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RESEARCH

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Sarcopenia in Egypt: epidemiology of sarcopenia risk among older adults presenting with fragility fractures—an initiative by the Egyptian Academy of Bone Health

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Abstract

Purpose (1) This was a multi-center, cross-sectional, observational study. Both old men and postmenopausal women over 50 years old who were admitted with an osteoporotic fracture (whether hip fracture or major osteoporosis) were consecutively recruited for this work and managed under the Fracture Liaison Service. All the patients were assessed for their sarcopenia risk (SARC-F), fracture risk (FRAX), and fall risk (FRAS) as well as functional disability (HAQ). The aim was to assess the prevalence of sarcopenia risk among older adult Egyptians presenting with fragility fractures. (2) To identify the relation between sarcopenia risk with the risk of falling as well as sustaining a fragility fracture.

Results Two hundred and thirty-six patients (69 males, 167 females) were included in this work. The mean age was 70.1 (SD = 9.2) years. The prevalence of sarcopenia was 69.7%. The sarcopenia risk score was positively correlated with the FRAX score ($p = 0.01$). The prevalence of high sarcopenia risk was 78% of the patients presenting with a high 10-year probability of major osteoporosis fracture as well as a 10-year probability of hip fracture. The sarcopenia risk score was positively correlated with the increased fall risk ($p = 0.01$) as scored by the FRAS scale. There was a significant relation ($p < 0.05$) between the functional disability score and the SARC-F score. This was persistent when assessed in relation to fall risk.

Conclusion This study highlighted the high sarcopenia risk in the patients presenting with fragility fractures. Identification of patients at increased risk of sarcopenia should be a component of the standard practice.

Keywords Sarcopenia, Bone mineral density, Dual-energy X-ray absorptiometry, Disability, Fractures, Falls, Fracture risk assessment, Fall risk assessment score, Osteoporosis, Sarcopenia risk assessment questionnaire, Diabetes mellitus, Hypertension, Egypt, Egyptian Academy of Bone Health

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Background

Aging of the musculoskeletal system is characterized by a "loss" triad: loss of muscle mass and consequently strength, loss of bone mass and consequently fractures, and loss of balance and consequently falls. This triad is one of the typical features of the aging process. The definition of sarcopenia as an age-related condition has been recently updated to involve 3 components: decreased muscle mass, decreased muscle power, and impaired muscle dysfunction [1].

Evidence was revealed from both prospective and cross-sectional research, indicating the presence of variable directions of causal pathways, that is, sarcopenia as a predisposing factor for falls and consecutive fractures, and in turn falls and fractures as a reason for sarcopenia [2]. As independent mobility is a fundamental component of healthy aging, over the span of years, there has been rapidly growing interest in the underlying mechanisms and possible interactions in the musculoskeletal system that cause such deterioration in the locomotor health in older adults.

Sarcopenia has a broad spectrum of seriousness and damage leading to incapacitation and frailty [3]. It can also be regarded as a poor prognostic risk factor for a variety of chronic illnesses including type II diabetes mellitus, liver cirrhosis, and tumors [4]. Furthermore, sarcopenia puts the older adult at a higher risk of all-cause mortality in comparison to non-sarcopenic older adults > 60 years (HR 1.29 [NANHES III]) and predominantly in > 80 years older adults (HR 2.32 [aging and longevity study]) [5–7].

Though in older adults, sarcopenia is considered a potential modifiable risk factor for fractures and falls, the strength of such a relation is not clear. In community-dwelling older adults, sarcopenia prevalence ranges from 2 to 37%, depending on which sarcopenia definition has been adopted [8–10]. Interventions to manage or prevent sarcopenia have been reported to be effective in increasing muscle mass, strength, and physical function [11, 12]. However, on the other hand, it has been shown yet that this leads to a reduction of fractures and falls [2]. In Egypt, there has not been a study to assess sarcopenia risk in older adults and its association with falls and fracture risk. This work aimed to assess the prevalence of sarcopenia among older adults presenting with fragility fractures to the Fracture Liaison Service (FLS). Also, to define the relation between increased sarcopenia risk with increased risk of falling as well as sustaining a fragility fracture.

Methods

Study design and setting

This is a multicenter, cross-sectional observational study to assess the sarcopenia risk and its associated risk factors among Egyptian men and postmenopausal women above the age of 50 years. Data were recovered from the Fracture Liaison Service (FLS) National Register database during the period of February 2022 to February 2023.

