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Original Article

PROPOSAL FOR NEW DIAGNOSTIC CRITERIA FOR SARCOPENIA BASED ON CT IMAGING IN SAUDI POPULATION: A NOVEL METHOD IN ONCOLOGY RESEARCH.

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ABSTRACT

Purpose: Sarcopenia is regarded as a diagnostic and prognostic marker for various diseases and health issues. Several studies have used CT to measure psoas muscle surface area (PMA) to define sarcopenia. However, the cut-off values based on CT imaging remain undetermined in Saudi population. The aim of this study is to provide sex and age-specific percentiles for PMA, psoas muscle index (PMI) and psoas muscle density (PMD) in Saudi population and to establish a formula to calculate the standard PMA based on individual anthropometric measurement.

Method: Sarcopenia is regarded as a diagnostic and prognostic marker for various diseases and health issues. Several studies have used CT to measure psoas muscle surface area (PMA) to define sarcopenia. However, the cut-off values based on CT imaging remain undetermined in Saudi population. The aim of this study is to provide sex and age-specific percentiles for PMA, psoas muscle index (PMI) and psoas muscle density (PMD) in Saudi population and to establish a formula to calculate the standard PMA based on individual anthropometric measurement.

Results: Males had significantly higher measurements of PMA than females (10.7 ± 2.7 cm2 vs 5.8 ± 1.9 cm2). PMA was positively correlated with body weight in both genders. The estimated PMA using the generated formula correlated strongly with the manually traced PMA measurements. The mean differences between estimated and measured PMA values were 0.81 ± 1.70 cm2 among males and 0.17 ± 1.19 cm2 among females. These outcomes emphasize the validity of our predictive computations.

Conclusion: Defining population specific cut-off values of PMA and PMI aids in CT based opportunistic screening for sarcopenia.

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الملخص

الغرض: يُعتبر ضمور العضلات علامة تشخيصية وتنبؤية لمختلف الأمراض والمشاكل الصحية. استخدمت العديد من الدراسات التصوير المقطعي المحوسب لقياس مساحة سطح العضلة القَطَنِيَّة الكبيرة لتعريف ضمور العضلات. ومع ذلك، تظل القيم الحدية المستندة إلى التصوير المقطعي المحوسب غير محددة في السكان السعوديين. يهدف هذاالبحث إلى توفير النسب المئوية الخاصة بالجنس والعمر لمساحة سطح العضلة القَطَنِيَّة الكبيرة، ومؤشر العضلة وكثافتها البصرية في السكان السعوديين، وإنشاء معادلةرياضية لحساب مساحة سطح العضلة القَطَنِيَّة الكبيرة القياسي بناءً على القياسات الأنثروبومترية الفردية.

الطرق: تم استخدام التصوير المقطعي المحوسب قبل الجراحة ل 400 شخص من متبرعين الكلى البالغين وذلك لقياس مساحة سطح العضلة القَطَنِيَّة الكبيرة، ومؤشر العضلةوكثافتها عند مستوى الفقرة القطنية الثالثة. حددنا القيم الحدية الخاصة بالعمر والجنس لمساحة سطح العضلة القَطَنِيَّة الكبيرة من أجل تعريف كتلة العضلات الهيكليةالمنخفضة. تم إنشاء معادلة رياضية لحساب مساحة سطح العضلة القَطَنِيَّة الكبيرة القياسي باستخدام وزن الجسم كمتغير مستقل وتم التحقق منها على مجموعة بياناتجديدة تشمل أفرادًا من السكان العامين.

النتائج: كان لدى الذكور قياسات لمساحة سطح العضلة القَطَنِيَّة الكبيرة أعلى بشكل ملحوظ من الإناث. كانت مساحة سطح العضلةالقَطَنِيَّة الكبيرة مرتبطة إيجابيًا (سم² مقابل 5.8 ± 1.9 سم² 2.7 ± 10.7) بوزن الجسم في كلا الجنسين. ارتبطت مساحة سطح العضلة القَطَنِيَّة الكبيرة المقدرة باستخدام المعادلة الرياضية المُنشأة بقوة معقياسات المساحة المرسومة يدويًا. كانت الفروق المتوسطة بين القيم المقدرة ± والمقاسة لمساحة سطح العضلة القَطَنِيَّة الكبيرة هي 0.81 ± 1.70 سم² بين الذكور و0.17 سم² بين الإناث. تؤكد هذه النتائج على صحة حساباتنا التنبؤية 1.19.

