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Study of the Relation between Body Composition and Physical Performance among Elderly

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Abstract
Aim: To study the relation between body composition and physical performance in elderly population.

.**Methods:** A cross sectional study conducted on 267 elderly participants 60 years old or more. All of them were subjected to assessment of body composition using anthropometric measures and Bioelectrical impedance analysis, as well as assessment of physical performance hand grip strength, 6 meters walking speed, Basic activity of daily living and Instrumental activity of daily living .

Results: Study showed that elderly participants either with low skeletal muscle mass index or high fat mass percentage measured by Bioelectrical Impedance have the lowest physical performance measures. Also increased age, smoking, institutionalization and malnutrition were associated with low physical performance.

Conclusions: low skeletal muscle mass index and high fat mass percentage were both risk factors of low physical performance measures. Combination of both showed the worst physical performance measures. Increasing age, institutionalization and low nutritional state were also independent risk factors of low physical performance in elderly

Keywords: body composition – functional assessment- elderly- Egyptians

Background

Body composition consists of fat and fat free mass muscle, bone, water and organs in the body [1].

With advancing age, changes in body composition take place in the form of decline in skeletal muscle mass and increase in body fat with redistribution on fat in the body [2].

Many physiological and pathological changes are responsible for these changes and the degree of these changes vary greatly among elderly population [3]

Neuronal loss with age results in decrease in number of motor neurons with age and chronic denervation of muscle tissue with loss of muscle fibers and muscle mass. [4]

Age related hormonal changes in the form of decrease in Growth Hormone, insulin like growth factor 1 and testosterone, increase in cortisol level and insulin resistance results in increase in body adiposity specially visceral fat, decrease in lean mass and bone mineral density [5]

Also some inflammatory cytokines were observed to be increased in older adults such as tumor necrosis factor alpha, interleukin-[6], interleukin-1 and C- reactive protein. All of them induce inflammatory process which negatively affect muscle mass and strength. [6]

Different methods used to assess body composition in elderly. Anthropometric measures such as Body mass index, waist circumference, waist hip ratio and skin fold thickness are all easy, inexpensive and portable measurements to evaluate body composition. Although they depend on skills of operator and their accuracy may vary between populations. [7 8]

Dual Energy X-ray Absorpiometry DEXA , Computed Tomography CT and Magnetic Resonance Imaging MRI are all accurate validated methods to assess body composition. But all of them are expensive and non-portable methods using radiation and cannot be used in large population based studies. [9 10 11]

Bioelecterical impedence analysis is a safe, portable, inexpensive and easy to use alternative that is suitable for evaluating large number of people. Results from

BIA correlate well with MRI and DEXA results and so it is a good reliable alternative. [12 13 3]
Physical performance has been described as the observed ability to perform tasks. [14] It is related to different sensory and motor function in the body. [15]
With advancing age, physical performance decline gradually which may end with disability, impairment of daily function, dependence, institutionalization and increased mortality. [16]
Many factors affect physical performance in elderly. Gender difference between males and females has been reported in previous studies as men showed higher physical performance even after adjustment to height. The difference was attributed to the lower lean mass, higher fat mass and lower levels of physical activities in females. Also hormonal factor plays role as testosterone has proved effect on lean mass enhancement. [17 18]
Short and long self-reported sleep duration and increased sleep interruption are also associated with lower levels of physical performance. [19]
Multiple comorbidities add more physical limitation in elderly. Prevalence of many chronic diseases increases with age and lead to decline in physical function. Diabetes Mellitus, Hypertension, heart diseases, visual impairment and arthritis are all risk factors of low physical performance. [20 21]
Mental state and mood play role in physical performance in elderly. Cognitive impairment and dementia has been associated with decline in physical performance. Also depressive symptoms showed to be a risk factor for low levels of physical function. [22 23]
Smoking also found to cause significant decline in muscle mass and performance due to induction of oxidative stress that affect muscles and lead to destruction of muscle fibers [24] .
Many studies were concerned about the role of body composition changes with age in physical performance impairment. Many studies reported decline in physical performance associated with the decrease in lean body mass. While others found that increased fat mass showed stronger relation with low performance. [25 17]
This study was conducted to assess the association between body composition and physical performance in elderly.