Targeted population and case definition

Egyptian patients, above 50 years of age, either male or postmenopausal female presenting with one of the major osteoporosis fractures or hip fragility fractures were assessed as part of the local FLS services. Fragility fracture defined as a fracture after falling from standing height or less was included; however, those with pathological fractures or a history of violent trauma were excluded from the study.

Two hundred seventy-three age and sex-matched patients were enrolled as control. Patients with conditions contributing to the development of secondary sarcopenia, e.g., malignancy, advanced chronic illness, and malnutrition or past history of fragility fracture, were excluded from sharing in this study.

Patients' assessment

Patients' assessment was carried out by the principal FLS investigators for all the participants. This included the following:

1. Filling a structured baseline questionnaire that consisted of (a) complete history taking, including smoking, alcohol use, medication including glucocorticoids, previous fracture, or family history of fracture in a first-degree relative; (b) general clinical examination, including height and weight, with BMI calculated; (c) examination of the locomotor system; and (d) patients with a history of joint replacement were assessed regarding the site and mechanism of injury.
2. Fracture risk assessment was carried out using the FRAX score. Other risk factors for fractures were also identified including low-impact trauma fracture in the past 2 years, cancer prostate on androgen depletion therapy, cancer breast on hormone antagonist therapy, thyroid diseases, and epilepsy (on anticonvulsant therapy)
3. Bone mineral density assessment was carried out using a hologic DXA scan. *T* and *Z* score were calculated for every patient.
4. Assessment of functional disability using Health Assessment Questionnaire (HAQ) [6]
5. Evaluation of sarcopenia risk was carried out using the Arabic SARC-F questionnaire [7]. The questionnaire screens patients for 5 self-reported signs suggestive of sarcopenia, namely impairment in strength, walking, rising from a chair, climbing stairs, and suf-

fering falls. Each of these parameters receives a score from 0 to 2, respectively, with the maximum SARC-F score of 10. A SARC-F score of ≥ 4 indicates an increased risk of sarcopenia and the need for further, more comprehensive assessment.

6. Fall risk assessment (FRAS) was carried out for every patient using the FRAS questionnaire [8]. The questionnaire includes 5 questions: fall history in the last 12 months, slowing of the walking speed/change in gait, history of loss of balance in the last 12 months, and impaired sight and weak hand grip. The FRAS score ranged from 0 to 6.5 and met the percent chance of experiencing a fall. A score ≥ 3.5 indicates a high-fall risk.

Data manipulation and statistical analysis

Data was revised for missing, and consistency before appropriate statistical analysis is conducted. All collected categorical data were described as frequency and percentages. The chi-square test was used to test the association between 2 categorical variables, and continuity correction was taken in the 2 × 2 table. *P* value was always set at 0.05, and all statistical analyses were performed using the 26th version of SPSS.

Results

The total number of 390 patients (136 males, 254 females) were included, with a mean age of 70.1 (SD = 9.2) years. One hundred ninety-one patients (47.2%) of the patients were above 70 years old, 138 patients (34.1%) were between 60– ≤ 70 years old whereas 76 patients (18.8%) were between 51– ≤ 60 years old. All patients were either admitted to the hospital with hip fractures or attended the fracture clinic with spine or any other major osteoporosis fracture. BMD results were available for 186 of the patients. Accordingly, a subset of the cohort provided the number of patients classified as osteoporosis depending on the *T* score. As regards the control group ($n = 274$), their mean age was 59.93 (SD = 13) and the sarcopenia was reported in 53.28% of them.

The prevalence of high sarcopenia risk among patients presenting with fragility fracture

The prevalence of sarcopenia risk (Table 1) was persistently and significantly high in all age groups in both men and women who sustained fragility fractures. In total, 272/390 (69.7%) of the patients with fragility fractures had a history of one or more falls in the last year. It is significantly higher in the fractured group compared to the control non-fractured ones ($p < 0.05$).