الاستنتاج: يساعد تحديد القيم الحدية الخاصة بالسكان لمساحة سطح ومؤشر العضلة القَطَنِيَّة الكبيرة في الفحص الفرصي لضمور العضلات باستخدام التصوير المقطعيالمحوسب.

الكلمات المفتاحية : ضمور العضلات؛ التصوير العضلي الهيكلي؛ التصوير المقطعي المحوسب؛ الفحص؛ الأورام

Keywords: Sarcopenia; Musculoskeletal Imaging; CT; Screening; Oncology.

1. INTRODUCTION

Sarcopenia, characterized by the progressive depletion of skeletal muscle mass, strength, and physical function, poses significant challenges to global health. Primarily associated with aging, sarcopenia also arises secondary to specific diseases, malnutrition, or reduced physical activity [1-2]. As elderly population continues to expand, the prevalence of sarcopenia has surged, affecting an estimated 50 million individuals worldwide [3-4]. This escalating trend is particularly concerning given the projected doubling of the global population aged over 60 by 2050 [5-6]. Given its significance alongside osteoporosis and osteoarthritis, sarcopenia will emerge as a critical determinant of health, necessitating active involvement from both clinicians and radiologists in its precise and timely diagnosis.

Beyond its diagnostic implications, sarcopenia serves as a powerful prognostic marker. Recent evidence underscores its independent association with adverse outcomes in various diseases [7-10], including increased postoperative complications, prolonged hospital stays, and elevated mortality rates [11-16]. Consequently, healthcare expenditures related to sarcopenia have risen significantly, reaching 18.5 billion USD in the United States alone [17].

The European Working Group on Sarcopenia in Older People (EWGSOP) originally defined sarcoenia emphasizing skeletal muscle measurement as a crucial criterion [4]. Techniques such as dual-energy x-ray absorptiometry (DXA), CT, MRI, and bioimpedance analysis (BIA) facilitate precise assessment of skeletal muscle composition [18]. Among these, CT and MRI stand out as gold standard methods due to their accuracy in quantifying muscle mass [19-21].

However, regional variations necessitate context-specific approaches. For instance, the Asian Working Group for Sarcopenia recommends a diagnostic cutoff based on deviations from the mean muscle mass of a young reference group [3]. Yet, applying identical cutoff values from studies conducted in Japan or Western countries may not align with the Saudi population's unique characteristics, including body size, lifestyle, and ethnicity [22-24]. Thus, tailored cutoff values for low skeletal muscle mass are essential for accurate diagnosis in each regional context.

2. MATERIALS AND METHOD

2.1 Study design and objectives

This is a cross-sectional retrospective single-institution study conducted on potential kidney donors from January 2019 to December 2021. The study was approved by the institutional ethics committee. The requirement for written informed consent was waived due to data anonymization and retrospective nature of the study. The aim of this study is to provide age and sex specific percentiles for PMA, PMI, and PMD in the Saudi population, measured by CT analysis at third lumber vertebral level. Secondly, to generate an equation to estimate the expected standard area of the psoas muscle based on an individual's anthropometric measurement. Thirdly, to validate the generated equation on a new dataset involving individuals from the general population.

2.2 Inclusion and exclusion criteria

2.2.1 Inclusion criteria:

Medical evaluation for potential kidney donors includes a review of the medical history, physical examination, blood and urine tests and medical imaging. Individuals were included in the study if:

1. Saudi population between 18-60 years old.
2. The individual was considered to be healthy, i.e., when an individual was medically approved as a kidney donor candidate.
3. The individual has enhanced CT of the abdomen and pelvis in the arterial and venous phase performed as part of the evaluation for kidney donation.
4. The individual had weight and height measurements recorded in their chart on the same day of CT imaging.

