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Original Article

Prevalence and associated factors of sarcopenia among patients underwent abdominal CT scan in Tertiary Care Hospital of South India

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Abstract

Objective: To estimate the proportion of radiologically significant (LSMI) sarcopenia and the factors associated with it among patients undergoing Computerized Tomography scan. **Methods**: A Cross sectional study was conducted among 152 patients underwent CT scan in the radiology department of Government medical college Thiruvananthapuram. Sarcopenia was estimated based on lumbar skeletal muscle index obtained using cross sectional areas of various abdominal muscles by CT scan. The proportion of sarcopenia was estimated and associated factors studied. Binary logistic regression model was used to adjust the confounders. **Results**: Out of 152 individuals, sarcopenia was present in a total of 82 (53.95%) individuals. Male gender (Adjusted OR= 8.42, 3.64 - 19.52 (95% CI)) was a risk factor for and a body mass index more than 25Kg/m^2 (Adjusted OR= 0.36, 0.15- 0.67 (95% CI)) was a protective factor against sarcopenia. **Conclusion**: The burden of sarcopenia is found to be high and considering the double burden of sarcopenia and obesity in the Kerala community, newer strategies for health promotion and early detection need to be developed.

Keywords: Computerized tomography, Lumbar skeletal muscle index, Predictors of sarcopenia, Prevalence of sarcopenia, Sarcopenia among Indians

Introduction

The term sarcopenia is derived from the Greek meaning 'poverty of flesh' and is characterized by the progressive loss of skeletal muscle mass, muscle strength, and physical performance. This term was first coined by I.H. Rosenberg to denote "ageing related loss of skeletal muscle mass and strength"[1]. Sarcopenia has a biological component with the genes involved in skeletal muscle mitochondrial function, oxidative capacity, and glucose uptake showing reduced expression with ageing[2]. It affects women and men equally, starting from the fourth decade and accelerating from the 6th decade[3]. It was originally described in the elderly population, and is often now defined as a geriatric syndrome associated with functional impairment, increased risk of falls, fractures, and reduced survival. Sarcopenia has been found to be a predictor of chronic disease progression, poorer functional outcomes, and postoperative complications (both infections and non-infectious complications)[4].

Standardization of sarcopenia assessment, especially in diagnosis of low muscle mass, will be crucial for clinical practice and interventions in the future. Dual energy X-ray absorptiometry (DEXA), bioelectrical impedance analysis

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(BIA), and CT are the most frequent methods of assessment of sarcopenia employed. CT and other advanced imaging including MRI are precise and have high validity in assessing muscle mass[5]. Results of several studies conclude that quantification of sarcopenia is possible through estimation of lumbar muscle mass in the 2 dimensional planar CT scans taken at the level of the third lumbar vertebra (Third lumbar vertebra skeletal muscle index -L3SMI)[6]. Radiologically significant sarcopenia is defined as a lumbar skeletal muscle index </=38.5 cm^2/m^2 in females and </=52.4 cm^2/m^2 in males[7].

However only a few studies have been conducted in Indian population to assess Sarcopenia, employing imaging modalities like CT. Many people undergo abdominal CT scan at Radio-diagnosis department of Government Medical College Thiruvananthapuram and was an opportunity to study the burden of sarcopenia of the population. Aim of the study was to determine the proportion of patients with radiologically significant sarcopenia (lumbar skeletal muscle index </=38.5 cm^2/m^2 in females and </=52.4 cm^2/m^2 in males) who underwent abdominal CT evaluation. The study also tried to analyse the difference in pattern of people without any radiological lesions, with benign conditions and with malignant lesions. Anthropometric and demographic factors associated to sarcopenia were also studied.

