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An epidemiological study on the prevalence and predictors for geriatric sarcopenia from a public hospital of Ooty, India

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ABSTRACT

The study aimed at reporting the prevalence and predictors for sarcopenia in the elderly visiting a public hospital. The present study recruited patients aged ≥60 visiting the medicine department of Government Medical College Hospital, Ooty. Strength, assistance in walking, rise from a chair, climb stairs, and falls questionnaire (SARC-F), Ishii score, sociodemographic data, and nutritional status were collected to analyze the possible association with sarcopenia. Data were subjected to bivariate analysis and subsequent multivariate logistic regression. About 325 elderly were recruited for the study. Most of them belonged to low socioeconomic status (85.54%) and were found to be either malnourished (34.15%) at risk of malnourishment (51.08%). The prevalence of sarcopenia was 47.69% and 63.08% as per SARC-F and Ishii scoring systems, respectively. The logistic regression model identified smoking (OR-3.585, $p = 0.014$), unsatisfied sleep (OR-4.242, $p < 0.001$), nutrition [malnourishment (OR-17.237, $p < 0.001$), risk of malnourishment (OR-5.026, $p = 0.002$)] and lower socioeconomic status (OR-4.210, $p = 0.033$) to be predictors for Sarcopenia according to SARC-F whereas for Ishii Scoring, BMI [<18.5 (OR-22.182, $p < 0.001$), 18.5–24.99 (OR-5.658 $p < 0.001$), 25–29.99 (OR-2.832 $p = 0.033$)] and malnourishment (OR-4.191, $p < 0.001$) were found as influential predictors of sarcopenia. Sarcopenia should be considered as a public health priority. Nearly half of the elderly were found to be sarcopenic and hailed from malnourished and low-socioeconomic status. Proper awareness of the intake of nutritious food and adequate physical activity among the geriatric population is necessary.

INTRODUCTION

The Technical Group on Population Projections for India reported a 138 million geriatric population in 2021 and this trend is expected to grow steadily (Ministry of Statistics and Program Implementation, 2021). As age progresses, a great extent of anatomical and physiological changes occur leading to deteriorating effects on the elderly. Muscle atrophy and weakness are some of the inevitable processes of aging which can result in Sarcopenia (Volpi *et al.*, 2012). As defined by the Asian Working Group for Sarcopenia (AWGS), it is a group of disorders that are characterized by low muscle mass, low muscle strength, and poor physical functioning (Chen *et al.*, 2020). It particularly affects the appendicular skeletal muscle mass leading to a decline in walking speed and grip strength thus impairing the daily performance of the elderly (Cho *et al.*, 2022). In the worst scenarios, sarcopenic conditions can lead to disabilities from falls and even death. Sarcopenia remains underdiagnosed and thus, an early diagnosis can help in providing resistance training and correction of nutritional deficiencies (Feike *et al.*, 2021). This can reduce the progression of the disease and the extent of physical disability.

The diagnosis of sarcopenia requires two criteria—low muscle mass and strength with or without low physical performance (Dionyssiotis, 2019). These criteria can be assessed in daily clinical practice by the Strength, assistance in walking, rise from a chair, climb stairs, and falls questionnaire (SARC-F) score (Beaudart *et al.*, 2016).

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As per the consensus of AWGS 2019, SARC-F with a score greater than or equal to 4, SARC-CalF with a score less than or equal to 11, or calf circumference with a cut-off of less than 34 cm in males and less than 33 cm in females have been suggested for case finding in routine care settings (Chen *et al.*, 2020).

With these criteria, the prevalence of Sarcopenia varies worldwide ranging from 10% to 27% in 60 years and above (Petermann *et al.*, 2021). A meta-analysis of geriatric epidemiological studies reported a prevalence rate varying from 1.8% to 66.7% using SARC-F across Asia (Voelker *et al.*, 2021). A South Indian study from Tamil Nadu reported a prevalence of 39.2% (Rahman *et al.*, 2021).