2.2.2. Exclusion criteria:

1. Patients with comorbidities, i.e. diabetes mellitus, hypertension, dyslipidemia, ischemic heart disease.
2. Patients on medications that could affect whole body composition, such as hormone or steroid-containing drugs.
3. Smoker.
4. Alcoholic.
5. Hip osteoarthritis.
6. Scoliosis.
7. Spinal fixation device.

2.3 Sample Size

The total population in Saudi Arabia amounted to 34.1 million in 2021, according to estimates by the General Authority for Statistics. Population between 18-60 years old are estimated to be around 22 million [25]. We used a sample size calculator that computes the minimum number of necessary samples to meet the desired statistical constraints. 95% confidence interval and 5% margin of error were used and computed 385 participants as a representative sample size. We included 400 participants, 200 males and 200 females.

2.4 Data collection tool

All scans were made in the supine position. The transverse image at the third lumber vertebra level most clearly displaying both vertebral transverse processes was selected. The selected image had to be of sufficient quality for muscle analysis, meaning:

1. No oral contrast.
2. No artefacts.
3. No cut-off of the muscle.
4. Clear differentiation between the muscle and surrounding tissue.

Manual tracing of the cross-sectional area of the right and left psoas muscles at third lumber vertebral level (where transverse processes are fully visualized) was measured by two blinded readers with different experience levels (radiologist 1 is musculoskeletal radiologist with five years experience and radiologist 2 is senior radiology resident) (**Figure 1**). Inter- and intra-observer agreement between the two readers is evaluated using intraclass correlation coefficient (ICC).

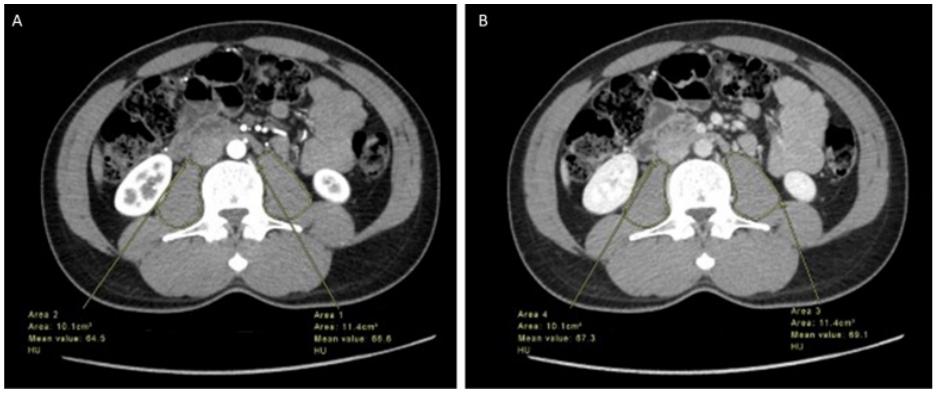

Figure 1. Manual tracing of the cross-sectional surface area of the right and left psoas muscle at the level of the third lumbar vertebra in the arterial (a) and venous phase (b).

PMI values were derived from patients' height and PMA by using the following formula: (right PMA + left PMA)/square of height. PMD was assessed by quantifying the radiation attenuation in Hounsfield Units (HU). PMD values were computed by taking the average of muscle attenuation measurements of the right and left psoas. These readily available PMD measurements were based on data of the arterial (A) and venous (V) phases of the enhanced CT.

