ORIGINAL ARTICLE

The Low Level of Fat-Free-Mass is a Risk Factor for Cognitive Impairment among Morocco's Older Adults

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ABSTRACT

Aim: The aim of this study was to determine the relationship between body composition and risk of cognitive impairment among Morocco older adults. **Materials and Methods:** A sample of 237 older adults aged above 60 years were recruited from three nursing homes belong to three different cities Rabat, Kenitra, and Sidi Kacem city and from one health center in Sidi Kacem city. From them, 151 subjects (59.6% men and 40.4% women) were included in our study for their complete data. Sociodemographic characteristics and health condition were collected using a general questionnaire. Body compositions evaluation using bioelectrical impedance analysis accompanied with a measure of body mass index, calf circumference, mid-upper arm circumference, waist circumference, and waist-to-hip ratio. Cognitive functions were assessed by the Mini–Mental State Examination. Nutritional status, depression, and physical activity (PA) were assessed using, respectively: Mini nutritional assessment, geriatric depression scale-15, and global PA questionnaire which were taking as confounder factors. **Results:** The multivariate logistic regression adjusted for gender, education, kind of profession, pension, PA, depression, and malnutrition shows that only the first tertile (adjusted odds ratio [ORa] = 4.11, 95% CI: 1.58–10.66) and second tertile (ORa = 4.25, 95% CI: 1.64-10.97) of fat-free mass (FFM) compared to the third tertile, were found to be risk factors for cognitive impairment. **Conclusions:** The present study demonstrated that lower level of FFM was associated with a higher risk of cognitive impairment among the elderly. This indicates that the preservation of muscle mass by good nutrition and PA could save cognitive function from the onset of Alzheimer's disease.

Key words: Body composition, body mass index, cognitive function, older adults

INTRODUCTION

Aging is characterized by physiological and psychological changes induced by genetic factors called intrinsic factors and environmental factors called extrinsic, on which various pathologies are added to accelerate the aging process.[1] The last two factors (extrinsic and pathological) represent the most modifiable target we can act on to slow down the effects of aging and preserve the maximum independence of the elderly. Aging is characterized by body composition changes, with an increasing of adiposity (fat mass [FM]) (sarcopenic obesity) and decreasing of fat-free mass (FFM) (sarcopenia), which has a negative impact on health outcomes and quality of life.[2,3] The quantification of these two parameters FM and FFM among elderly is important to describe their changes associated with the functional decline, diseases, and survival.[2]

It is confirmed that aging is associated with the progression of cognitive decline, which could be convert in à 8.3% of cases to Alzheimer's disease (AD) per years.[4,5] Alzheimer's (AD) is a neurodegenerative disease that characterized by memory

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lost, cognitive and behavioral disorders with repercussions on the daily life of patient.[6] Memory deficit or mild cognitive impairment (MCI) is one of the earliest and most pronounced symptoms of AD.[7] At this stage the population may constitute, a particularly suitable population for preventive approaches, and clinical trials of drug therapies.[5] By 2050 cognitive impairment including MCI is expected to affect 115 million people in the world.[8] The Mini–Mental State Examination (MMSE) represents the most used tool in world elaborated by on Anthony *et al*. on 1975 to assess global cognitive impairment with specificity and sensitivity 82% and 87%, respectively.[9] The MMSE is a brief test that takes a few minutes in its execution. It is composed of a series of questions grouped into seven subtests. The questions relate to: Orientation in time, orientation in space, immediate recall of three words, attention, delayed recall of three words, language, and constructive praxis.[10]

The aim of this study was the identification the link between body compositions and cognitive impairment (CI) among the elderly living in three cities (Rabat, Kenitra, and Sidi Kacem city) in north out of Morocco.

MATERIALS AND METHODS

Participants

In this cross-sectional study which was conducted between March 2017 and May 2018, all participants were recruited from three nursing homes belong to three different cities, Rabat, Kenitra, and Sidi Kacem city and from one health center in Sidi Kacem city. The three cities are located in north out of Morocco. The four exclusion criteria were: (1) Persons cannot stand up for body composition measurement, (2) age <60 years, (3) subjects with renal insufficiency which could confounder and overestimate the body mass index, and (4) persons with acute pain that could influence their performance on MMSE test. At beginning 237 subjects were recruited for this study, but after excluding 56 subjects for MMSE, 5 subjects for mini nutritional assessment (MNA), 20 subjects for body compositions, and 5 subjects for physical activity (PA) missing data, 151 subjects were included in our study for their complete data.

Demographic data and medical conditions were obtained from social and medical assistance in nursing homes and by direct interview with patients visiting a health center in Sidi Kacem city. Oral consent was obtained from each participant before be including in this study.