Materials and methods

A hospital based cross sectional study was conducted at the department of Radio diagnosis, Government Medical College Hospital, Thiruvananthapuram. Adults (more than 18 years) who underwent radiological evaluation of abdomen with CT scan at the study setting during second half of the year 2019 were studied. CT scans done in emergency situations were excluded from the analysis as the reading of muscles mass could not be made because of time constraints and ethical ground. To calculate sample size for the current study, it was assumed that one-third (33%) of the study population is sarcopenic. According to Cruz-Jentoft AJ et al[8] the prevalence of sarcopenia could be ranged between very small proportions to one-third of the population. Upper limit of the prevalence range given by the reference study was used because being hospital based and being conducted on people with Asian-Indian ethnicity, the estimation made by the current study is likely to be high. We used a sample size calculation formula for estimating proportions with 8.25% (25% of prevalence) error and the sample size was estimated to be 125. Eligibility to be enrolled was evaluated at the setting and participants were enrolled consecutively to the study.

The data collection process was initiated following approval from Institutional Ethics committee of Government Medical College Thiruvananthapuram (Ethics clearance certificate number-HEC.No.08/14/2019/MCT). Written informed consent was obtained from all the participants/ responsible bystanders (bystanders in case if the patient is not in a psychological/physical condition to take the decision). The personal details regarding the patients were kept confidential. There were no financial implications from the patients.

A structured proforma was used to collect data by the radiologist at the time of CT scan. Clinical and anthropometric data were collected from the patient and bystanders. Information on the provisional diagnosis was obtained from the requisition format. The treating doctor was then contacted/case sheets were verified to complete the data collection format as and when required. The composite muscle mass of the psoas, the quadratus lumborum, the erector spinae, the internal and the external obliques and the transversus abdominis was studied in detail and the parameters were recorded. Outcome variables for the study were; 1) Lumbar skeletal muscle index (The composite muscle mass of the psoas, the quadratus lumborum,the erector spinae,the internal,the external obliques and the transversus abdominis), 2) Area of visceral fat in mm^2, 3) Area of subcutaneous fat in mm^2, 4) Liver density in mm^2, 5) Psoas muscle density in mm^2 and 6) Density of erector spinae in mm^2.

Data was entered into MS Excel and analysed using SPSS version 16 (SPSS Inc., Chicago, IL., USA). The proportion of sarcopenia was calculated in percentage. Mean and standard deviation with minimum and maximum values of areas of visceral fat, subcutaneous fat, liver density, psoas muscle density and erector spinae density were calculated. Association between lumbar skeletal muscle index, chronicity of disease, malignancy status, comorbidities and clinical diagnosis were assessed using Chi square test. Association between sarcopenia and the CT parameters like area of visceral and subcutaneous fat, density of liver, psoas muscle and erector spinae were also assessed using Independent sample t test after checking normality. Association between sarcopenia and anthropometric parameters like height and weight were tested using independent sample t test. All the variables found to be associated with sarcopenia were entered into logistic regression model to find the adjusted Odds ratio.

Results

The 152 individuals analyzed radiologically during the study period were categorized to three groups based on the final diagnosis, 59 (38.8%) had no significant abnormalities, 65 (42.8%) had benign lesions and 28 (18.4%) were suffering from some kind of malignant lesions. The mean (SD) age of individual without lesions, with benign lesions and with malignant lesion were 44.88(16.17), 50.14 (15.29), 60.93 (12.96) years respectively. Number of men were almost equal to women in normal group (n=30, 50.8%), slightly more in benign group (n=35, 53.8%) and were less in malignant group (n=11, 39.3%). The distribution of demographic variables across the study groups are given in Table 1. About half of the individuals in radiologically normal

Variable	Category	Radiologically normal category (n=59)	With benign lesion in CT Abdomen (n=65)	With malignant lesion in CT abdomen (n=28)
		Frequency(Percentage) or mean (SD)		
Age in years*	45.00 (16.78)	50.06 (15.47)	60.93 (12.96)	
Gender	Men	30(50.8)	35(53.8)	11(39.3)
Body Mass Index	Underweight (<18.5Kg/m^2)	4(6.8)	2(3.1)	1(3.6)
	Normal weight (18.5-25Kg/m^2)	27(45.8)	22(33.8)	17(60.7)
	Overweight (25-30Kg/m^2)	19(32.2)	24(36.9)	7(25)
	Obese (>30Kg/m^2)	9(15.3)	17(26.2)	3(10.7)
Subcutaneous fat*mm	22.69 (12.36)	25.73 (11.38)	20.91 (11.22)	
Visceral fat mm^2	4057.41(2851.59)	5136.32(3043.62)	3825.17(2508.31)	

Table 1. Age, Sex and Body Mass Index of study participants.