2.5 Statistical Analysis

Since the PMA and PMI measurements were recorded by two data collectors, we assessed inter- and intra-observer agreement between these measurements by using intraclass correlation coefficients (ICC). Results showed ICC values of 0.92 (excellent) and 0.85 (good) for the inter-rater agreement in PMA and PMI, respectively. Furthermore, the intra-observer agreement values in PMA and PMI were good (0.84 and 0.73, respectively). For the analysis, we constructed a descriptive table to demonstrate and compare different characteristics and measurements among the overall cohort and between males and females. Categorical data was presented as frequencies and percentages while continuous data was expressed as mean ± standard deviation (SD). Given that the tests of normality indicated that the numerical variables were non-normally distributed, we determined the cutoff values of low PMA, low PMI and low PMD using the 5^{th} percentile of the respective parameter. The comparative analysis was carried out using Fisher's exact test for categorical variables and Wilcoxon rank sum test for numerical variables. We quantified the correlation between PMA and other numerical variables by the Spearman's correlation coefficient, and the results were depicted on scatterplots. Statistical analysis was performed using R (version 4.1.1).

3. RESULTS

3.1 Demographic characteristics and body-related measurements

A total of 400 kidney donor candidates were included in the current study (50% males). As demonstrated in **Table 1**, males had significantly higher mean values of body height (1.7 ± 0.1 vs 1.6 ± 0.1 among females, $p < 0.0001$), body weight (77.8 ± 14.0 vs 68.0 ± 12.5 among females, $p < 0.0001$) and body surface area (BSA, 2.0 ± 1.3 vs 1.7 ± 0.2 among females, $p < 0.0001$). However, males and females did not differ significantly in their age and BMI measurements. Males had significantly higher measurements of PMA (10.7 ± 2.7 vs 5.8 ± 1.9 among females, $p < 0.0001$) and PMI (3.7 ± 0.9 vs 2.3 ± 0.8 among females, $p < 0.0001$), as well as higher PMD measurements in the arterial (57.8 ± 6.7 vs 55.9 ± 7.4 among females, $p = 0.008$) and venous phases (63.2 ± 6.1 vs 60.8 ± 7.2 among females, $p < 0.0001$, **Table 1**). The estimated cutoff values for different muscle measurements based on gender and age categories are listed in **Table 2**.

Table 1 Demographic and body-related characteristics of the participants.

Characteristic	Overall, N = 400[1]	Male, N = 200[1]	Female, N = 200[1]	p-value[2]
Age, y	31.7 ± 8.5 (18.0-59.0)	31.1 ± 7.7 (18.0-57.0)	32.3 ± 9.1 (18.0-59.0)	0.263
Height, m	1.6 ± 0.1 (1.4-1.9)	1.7 ± 0.1 (1.5-1.9)	1.6 ± 0.1 (1.4-1.8)	<0.0001
Weight, kg	72.9 ± 14.1 (38.0-113.7)	77.8 ± 14.0 (47.4-113.7)	68.0 ± 12.5 (38.0-107.5)	<0.0001
BSA, m2	1.9 ± 0.9 (1.3-20.1)	2.0 ± 1.3 (1.5-20.1)	1.7 ± 0.2 (1.3-2.3)	<0.0001
BMI, kg/m2	27.0 ± 4.4 (15.8-38.4)	26.6 ± 4.2 (15.8-35.4)	27.4 ± 4.6 (16.0-38.4)	0.088
BMI Category				0.426
Underweight	9 (2.2%)	3 (1.5%)	6 (3.0%)	
Normal	122 (30.5%)	66 (33.0%)	56 (28.0%)	
Overweight	159 (39.8%)	82 (41.0%)	77 (38.5%)	
Obese I	98 (24.5%)	45 (22.5%)	53 (26.5%)	
Obese II	12 (3.0%)	4 (2.0%)	8 (4.0%)	
Obese III	0 (0.0%)	0 (0.0%)	0 (0.0%)	
PCSA, cm2	8.2 ± 3.4 (3.4-19.9)	10.7 ± 2.7 (4.8-19.6)	5.8 ± 1.9 (3.4-19.9)	<0.0001
PMI, cm2/m2	3.0 ± 1.1 (1.4-8.0)	3.7 ± 0.9 (1.8-6.8)	2.3 ± 0.8 (1.4-8.0)	<0.0001
PMD (A), HU	56.9 ± 7.1 (29.3-75.6)	57.8 ± 6.7 (29.3-75.6)	55.9 ± 7.4 (34.2-74.6)	0.008
PMD (V), HU	62.0 ± 6.7 (38.8-80.8)	63.2 ± 6.1 (40.9-78.1)	60.8 ± 7.2 (38.8-80.8)	<0.0001

BSA: body surface area; BMI: body mass index; PCSA: Psoas muscle cross-sectional area; PMI: psoas muscle index; PMD: psoas muscle density; A: the arterial phase; V: the venous phase.

