-120/rc

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-24-120/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted following the Declaration of Helsinki (as revised in 2013). Approval for this study was obtained from the Ethics Committee of the First Affiliated Hospital of Kunming Medical University (No. 2022L305) and the requirement for individual consent for this retrospective analysis was waived.

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