Sl No	Radiological diagnosis	Frequency
	Benign Lesions	**65**
1	Renal calculi	9
2	GB calculus	8
3	Chronic liver disease, Portal Hypertension	4
4	Acute appendicitis	4
5	Fibroid uterus	4
6	Acute pancreatitis	4
7	Chronic pancreatitis	3
8	Ureteric calculi	3
9	Fatty liver	3
10	Ovarian cyst	2
11	Incisional hernia	2
12	Hemangioma liver	2
13	Pyelonephritis	2
14	PUJ obstruction	1
15	Hepatic adenoma	1
16	Tuberculous pleural effusion	1
17	Intestinal obstruction	1
18	Fatty pancreas	1
19	Pheochromocytoma	1
20	Acute cholecystitis	1
21	Schwannoma	1
22	Ileo caecal TB	1
23	Perthes disease	1
24	Pericardial effusion	1
25	Renal cyst	1
26	Tuberculous ascites	1
27	Carcinoma insitu cervix(CIN)	1
28	Retroperitoneal lipoma	1
	Malignant Lesions	**28**
1	HCC with CLD, Portal hypertension	6
2	Carcinoma pancreas	6
3	Carcinoma colon/rectum	5
4	Liver metastases	4
5	Carcinoma ovary	2
6	Carcinoma stomach	2
7	Carcinoma breast	1
8	Lymphoma	1
11	Carcinoma oesophagus	1

Table 2. Distribution of Radiological lesions.

category (n=28, 47.5%) were either overweight or obese according to the BMI criteria. The proportions of overweight/obesity were more among patients with benign lesions 63.1% (n=41) and less among patients with malignant lesions 35.7% (n=10). Thickness of subcutaneous fat (mean and SD) among normal, benign and malignant groups were 22.69 (12.36) mm, 25.73 (11.38) mm and 20.91 (11.22) mm respectively. Details are given in Table 1.

Among the benign lesions, Renal calculi was the most frequent diagnosis (n=9) followed by Gall bladder Calculi

Variable	Category	Prevalence of LSMI sarcopenia		
		Radiologically normal category	With benign lesion in CT Abdomen	With malignant lesion in CT abdomen
Age	Less than 60 years	23 (47.9%)	25 (54.3%)	8 (80.0%)
	60 years or above	6 (54.5%)	12 (63.2%)	8 (44.4%)
Gender	Male	20 (66.7%)	26 (74.3%)	10 (90.9%)
	Female	9 (31.0%)	11 (36.7%)	6 (35.3%)

Table 3. Age and Gender specific prevalence of LSMI sarcopenia in study groups.

Muscle	Radiologically normal category (n=59)	With benign lesion in CT Abdomen (n=65)	With malignant lesion in CT abdomen (n=28)	Correlation coefficient (r)
	Cross sectional area in mm^2 – Mean (SD)			
Erector spinae (right)	1986.40(590.16)	1981.69(545.97)	1838.66(342.04)	**0.475**
Erector spinae (Left)	1987.41(530.02)	1960.98(487.89)	1785.36(305.99)	**0.533**
External oblique (right)	2158.83(1032.13)	2281.58(609.67)	1935.40(517.26)	0.346
External oblique (left)	2087.76(720.01)	2225.79(609.67)	1892.02(448.26)	0.382
Rectus abdominis (right)	478.48(170.99)	540.45(216.26)	414.98(136.32)	0.303
Rectus abdominis (left)	554.71(433.47)	529.56(159.53)	435.36(143.44)	0.173
Psoas (right)	736.46(331.73)	696.53(291.64)	532.76(191.35)	0.399
Psoas (left)	730.86(334.41)	717.6(283.46)	584.48(215.48)	0.366
Quadratus lumborum (right)	456.05(160.22)	438.5(192.48)	408.35(192.44)	0.357
Quadratus lumborum (left)	484.34(184.84)	460.7(183.37)	398.12(149.68)	0.334

Table 4. Radiological measurement of core abdominal muscles.