Measurements

Nutritional status of our sample was evaluated by MNA, tool developed by Guigoz *et al*. and recommended by the European Society for Clinical Nutrition and Metabolism.[11,12] It is composed of 18 items grouped in four sections: Anthropometric assessment (weight, height, and weight loss), general assessment (living situation, number of medicine use, and mobility), dietary assessment (number of meals, food and fluid intake, and autonomy of feeding), and subjective assessment (self-perception of nutritional status and health).[13] A total score ranges from 24 to 30 reflects good nutritional status. Score between 17 and 23, 5 indicates a risk of malnutrition. MNA score <17 points indicates malnutrition.[14]

The participants were referred to body compositions evaluation using bioelectrical impedance analysis (BIA) (Rossmax, Glass Body Fat Monitor with Scale, model: WF 260, Swiss). The noninvasive, simple applicable, safe, inexpensive, and low collaboration requirement from patients of the BIA make it widely used for the study of body composition.[2,15] The limitation of this tool is give the FM in whole body and not in special part of body for this reason another parameter was measured in our study is waist circumference (WC) that is used as an indicator of body fatness and abdominal body fat.[16] The participants were asking to stand up, on the exhale, a flexible nonelastic tape measure across the belly button between the lower rib margin and the iliac crest at the nearest 0.5 cm the WC. FFM was measured by subtracted the FM from total body weight.

Cognitive function evaluation

Cognitive function was assessed with the MMSE. With a cutoff of 24, the elderly was classified into two categories: Normal or cognitive impairment.

Psychological evaluation

The geriatric depression scale-15 was used to evaluate the depressive syndrome among elderly participants, with score maximal of 15 points. A score between 5 and 12 was used to indicate slight depression and score >12 for severe depression.[17]

PA evaluation

The global PA questionnaire is one of the validated questionnaire developed by the WHO to assesses PA in developing countries.[18] The questionnaire composed of 16 items, collecting information about vigorous and moderate intensity PA, covering three domains: Working (paid or unpaid), commuting (walking or cycling), and leisure times.[19] According to the norms recommended by the WHO for this tool, the participants' were classified into three levels:

High level

- If the person practices vigorous intensity PA on at least 3 days with an expending of 1500 MET-minutes a minimum per week or
- If the person practices seven or more days of walking, moderate- or vigorous-intensity activities with an expending a minimum of 3000 MET-minutes per week.

Table 1: Baseline characteristics according to cognitive function

	Total *n*=151	Normal *n*=47 (31.1%)	Cognitive impairment *n*=104 (68.9%)	*P* value
Gender *n* (%)				0.01
Females	61 (40.4)	10 (21.3)	51 (49)	
Males	90 (59.6)	37 (78.7)	53 (51)	
Age (years)				0.45
Mean±SD	66.71±6.91	65.66±6.63	67.18±7.01	
Education *n* (%)				<0.001
Illiterate/primary	130 (86.1)	36 (76.6)	94 (90.3)	
Middle school	14 (9.3)	6 (12.8)	8 (7.7)	
Secondary school	5 (3.3)	4 (8.5)	1 (1.0)	
University	2 (1.3)	1 (2.1)	1 (1.0)	
Marital status *n* (%)				0.10
Married	80 (52.9)	31 (66.0)	49 (47.1)	
Single	27 (17.9)	6 (12.8)	21 (20.2)	
Divorced	14 (9.3)	5 (10.6)	9 (8.7)	
Widowed	30 (19.9)	5 (10.6)	25 (24.0)	
Children's number				0.88
Mean±SD	3.07±2.63	3.09±2.38	3.06±2.75	
Kind of profession *n* (%)				0.017
Free	93 (61.6)	32 (68.1)	61 (58.7)	
Public sector	11 (7.3)	6 (12.8)	5 (4.8)	
Private sector	12 (7.9)	5 (10.6)	7 (6.7)	
Never had a profession				
Free	35 (23.2)	4 (8.5)	31 (29.8)	
Pension *n* (%)				0.013
Yes	17 (11.3)	10 (21.3)	7 (6.7)	
No	134 (88.7)	37 (78.7)	97 (93.3)	
Dental problems *n* (%)				0.055
Yes	82 (54.3)	20 (42.6)	62 (59.6)	
No	69 (45.7)	27 (57.4)	42 (40.4)	
Smoking *n* (%)				0.648
Yes	27 (17.9)	7 (14.9)	20 (19.2)	
No	124 (82.1)	40 (85.1)	84 (80.8)	
Alcohol consumption *n* (%)				1.000
Yes	3 (2.0)	1 (2.1)	2 (1.9)	
Yes	148 (98.0)	46 (97.9)	102 (98.1)	
Diabetes mellitus *n* (%)				0.830
Yes	32 (21.2)	9 (19.1)	23 (22.1)	
No	119 (78.8)	38 (80.9)	81 (77.9)	
Hypertension *n* (%)				0.876
Yes	56 (37.1)	17 (36.2)	39 (37.5)	
No	95 (62.9)	30 (63.8)	65 (62.5)	

