ORIGINAL ARTICLE

Association between Malnutrition and Cognitive Impairment among Morocco Older Adults

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ABSTRACT

Objective: The aim of this study was to determine the association between the malnutrition 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, 172 subjects (56.4% men) were included in our study for their completion. 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. The binary logistic regression was performed where the cognitive function was taking as the dependent variable and all other outcomes as independent variables. **Results:** Our results shows that 69.8% of total sample were classed as having cognitive impairment while only 30.2% were normal. The binary logistic regression assessed showed that the malnutrition (odds ratio [OR] = 3.03, 95% confidence interval [CI]: 1.34–6.85), gender (OR = 2.22, 95% CI: 1.03–5.71), and low education (OR = 8.35, 95% CI: 1.32–52.83) were risk factors for cognitive impairment, when moderate level of PA (OR = 0.19, 95% CI: 0.06–0.54) was a protective factor compared to the limited level. **Conclusions:** Our study supported past literature that malnutrition is a risk factor of cognitive impairment. This signified that nutritional status monitoring can prevent its leading to Alzheimer's disease.

Key words: Cognitive impairment, cognitive function, malnutrition older adults

INTRODUCTION

In Morocco according to Directorate of Statistics of the high commission for planning, the percentage of the population aged over 60 years was 8.1% and 9.4%, respectively, in 2004 and 2014 and will reach 23.2% of the total population, with a growing effective of 3.3% per year, from 3.2 million in 2014 to 10.1 million by 2050.[1] This rapid increase of the older population requires more studies on this category, their physical health, mental health, as well as their nutritional status, this for tow essentials objectives: Put a maximum of available data for people making decisions, study the risk factors on which we can act to ensure the elderly population aging success.

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.[2] The latter two factors (extrinsic and pathological) represent the most modifiable target on which we can act to slow down the effects of aging.

The elderly are particularly vulnerable to nutritional change deficits.[3] Around the world malnutrition has been reported to affect 3.2–17% of community living elderly people and 12.6–25.7% in nursing home.[4-8] Protein-energy malnutrition results from an imbalance between intake and body requirements. This imbalance causes tissue loss, in

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particular of muscle tissue which could worsen the prognosis of underlying diseases and increased risk of death and institutionalization.[8,9]

Aging is confirmed to be associated with a progressive of cognitive decline, which could be convert in à 8.3% of cases to Alzheimer's disease (AD) per years.[10,11] AD is a neurodegenerative disease that characterized by memory loss, cognitive and behavioral disorders with repercussions on the daily life of the patient.[12] Some causes know to lead to AD: A neurofibrillary protein called tau protein abnormally phosphorylated causes his intracellular accumulation. Another accumulation but this time extracellular is of β-amyloid peptide (Aβ) at the senile plaques.[13] The formation of Aβ is generally due to mutations of PSEN1 (69%), amyloid precursor protein (APP) (13%), APP (7.5%), duplication, and rarely to mutations of PSEN2 (2%), which are responsible for an early age of onset of AD, in general before 60 years.[14,15] PS1 or PS2 genes, code for presenilin proteins that are part of gamma-secretase complex (g-secretase complex), cleaving APP at the C-terminal level from Abeta.[16] The ε4 allele which is associated with late sporadic AD (after 60 years), localized on chromosome 19 code for apolipoprotein E, protein involved in the transport of blood lipids and enter in link with Aβ for the formation of senile plaques.[15,17] The extracellular formation of senile plaque and intracellular accumulation causes lesions that preferentially affecting the limbic system responsible for memory loss and also the neocortex.[18]

Memory deficit or mild cognitive impairment (MCI) is one of the earliest and most pronounced symptoms of AD.[19] At this stage the population may constitute, a particularly suitable population for preventive approaches and clinical trials of drug therapies.[11] By 2050, cognitive impairment including MCI is expected to affect 115 million people in the world.[20] 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.[21] 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.[22]

Many studies have been linked an association between cognitive function and nutritional status explored by mini nutritional assessment (MNA).[23,24] In a cross-sectional study performed by Mohamad *et al.*, in three long-stay elderly institutions in Beirut among 111 elderly (55 men and 56 women), showed that cognitive state of the elderly was only explained by lower nutrition status (adjusted odds ratio [ORa] = 3.03) and education (ORa = 1.72).[6] To the best of our knowledge, no one like those studies were conducted in Morocco country. The aim of this study was the identification the link between nutritional status and cognitive state among the elderly population living in three cities (Rabat, Kenitra, and Sidi Kacem city) in North-out of Morocco.