Liu *et al.* (2020) conducted a study in Taiwan that stated increasing age, body composition changes, and decrease in muscle mass are key risk factors in the geriatric population that could lead to sarcopenia. Another study by Lau *et al.* (2005) studied the relationship of other factors like alcohol consumption, smoking habit, inactivity, and chronic diseases in the development of sarcopenia in China.

Studies pertaining to the prevalence of sarcopenia and its associated risk factors in the Indian elderly are few in number. Hence, it was planned to conduct a study among the elderly visiting a Government hospital of Ooty, Nilgiris to report the prevalence and predictors of sarcopenia.

METHODS

Study design

This is a prospective, case-control, single-center study on community-dwelling elderly visiting Government Medical College Hospital, Ooty, Nilgiris

Study population

EPITOOLS was used for calculating the sample size. The expected proportion of controls was found to be 39.2% in a previous study (Rahman *et al.*, 2021). At an assumed odds ratio of 2, a confidence interval of 95%, and a power of 0.8 the sample size per group was found to be 130 and the total sample size was found to be 260 for a case-control study

Elderly aged 60 and above visiting outpatient departments and/or admitted in medical inpatient wards at Government Medical College & Hospital, Nilgiris were assessed for the study. Those patients who were physically handicapped had fractures, or had any chronic illness like rheumatoid arthritis, muscular disorders like Myasthenia gravis, Myositis, Muscular dystrophy, Multiple sclerosis, Peripheral neuropathy, etc., hemiparesis from stroke, or any psychiatric illness were excluded from the study as these conditions can cause deterioration of muscle mass or functioning. The study was conducted for 6 months (February–July). During the study period, the data of a total of 325 patients were collected which exceeded the calculated sample size of 260.

Ethical consideration

The present study was approved by the Institutional Review Board of Government medical college hospital, Ooty, Nilgiris (Ref No:IRBCTN008).

Study measures

SARC-F questionnaire

SARC-F comprises a set of five questions, namely strength, assistance in walking, rising from a chair, climbing stairs, and falls. It was developed by John E. Morley and is a validated tool for case finding of sarcopenia. Patient with SARC-F score ≥4 is considered to be sarcopenic (Malmstrom *et al.*, 2015).

ISHII score

Ishii *et al.* (2014) score was developed by Shinya Ishii and the team. Important variables like Calf circumference, Handgrip strength along with age are used to calculate Ishii score. An Ishii score ≥105 in males and a score ≥120 in females is considered sarcopenic.

Grip strength

This was assessed using a calibrated digital handgrip dynamometer (maximum of 90 kg/198 lbs with division 0.2 lbs/0.1 kgs). The participant was asked to give the maximum muscle force on the device by pressing the handle. This was repeated twice and the mean values following the reading were taken.

A standard measuring tape was used to measure the calf circumference in the study population. Participants were asked to place their legs in such a way that calf muscles were at right angles to the thigh.

Mini nutritional assessment—short form (MNA-SF)

MNA®-SF is a screening tool to help identify elderly patients who are malnourished or at risk of malnutrition. The MNA®-SF was developed by Nestlé and leading international geriatricians and remains one of the few validated screening tools for the elderly (Guigoz *et al.*, 1996). The previous form had 18 questions whereas the newer form comprises 6 questions that help in better feasibility and quick calculation. Many studies have proven the accuracy of the tool in detecting nutritional status in India and many other developing countries (Lahiri *et al.*, 2015; Liguori *et al.*, 2018). A score of 0–7 is indicative of malnourishment, whereas a score of 7–11 is suggestive of risk of malnourishment, and a score above 11 is considered to be normally nourished.

Modified Kuppuswamy socio-economic scale

The scoring is based on education, occupation, and monthly income as per the updated modified Kuppuswamy socioeconomic scale 2020. The socioeconomic classes are classified into lower, upper lower, lower middle, upper middle, and upper, respectively (Mohd Saleem, 2020).