(n=8). Among malignant lesions, hepatocellular carcinoma and ca pancreas were found to be common (n=6) followed by Carcinoma colon/rectum (n=5). Details given in Table 2.

Lumbar skeletal muscle index estimated sarcopenia (*LSMI sarcopenia*) was found to be present in 82 (53.95%) among the study population. It included 49.2% (n=29) of radiologically normal, 56.9% (n=37) with benign lesion and 57.1% (n=16) with malignant lesion. LSMI Sarcopenia appeared to be more prevalent in malignant category but the difference between groups was not statistically significant (p=0.640). It was more among people aged 60 years or above compared to youngsters in normal and benign group as expected, but the pattern reversed in malignant group (Table 3). The proportion of LSMI sarcopenia was found to be high in male gender cutting across all radiological categories (66.7% to 90.9%) and among women were less than half of the proportions of men (31.0% to 36.7%) (Table 3). The prevalence was above 40% in all age and gender categories and about half of the normal young individuals were also found to be sarcopenic. Mean (SD) of different muscle masses used in the calculation of LSMI sarcopenia measured in mm^2 are given in given in Table 4. Cross sectional area of erector spinae left (Pearson correlation coefficient, r=0.53) and right (r=0.46) had strong positive correlation with sarcopenia.

Gender and BMI were found to be significant predictors of LSMI sarcopenia as per the multivariable analysis. Binary logistic regression model with R^2 value (Negelkerke) of 0.362 showed that male gender is a significant risk factor (Adjusted OR= 8.42, 3.64 - 19.52 (95% CI), p<0.001) and BMI more than or equal to 25 Kg/m^2 is a protective factor (Adjusted OR= 0.36, 0.15- 0.67 (95% CI), p<0.001). Age more than 60 years and presence of malignancy were not found to be significant predictors. The model was statistically significant (p<0.001) (Table 5). Thickness of subcutaneous fat and liver density were not used in model because of correlation with BMI. Table 6 shows the association of liver density and subcutaneous fat with sarcopenia. Subcutaneous fat was found to be significantly reduced in patients with LSMI sarcopenia in all radiological categories.

Exposure factors	LSMI Sarcopenia present (N=82)	LSMI Sarcopenia Absent (N=70)	Crude OR (95% CI)	AOR (95% CI)	P value
Age more than 60 years	26 (31.7%)	22 (31.4%)	1.01 (0.51-2.01)	1.15 (0.48-2.77)	0.760
Male gender	56 (68.3%)	20 (28.6%)	5.38 (2.68-10.81)	8.42 (3.64-19.52)	<0.001
BMI more than or equal to 25 Kg/m^2	30 (36.6%)	49 (70.0%)	0.25 (0.13-0.49)	0.36 (0.15- 0.67)	<0.001
Malignancy	16 (19.5%)	12 (17.1%)	1.17 (0.51-1.46)	1.10 (0.37-3.26)	0.369

Table 5. Factors associated to LSMI sarcopenia.

Variable	Category		Mean(SD)	P value
Liver density	Normal	Sarcopenia present	49.28(9.14)	0.589
		Sarcopenia absent	47.93(9.88)	
	Benign	Sarcopenia present	44.56(10.04)	0.007
		Sarcopenia absent	36.44(13.36)	
	Malignant	Sarcopenia present	46.97(7.3)	0.07
		Sarcopenia absent	39.59(13.1)	
Thickness of subcutaneous fat	Normal	Sarcopenia present	14.63(8.43)	<0.001
		Sarcopenia absent	30.47(10.44)	
	Benign	Sarcopenia present	23.29(10.09)	0.046
		Sarcopenia absent	28.94(12.36)	
	Malignant	Sarcopenia present	15.03(5.70)	<0.001
		Sarcopenia absent	28.75(12.15)	

Table 6. Liver density and subcutaneous fat in study participants with and without LSMI Sarcopenia.