Data is expressed as mean ± standard deviation (Minimum – Maximum) for numerical variables and frequencies (percent) for categorical variables.

Table 2 Gender- and age-specific cutoff values of different CT muscle measurements among healthy kidney donors

Parameter	Category	Females		Males		Overall	
		Mean ± SD	Cutoff	Mean ± SD	Cutoff	Mean ± SD	Cutoff
PCSA, cm^2	All	5.81 ± 1.90	3.82	10.70 ± 2.70	6.32	8.24 ± 3.36	4.30
	< 20y	6.20 ± 2.28	3.62	9.75 ± 2.33	6.87	7.51 ± 2.84	3.78
	20 to < 30y	5.88 ± 1.68	3.87	10.70 ± 2.59	6.28	8.40 ± 3.26	4.35
	30 to < 40y	5.56 ± 1.67	3.75	10.92 ± 2.53	7.31	8.61 ± 3.45	4.33
	40 to < 50y	6.04 ± 2.54	3.95	10.40 ± 3.49	6.12	7.58 ± 3.57	4.09
	50y or more	5.48 ±0.84	4.45	7.20 ± 1.63	5.56	6.05 ± 1.38	4.50
PMI, cm^2/m^2	All	2.34 ± 0.78	1.61	3.65 ± 0.89	2.29	3.00 ± 1.06	1.74
	< 20y	2.43 ± 0.75	1.46	3.63 ± 0.97	2.66	2.87 ± 1.01	1.49
	20 to < 30y	2.35 ± 0.63	1.60	3.66 ± 0.87	2.40	3.03 ± 1.01	1.72
	30 to < 40y	2.28 ± 0.82	1.62	3.69 ± 0.83	2.49	3.08 ± 1.09	1.76
	40 to < 50y	2.44 ± 0.99	1.69	3.67 ± 1.14	2.04	2.87 ± 1.19	1.80
	50y or more	2.23 ± 0.41	1.85	2.50 ± 0.47	2.05	2.32 ± 0.43	1.86

PMD (A), HU	All	55.90 ± 7.42	43.4	57.8 ± 6.72	47.20	56.9 ± 7.14 44.50
	< 20y	55.95 ± 6.65	46.46	66.50 ± 7.00	56.92	59.84 ± 8.41 46.88
	20 to < 30y	57.52 ± 7.05	44.84	60.13 ± 6.13	50.31	58.88 ± 6.69 47.23
	30 to < 40y	56.46 ± 6.77	44.71	56.30 ± 5.43	47.31	56.37 ± 6.02 45.63
	40 to < 50y	53.24 ± 7.98	39.89	53.86 ± 8.08	35.91	53.46 ± 7.96 38.91
	50y or more	50.34 ± 9.20	37.23	51.26 ± 5.90	45.47	50.65 ± 7.97 38.93
PMD (V), HU	All	60.8 ± 7.20	48.10	63.2 ± 6.05	52.70	62.00 ± 6.74 49.80
	< 20y	64.12 ± 7.93	53.34	70.46 ± 4.05	66.78	66.45 ± 7.34 53.82
	20 to < 30y	62.84 ± 6.42	51.51	65.06 ± 5.55	55.15	64.00 ± 6.06 52.41
	30 to < 40y	60.60 ± 6.92	48.16	61.75 ± 5.25	51.49	61.25 ± 6.03 50.00
	40 to < 50y	58.20 ± 7.11	45.89	60.36 ± 7.37	45.98	58.96 ± 7.22 45.49
	50y or more	53.59 ± 7.32	44.21	59.55 ± 7.20	52.95	55.58 ± 7.54 45.96

PCSA: Psoas muscle cross-sectional area; PMI: psoas muscle index; PMD: psoas muscle density; A: the arterial phase; V: the venous phase; HU: Hounsfield Units.

