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Prognosis Assessment in Emergency Department via Nutritional and Muscle Measurements for Home Health Care Patients

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Abstract

Aim: This study examined the relationship between the factors contributing to emergency department visits for patients who receive home health care services and the density and area of the pectoralis major muscle.

Materials and Methods: In this study, the relationship between demographic data, mini nutritional assessment form data, scores, malnutrition situation, pectoralis major muscle density and area measured on thoracic tomography and prognosis of patients receiving home health care who applied to the emergency department between January and December 2023 was examined.

Results: A total of 220 patient files were found that met the study criteria. The mean screening score of all patients and the mean malnutrition indicator score indicated a risk of malnutrition. In the Ex-group, pectoralis major muscle density (especially on the right side) and area (especially on the left side) were significantly lower, respectively. Pectoralis major muscle density and area measurements of patients with sarcopenia in both sexes were significantly lower compared to control subjects.

Conclusion: The contribution of the pectoralis major muscle to daily living activities is limited, which may lead to a more pronounced occurrence of sarcopenia in patients who are bedridden and immobile for extended periods. Moreover, monitoring the decline in area and density within this muscle group is crucial for accurately predicting prognosis.

Keywords: Emergency department, pectoralis major muscle, prognosis, home healthcare

Introduction

Many studies have thoroughly explored the challenges and health implications associated with the rising elderly population, directly resulting from increased life expectancy. An effort has been made to investigate how reducing muscle volume due to ageing affects healing time for diseases, treatment responses, complications, and survival rates.

Nutrition is crucial for effective muscle building. Hormonal changes associated with ageing, chronic diseases, and long-term medication use significantly decrease muscle anabolism and increase catabolism. Furthermore, factors such as reduced mobility, insufficient protein intake, and malnutrition from unbalanced and inadequate diets directly contribute to pronounced muscle loss in older adults. It is imperative to address these issues to maintain muscle health as we age. In this group, muscle breakdown and reduced muscle function are evident among individuals with significant mobility limitations who can walk with support and depend on others for food and toileting (1). Older adults who are bedridden, require assistance to

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walk, and depend on others for daily activities often experience significant muscle loss. These issues must be prioritised to ensure enhanced support and improved quality of life for this vulnerable population.

Research illustrates that ageing is associated with decreased muscle mass and increased intramuscular fat accumulation. These factors contribute to elevated levels of pro-inflammatory cytokines, which are linked to a heightened risk of metabolic and cardiovascular diseases (2,3). Decreased muscle density is linked to functional loss, leading to longer hospital stays in intensive care patients and worse outcomes for cancer patients (4,5). Sarcopenia, often seen in elderly patients with malnutrition, reduces infection resistance, slows recovery, and causes frequent long-term hospitalisations. Muscle weakness also heightens the risk of falls. The dislocation and fracture of the hip can result in significant adverse effects, such as heightened medication usage and a diminished quality of life for patients (6). In patients who are bedridden or have limited mobility, the prognosis is typically poor due to the exacerbation of chronic diseases, decreased muscle strength, and prolonged infection duration (7). Malnutrition weakens respiratory muscles and alters lung structure, raising the risk of pulmonary infections and negatively impacting lung function. In an experimental study, rats were subjected to a ten-day fasting diet. The findings indicated that malnutrition led to an expansion of the alveolar spaces, reduced surfactant production, and the development of shortness of breath. These results underscore the significant impact of nutritional deprivation on respiratory function (8).

The pectoralis major muscle (PMM) is located in the anterior region of the chest. Its primary function is to connect the ribcage to the arm and scapula. Although it does not function directly as a respiratory muscle, it provides support during inspiration (9,10). Studies show that internal skeletal muscle strength can be evaluated with PMM measurement and can be a prognostic factor for disease outcomes (11).