Data collection

The data collection form was prepared by the study team in collaboration with a senior physician. The data collection form included sections like demographic information, socioeconomic status, and the sarcopenic status of the patient. An informed consent was obtained from all the participants prior to data collection which was preceded

by the explanation of the study procedures to the subjects. Prior permission was obtained by the study team to use study measures [Ishii *et al*. (2014) scoring system, MNA-SF and SARC-F Questionnaire]. Assistance was provided to participants in filling out the data collection form and study measures. All the data collected were entered digitally into the database created in the KOBO toolbox and the data was extracted to an Excel worksheet for further analysis and data processing.

Statistical analysis

Data from the KOBO toolbox database was exported to MS Excel. Data cleaning and data validation were performed before the execution of the statistical tests. The Statistical analysis was performed with the help of Statistical Package for the Social Sciences (SPSS) Version 21.0 (IBM SPSS Amos). Data variables were subjected to the "normality" using the Shapiro-Wilk Test. Comparisons between the variables were done using suitable parametric or non-parametric tests. Further, the data were subjected to bivariate and subsequent logistic regression analysis. In the Logistic regression, sarcopenia was considered as the dependent variable, and other demographic and socioeconomic variables were considered as independent variables. Outcome measures were represented as odds ratios (bi-variate analysis) and adjusted odds ratios (logistic regression analysis). Mann–Whitney test was used to compare a few demographic characteristics between cases and controls in order to confirm whether the cases and controls were homogenous. A "*p*" value of less than 0.05 is considered as statistically significant.

RESULTS AND DISCUSSION

A total of 325 patients were screened in this case-control study of which 155 subjects (47.69%) were cases according to SARC-F Questionnaire and 205 (63.08%) were cases according to Ishii *et al*. (2014) scoring. Ishii scoring presented a higher prevalence of sarcopenia when compared to SARC-F. The median age of the study group was 65 and the average age was found to be about 67 years. The subject's characteristics and the corresponding prevalence according to SARC-F and Ishii Scoring are shown in Table 1.

Mean age in control and case groups with SARC-F and Ishi scoring system was almost similar (67.97 years ± 6.09 *vs*. 66.45 years ± 5.64 for SARC-F, 67.73 years ± 5.85 *vs*. 66.23 years ± 5.89). Also, in control and case groups with the SARC-F and Ishi scoring system, the majority of the elderly were from lower socioeconomic status as defined by the Modified Kuppuswamy scale (85.54%).

From the study population, two variables, i.e., age and SES were compared to check for the population homogeneity between cases and controls. Upon executing, the Mann–Whitney test, no statistical differences were observed ($p > 0.05$). The bivariate analysis identified female sex, smoking, unsatisfied sleep, malnourishment, risk of malnourishment, and lower socioeconomic status to be the predictors of sarcopenia according to SARC-F. Malnourishment, lower body mass index, and the number of diseases ≥2 were the predictors identified as per Ishii scoring. The detailed results of the bivariate analysis with the corresponding Odds ratio are represented in Table 2.

Table 1. Patient characteristics and the corresponding prevalence of sarcopenia.