Discussion

The overall proportion of LSMI sarcopenia was found to be 54%, which is one of the highest among hospital based studies[9]. Few studies in Malaysian population reported prevalence of sarcopenia as high as 59.8%[10]. The prevalence may vary in hospital setting and community level. Even though many studies were done among hospital population, they were mainly restricted to the geriatric population and cancer patients[11–14]. The prevalence of sarcopenia was found to be generally high in a hospital setting compared to the community[15,16]. In the current study, almost half (49.2%) of the individuals without benign/malignant lesions were also found to have LSMI sarcopenia. This is much higher than the prevalence among the general population reported elsewhere[17]. In a multicontinent study done on sarcopenia it was found that the prevalence of sarcopenia in India was 17.5% with male predominance[18]. Asian population have the highest prevalence of sarcopenia[19]. Even though the reported prevalence was much less than that of the present study, it was highest among the seven countries from five continents included in the study.

Lower LSMI correlated well with poor ECOG scores, and it significantly increased the mortality in a multivariate analysis in Non Small Cell Lung Cancer patients in a study by D Portal et al in an Israeli population[6]. Unintentional weight loss, along with a low lumbar skeletal muscle index and low muscle attenuation in CT scan was found to portend a poor prognosis, regardless of overall body weight and BMI in cancer patients in a Canadian study[20].

In this study, the prevalence of sarcopenia in males was found to be almost double that in females. Gender was found to be an independent predictor of sarcopenia irrespective of age and disease category. The high proportion of sarcopenia among the males is consistent with reports from other studies[10,19,21–23]. However predisposition for sarcopenia was noted among women during post-menopausal period compared to men explained by the decrease in concentrations of sex steroids, both estrogens and androgens after menopause[23–25]. On the contrary, even among the elderly, the present study showed a significantly higher proportion of LSMI sarcopenia among men. In a systematic review and meta-analysis on the prevalence of sarcopenia in general population the prevalence of sarcopenia was found to be similar in both genders[22]. There is ample evidence from existing literature on sarcopenia associated with elderly age[26]. More than half of the study participants above the age of 60 years had sarcopenia. However proportion was further higher among the youngsters with malignant lesions, might be contributed by the disease parse.

Sarcopenia has been used as a predictor of prognosis of various treatment modalities and morbidity and mortality as well[27–29]. A low BMI with high body fat percentage is likely to result in negative life prognosis[30,31]. In addition,

many studies have reported association of lean muscle mass reduction with poor outcomes in malignancy[32,33]. The Asian cut off for obesity (BMI>25), is fixed at a level lower than the global criteria(WHO). In this study, Body Mass Index less than 25 kg/m^2 was found to be a risk factor for sarcopenia irrespective of the disease category. However, no significant association was found between sarcopenia and Body Mass Index category among participants aged more than 60 years. As age advances, it may be a more significant contributor to muscle mass than height and weight. So muscle mass and body fat percentage might be considered before advising patients regarding weight reduction. More than one-third of obese study participants also had sarcopenia in the present study.

A single-muscle approach for assessing sarcopenia is a recent trend on CT-defined muscle quantification[34]. Some studies showed erector spinae as the most important muscle cross sectional area predicting sarcopenia and a reduction in skeletal mass of erector spinae has been associated with higher mortality[35,36]. The present study also showed the cross sectional area of erector spinae on either side had the strongest positive correlation with LSMI sarcopenia. Some literature identifies psoas[37] as the single muscle with maximum correlation whereas some takes erector spinae for the prediction of sarcopenia[25].

Limitation

As it is a hospital based study, the prevalence of sarcopenia is likely to be overestimated. We do not have data on comorbidities and the outcome was not adjusted for it.

Conclusion

The burden of LSMI sarcopenia is found to be high in the study population. This high proportion of LSMI sarcopenia needs attention, being a prognostic factor for mutimorbidity and mortality. It is high time we engage in studies to find its associated factors (modifiable and non-modifiable). Apart from the age and malignancy status which were perceived to be the main predictors of sarcopenia, adjusted analysis in our study projected male gender and low BMI to be the major risk factors. Considering the double burden of sarcopenia and obesity in the Kerala community, dietary modification and promotion of physical activity should be recommended. Further studies on the early clinical diagnosis and prevention of sarcopenia is to be entertained.

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