Table 1 Sarcopenia risk in patients presenting with osteoporotic fragility fractures in relation to age and sex

	Sarcopenia score categories		*p* value
	< 4 No risk	≥ 4 High risk	
Sex			
Male			
51-	6	20	0.845 NS
	23.1%	76.9%*	
60-	12	29	
	29.3%	70.7%	
70 +	20	49	
	29.0%	71.0%*	
Total	38	98	
	27.9%	72.1%	
Females			
51-	15	24	0.112 NS
	38.5%	61.5%	
60-	23	66	
	25.8%	74.2%	
70 +	42	84	
	33.3%	66.7%	
Total	80	174	
	31.5%	68.5%	
Both males and females			
51-	21	44	0.108 NS
	32.3%	67.7%	
60-	35	95	
	26.9%	73.1%	
70 +	62	133	
	31.8%	68.2%	
Total	118	272	
	30.3%	69.7%	

*$p<0.05$

Sarcopenia risk in relation to fracture risk

Table 2 shows some of the risk factors for sarcopenia in the study group. Diabetes mellitus, hypertension, and smoking were the most significant risk factors that were correlated to sarcopenia risk. Assessing the relation of sarcopenia to the fracture risk probability revealed that the sarcopenia risk score was positively correlated with the FRAX score ($P < 0.01$). The prevalence of high sarcopenia risk was 78% of the patients presenting with a high 10-year probability of major osteoporosis fracture as well as a 10-year probability of hip fracture (Table 3). Assessing the relation between the sarcopenia risk and BMD revealed that 70% of the osteopenia patients who sustained fragility fracture had high SARC-F score and or fall risk.

Table 2 Risk factors of sarcopenia in the study group

	Sex		Total	*p* value
	Male	Female		
Diabetes	30 (23.8%)	84 (34.7%)	114 (31.0%)	0.043
HTN	17 (13.5%)	91 (37.8%)	108 (29.4%)	< 0.001
RA	2 (5.4%)	7 (5.6%)	9 (5.6%)	1.000 NS
High dose Glucocorticoid Intake	3 (8.1%)	13 (10.5%)	16 (9.9%	0.912 NS
Smoking	47 (34.8%)	5 (1.9%)	52 (13.2%)	< 0.001

HTN hypertension, *RA* rheumatoid arthritis

p value was considered significant when < 0.05

Table 3 Sarcopenia risk in relation to the FRAX categories

	FRAX any		*P* value
	No risk	High risk	
Male			
Sarcopenia score categories			
< 4 No risk	24 (60.0)	20 (74.1)	0.354
= > 4 High risk	16 (40.0)	7 (25.9)	
Female			
Sarcopenia score categories			
< 4 No Risk	34 (60.7)	39 (35.5)	0.003*
= > 4 High risk	22 (39.3)	71 (64.5)	
Total			
Sarcopenia score categories			
< 4 No risk	58 (60.4)	59 (43.1)	0.013*
= > 4 High risk	38 (39.6)	78 (56.9)	

FRAX fracture risk assessment

*$p<0.05$

Table 4 The prevalence of the sarcopenia risk and functional disability in relation to the fall risk assessed by FRAS score

	Falls score		*p* value
	No risk	High risk	
Sarcopenia score category			
< 4 No risk	35 (62.5)	32 (29.1)	0.003*
= > 4 High risk	21 (37.5)	78 (70.9)	
Functional disability			
< 0.5 No risk	64 (66.7)	51 (37.2)	0.013*
= > 2 High risk	32 (33.3)	86 (62.8)	

*$p<0.05$

Sarcopenia risk in relation to falls

Table 4 shows that the sarcopenia risk score was positively correlated with the increased fall risk ($P<0.01$) as scored by the FRAS scale.

Assessment of functional disability

Assessment of functional disability revealed a significant relation ($p<0.05$) between functional disability score and SARC-F score. This was persistent when assessed in relation to fall risk (Table 5).

Discussion

Sarcopenia is a common syndrome in older adults which reflects a gradual decline in mass and strength with increased risk of weakness, falls, fractures, and mortality in this cohort of population [2]. This study was carried out to assess the prevalence of sarcopenia among older adults presenting with fragility fractures and to study the relation between increased sarcopenia risks with increased risk of falling as well as sustaining a fragility fracture.

