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Original Study

Decreased Basal Metabolic Rate Can Be an Objective Marker for Sarcopenia and Frailty in Older Males

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A B S T R A C T

Objectives: The aim of this study is to demonstrate the ability of the basal metabolic rate (BMR) to detect frailty and sarcopenia in older males.
Setting and Participants: A total of 305 male patients undergoing comprehensive geriatric assessment were included in the study.
Measures: The frailty status was assessed with the Fried criteria. Sarcopenia was diagnosed according to the European Working Group on Sarcopenia in Older People criteria. BMR is calculated by bioimpedance analysis. Areas under the curves (AUCs) of receiver operating characteristic analyses were used to test the predictive accuracy of BMR in detecting sarcopenia.
Results: The mean age was 74.52 ± 7.51 years. Among the patients in the sample, 95 (31.1%) had sarcopenia and 55 (18%) had frailty. Patients who had a BMR <1612 kcal/d had a higher frequency of frailty than those who had a BMR ≥1612 kcal/d (67.3 vs 32.7, $P < .001$). Results were similar for sarcopenia (77.9 vs 22.1, $P < .001$). When BMR was divided by body surface area (BSA), BMR/BSA with a cut-off of 874 kcal/m^2 had a sensitivity of 80% and a specificity of 68%, and the AUC was 0.82 for BMR/BSA, in diagnosing sarcopenia ($P < .01$). The participants without sarcopenia had a higher BMR/BSA for the unadjusted (OR = 8.00, 95% CI 4.52-14.19, $P < .001$) and adjusted analyses (OR = 6.60, 95% CI 3.52-12.38, $P < .001$).
Conclusions: Older male patients with sarcopenia and frailty have a higher BMR reduction. Therefore, it should be kept in mind that patients with low BMR should alert us to screen sarcopenia and frailty. BMR/BSA may play a role in objective screening to detect sarcopenia in older males.
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Increasing age leads to age-related changes in body composition that can negatively affect functional status in older adults, including a progressive decrease in muscle mass, strength, and quality accompanied by an increase in fat mass. All these changes also play a role in the development of geriatric syndromes such as frailty and sarcopenia.[1] Frailty and sarcopenia are relatively newer and commonly overlapping syndromes. Both syndromes with key features such as muscle mass and power decline are associated with mortality and morbidity.[2] Sarcopenia is diagnosed by the presence of concurrent low muscle mass plus low muscle strength or low physical performance.[3] In addition, frailty was regarded by Fried et al as a biologic syndrome of decreased reserve and resistance to stressors, resulting from cumulative declines in multiple physiologic systems and defensibility to adverse outcomes.[4]

Increased age is also associated with reduced peak and total energy expenditure, energy availability, and increased energy needs for independent living.[5] Obviously, energy metabolism and body composition are closely related; active tissue/organ mass is a major contributor to the basal metabolic rate (BMR),[1] and skeletal muscle is the main tissue consuming most of the energy required by the entire human body. Furthermore, fat-free mass (FFM) is the best independent determinant of BMR, and age is one of the most important factors that regulates energy metabolism.[6] As a result of skeletal muscle loss in sarcopenia, the BMR decreases by about 30% between the ages of 20 and 70 years.[7] In the aforementioned studies, the reduction in energy consumption on aging is not only due to a reduced BMR but also due to a decreased intensity and duration of physical activity, in addition to

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reduced postprandial energy expenditure as a result of decreased fat oxidation.[1] On the other hand, age-associated chronic diseases or inflammatory conditions increase the BMR.[8] Studies conducted in recent years have reported that an increased BMR may be a global marker of poor health[9] and that a high BMR is a risk factor for higher mortality.[10] In addition, gender and hormonal differences between men and women are important contributors to the BMR.[9]

For this reason, the role and location of BMR measurement in detecting sarcopenia and frailty is very complex. One of the aims of this study is to show whether there is any relationship between sarcopenia-frailty and BMR in older male adults. The second is to find out whether the BMR has any cut-off value to identify sarcopenia and frailty.