Characteristics	Frequency (%) *n* = 325	Prevalence of sarcopenia	
		SARC-F	Ishii
Sex			
Males	144 (44.31)	55 (38.19)	87 (60.42)
Females	181 (55.69)	100 (55.25)	118 (65.19)
Age (years)			
60–70	245 (75.38)	111 (45.31)	148 (60.41)
>70	80 (24.62)	44 (55.00)	57 (71.25)
Alcohol intake			
Alcoholic	36 (11.08)	12 (33.33)	22 (61.11)
Non-alcoholic	289 (88.92)	143 (49.48)	183 (63.32)
Smoking habit			
Smoking	35 (10.77)	8 (22.86)	24 (68.57)
Non-smoking	290 (89.23)	147 (50.69)	181 (62.41)
Sleep			
Satisfied	147 (45.23)	38 (25.85)	94 (63.95)
Non-satisfied	178 (54.77)	117 (65.73)	111 (62.36)
Nutrition (MNA-SF questionnaire)			
Malnourished	111 (34.15)	83 (74.77)	91 (81.98)
Risk of malnourishment	166 (51.08)	67 (40.36)	92 (55.42)
Normally nourished	48 (14.77)	5 (10.42)	22 (45.83)
Body mass index			
<18.5	25 (7.69)	9 (36.00)	23 (92.00)
18.5–24.99	195 (60.00)	92 (47.18)	134 (68.72)
25–29.99	75 (23.08)	41 (54.67)	39 (52.00)
≥30	30 (9.23)	13 (43.33)	9 (30.00)
Socioeconomic status (Modified Kuppuswamy Scale)			
Lower	69 (21.23)	50 (72.46)	54 (78.26)
Upper lower	209 (64.31)	91 (43.54)	124 (59.33)
Lower middle	28 (8.62)	9 (32.14)	16 (57.14)
Upper middle	19 (5.85)	5 (26.32)	11 (57.89)
No. of diseases			
<2	233 (71.69)	118 (50.64)	160 (68.67)
≥2	92 (28.31)	37 (40.22)	45 (48.91)
No. of drugs			
<3	278 (85.54)	132 (47.48)	175 (62.95)
≥3	47 (14.46)	23 (48.94)	30 (63.83)

SARC-F—Strength, assistance with walking, rising from a chair, climbing stairs and falls; MNA-SF—Mini Nutritional Assessment Short Form.

Table 2. Bivariate analysis.

Subject characteristic	SARC-F			Ishii *et al.* (2014) score		
	OR (95% CI)		*p* value	OR (95% CI)		*p* value
Sex						
Males	1	Reference	0.0024	1	Reference	
Females	2.00	(1.28–3.12)		1.23	(0.78–1.93)	0.3757
Age						
60–70	1	Reference		1	Reference	
>70	1.48	(0.89–2.45)	0.1328	1.62	(0.94–2.81)	0.0826
Alcohol intake						
Alcoholic	1	Reference		1	Reference	
Non-alcoholic	1.96	(0.94–4.07)	0.0712	1.10	(0.54–2.24)	0.7955
Smoking habit						
Smoking	5.15	(3.22–8.25)	<0.0001	1.31	(0.62–2.79)	0.4768
Non-smoking	1	Reference		1	Reference	
Sleep						
Satisfied	1	Reference		1	Reference	
Non-satisfied	5.50	(3.40–8.91)	<0.0001	0.93	(0.59–1.47)	0.7681
MNA-score						
Malnourished	25.49	(9.19–70.72)	0.0001	5.38	(2.55–11.34)	<0.0001
Risk of malnourishment	5.82	(2.19–15.46)	0.0004	1.47	(0.77–2.80)	0.2423
Normally nourished	1	Reference		1	Reference	
Body mass index						
<18.5	0.63	(0.27–1.49)	0.294	5.24	(1.20–22.91)	0.028
18.5–24.99	1	Reference		1	Reference	
25–29.99	1.35	(0.79–2.30)	0.2711	0.49	(0.29–0.85)	0.011
≥30	0.86	(0.39–1.86)	0.6944	0.20	(0.08–0.45)	0.0001
SES						
Lower	7.37	(2.33–23.26)	0.0007	2.62	(0.89–7.68)	0.0794
Upper lower	2.16	(0.75–6.22)	0.1535	1.06	(0.41–2.75)	0.903
Lower middle	1.33	(0.36–4.83)	0.6686	0.97	(0.30–3.15)	0.9592
Upper middle	1	Reference		1	Reference	
No. of diseases						
<2	1	Reference		1	Reference	
≥2	1.21	(0.72–2.04)	0.4769	0.96	(0.56–1.66)	0.9085
No. of drugs						
<3	1	Reference		1	Reference	
≥3	1.06	(0.57–1.97)	0.8536	1.03	(0.54–1.97)	0.9079