3.2 Estimation of PMA based on the associated factors and the validation analysis

Among male participants, the measured PMA was not associated with age (**Figure 2a**). However, PMA was positively correlated with body weight (r = 0.485, p < 0.0001) (**Figure 2b**), height (r = 0.269, p = 0.0001) (**Figure 2c**), BMI (r = 0.355, p < 0.0001) (**Figure 2d**) and BSA (r = 0.470, p < 0.0001) (**Figure 2e**). Since the strongest correlation was observed with the body weight, we constructed a linear regression model, where PMA was the dependent variable and weight as an independent variable. The resultant equation for males was: *PMA in males* (cm^2) = 4.1326 + (0.0838 × weight).

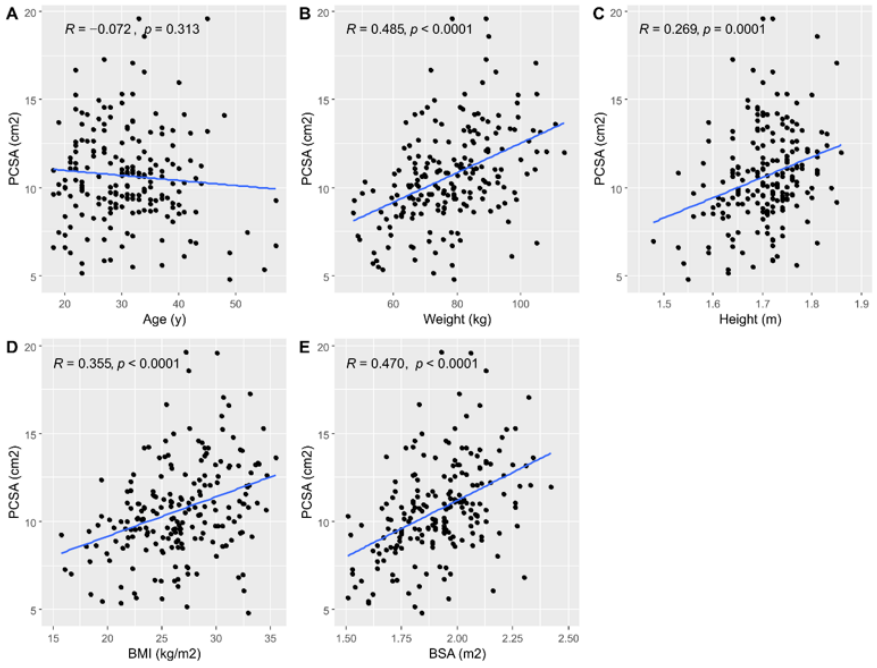

Figure 2. Estimation of psoas muscle cross-sectional area (PCSA) based on the associated factors in males.

Focusing on females, age was not significantly associated with PMA (**Figure 3a**). Contrastingly, PMA measurements correlated significantly with body weight (r = 0.363, p < 0.0001) (**Figure 3b**), height (r = 0.337, p < 0.0001) (**Figure 3c**), BMI (r = 0.220, p = 0.002) (**Figure 3d**) and BSA (r = 0.340, p < 0.0001) (**Figure 3e**). Accordingly, a linear regression model was carried out, indicating the following regression formula to predict PMA among females: *PMA in females* (cm^2) = 3.0274 + (0.0409 × weight).