MATERIALS AND METHODS

Participants

In this cross-sectional study that was conducted between March 2017 and May 2018, all participants were recruited from three nursing home 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-oust of Morocco. The subjects were excluded from the study if showing one of those following criteria: (1) Age below 60 years, (2) subjects with renal insufficiency which could confounder and overestimate the body mass index, and (3) persons with acute pain that could influence their performance on MMSE test. At beginning 237 subjects were recruited for this study, but after excluding 65 subjects with missing data (65 subjects for MMSE, five subject for MNA and four subjects for physical activity [PA] missing data), 172 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 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.[25,26] It is composed of 18 items grouped into 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).[5] 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.[27]

Cognitive function evaluation

Cognitive function was assessed with the MMSE. With a cutoff of 24, the elderly were 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.[28]

PA evaluation

The global PA questionnaire is one of a validated questionnaire developed by the WHO to assess PA in developing countries.[29] 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.[30] According to the norms recommended by the WHO for this tool, the participants' were classified into three levels:

Height 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.

Moderate level

- If the subject practices at least 20 min per day of vigorous-intensity activity 3 or more times per week or
- At least 30 min per 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 do not meet any of 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 were used to analyze the correlation between two quantitative variables normally and non-normally distributed, respectively.

The binary logistic regression was applied, in which cognitive status was taking as the dependent variable and others variables as independent variables. $P < 0.05$ was considered significant for all analysis.

RESULTS

Baseline characteristics according to gender

The distribution of all characteristics included in this study according to gender is shown in Table 1. Compared to the men, women are more likely to be in low level of education ($P = 0.047$), more likely to be Widowed ($P < 0,001$), never practiced some profession ($P < 0.001$), without pension ($P = 0.048$), women are also more likely to have hypertension ($P = 0.037$), and depression ($P = 0.045$). On the other hand, men are more likely to have dental problems to use smoking. There was no significant difference for all other variables between women and men.

Baseline characteristics according to cognitive function

Our results show that 69.8% of total sample were classed as having cognitive impairment while only 30.2% were normal Table 2. Cognitive impairment is more frequent among women than men in our simple ($P < 0.001$). The subjects with cognitive impairment were more likely to have low education ($P < 0.001$), to never practiced some profession ($P = 0.015$), without pension ($P = 0.048$), and to have less physical activities ($P < 0.001$). The depression ($P = 0.012$) and malnutrition ($P = 0.02$), both were more frequent in subjects with confidence interval (CI) than normal.

Multivariate analysis

The binary logistic regression assessed Table 3 showed that the malnutrition (OR = 3.03, 95% CI: 1.34–6.85), gender (OR = 2.22, 95% CI: 1.03–5.71), and low education (OR = 8.35, 95% CI: 1.32–52.83) were risk factors for cognitive impairment, when average level of PA (OR = 0.19, 95% CI: 0.06–0.54) was a protective factor compared to the limited level.

DISCUSSION

This study was a cross-sectional study conducted among three nursing homes and one health center in three localized in the north-west of Morocco for one purpose to determine the relationship between malnutrition and cognitive function. MCI is a transitional state in which people who suffer from it have a higher risk of progression to dementia within 5 years.[31] The rat prevalence of cognitive impairment in our study was 69.8% and it's higher than other similar studies.[32,33] This higher prevalence could be explained by the higher number of individuals with low education, 85.5% against almost 68% and 40%, respectively, in the studies mentioned above. In study of Kurkcu *et al.*, among 475 patients who visited the geriatric Outpatient Department of a Dutch Hospital between 2005 and 2010, the prevalence of CI was 53.2 when the low education was found only in 31% for the total sample.[28] Saghafi-Asl M and Vaghef-Mehrabany, in their case–control, age- and gender-matched study in Tabriz (East Azarbaijan, Iran), elderly subjects aged 65 years and older were recruited from nursing homes ($n = 76$) and community ($n = 88$).[34] Of the total sample, 70.7% were illiterate and 76.8% had score on MMSE below 24 point. Other explanation could be given to the higher prevalence of CI in our results is that the majority of simple subjects were recruited in tow cities