(*Contd...*)

Table 1: (*Continued*)

Osteoporosis *n* (%)				0.571
Yes	23 (15.2)	6 (12.8)	17 (16.3)	
No	128 (84.8)	41 (87.2)	87 (83.7)	
Anemia *n* (%)				0.589
Yes	4 (2.7)	2 (4.3)	2 (1.9)	
No	147 (97.3)	45 (95.7)	102 (98.1)	
Cardiac diseases *n* (%)				0.118
Yes	27 (17.9)	5 (10.6)	22 (21.2)	
No	124 (82.1)	42 (89.4)	82 (78.8)	
Medications use				0.98
Mean±SD	1.03±1.30	1.00±1.26	1.04±1.32	
Physical activity level *n* (%)				0.026
Low	48 (31.8)	11 (23.4)	37 (35.6)	
Moderate	37 (24.5)	18 (38.3)	19 (18.3)	
High	66 (43.7)	18 (38.3)	48 (46.1)	
Depression *n* (%)				0.039
Normal	45 (29.8)	20 (42.5)	25 (24.0)	
Slight depression	91 (60.3)	25 (53.2)	66 (63.5)	
Severe depression	15 (9.9)	2 (4.3)	13 (12.5)	
Nutritional status *n* (%)				
Normal	74 (49.0)	32 (68.1)	42 (40.4)	
Risk of malnutrition	70 (46.4)	13 (27.7)	57 (54.8)	
Malnutrition	7 (4.6)	2 (4.2)	5 (4.8)	0.006

Moderate level

- If the subject practices at least 20 min/day of vigorous-intensity activity 3 or more times per week or
- At least 30 min/day of moderate-intensity activity or walking 5 or more times per week or
- 5 or more days of walking, moderate - or vigorous-intensity activities expending a minimum of 600 MET-minutes per week.

Low level

The subject considered as having low level of PA if he does not meet any of the above criteria.

Statistical analysis

Statistical analysis was performed using software SPSS version 24. Student's *t*-test was used for comparison of quantitative variables between two groups, for those follow a normal distribution, Mann–Whitney U-tests for those has no normal distribution. The Chi-square test was used to analyze the association between categorical variables. Pearson and Spearman tests for correlation between two quantitative variables had a normal and not normal distribution, respectively. After that, a binary logistic regression was applied, where cognitive function was taking as the dependent variable and body composition parameters as independent variables. Those baseline characteristics showing an association with cognitive function in bivariate analysis were taking as confounder factors. The adequacy of the logistic regression was checked using Hosmer–Lemeshow test. $P < 0.05$ was considered significant for all analysis.

RESULTS

Baseline characteristics according to cognitive function

Our results show that Table 1, cognitive impairment was more frequent among women than men in our simple ($P = 0.01$). The subjects with cognitive impairment were more likely to have low education ($P < 0.001$), to never practiced some profession ($P = 0.017$), without pension ($P = 0.013$), and to have less physical activities ($P = 0.026$). The depression ($P = 0.039$) and malnutrition ($P = 0.006$), both were more frequent in subjects with CI than normal.

Body composition and anthropometric parameters according to cognitive function

Table 2 shows body composition distributions according to cognitive function. Person's with cognitive impairment tend

Table 2: Body composition and anthropometric parameters according to cognitive function

	Total *n*=172	Normal *n*=47 (31.1%)	Cognitive impairment *n*=104 (68.9%)	*P* value
BMI (kg/m^2)	27.14±5.19	28.31±5.22	26.61±5.12	0.06
BF (%)	38.56±8.36	37.80±6.73	38.90±9.00	0.50
FM (kg)	28.05±9.79	29.92±9.97	27.20±9.63	0.12
FFM (kg)	43.36±8.40	47.82±9.02	41.35±7.31	<0.001
WC (cm)	99.89±13.19	102.89±12.01	98.66±13.51	0.07
Waist-to-hip ratio	1.00±0.21	0.98±0.06	1.01±0.24	0.80
CC (cm)	35.25±4.49	36.72±4.05	34.62±4.55	0.01
AC (cm)	27.75±3.83	28.60±3.57	27.38±3.89	0.09

BF: Body fate, BMI: Body mass index, FM: Fat mass, FFM: Fat-free mass, WC: Waist circumference, CC: Calf circumference, AC: Arm circumference

to have less FFM ($P < 0.001$), and less calf circumference (CC) ($P = 0.01$). No statistically difference was found for all other parameters between cognitive impaired and normal subjects ($P > 0.05$).