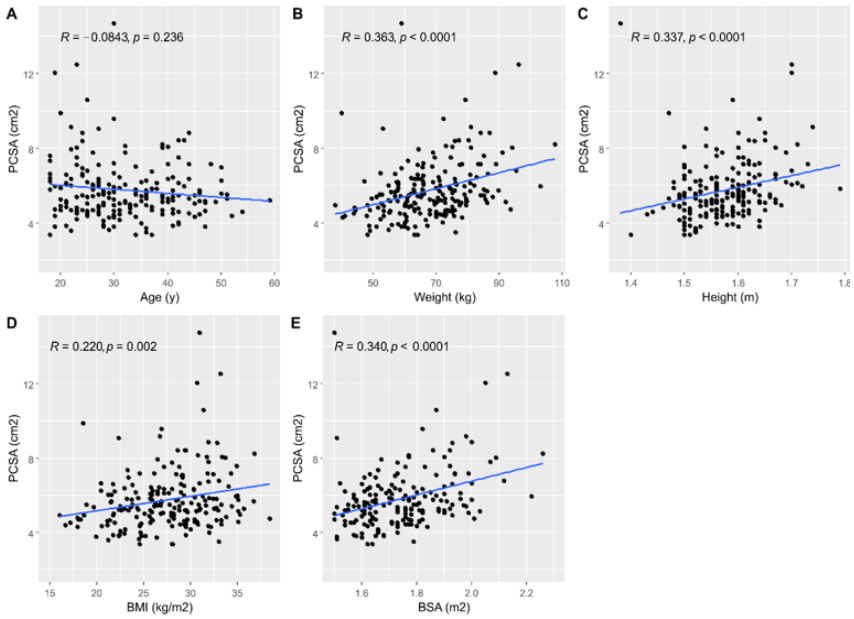

Figure 3. Estimation of psoas muscle cross-sectional area (PCSA) based on the associated factors in females.

To further validate our results, we estimated PMA values using the aforementioned formulas on a new dataset involving individuals from the general population comprising of 15 men and 15 women. Results showed that the estimated PMA values correlated strongly with the actual PMA measurements among males (r = 0.864, p < 0.0001, **Figure 4a**) and females (r = 0.744, p = 0.002, **Figure 4b**). The mean differences between estimated and measured PMA values were 0.81 ± 1.70 (95%CI, -1.75 to 0.13) among males and 0.17 ± 1.19 (95%CI, -0.49 to 0.83) among females. These outcomes emphasize the validity of our predictive computations.

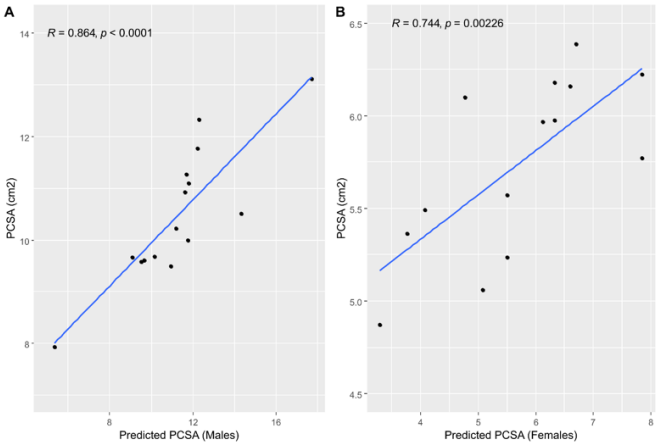

Figure 4. Comparison between the manually traced and predicted psoas muscle cross-sectional area (PCSA) using the generated equation in males (a) and females (b).

4. DISCUSSION

CT scan has emerged as the most widely used cross-sectional imaging technique for assessing body musculature. Its popularity stems from its widespread availability in hospitals worldwide, reasonable cost, and rapid scan speed. Unlike dual-energy X-ray absorptiometry (DXA), which solely quantifies muscle mass, CT provides information on both muscle quantity and quality. Specifically, CT allows for the assessment of myosteatosis, a condition characterized by increased fat infiltration within muscles. In myosteatosis, higher fat content leads to reduced CT attenuation of the muscles [26].

Researchers, including Goodpaster BH et al., have conducted single-slice CT scans on phantoms with varying lipid concentrations. Their findings demonstrate a strong correlation between muscle attenuation and lipid concentration. For instance, increasing the phantom's lipid concentration by 1 g/100 ml results in a 1 Hounsfield Unit (HU) decrease in attenuation. This highlights the relationship between skeletal muscle attenuation determined by CT and its lipid content. Importantly, this non-invasive method may offer additional insights into the association between muscle composition and function [26].