Methods

A total of 305 male patients who attended geriatric clinics between September 2016 and November 2017 were included in the study. The investigation protocol conformed to the Declaration of Helsinki and was approved by the local ethics committee.

Patients with severe osteoarthritis or neuromuscular disease, which impairs both ambulatory and immobile patients; patients who had a severe illness that can impair general health status, such as an acute cerebrovascular event, gastrointestinal bleeding, sepsis, acute renal failure, acute coronary syndrome, acute liver failure, or acute respiratory failure; patients with a pacemaker (because of contraindication to electrical bioimpedance); those with malignancy and similar diseases (because these might cause cachexia); patients younger than 60 years; and those of female gender.

Patients' age, gender, education level, accompanying systemic diseases, and number of drugs used were recorded. Those with hypertension, coronary artery disease, congestive heart failure, diabetes mellitus, hyperlipidemia, peripheral arterial disease, chronic obstructive pulmonary disease, osteoporosis, thyroid disease, or cerebrovascular disease were identified by their self-reports. Dementia and depression were diagnosed according to *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*, criteria.

All the patients underwent comprehensive geriatric assessment (CGA),[11] including Montreal Cognitive Assessment Scale,[12] Mini Mental State Examination,[13] Geriatric Depression Scale[14] for neurocognitive evaluation, Basic and Instrumental Activities of Daily Living (BADL, IADL)[15] for functionality evaluation, Tinetti Performance-Oriented Mobility Assessment (POMA)[16] for mobility evaluation, and Mini Nutritional Assessment (MNA)[17] for nutritional evaluation. CGA was performed to identify and manage geriatric conditions.

Laboratory tests including those for renal and liver function; fasting blood glucose level; hemogram; thyroid-stimulating hormone level; hemoglobin A1c; cholesterol levels; C-reactive protein sedimentation rate; and vitamin D, vitamin B_{12}, and folic acid levels were performed to evaluate the biochemical, metabolic, and nutritional status of the patients. All of these parameters were obtained with the auto-analyzer diagnostic modular system (Roche E170 and P-800). Serum 25-hydroxy D vitamin [25(OH)D] was measured by radioimmunoassay.

For assessing walking speed, muscle strength, and muscle mass with BMR, the 4-meter walking test, handgrip test, and bioimpedance analysis, respectively, were performed for each patient. Bioimpedance analysis (BIA) was first performed on patients. Handgrip test was measured by a Jamar hand dynamometer (Model J00105; Jamar, Lafayette, LA), and BIA was established by a multifrequency segmental body composition analyzer (model no. MC-780U; Tanita, Tokyo, Japan). We adopted thresholds of slow walking as speed <0.8 m/s, and low hand grip power as <30 kg in males.[4] Based on muscle mass bioimpedance values, estimated skeletal muscle (kilograms) = (height-squared/$R \times 0.401$) + (sex $\times$ 3.825) + (age $\times$ −0.071) + 5.102 is formulated.[18] Values in terms of resistance (R) 50 Hz hand-leg (body), length in centimeters, female gender 0, male gender 1, and age in years were adopted and replaced in the formula. BIA is based on the relationship between the volume of a conductor and its electrical resistance. Because skeletal muscle is the largest tissue in the body, it is the dominant conductor. Previous studies have shown a strong correlation between BIA resistance and skeletal muscle measurements in the arms and legs. For this reason, all resistance measurements were adjusted for height.[18]

In males, a muscle mass index (muscle mass divided by height-squared) <8.87 was considered as low.[3] Decreased muscular strength and/or walking speed together with decreased muscle mass was evaluated as sarcopenia.[3]

A modified Fried physical frailty scale was used to evaluate frailty, which was defined according to a physical model, and 3 or more of the following criteria had to be present: weight loss, exhaustion, low physical activity, slowness, and weakness.[4] Low physical activity was considered positive in patients who spent most of their time sitting or rarely had short walks in the past year; we did not use the Minnesota Leisure Time Questionnaire.[19]