This study examined the relationship between the factors contributing to emergency department (ED) visits for patients who receive home health care services and the density and area of PMM, where PMM refers to (define PMM if not previously defined). We focused on clinical outcomes in this patient group by providing precise prognostic assessments. Our efforts emphasise implementing structured rehabilitation and nutrition programs to prevent or mitigate muscle loss and enhance muscle quality.

Materials and Methods

Patient Selection

This study involved a retrospective review of patient files of patients who presented to the ED, possessed home health care records, and underwent thorax computed tomography (CT) imaging. Furthermore, we analyzed how all collected data impacted mortality during the hospital stay.

Patients who were not registered with home health care services, did not have a thoracic CT, did not complete an Mini Nutritional Assessment (MNA) form, presented due to trauma, or died in the ED were excluded from the study (Figure 1).

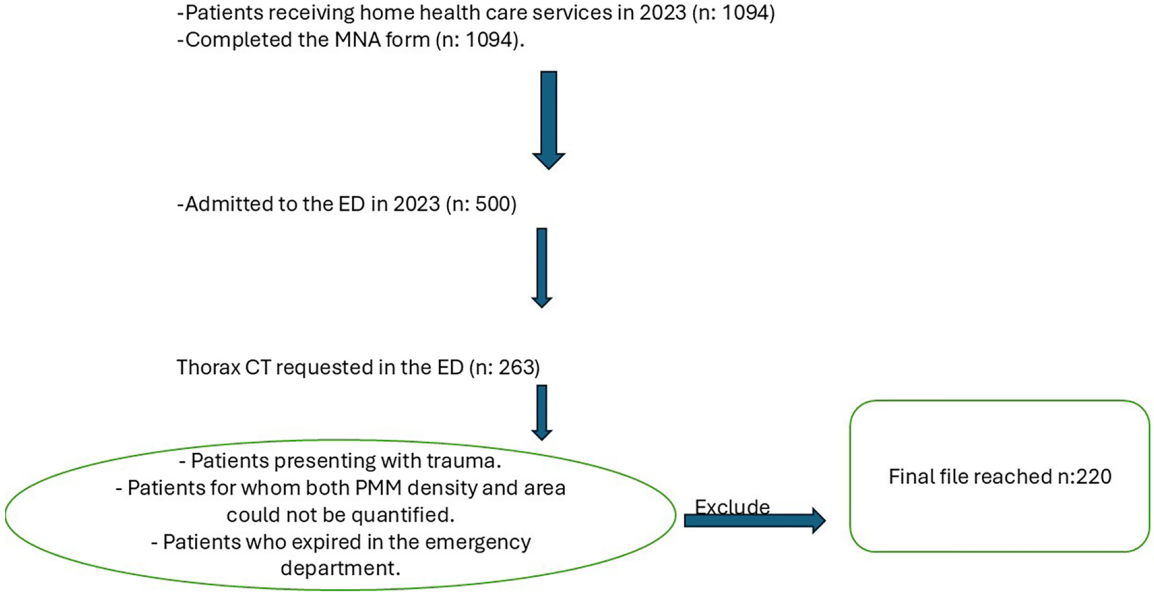

Figure 1. Study inclusion and exclusion criteria

PMM: Pectoralis major muscle, ED: Emergency department, CT: Computed tomography

For the study, demographic data, diagnosis, dependency classification (such as bedridden, dependent on others for toilet or food), service they were admitted to if hospitalised, duration of hospital stay, and outcomes for those who received home health services and applied to the ED between January 1, 2023, -and December 31, 2023, were noted. This information was combined with data from MNA forms recorded in the home health services archive. This study was approved by the Kırklareli University Faculty of Medicine Ethics Committee (decision number: P202400017/4-date: 29.05.2024). The study was conducted in accordance with the Declaration of Helsinki. Due to the retrospective nature of the study, informed consent was not obtained. However, we ensured the privacy and confidentiality of the patients' data.