Multivariate analysis

Table 3 shows the multivariate logistic regression adjusted for gender, education, kind of profession, pension, PA, depression, and malnutrition shows that only the first tertile (adjusted odds ratio [ORa] = 4.11, 95% CI: 1.58–10.66) and second tertile (ORa = 4.25, 95% CI: 1.64-10.97) of FFM compared to the third tertile, were found to be risk factors for cognitive impairment.

Table 3: Multivariate logistic regression for subjects with cognitive impairment

	ORa	CI 95%	*P* value
FFM (kg)			
First tertile versus third tertile	4.11	1.58–10.66	0.004
Second tertile versus third tertile	4.25	1.64–10.97	0.003

Adjusted for gender, education, kind of profession, pension, ORa: Adjusted odds ratio, CI: Confidence interval. PA: Depression and malnutrition. FFM: Fat-free mass

DISCUSSION

In lack of its cure or agreed prevention, cognitive impairment (CI) continued to increase in our aging societies and has been previously associated with comorbidity, mortality, and risk of dementia.[20-22] Body composition parameters could be modifiable risk factors for cognitive impairment progression to dementia. This study investigated the relationship between body composition and CI. Our findings suggested that cognitive impairment was associated only with FFM. The studies finding are less controversial for FFM than FM in term of relationship with CI. From a positive association, negative to no association between FM and cognitive decline.[23-29] While from seven studies found in literature six have demonstrated that FFM was associated with cognitive function and only one showed, no association between changes in body composition and cognitive dysfunction, with arm muscular mass was taking instead of FFF in last study.[23-31] Moreover, Bas *et al*.[32] in their study among 840 participants with MCI and 1740 without MCI. After adjusting for confounding factors, the lowest quartile of FFM was associated with a higher risk of MCI. However, FM was not associated with risk of MCI in this study. We did not find any association between WC, Waist-to-hip ratio, BMI, and arm circumference with CI this finding contradict those reported in other previous studies.[33-40] In study conducted by Ashrafi *et al*.[41] among 118 consecutive patients with different cardiovascular and metabolic primary complaints, none of the cognitive domains had a significant association with BMI. The relationship between waist-to-hip ratio and cognitive function was attenuated with adjustment for cardiovascular disease risk factors and PA in study realized by Dore *et al*.[42]. In a cross-sectional analysis performed on the 1st-year baseline data of 1559 adults aged 70–84 years enrolled in the Korean, low calf circumference (<32 cm) was much greater in the prefrail with cognitive impairment.[43] In our finding, CC was significantly associated with CI. However, in multivariate analysis, this association did not rich the signification.

Our finding suggested that the subjects with low FFM have a higher risk of CI. This association could be explained by the fact that low level of muscle mass (MM) and CI shares common mechanisms such as oxidative stress and inflammation.[44] The elevation in mediators of inflammation such as interleukin-1, interleukin-6, and tumor necrosis factor in response to stress situation, chronic or acute disease cause a muscular mass catabolism. Those mediators were found in many studies to be associated with cognitive decline.[45-48] Moreover, previous studies suggested that loss of MM might be related to brain atrophy and cognitive decline.[49] The preservation of MM during stress periods depend to food intake, and malnutrition was linked to cognitive impairment

in many studies El Zoghbi *et al*.[50] and Hai *et al*.[51] Other parameter should be taking into account in the relationship between FFM and CI is PA which seems to contribute to protection against muscle wasting.[52] Lochbaum *et al*.[53] have demonstrated that aerobically trained or active participants performed significantly better on the fluid intelligence task than aerobically untrained or inactive. In our finding, both nutritional status and PA were associated with CI ($P < 0.005$) and were taking as confounder factors in multivariate analysis.

This study has some limitations. It's kind of cross-sectional make the cause and effect between body composition and cognitive impairment cannot be established. Moreover, the association between the last two parameters was not analyzed according to gender cause of our small simple size. Further longitudinal studies among large simple size are needed to confirm our finding.

CONCLUSIONS

The present study demonstrated that lower level of FFM was associated with a higher risk of cognitive impairment among elderly. This indicates that the preservation of MM by good nutrition and PA could save cognitive function from the onset of AD.

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