BMR is calculated by the BIA, which is a validated formula confirmed by indirect calorimetry measurement.[20] In addition, we divided the BMR by height-squared (cm^2), body surface area, and body mass index (BMI) to negate the effect of the height and weight. Body surface area (BSA) was calculated by the formula BSA (m^2) = square root of [height (cm) $\times$ weight (kg)/3600].[21]

Data were analyzed using SPSS, version 22. Descriptive statistics are shown as mean ± standard deviation for variables with normal distribution, median (minimum to maximum) for nonnormal distributions, and number of cases and percentage for nominal variables. When the group number was 2, the significance of differences between the groups in terms of averages was investigated by t test, and if in median values it was investigated by Mann-Whitney test. When the number of groups was more than 2, the significance was investigated by analysis of variance and the Kruskal-Wallis test for averages and medians, respectively. Nominal variables were assessed by the Pearson chi-square or Fisher exact test. Variances in more than 2 groups were assessed by post hoc Tukey tests. Linear regression and logistic regression were used to assess the association between BMR and CGA parameters, frailty, and sarcopenia. The area under the receiver-operating characteristic curve was used to test the predictive accuracy of the BMR in detecting sarcopenia and to determine a suitable cut-off (Figure 1). For $P < .05$, results were considered statistically significant. The sample size needed was calculated to be at least 175 patients with an acceptable error of 5% and a 95% confidence level.[22]

Results

Of the 305 patients in the sample, 95 (31.1%) had sarcopenia, 55 (18%) had frailty, and 35 (11.5%) had both sarcopenia and frailty. When the BMR was divided into quartiles, patients in the lowest quartile had 28.9% frailty and 52.6% sarcopenia ($P < .01$). There were no significant differences between the quartile groups in terms of comorbidities ($P > .05$). Table 1 summarizes the demographic characteristics and CGA parameters of patients according to the BMR quartile groups.

A BMR with a cut-off of 1612 had a sensitivity of 80% and a specificity of 63% for the diagnosis of sarcopenia. The BMR was also divided into BSA (square-meters), BMI, and height-squared (meters), to negate the effect of weight and height. BMR/BMI with a cut-off of 66.21 had sensitivity of 80% and a specificity of 25% ($P > .05$); BMR/BSA with a cut-off of 874 kcal/m^2 had a sensitivity of 80% and a specificity of 68% ($P < .01$); and BMR/height-squared with a cut-off of 575 kcal/m^2 had a sensitivity of 80% and a specificity of 65% for detecting sarcopenia ($P < .01$).

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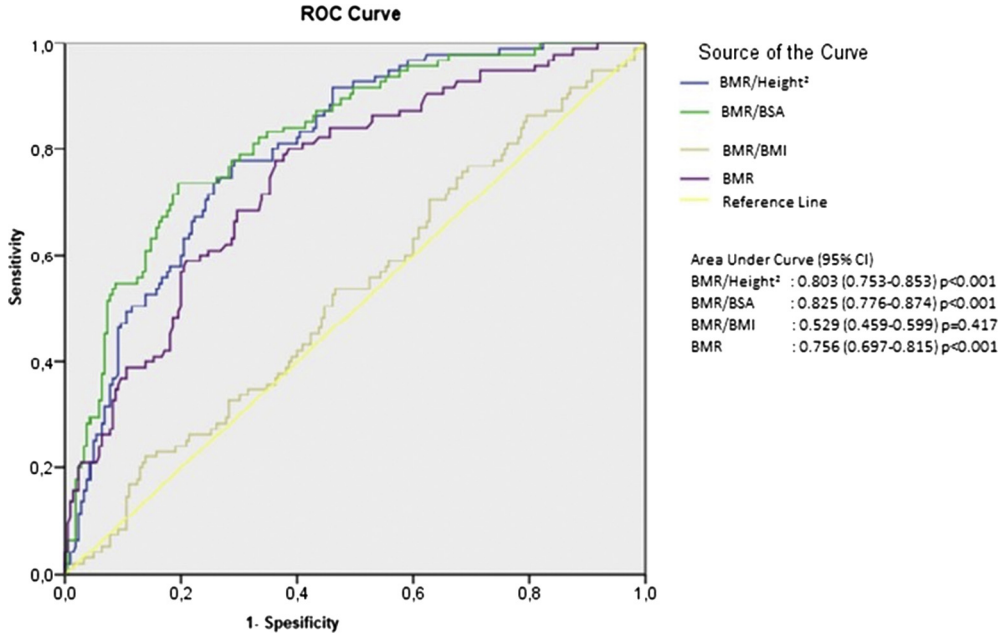