The study revealed a high prevalence of sarcopenia risk among Egyptian older adults in both the control group as well as the cohort of patients who presented with fragility fractures. It was significantly higher in the studied group with low trauma fractures. In Egypt, the prevalence of sarcopenia risk among the general population was not studied before; however, globally, sarcopenia was estimated to affect 10–16% of the elderly population. Compared to the general population, sarcopenia was found to be more prevalent among older adults. Its prevalence ranged from 18% in diabetic patients to 66% in patients with non-operable oesophageal cancer [13]. This study revealed a significant relation between diabetes mellitus and sarcopenia among the Egyptian population. This is important as the prevalence of diabetes mellitus in Egypt is 25.5% in Egyptian women and 22.6% in Egyptian men [] (Egypt is ranked ninth in the prevalence of DM worldwide) [14]. Similarly, there was a significant relation between sarcopenia and hypertension among Egyptians. This is of relevance as hypertension has been reported in 71.8% of Egyptian women and 59.9% of Egyptian men above the age of 60 years old [15]. A third significant relation was reported between sarcopenia risk and smoking. Recent data revealed that the percentage of smokers in Egypt decreased from 17.3% in 2020 to 16.8% in 2022, according to surveys conducted by the Central Agency for Public Mobilization and Statistics (CAPMAS) [16].

Genetic variants have been also linked to age-related sarcopenia. NUDT3, RPS10, and GPD1L have been identified as appreciable genetic biomarkers for sarcopenia. These genetic loci are linked to energy and lipid metabolism, suggesting that genes involved in metabolic dysregulation may lead to the pathogenesis of age-related sarcopenia [17]. This would warrant a genetic study for sarcopenia patients in Egypt. On another front, less than 10% of the Egyptian population participates in regular

Table 5 Relation between sarcopenia risk and both quality of life, fall risk

		Sarcopenia risk		Total	*p* value
		< 4 No risk	= > 4 High risk		
HAQ					
Male	≥ 1 High risk	11 (11.1%)	29 (78.4%)	40 (29.4%)	< 0.001
Female	≥ 1 High risk	22 (18.3%)	100 (73.0%)	122 (47.5%)	< 0.001
Total	≥ 1 High risk	33 (15.1%)	129 (74.1%)	162 (41.2%)	< 0.001
Fall score					
Male	< 2.50 No risk	64 (65.3%)	12 (32.4%)	76 (56.3%)	< 0.001
	2.5– < 3.5 Moderate risk	16 (16.3%)	2 (5.4%)	18 (13.3%)	
	≥ 3.5 High risk	18 (18.4%)	23 (62.2%)	41 (30.4%)	
Female	< 2.50 No risk	68 (57.1%)	43 (31.4%)	111 (43.4%)	< 0.001
	2.5– < 3.5 Moderate risk	18 (15.1%)	18 (13.1%)	36 (14.1%)	
	≥ 3.5 High risk	33 (27.7%)	76 (55.5%)	109 (42.6%)	
Total	< 2.50 No risk	132 (60.8%)	55 (31.6%)	187 (47.8%)	< 0.001
	2.5– < 3.5 Moderate risk	34 (15.7%)	20 (11.5%)	54 (13.8%)	
	≥ 3.5 High risk	51 (23.5%)	99 (56.9%)	150 (38.4%)	

HAQ Health Assessment Questionnaire, *p* value was considered significant when < 0.05

exercise, and the most sedentary group is older than 50 years of age [18]. Even among healthcare providers, a recent study reported the low prevalence of regular exercise and its inverse relation to the female gender, physical exertion, BMI, and direct relation to life enhancement benefit subscale score. This was persistent among both physicians and nurses [19]. Nutritional factors can also contribute to such a high prevalence of sarcopenia risk in Egypt. Vitamin D deficiency was reported in almost all the Egyptian studies [20, 21]. The overall prevalence of vitamin D deficiency with vitamin D less than 30 ng/ml was 90.09%, while only 9.03% were within the normal vitamin D range [20]. This highlights the importance of health education programs targeting older adults explaining the benefits of exercise. Programs for sarcopenia awareness and physical exercise promotion as well as appropriate nutrition and vitamin supplementation initiatives have already been in collaboration with the Food Bank in Egypt and the Egyptian Academy of Bone Health [22]. This agrees with the World Health Organization (WHO) recommendations which state that all adults are advised to engage in regular exercise that is outlined as "any planned physical activity performed to increase physical fitness. Such activity ought to be performed 3 to 5 times per week for 20–60 min per session" [23].

The increased risk of sarcopenia was similar in both males and females included in this work, though there were slight, insignificant, variations at different age groups. This agrees with the results of a recent systematic review and meta-analysis of general population studies to assess the global prevalence of sarcopenia [24] which reported similar sarcopenia prevalence in both genders.