Those variables which were found to be significant in bivariate analysis were subjected to the logistic regression model. In the final logistic regression model, smoking (OR 3.585, CI 1.293–9.937, $p = 0.014$), unsatisfied sleep (OR 4.242, CI 2.461–7.312, $p < 0.001$), nutrition [malnourishment (OR 17.237, CI 5.821–51.042, $p < 0.001$), risk of malnourishment (OR 5.026, CI 1.781–14.188, $p = 0.002$)] and lower socioeconomic status (OR 4.210, CI 1.122–15.803 $p = 0.033$) were found to be influential predictors for Sarcopenia according to SARC-F scoring. According to Ishii scoring, BMI [<18.5 (OR 22.182, CI 4.013–122.618, $p < 0.001$), 18.5–24.99 (OR 5.658, CI 2.287–13.998, $p < 0.001$), 25–29.99 (OR 2.832, CI 1.086–7.389, $p = 0.033$)] and malnourishment (OR 4.191, CI 1.915–9.171, 12 $p < 0.001$) were found to be influential predictors.

Worldwide the population of elderly is increasing at an alarming rate. Sarcopenia is one of the growing concerns in the elderly. The present study aimed at reporting the burden

of sarcopenia along with the common predictors for sarcopenia from the highlands of Nilgiris, Tamil Nadu.

In the present study, in order to identify case finding for Sarcopenia, we implemented two validated tools namely SARC-F and Ishii scoring, which are proven to be feasible and are developed in accordance with the consensus of the European Working Group on Sarcopenia in Older People (Ishii *et al.*, 2014; Malmstrom *et al.*, 2015). Pubmed and Google Scholar search by the study team revealed that since 2014, SARC-F was the most cited tool and has been translated and validated into more than 15 languages with excellent validity, reliability, and internal consistency. The Ishii *et al*. (2014) scoring system incorporates a few important variables like age, grip strength, and calf circumference, which are related to muscular health. Also, Ishii scoring was developed by an Asian country, which motivated the research team to incorporate it into the present study. Proper consumption of micronutrients and proteins in the elderly can actually help in maintaining muscle mass and general health (Bauer *et al.*, 2013; Cruz *et al.*, 2017; Malafarina *et al.*, 2013). Hence, the study team decided to include nutritional components of the elderly in the study by utilizing MNA-SF.

The overall prevalence of sarcopenia was found to be 47.7% and 63.1% as per SARC-F and Ishi scoring, respectively. We observed females to be more sarcopenic than men in both instruments. Sarcopenic prevalence was found to be more in elderly aged greater than 70 when compared to those aged less than 70 years. Most of the sarcopenic elderly were found to be from lower socioeconomic status. The prevalence of sarcopenia in our study was found to be relatively higher than previous studies reported from Asia (Dorosty *et al.*, 2016; Shaikh *et al.*, 2020).

Several factors predict sarcopenia in the elderly. Studies have shown that factors like female gender, reduced physical activity, alcohol consumption, smoking, low socioeconomic status, and decreased nutrition are associated with the development of sarcopenia (Hwang and Park, 2022; Ko *et al.*, 2021). The number of predictors for sarcopenia identified in the bivariate analysis of the present study differed from SARC-F and Ishii scoring (6 *vs.* 3). However in bivariate as well as logistic regression, both the instruments showed malnourishment as the common influential predictor for sarcopenia.

The majority of the elderly in our study were found to be in the category of "risk of malnourishment" and "malnourished" as per MNA-SF. Previous research studies have shown that malnutrition is common in the elderly as food intake declines with age (Lahiri *et al*., 2015; Liguori *et al.*, 2018) This could be partly from the physiological changes or could be from advancing diseases or due to financial crisis. Also, the majority of the elderly consumed proteins and carbohydrates below the suggested intake (Lahiri *et al.*, 2015; Liguori *et al.*, 2018).

In the present study, we observed females to be more sarcopenic than males. Similar findings have been reported by previous research studies. The reason could be the reduced muscle mass in females compared to males. Additionally, there is a difference in exogenous and endogenous components. Hormone changes in females have been linked to promote skeletal muscle loss which may also be a contributing factor (Dorosty *et al.*, 2016; Kwon *et al.*, 2020; Tzeng *et al.*, 2020).