Fig. 1. Receiver operating characteristic curves of BMR and BMR/BMI, BMR/BSA, BMR/height-squared.

The BMRs of patients were log transformed in order to obtain normality. The relations between the CGA parameters and BMRs were investigated using multiple linear regression models, adjusting for age, hypertension, and diabetes. Results show that there was a statistically significant positive correlation between MNA, BADL, and IADL scores and the BMRs of patients, whereas a significant negative correlation existed between both sarcopenia and frailty status and BMRs.

BMRs were categorized into 2 groups (≤1612: low, >1612: high) according to the findings from the receiver-operating characteristic analysis, and multiple logistic regression was used to examine the relationship between the BMR and the geriatric parameters adjusted for age, hypertension, and diabetes. There was a significant positive correlation between MNA, IADL, BADL, POMA, POMA balance, and Mini Mental State Examination scores and BMRs, whereas sarcopenia and frailty status showed a significant negative correlation. Multiple

Table 1
Patients' Characteristics According to BMR Quartile Groups

	<25th Percentile BMR: <1465 kcal (n = 76)	25-50th Percentile BMR: ≥1465-<1612 kcal (n = 76)	50-75th Percentile BMR: ≥1612-1756 kcal (n = 76)	>75th Percentile BMR: ≥1756 kcal (n = 77)	*P*
Demographics, %					
Age, years	78.74 ± 7.50	75.67 ± 5.94	72.03 ± 7.20	71.69 ± 7.14	**<.001**
Education (≥11 years)	50	51.3	56.6	70.6	**.04**
CCI	1.37 ± 1.44	1.28 ± 1.28	1.25 ± 1.55	1.36 ± 1.51	.74
Frailty and sarcopenia, %					
Sarcopenia	52.6	44.7	17.1	9.1	**<.001**
Frailty	28.9	19.7	10.5	13	**.002**
Fried Score	1.72 ± 1.39	1.47 ± 1.25	0.96 ± 1.18	0.98 ± 1.12	**<.001**
Blood biochemistry					
CRP	4.83 ± 6.33	8.60 ± 12.36	4.66 ± 5.07	5.75 ± 10.77	.371
eGFR	74.83 ± 17.75	73.32 ± 16.22	73.85 ± 17.88	75.01 ± 17.19	.944
Albumin, g/dL	4 ± 0.42	4.06 ± 0.26	4.70 ± 0.17	4.22 ± 0.30	**<.001**
TSH, μIU/mL	1.52 ± 0.98	1.39 ± 1.08	1.35 ± 0.65	1.53 ± 1.76	.615
Vitamin D, ng/mL	24.75 ± 11.23	25.92 ± 13.16	28.54 ± 8.45	25.51 ± 9.02	**.04**
Vitamin B_{12}, pg/mL	437.4 ± 326.7	405.8 ± 285.8	394.2 ± 244.8	396.6 ± 286.4	.906
Folate, ng/mL	7.67 ± 3.77	8.32 ± 3.93	7.63 ± 3.43	8.01 ± 3.57	.529
Comprehensive Geriatric Assessment					
MMSE	21.98 ± 7.04	20.65 ± 8.71	25.32 ± 5.82	24.86 ± 7.13	**.012**
MOCA	22.08 ± 6.40	23.63 ± 4.79	23.39 ± 6.37	23.59 ± 4.50	.633
GDS	2.38 ± 2.82	2.44 ± 3.07	2.45 ± 3.11	1.69 ± 1.94	.778
Balance (POMA)	14.29 ± 2.34	14.28 ± 2.93	15.54 ± 0.90	14.97 ± 1.81	**.002**
Gait (POMA)	10.65 ± 2.02	10.80 ± 1.98	11.48 ± 1.00	11.11 ± 1.81	.063
POMA	24.95 ± 4.13	25.08 ± 4.64	27.04 ± 1.77	26.07 ± 3.48	**.002**
TUGT	13.76 ± 8.50	12.82 ± 7.65	10.28 ± 3.44	11.12 ± 5.65	**.01**
4-m walk test	0.94 ± 0.32	1.09 ± 0.33	1.18 ± 0.35	1.16 ± 0.35	**<.001**
BADL	89.09 ± 14.91	90.70 ± 13.54	94.55 ± 11.60	94.91 ± 10.68	**.002**
IADL	15.43 ± 6.63	16.70 ± 6.47	19.75 ± 10.82	19.80 ± 4.77	**<.001**
MNA	11.89 ± 2.18	12.57 ± 1.78	12.53 ± 2.21	13.43 ± 1.06	**<.001**