Data Classification

The MNA form is a screening test designed for geriatric patients. It comprises two key components: screening and assessment. There are six questions in the screening score section:

1- Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties? (0 point (p)= severe decrease in food intake, 1 p= moderate decrease in food intake, 2 p= no decrease in food intake)

2- Weight loss during the last 3 months (0p = weight loss greater than 3 kilogram (kg), 1p= does not know, 2p= weight loss between 1 and 3 kg, 3p= no weight loss)

3- Mobility (0p= bed or chair bound, 1p= able to get out of bed/chair but does not go out, 2p= goes out)

4- Has suffered psychological stress or acute disease in the past 3 months? (0p= yes, 2p= no)

5- Has neuropsychological problems? (0p= severe dementia or depression, 1p= mild dementia, 2p= no psychological problems)

6- Body mass index (BMI) (0p= BMI less than 19, 1p= BMI 19 to less than 21, 2p= BMI 21 to less than 23, 3p= BMI 23 or greater) is questioned and noted.

The highest score that can be obtained from this section is 14. Scores between zero and 7 indicate that individuals are "malnourished"; scores between 8 and 11 suggest that individuals are "at risk of malnutrition"; and scores between 12 and 14 indicate that individuals are in "normal nutritional status." If a score of 11 or below is received from this section, the assessment section will be started.

The purpose of the assessment score section is to calculate the individuals' "malnutrition indicator score." The assessment consists of 12 sections, and the maximum score is 16:

1- Lives independently (not in nursing home or hospital) (1p= yes, 0p= no)

2- Takes more than 3 prescription drugs per day (0p= yes, 1p= no)

3- Pressure sores or skin ulcers (0p= yes, 1p= no)

4- How many full meals does the patient eat daily? (0p= 1 meal, 1p= 2 meals, 2p=3 meals)

5- Selected consumption markers for protein intake (yes or no answers were recorded for consuming eggs/legumes 2 or more times a week, at least 1 serving of dairy products per day, and meat/fish/white meat every day (0p= if the number of yes is 0/1, 0.5p= if the number of yes is 2, 1p= if the number of yes is 3)

6- Consumes two or more servings of fruit or vegetables per day (1p= yes, 0p= no)

7- How much fluid (water, juice, coffee, tea, milk...) is consumed per day? (0p= less than 3 cups, 0.5p= 3 to 5 cups, 1p= more than 5 cups)

8- Mode of feeding (0p= unable to eat without assistance, 1p= self-fed with some difficulty, 2p= self-fed without any problem)

9- Self view of nutritional status (0p= views self as being malnourished, 1p= is uncertain of nutritional state, 2p= views self as having no nutritional problem)

10- In comparison with other people of the same age, how does the patient consider his or her health status? (0 points = not as good, 0.5 points= does not know, 1 point= as good, 2 points= better)

11- Mid-arm circumference (MAC) in cm (0p= MAC less than 21, 0.5p= MAC 21 to 22, 1p= MAC greater than 22)

12- Calf circumference (CC) in cm (0p= CC less than 31, 1p= CC 31 or greater)

The malnutrition indicator score is determined based on the scores acquired from these two sections. In this section, three different score ranges are used to define patients regarding nutrition. According to these ranges, if the test score is below 17, the patient is "malnourished." If the score is between 17 and 23.5, the patient is at risk of malnutrition. If the score is between 24 and 30, the patient is considered to have a "normal nutritional status" (12).

Thoracic Tomography Evaluation

Thorax CT examinations were performed using Siemens Healthineers Somatom go.now (Erlangen, Germany), a model device with 32 detectors, a slice thickness of 3 mm, and a dose

of 110 kV. Measurements were made on a radiology workstation called “Radiant".

The areas and densities of the PMM were measured by a radiologist with 15 years of experience.

The area of the PMM was measured manually by drawing a polygonal region of interest on a single axial image of the CT scan just above the aortic arch. PMM contours were determined and measured. Area measurements were made in all patients included in the study.