Hormonal changes that occur in older adults might explain such findings. After menopause, there is a dramatic decrease in the sex steroid concentrations, both estrogens and androgens [25]. In women, the decline of sex steroids is much faster than in men [26]. This could explain the slightly higher prevalence of sarcopenia among women aged between 60 and 70 years. After the seventh decade of life, the concentrations of testosterone in men decline rapidly which may contribute to the decline in lean body mass and the development of sarcopenia.

The results of this study revealed a significantly higher prevalence of sarcopenia risk in relation to the fracture risk (as assessed by FRAX score). Also, 70% of the osteopenia patients who sustained fragility fractures had a high SARC-F score and or fall risk. This is of vital importance as the identification of all modifiable risk factors particularly sarcopenia has been recognized as a key factor for fragility fracture prevention which is an important problem in all ageing societies. This could be a favorable approach to stop the devastating threat of the "hazardous duet" [27] which best describes the combined impact of both sarcopenia and osteoporosis. The increased risk of fracture in patients with sarcopenia and osteoporosis can be linked to a decrease in muscle mass and strength, decreased bone density, and limited movement [28, 29].

This study revealed a positive correlation between the sarcopenia risk score and the high fall risk ($P=0.01$). This agrees with the outcomes of earlier studies which reported that elderly people with sarcopenia have a fold risk to fall [2, 30]. Preventing falls relies on ensuring core stability and improving the capacity for correcting the

imbalance, sway, and trips which is mainly controlled by the combined neuromuscular fitness. Studies of sarcopenic muscles revealed that sarcopenia is characterized by 2 principal features: loss of both motor neurons and fast twitch type II fibers. These losses are critical key factors involved in the occurrence of falls [31].

The causal nexus between osteoporosis and sarcopenia could be explained by the close relation between bones and muscles. They are not only anatomically adjacent but also share similar molecular signal regulation pathways, endocrine and paracrine control, and common therapeutic targets and drugs [32, 33], which are biologically and functionally in line with increasing the risks of fracture in the elderly [34]. A study published in the American Journal of Physiology (Cell Physiology) found that RANK is expressed in fully differentiated C2C12 myotubes and skeletal muscles [35]. This was supported by the results of a recent study that reported the positive impact of Denosumab on all sarcopenia measures and the reduction of fall risk with the improvement of multidirectional agility [36].

The limitation of this work is that it was based on a sarcopenia risk assessment. Further assessment to meet the EWGSOP definition of sarcopenia is recommended to assess the prevalence of sarcopenia in Egypt. Genetic analysis is also warranted to assess for genetic predisposition to this disorder.

In conclusion, sarcopenia is an underestimated major clinical problem in public health among older people; with hostile consequences such as fractures, falling, disability, and poor quality of life. The results of this work revealed a high prevalence of sarcopenia risk in Egyptian patients with fractures. It was also significantly associated with increased fall risk. This is alarming for clinicians. Effective measures should be considered to slow down or even reverse the sarcopenia progression in older adults and avert the occurrence of adverse clinical outcomes.

Abbreviations

BMD	Bone mineral density
BMI	Body mass index
DXA	Dual-energy X-ray absorptiometry
FLS	Fracture Liaison Service
FRAX	Fracture risk assessment
FRAS	Fall risk assessment score
HAQ	Health Assessment Questionnaire
SARC-F	Sarcopenia risk assessment questionnaire

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Authors' contributions
All authors contributed to the study methodology, analysis, and interpretation of the data and outcomes as well as the manuscript writing, reading, and approval of the final version.

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Availability of data and materials
The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study is in agreement with the ethical guidelines of the Declaration of Helsinki, and it follows the ethical standards of Tanta Faculty of Medicine, with the institution's ethics board approval number 33997/8/20. Informed written consent from all the participants was obtained. Privacy of all patients' data was granted as there was a code number for every patient file that included all investigations.

Consent for publication
Not applicable.

Competing interests
The authors declare that Mohammed H. Abu-Zaid is an associate editor in the Egyptian Rheumatology and Rehabilitation. Waleed Hassan, Safaa Mahran, Naglaa GadAllah, and Yasser El Miedany are from editorial board of the journal. Maha El Gaafary, Naglaa Gadallah, Walaa Elwakil, Waleed Hassan, Nihal Fathi, Samar abd Alhamed Tabra, Radwa H Shalaby, and Safaa A Mahran declare that they have no competing interests.

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