Note. Bold values are statistically significant ($P < .05$).
CCI, Charlson Comorbidity Index; CRP, C-reactive protein (mg/L); eGFR, estimated glomerular filtration rate; GDS, Geriatric Depression Scale; MMSE, Mini Mental State Examination; MOCA, Montreal Cognitive Assessment; TSH, thyroid-stimulating hormone; TUGT, timed up and go test.

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linear regression of BMR/BMI values adjusted for age, hypertension, and diabetes show that BADL, POMA, POMA balance, and POMA Gait had significant positive effects, whereas MNA, timed up and go test, and frailty status had significant negative effects on BMR/BMI. In addition, it was found that sarcopenia and frailty status both had stronger negative relationships with BMR/BSA. Sarcopenia status also had a significant negative effect on BMR/height-squared (Table 2).

Participants without sarcopenia had a higher BMR (OR = 6.79, 95% CI 3.77-12.23, $P < .001$), and after adjusting for potential confounders (age, hypertension, diabetes, dementia, and timed up and go test), that effect was still significant (OR = 5.47, 95% CI 2.84-10.54, $P < .001$). Participants without frailty also had a higher BMR (OR = 2.75, 95% CI 1.67-4.53, $P < .001$), and after adjusting for the same set of potential confounders, the adjusted OR was found to be 2.13 (95% CI 1.19-3.83, $P = .011$). Similar to the findings with respect to BMR, the participants without sarcopenia had higher BMR/BSA for the unadjusted (OR = 8.00, 95% CI 4.52-14.19, $P < .001$) and adjusted analyses (OR = 6.60, 95% CI 3.52-12.38, $P < .001$). Participants without frailty also had a higher BMR/BSA (OR = 2.81, 95% CI 1.72-4.58, $P < .001$), and after adjustment, OR was found to be 2.42 (95% CI 1.38-4.25, $P = .002$).

Discussion

This study showed that a lower BMR is associated with a higher prevalence of sarcopenia and frailty in older males. The BMR/BSA ratio, which we used to negate the effect of length and weight on BMR, may be a practical and objective screening method for sarcopenia.

Sarcopenia and frailty are 2 geriatric syndromes that have been defined in the past 2 decades. They lead to functional decline, increased morbidity and mortality, as well as increased health care costs.[2,23] Because of the varieties of diagnostic criteria in the literature, in addition to racial, ethnic, and gender differences, the prevalence of sarcopenia and frailty is wide ranging. Because of significant differences in BMR and muscle mass between the 2 genders, only male older adults were included in the present study, and the prevalence of sarcopenia and frailty was found to be 31.1% and 18%, respectively.