Social habits like smoking and alcoholism have a negative impact on geriatric health. Alcohol consumption, the compound itself, and its metabolite acetaldehyde were found to have effects on the protein synthesis of muscles. Animal studies have reported a negative association between concentration of alcohol and insulin-like growth factor (IGF-1), which is an important hormone responsible for muscle protein synthesis (Rom *et al.*, 2012). Smokers are expected to have an increased risk of progression to sarcopenia as smoking can degenerate the muscle protein from oxidative stress (Locquet *et al.*, 2021). A Tehran study stated that there exists a relationship between Sarcopenia and socioeconomic status that include education, occupation, and income leading to poor nutrition and diminished quality of life (Dorosty *et al.*, 2016).

Physical activity has a positive influence on skeletal muscles (Gong *et al.*, 2019). A Taiwanese cross-sectional study reported that in the elderly, regular physical activity can result in reduced apoptosis and oxidative stress, improved insulin-glucose dynamics, and enhanced quality and quantity of muscle proteins (Tzeng *et al.*, 2020). Mild exercises in the elderly are linked with enhanced skeletal muscle hypertrophy (Kwon *et al.*, 2020).

Advancing age leads to increased morbidities and reduced functional status, leading to increased medication intake and other consequences. A number of studies have previously reported increased morbidities and increased drug use to be negatively impacting the muscles leading to sarcopenia. When multiple chronic comorbidities exist, there will be an increased risk of frailty, and falls also elevate, consequently leading to sarcopenia (Gong *et al.*, 2019). The present study reported patients having more than two comorbidities to have a higher prevalence of sarcopenia when compared to subjects having less than two diseases.

Majority of our elderly hail from lower socioeconomic status, which may have contributed to the higher prevalence of sarcopenia in the study as it is demonstrated from previous studies that lower socioeconomic status can negatively impact sarcopenia (Ko *et al.*, 2021). We believe that because of unemployment, the elderly are affected economically. With limited financial resources, food preferences and lifestyle could be affected in the elderly placing them at a risk for developing sarcopenia.

Research studies have shown that the functioning of the skeletal muscle is highly related to the maintenance of the circadian rhythm (Hirshkowitz *et al.*, 2015). In our study, it was observed that those who self-reported themselves as non-satisfied sleepers were found to be more sarcopenic compared to their healthy counterparts. There could also be problems with hormonal regulation leading to higher levels of cortisol and lower levels of insulin IGF-1, which can contribute to muscle deterioration (Buchmann *et al.*, 2016).

Due to the lack of a gold standard diagnostic tool to identify sarcopenia in the Indian elderly, the study team had to use validated instruments that were developed overseas. Considering the expanding elderly population in India, there is a need for Geriatric researchers to develop Indigenous instruments.

Even though our study is the first systematic study from the region of Nilgiris, India to report the prevalence and predictors for sarcopenia in elderly visiting a Government hospital, our study is not devoid of limitations. Few research studies have utilized diagnostic methods like computed tomography, dual-energy X-ray absorptiometry, and bio-impedance analysis for the identification of sarcopenia (Carmeli, 2017; Coin *et al.*, 2013; Tank *et al.*, 2002). In order to generalize the results of the present study, future research should focus on conducting large multicentric research studies.

CONCLUSION

By observing the results of the present study, we conclude that nearly half of our elderly report symptoms of sarcopenia. Most of the sarcopenic elderly from our region reported malnutrition and hailed from low-socioeconomic status. Females were found to be more sarcopenic compared to males. Finally, we are of the opinion that public health departments should focus on creating awareness in the community about this widely prevalent geriatric condition.

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AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the international committee of medical journal editors (ICMJE) requirements/guidelines.

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CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

ETHICAL APPROVALS

The present study was approved by the Institutional Review Board of Government medical college hospital, Ooty, Nilgiris (Ref No:IRBCTN008).

DATA AVAILABILITY

All data generated and analyzed are included in this research article.

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