Methods

A cross sectional study included 267 elderly participants, males and females aging 60 years old or more recruited from geriatric clubs and nursing homes in Cairo.
Exclusion criteria: elderly with hemiplegia, paraplegia, any hand problem interfering use of dynamometer, terminal illness, elderly people with peripheral edema, bedridden, MMSE less than normal for age and education or who refused to share will be excluded.

Every study participant was subjected to the following:

1 Comprehensive geriatric assessment in the form of: Detailed history taking, including personal history, demographic data, past medical history and screening for dementia: using the Arabic version of mini-mental state examination MMSE . [26] MMSE below normal range for age and education were excluded.

2 Nutritional assessment: using mini-nutritional assessment scale [27]

3 Assessment of body composition using: a Anthropometric measures: Body weight measured in kilogram, Body height measured in centimeters, Body mass index BMI will be calculated as weight in kilograms divided by the square of height in meters [28] and Waist/hip ratio WHR in centimeters [29.] b Bioelecterical impedance analysis: to assess skeletal muscle mass index and body fat percentage [30].

4 Assessment of Physical Performance: a 6 meters walking speed test [31], Hand Grip Strength Measure 3 and Self-reported Physical Function: ADL [32] and IADL scales [33].

Statistical Analysis

Analysis of data performed by using SPSS package version 20.0.
Description of data in the form of mean M and standard deviation SD for all quantitative variables and frequency and percentage for all qualitative variables. Comparison of qualitative variables was done using chi-square test X2 . Significance levels measured according to P value probability P>0.05 insignificant, P<0.05 significant, P<0.01 highly significant.

Results

The study conducted on 267 elderly participants 67.5% of them were females, 72% recruited from geriatric clubs. Most of them were married, non-smoker, highly educated and at good nutritional state. Diabetes mellitus and hypertension were the most prevalent comorbibities. Most of our study populations were overweight and obese. 67.8% had high fat mass percentage and 14.6% had low skeletal muscle mass index. Table 1

Assessment of the relation between body composition and physical performance measures revealed that low skeletal muscle index and high fat mass percentage significantly related to low physical performance measures. While anthropometric measures waist hip ratio and body mass index showed non-significant association with physical performance measures except high body mass index was significantly associated with better hand grip. table 2-3
The elderly participants with low skeletal muscle mass index either combined with high fat percentage or not showed the worst physical performance measures table 4 .

Table 1: Demography of the study population

Demographic data	N	%
Age Mean age ±SD	69.238±7.805	
Gender		
Male Female		32.58 67.42
Marital state		
Single	11	4.12
Married	177	66.29
Widow	77	28.84
Divorced	2	0.75
Education		
Illiterate	15	5.62
Primary	29	10.86
High school	27	10.11
College	196	73.41
Residence		
Nursing home	74	27.72
Club	193	72.28
Smoking		
No	211	79.03
Yes	31	11.61
Ex-smoker	25	9.36
MNA*		
Malnourished	2	0.75
At risk of malnutrition	55	20.60
Normal	210	78.65
Chronic diseases		
Hypertension	120	44.94
Diabetes Mellitus	79	29.59
Cardiac diseases	26	9.74
Respiratory diseases	17	6.37
others	45	16.85

Table 2: association between skeletal muscle mass index and physical performance.

Physical performance		Normal		Low			
		N	%	N	%	X2	P-value
Hand grip strength	Normal	122	53.51	1	2.56	34.789	<0.001*
	Low	106	46.49	38	97.44		
Walking speed	Normal	68	29.83	3	7.69	3.857	0.049*
	Low	160	70.17	36	92.31		
ADL	Independent	219	96.05	34	87.18	5.277	0.022*
	Assisted	9	3.95	5	12.82		
IADL	Independent	202	88.59	28	71.79	7.876	0.005*
	Assisted	26	11.41	11	28.21		

Table 3: association between Fat mass percentage and physical performance.