Right and left pectoral muscle density was measured at the same level (Figure 2). Muscle density measurement was performed only on images obtained without a contrast agent. Density measurement was not performed on contrast-enhanced scans. Additionally, images showing artefacts were excluded; density measurements were not conducted.

The right and left PMM areas were measured (in cm^2), and the density was calculated in Hounsfield units.

Statistical Analysis

The analysis was conducted to determine the statistical significance of the relationships among patients' nutrition types, nutritional adequacy, weight and muscle loss, and the duration and prognosis of the disease.

The descriptive statistics of the data included the mean, standard deviation, median, minimum, maximum, frequency, and ratio values. The distribution of variables was measured by Kolmogorov-Smirnov and Shapiro-Wilk tests. The independent sample t-test was used to analyse quantitative independent data with a normal distribution, and the Mann-Whitney U test was used to analyse data with a non-normal distribution. The chi-square test was used in the analysis of qualitative independent data. The SPSS 28.0 program was used in the analyses. When the chi-square test conditions were not met, the Fisher's exact test was used. In all tests, a p-value of less than 0.05 was considered statistically significant.

Results

A total of 220 patient files were found that met the study criteria. 54.1% of the patients were female, and the mean age was 79.0±12.0 years. 37.7% of the patients were bedridden or chair-bound. A severe decrease in nutrition was detected in 8.6% of them, and a decrease of more than three kilograms in weight was detected in 9% of them, in the last three months. There were no patients in nursing homes or hospitals. 10.9% of the patients had pressure sores. Seven point seven percent stated that they ate at most one meal a day. It was determined that 45.4% did not consume enough protein, 52.2% consumed less than 2 servings of fruit/vegetables per day, and 33.7% consumed less than 3 glasses of liquid per day. 15.4% of the patients thought they were malnourished. 28.1% thought their health was not good compared to their peers. Thirty-five percent were dependent on someone else to eat. The mean screening score of all patients was 9.4±2.5, and the mean malnutrition indicator score was 19.3±4.7 points, which indicates they are at risk of malnutrition. PMM (right) density and area average was low in all patients. The most frequently diagnosed disease groups in the ED were related to lung, musculoskeletal, and cardiac diseases. It was

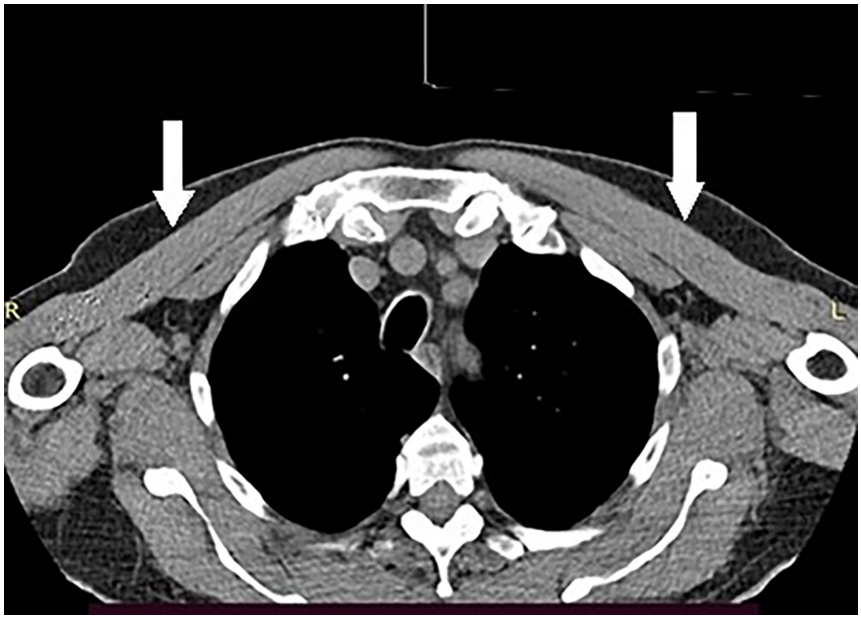

Figure 2. White arrows indicate right and left pectoralis major muscles

determined that 41.4% of the patients were admitted to the ward from the ED, and 22% of these patients expired in the ward (Table 1).