In the context of cancer patients, who are particularly susceptible to muscle wasting, assessing sarcopenia plays a crucial role. Sarcopenia serves as an independent predictor of lower overall survival in this patient group. Given that many oncology patients undergo CT scans of the chest, abdomen, and pelvis, efforts are increasing to evaluate muscle mass using CT scan [27].

When measuring sarcopenia on abdominal CT, the region of interest (ROI) may encompass various muscle groups, including the psoas muscle, paraspinous muscles, or all visualized abdominal muscles. However, there is variability regarding the optimal measurement site. Two common approaches involve measuring all visualized muscles or focusing solely on the psoas muscle at the level of the third lumbar vertebra. Notably, Mourtzakis M et al. and Shen W et al. have found that the cross-sectional skeletal muscle area (SMA, cm2) at the third lumbar vertebra correlates strongly with total body skeletal muscle mass [28,29]. Adjusting SMA for height squared yields the skeletal muscle index (SMI), a relative measure of muscle mass. Additionally, Hamaguchi et al. observed that psoas muscle index (PMI) shows a positive relationship with SMI, suggesting that PMI can serve as a surrogate marker for evaluating whole-body skeletal muscle mass [22] . Alternatively, manual tracing of the psoas muscle surface area is well-suited for opportunistic CT screenings.

Brian A. Derstine et al. studied the cutoff values of SMI at different thoracic and lumber vertebrae levels in healthy American population. They concluded that SMA peaks at the level of third lumber vertebra supporting its use as the primary site for sarcopenia assessment. The cutoff values of SMI at this level were 45.4 cm2/m2 in males and 34.4 cm2/m2 in females [23]. Similarly, A. van der Werf et al. found analogous cutoff values of SMI in a healthy Caucasian population measuring 41.6 cm2/m2 in males and 32.0 cm2/m2 in females [24].

On the other hand, a study was conducted in Japan by Yuhei Hamaguchi et al. where they used PMI as a measure for sarcopenia. The cutoff values of PMI was 8.85 cm2/m2 in males and 5.77 cm2/m2 in females [22]. Our results (PMI of 3.7 cm2/m2 in males and 2.3 cm2/m2 in females) are in line with the Japanese study, which confirmed a higher PMI in men as compared to women. However, the magnitude of sex specific proportions is different, which could be due to different lifestyles and ethnicities

In various studies, researchers have explored the relationship between muscle mass and clinical outcomes [30, 31]. While some investigations focused on the linear association between muscle mass and outcomes, others established cut-off values to differentiate between 'low' and 'normal' muscle mass. These cut-off values were often determined based on survival stratification, leading to variations in thresholds across different studies and populations [32, 33]. Notably, there were discernible differences in cut-off values between the Saudi and Japanese populations.

Previous studies typically employed specialized segmentation software on separate computers to define or segment muscle regions of interest (ROIs), allowing for

standardized thresholding of muscle and fat [22-24]. However, our study took a different approach. We utilized PACS-based measurements, which do not permit thresholding and segmentation but offer faster processing and seamless integration into clinical radiology workflows. Specifically, we manually traced the psoas muscle to measure its cross-sectional surface area. Although this method introduces some measurement variability, our excellent inter-observer agreement between data collectors of varying experience levels supports its practical incorporation into daily practice. Notably, the psoas muscle, being a large muscle, lends itself well to manual tracing.

This study has potential limitations. Qualitative assessment of psoas muscle is limited due to the lack of pre-contrast CT images, so the significance and pattern of muscle enchantment could not be assessed. This is attributed to the institutional policy in which pre-operative CT studies for kidney donors are performed in the arterial and venous phases only.

In conclusion, defining population specific cut-off values of PMA and PMI facilitates opportunistic screening for sarcopenia using CT scan.

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Not applicable.

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