Physical performance		Fat mass percentage				
		Normal		High		
		N	%	N	%	**P-value**
Hand grip strength	**Normal**	39	45.35	84	46.41	<0.001*
	Low	47	54.65	97	53.59	
Walking speed	**Normal**	31	36.05	40	22.1	0.016*
	Low	55	63.95	141	77.9	
ADL	**Independent**	83	96.51	170	93.92	0.375
	Assisted	3	3.49	11	6.08	
IADL	**Independent**	81	94.19	149	82.32	0.009*
	Assisted	5	5.81	32	17.68	

Table 4: comparison among studied populations according to fat percentage, skeletal muscle mass index and physical performance:

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Physical performance	Groups Fat % and Skeletal muscle index								P-value
	Normal fat Normal muscle		High fat Normal muscle		high fat low muscle		Normal fat Low muscle		
	N=61	%	N=167	%	N=14	%	N=25	%	
Hand grip strength **Normal** **Low**	39	63.93	83	49.70	1	7.14	0	0.00	<0.001*
	22	36.07	84	50.30	13	92.86	25	100.00	
Walking speed m/s **Normal** **Low**	28	45.90	40	23.95	0	0.00	3	12.00	<0.001*
	33	54.10	127	76.05	14	100.00	22	88.00	
ADL **Independent** **Assisted**	61	100.00	158	94.61	12	85.71	22	88.00	0.046*
	0	0.00	9	5.39	2	14.29	3	12.00	
IADL **Independent** **Assisted**	61	100.00	141	84.43	8	57.14	20	80.00	<0.001*
	0	0.00	26	15.57	6	42.86	5	20.00	

Discussion

The current work aimed to assess the relation between body composition and physical performance in elderly. Two hundred sixty seven elderly participants were involved in the study.

Many previous studies were concerned about the relation between body composition and physical performance. Some of them agreed with the current study results as they reported association of low muscle mass with impaired physical performance. A study carried out on Chinese elderly linked low muscle mass with weak hand grip strength and slow gait speed [25]. Other studies showed significant relation between low muscle mass and slow gait speed in elderly women [34] [35].

In addition, a study done on older American published in 2002 revealed that low skeletal muscle mass index is an independent risk factor of limited functional performance measured by ADL and gait speed [36]. A more recent study assessed the relation between muscle mass measured by DXA and physical performance measured by hand grip strength, walking speed test and timed Up and Go test in elderly confirmed previous results [37].

But results disagreed with a Korean study included 542 older men and women which found no association between muscle mass measured by DXA and physical performance measured by short physical performance battery SPPB [38].

This disagreement may be attributed to their studied sample that included elderly with weak physical performance only and the authors suggested that it is a matter of muscle quality strength per unit muscle mass not muscle mass in that group.

Previous studies have shown that the decrease in muscle strength was two to five times greater than the loss of the muscle size with ageing, reflecting declining muscle quality with ageing [39]. Muscle quality was reported to be a good predictor of physical performance in older adults [40]. Increased intermuscular or intramuscular fat infiltration was associated with lower muscle strength after adjusting for the muscle cross-sectional area [41] and with poorer physical performance. This indicates that the poor muscle quality is related to increased fat infiltration [42].

High fat mass as an independent predictor of low performance was also consistent with previous studies. Data from a study published in 2008 concluded that fat mass is a strong predictor of low physical performance measured by Continuous Scale-Physical Functional Performance in elderly males and females [43]. Another study on postmenopausal women showed that women with lower fat mass had stronger hand grip strength and faster walking speed [34]. In 2009, Bouchard and colleagues found strong relation between high fat mass and low physical function measured by gait speed and timed up and go test [44] and in 2011 they found significant relation between high fat mass and low leg strength [45]. A more recent study measured Body fat percentage using DXA confirmed association between high fat percentage and slow walking speed [37].

When we compared individuals with different fat percentage and skeletal muscle mass index we found that elderly individuals with low skeletal muscle mass index specially when combined with high fat percentage showed the worst physical performance measures. Only three elderly individuals of our study sample were found to have sarcopenic obesity which defined as combination of low muscle mass, high body fat and low physical performance .

Conclusion:

Low skeletal muscle mass index and high fat mass percentage were associated with low physical performance measures.

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