When the patients were examined according to their hospitalization status, the prevalence of inpatient treatment was higher in female patients (p=0.024). PMM density (especially on the right side) was significantly lower in the hospitalized group than in the other group (p<0.001). The PMM area (particularly the left side) was lower in the hospitalized group than in the other group; however, the difference was not statistically significant (p=0.241). Screening, assessment, and total malnutrition indicator scores were found to be low in both groups. The rate of hospitalization due to problems related to electrolyte disorders and neurological diseases was higher compared to other conditions (p=0.000/0.007). The ex-rate was significantly higher in the hospitalized group than in the other group (p=0.000) (Table 2).

When patients were analysed according to their prognosis, the death rate of female patients was higher than that of male patients (p=0.049). In the Ex-group, PMM density, especially on the right side (p=0.019), and area, especially on the left side (p=0.005), were significantly lower than in the other group. Screening (p=0.524), assessment (p=0.689), and malnutrition indicator scores (p=0.968) were low in both groups, but there was no difference between the groups. The hospital stay of patients with ex was longer than that of the other group, but there was no statistically significant difference between the groups (p=0.514) (Table 3).

Mean PMM density (p<0.001) and total PMM area (p=0.003) were significantly higher in men than women. The malnutrition score was considerably lower in men than in women (p=0.036). PMM area measurements of patients with sarcopenia in both sexes were significantly lower than those of patients without sarcopenia (p=0.027/0.033). Scores screening (p=0.023/0.024) and malnutrition scores of patients with sarcopenia in both genders were significantly lower than those of patients without sarcopenia (p=0.001/0.000) (Table 4).

Table 1. Demographic characteristics of patients and MNA form results

Age, years, mean ± SD	79±12.0
Gender, n (%)	
Female	119 (54.1)
Male	101 (45.9)
PMM density (HU), mean ± SD	
Right	46.6±11.5
Left	45.3±12.1
PMM area (cm^2), mean ± SD	
Right	9.4±5.0
Left	9.3±5.3
Screening score	9.4±2.5
Assessment	9.8±3.6
Malnutrition indicator score	19.3±4.7
Diagnosis in the ED, n (%)	
Pulmonary disease	73 (33.2)
Electrolyte disorders	17 (7.7)
GIS	23 (10.5)
GUS	18 (8.2)
Cardiac disease	29 (13.2)
Musculoskeletal disease	40 (18.2)
Neurological disease	20 (9.1)
The outcome in the ED, n (%)	
Discharge from ED	128 (58.1)
Hospitalization	92 (41.8)
Length of stay, days, mean ± SD	15.1±18
Outcome in the service, n (%)	
Discharge	71 (77.1)
Ex	21 (22.9)

SD: Standard deviation, GIS: gastrointestinal system, GUS: genitourinary system, HU: Hounsfield unit, PMM: Pectoralis major muscle, ED: Emergency department, MNA: Mini Nutritional Assessment

Discussion

This study provides compelling evidence that PMM density and area are inversely related to mortality rates. Additionally, it highlights that a reduction in PMM density is associated with a greater likelihood of patients receiving inpatient treatment.

It's essential to consider other factors for a more accurate assessment (13). The determination of area and density using imaging methods for internal skeletal muscles, such as PMM, produces more precise results.

Men inherently possess more muscle mass than women, which is a primary reason why sarcopenia is observed more markedly in women (14). While malnutrition affects both sexes, the greater muscle mass in men significantly enhances their prognosis. This explains why female patients in this study showed significantly lower muscle area and density compared to males, indicating sarcopenia.