The key component of sarcopenia as well as frailty is muscle mass loss, which was found to be closely related to a patient's age, BMR, physical status, and muscle strength. Because BMR is the largest component of total energy expenditure, it may give us some clues about a patient's energy metabolism, physical performance, total active healthy tissue mass, and disability status.[6] FFM is the best independent determinant of BMR, and the effect of age is evident not only in children but also in older adults. Sex, height, weight, and waist-hip ratio are other contributors to BMR.[24] We used various ratios in our study to eliminate the factors that could affect the BMR and found that BMR/BSA is the best predictor for sarcopenia. The tools currently used to screen for sarcopenia, such as SARC-F[25] and Screening grid,[26] have higher specificity but lower sensitivity (≈40%). Another screening tool, Score chart,[27] has been reported to have high specificity (84%) and sensitivity (80%), but it uses a complex formula that requires grip strength and calf circumference measurements.[28] Furthermore, the reliability of hand grip strength is low for older patients with severe dementia because of their difficulty with judgment, and conception, which can cause them to fail to fully comprehend and complete tasks.[29] Additionally, a study reported that calf circumference could not be used to predict sarcopenia,[30] and another study demonstrated that calf circumference was not useful in patients ≥65 years of age who have cardiovascular disease.[31] We found that patients without sarcopenia had a 6.6 times high BMR/BSA compared with those with sarcopenia, even after adjusting for all covariates, and BMR/BSA with a cut-off of 874 kcal/m^2 had a sensitivity of 80% and a specificity of 68% in diagnosing sarcopenia in older men, which makes BMR/BSA a useful, practical, and more objective option for screening independent of comorbidities, such as cognitive impairment or cardiovascular disease.

Additionally, BMR, just like appendicular skeletal muscle mass, is one of the easily obtainable data from BIA, as suggested by working groups for sarcopenia, because it is practical, simple, and quick to use; and inexpensive, portable, reproducible, and noninvasive.[3] Moreover, BIA has been shown to be useful in developing prediction equations for BMR.[32–34] Furthermore, there is no need to assess muscle strength and physical performance measurement. Therefore, BMR/BSA may be considered a practical method for evaluating sarcopenia.

On the other hand, changes in BMR in older adults may play a critical role in the pathogenesis of frailty, but it is currently not known whether BMR is high or low in frail older adults. Some studies reporting increases in the resting metabolic rate (RMR) with age typically involve participants with chronic diseases or inflammatory conditions.[2,5] Despite gender and age adjustment analysis, it was reported that higher RMRs correlated with the frailty index. For example, Utaka et al showed that a significant reduction in C-reactive protein levels was accompanied by a significant reduction in RMR in patients who received treatment for infection.[35] In addition, a high metabolic rate is associated with cachexia-like muscle loss and weakness in cancer patients, suggesting that the increase in BMR is associated with frailty.[36] In these studies, it was claimed that as health worsens, the metabolic burden increases to maintain hemodynamics. Increased catabolism, which may be disease related, causes a relatively hypermetabolic state and cumulative damage.[37]

However, like FRADEA, there are further studies that suggest frailty is associated with a lower RMR.[5] The lower RMR may be explained by a decrease in the Na/K-ATPase activity, a decrease in skeletal muscle protein turnover, potential changes in mitochondrial membrane

Table 2
Associations Between BMR, BMR/BMI, BMR/BSA, BMR/Height-Squared and Comprehensive Geriatric Assessment Parameters

Variable	BMR, Continuous Variable		BMR, Categorized Into 1612		BMR/BMI		BMR/BSA		BMR/Height-Squared	
	Beta	*P*	Beta	*P*	Beta	*P*	Beta	*P*	Beta	*P*
Sarcopenia	−0.093	**<.001**	−1.570	**<.001**	0.381	.663	−37.27	**<.001**	−51.24	**<.001**
MNA	0.018	**<.001**	0.183	**.009**	−0.573	**.003**	3.474	**.003**	9.307	**<.001**
TUGT	−0.001	.339	−0.033	.174	−0.240	**<.001**	−0.661	.071	0.601	.242
BADL	0.001	**.043**	0.029	**.026**	0.092	**.002**	0.631	**<.001**	0.234	.354
IADL	0.004	**.001**	0.068	**.003**	0.074	.142	0.779	**.011**	0.627	.142
MMSE	0.002	.140	0.072	**.028**	0.144	.059	1.471	**.001**	0.620	.331
MOCA	<0.001	.879	−0.031	.474	−0.057	.628	−0.273	.711	0.128	.894
POMA	0.003	.191	0.075	**.047**	0.322	**.002**	1.120	.076	−0.244	.785
POMA Balance	0.006	.117	0.152	**.026**	0.520	**.004**	1.934	.075	−0.214	.889
POMA Gait	0.004	.420	0.104	.177	0.623	**.004**	1.992	.134	−0.687	.715
Frailty	−0.040	**.021**	−0.799	**.006**	−3.066	**<.001**	−15.90	**.002**	−1.976	.782