Sarcopenia is defined as progressive muscle loss. It may develop due to age, loss of activity, diseases, and nutrition (15). Drummond et al. (16) observed impaired muscle signalling in individuals who were sedentary for 7 days, despite amino acid supplementation for basal muscle protein synthesis. The evidence indicates that sarcopenia and muscle deterioration

Table 2. Results of patients' hospitalization status			
	Discharge from ED (n=128)	**Hospitalization (n=92)**	**p value**
Age, median (min-max)	79.0 (21.0-98.0)	82.0 (51.0-96.0)	0.105
Gender, n (%)			
Female	61 (47.7)	58 (63.0)	**0.024**
Male	67 (52.3)	34 (37.0)	
PMM density (HU), mean ± SD			
Right	49.9±10.1	42.7±11.9	**<0.005**
Left	47.7±11.2	42.4±12.6	**<0.005**
PMM area (cm²), median (min-max)			
Right	8.9 (0.6-33.1)	8.1 (1.9-31.3)	0.318
Left	9.0 (0.0-28.5)	7.6 (1.6-34.3)	0.241
Screening score, median (min-max)	9.0 (1.0-14.0)	10.0 (3.0-14.0)	0.120
Assessment, median (min-max)	10.5 (2.0-16.0)	8.8 (1.0-16.0)	0.144
Malnutrition indicator score, median (min-max)	20.0 (9.0-29.0)	19.8 (8.0-29.0)	0.770
Mortality			
No	128 (100.0)	71 (78.3)	**<0.005**
Yes	0 (0.0)	21 (21.7)	
SD: Standard deviation, HU: Hounsfield unit, PMM: Pectoralis major muscle, ED: Emergency department			

Table 3. Prognosis of patients			
	Survived (n=199)	**Exitus (n=21)**	**p value**
Age, median (min-max)	81 (21.0-98.0)	83.0 (66.0-94.0)	0.226
Gender, n (%)			
Female	104 (52.0)	15 (71.4)	**0.049**
Male	96 (48.0)	6 (28.6)	
PMM density (HU)			
Right, mean ± SD	47.4±11.2	40.5±12.2	**0.019**
Left, median (min-max)	46.7 (14.6-80.5)	40.8 (6.8-60.3)	**<0.005**
PMM area (cm²), median (min-max)			
Right	8.8 (0.6-33.1)	6.6 (3.0-11.7)	**0.011**
Left	8.8 (0.0-34.3)	6.2 (2.8-13.2)	**0.030**
Screening score, median (min-max)	10.0 (1.0-14.0)	10.0 (6.0-13.0)	0.524
Assessment, median (min-max)	9.5 (1.0-16.0)	9.3 (4.0-14.0)	0.689
Malnutrition indicator score, median (min-max)	20.0 (8.0-29.0)	19.5 (12.0-26.5)	0.968
Length of stay, days, median (min-max)	10.0 (1.0-60.0)	9.0 (1.0-150.0)	0.514
SD: Standard deviation, HU: Hounsfield unit, PMM: Pectoralis major muscle			

can quickly become irreversible for patients who are bedridden for prolonged periods. To significantly improve outcomes, it is crucial to initiate radical changes in both nutrition and mobility from day one, including implementing passive exercises. Taking these steps early can make a profound difference in recovery. Furthermore, sarcopenic obesity arises when muscle tissue is lost at a faster rate than fat tissue during sarcopenia. Excess fat tissue within the muscle causes lower density readings in CT. Koçyiğit et al. (17) demonstrated that elderly patients with sarcopenic obesity exhibited lower scores on the MNA and showed greater susceptibility to infections compared to their peers. This study establishes that the elevated hospitalisation and death rates among patients with PMM area and low density are directly linked to immune system disorders caused by sarcopenia and sarcopenic obesity (18).