Note. Bold values are statistically significant ($P < .05$).
MMSE, Mini Mental State Examination; MOCA, Montreal Cognitive Assessment; TUGT, timed up and go test.

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proton permeability, and decreased fat oxidation in older adults. Additionally, decline in FFM, particularly in the muscle, a reduction in physical activity, and a blunted sympathoadrenergic response may be related to a reduction of RMR.[38]

It seems that body composition alone does not explain differences in RMR among older adults. As in the literature, the precise pathophysiological mechanisms for BMR and frailty remain uncertain, and the available evidence is inconsistent. In this study, it has been shown that a reduced BMR is associated with frailty and sarcopenia. The following may be possible explanations: First, frailty is a clinical condition in which mechanisms such as neuroendocrine system changes (eg, decreased anabolic hormonal stimulation, insulin resistance) and a higher proinflammatory state (eg, oxidative stress and damage, increased catabolism with increased cortisol levels) may play a role in the pathogenesis.[2,4,39,40] These hormonal and inflammatory changes lead to progressive loss of muscle mass and organ tissue, movement limitation, and long-term nutritional imbalance. Second, sedentary life, inadequate caloric intake, sympathetic nervous system activity, malnutrition, and micronutrient deficiencies cause impaired muscle mass and strength.[41,42] Third, functional reserve and regenerative capacity (decreased telomerase activity, increased senescence, and apoptosis) are reduced in particularly frail patients, thereby causing metabolic active tissue loss.[4] However, longitudinal studies are necessary to show if frailty is a cause, a consequence, or only a confounder in this complex relationship.

The present study is valuable as it is one of the largest studies to evaluate the relation between BMR and sarcopenia, frailty, and the involvement of all patients with CGA. The results have also been documented without any gender effect. We have obtained a cut-off value in older males to screen for sarcopenia, which will be a remarkable tool in clinical practice. An additional strength of the study is the inclusion of patients with dementia and depression, for whom it can be difficult to apply the existing frailty and sarcopenia criteria.

Nevertheless, the present study has some limitations. First, it is a cross-sectional study. Second, only male participants were included to eliminate differences in body composition between males and females. For example, males achieve higher values in total body potassium, which is a muscle-related component and a good predictor of skeletal muscle because it contains >50% of the total body potassium, and higher absolute and relative amounts of skeletal muscle mass than females during the adult years.[3,43] Furthermore, hormonal changes that enhance the decrease of muscle mass occur are slower in men than in women. Following the eighth decade of life, testosterone concentrations in men decrease rapidly, which can contribute to a reduction in skeletal muscle mass.[44] The third limitation might be that BMR was not calculated by indirect calorimetry, although BIA is shown to be useful in developing the prediction equations for BMR.[32–34] Finally, patients with any disease causing cachexia, such as malignancy, are excluded.

Conclusions/Relevance

In conclusion, older male patients with sarcopenia and frailty have lower BMRs. Although there are many simple instruments to screen for frailty and/or sarcopenia, BMR/BSA can be used as a simple, quick, and objective screening tool for detecting sarcopenia in older males. It also may be advantageous in clinical practice, as comorbidities, such as cognitive impairment or cardiovascular diseases, would not affect the outcome of the test. As a result, it should be kept in mind that when patients are found to have low BMR, they should be screened for sarcopenia and frailty. Nevertheless, we need confirmatory studies based on large sample sizes for both genders using a longitudinal design to demonstrate the pathogenesis and relation between BMR and the two.

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