This study demonstrated that the mean MNA score of all patients receiving home health care indicates a significant risk of malnutrition. The results show that patients lack adequate

Table 4. Analysis of sarcopenia presence by gender						
	Female			**Male**		
	Sarcopenia (+)	Sarcopenia (-)	p value	Sarcopenia (+)	Sarcopenia (-)	p value
BMI (kg/m²), n (%)						
Underweight	7 (5.9)	-		10 (9.9)	-	
Normal	-	19 (16)	0.409	-	12 (11.9)	0.409
Overweight	93 (78,2)	-		79 (78.2)	-	
PMM density (HU), mean ± SD	85.0±22.6	97.2±20.2	0.202	98.4±15.5	105.1±20.7	0.265
Total PMM area (cm²), median (min-max)	10.3 (5.6-18.4)	15.7 (0.6-61.1)	**0.027**	14.6 (5.7-24.8)	19.5 (5.1-64.0)	**0.033**
Screening score, median (min-max)	8.0 (1.0-11.0)	10.0 (3.0-14.0)	**0.023**	7.5 (4.0-11.0)	10.0 (4.0-14.0)	**0.024**
Malnutrition indicator score, median (min-max)	13.5 (9.0-20.5)	21.0 (8.0-28.0)	**0.001**	13.3 (9.0-21.5)	19.0 (9.0-29.0)	**<0.005**
BMI: Body mass index, SD: Standard deviation, HU: Hounsfield unit, PMM: Pectoralis major muscle						

and balanced nutrition. Limited movement further contributes to the inevitable onset of sarcopenia in these individuals. Malnutrition, similar to sarcopenia, also leads to impairment of the T-cell response, alterations in macrophage function and activity, and a decline in type IV hypersensitivity reactions. The increasing average age is particularly associated with an risk of serious infections due to a decline in immune system function, consequently raising the risk of sepsis (19). Pneumonia is the most common cause of death in elderly patients (20). This study demonstrates that a substantial proportion of patients who died had electrolyte disorders. While we could not definitively determine if these disorders arose as a consequence of pneumonia, it is evident that most patients experienced issues directly related to lung pathology. The ageing process leads to an increase in sarcopenia, which significantly impairs respiratory reflexes, including coughing. Furthermore, low PMM density and area play a important role in the development of pneumonia (21,22). We believe that the factor contributing to this situation is the generally low muscle mass and density observed within the patient population we examined. It is essential to strengthen the PMM to ensure that the respiratory reflex remains highly effective (23).

Study Limitations

The principal limitation of this study is its reliance on retrospective data from a single institution. Certain data may have been inaccessible. Additionally, because only the records of patients presenting to the ED and undergoing non-contrast thorax CT scans were evaluated, definitive conclusions cannot be generalized to all patients receiving home healthcare services. Nonetheless, considering that the data were derived from the sole hospital situated in the city center—the largest hospital in the province—the findings possess considerable relevance.

Conclusion

The contribution of PMM to daily living activities is limited, which may lead to a more pronounced occurrence of sarcopenia in patients who are bedridden and immobile for extended periods. Relying solely on measurements of exoskeletal muscles can lead to misunderstandings when identifying sarcopenia. This muscle group can be quantified via CT scans obtained in the ED, thereby potentially assisting in prognostic prediction.

Ethics

Ethics Committee Approval: This study was approved by the Kırklareli University Faculty of Medicine Ethics Committee (decision number: P202400017/4-date: 29.05.2024). The study was conducted in accordance with the Declaration of Helsinki.

Informed Consent: Due to the retrospective nature of the study, informed consent was not obtained.

Footnotes

Author Contributions

Surgical and Medical Practices: O.G., L.T., E.P.S., Concept: O.G., D.V.K., L.T., G.A., E.P.S., Design: O.G., L.T., E.P.S., Data Collection or Processing: L.T., E.P.S., Analysis or Interpretation: O.G., G.A., E.P.S., Literature Search: D.V.K., G.A., Writing: O.G., D.V.K.

Conflict of Interest: No conflict of interest was declared by the authors.

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