Table 1: Baseline characteristics according to gender

	Total *n*=172	Females *n*=75 (43.6%)	Males *n*=97 (56.4%)	*P*
Age				
Mean±SD	67.53±7.53	67.56±8.36	67.52±6.87	0.588
Living place				
Free living *n* (%)	96 (55.8)	38 (50.7)	58 (59.8)	0.232
In nursing home *n* (%)	76 (44.2)	37 (49.3)	39 (40.2)	
Education				
Low *n* (%)	147 (85.5)	69 (92.0)	78 (80.4)	0.047
Intermediate *n* (%)	22 (12.8)	5 (6.7)	17 (17.5)	
High *n* (%)	3 (1.6)	1 (1.3)	2 (2.1)	
Marital status				
Married *n* (%)	81 (47.1)	24 (32.0)	57 (58.8)	<0.001
Single *n* (%)	38 (22.1)	17 (22.7)	21 (21.6)	
Divorced *n* (%)	17 (9.9)	8 (10.7)	9 (9.3)	
Widowed *n* (%)	36 (20.9)	26 (34.7)	10 (10.3)	
Children's number				
Mean±SD	2.77±2.62	2.20±2.55	3.24±2.60	0.012
Kind of profession				
Free *n* (%)	104 (60.5)	30 (40.0)	74 (76.3)	<0.001
Public sector *n* (%)	13 (7.6)	2 (2.7)	11 (11.3)	
Private sector *n* (%)	14 (8.1)	5 (6.7)	9 (9.3)	
Never had a profession *n* (%)	41 (23.8)	38 (50.7)	3 (3.1)	
Pension				
Yes *n* (%)	19 (11.1)	4 (5.3)	15 (15.5)	0.048
No *n* (%)	153 (88.9)	71 (94.7)	82 (84.5)	
Dental problems				
Yes *n* (%)	90 (52.3)	29 (38.7)	61 (62.9)	0.002
No *n* (%)	82 (47.7)	46 (61.3)	36 (37.1)	
Smoking				
Yes *n* (%)	30 (17.4)	3 (4.0)	27 (27.8)	<0.001
No *n* (%)	142 (82.6)	72 (96.0)	70 (72.2)	
Diabetes mellitus				
Yes *n* (%)	34 (19.8)	17 (22.7)	17 (17.5)	0.401
No *n* (%)	138 (80.2)	58 (77.3)	80 (82.5)	
Hypertension				
Yes *n* (%)	63 (36.6)	34 (45.3)	29 (29.9)	0.037
No *n* (%)	109 (63.4)	41 (54.7)	68 (70.1)	
Osteoporosis				
Yes n (%)	25 (14.5)	12 (16.0)	13 (13.4)	0.632
No *n* (%)	147 (85.5)	63 (84.0)	84 (86.6)	
Anemia				
Yes *n* (%)	4 (2.3)	2 (2.7)	2 (2.1)	1.000
No *n* (%)	168 (97.7)	73 (97.3)	95 (97.9)	

(Contd...)

Table 1: *(Continued)*

	Total *n*=172	Females *n*=75 (43.6%)	Males *n*=97 (56.4%)	*P*
Cardiac diseases				
Yes *n* (%)	35 (20.3)	18 (24.0)	17 (17.5)	0.296
No *n* (%)	137 (79.7)	57 (76.0)	80 (82.5)	
Medications use				
Mean±SD	1.07±1.34	1.26±1.42	0.91±1.27	0.090
Physical activity level				
Limited *n* (%)	65 (37.8)	31 (41.3)	34 (35.1)	0.329
Moderate n (%)	39 (22.7)	13 (17.3)	26 (26.8)	
High *n* (%)	68 (39.5)	31 (41.3)	37 (38.1)	
Depression				
Normal	46 (26.4)	13 (17.3)	33 (34.0)	0.045
Slight depression	108 (62.8)	54 (72.0)	54 (55.7)	
Severe depression	18 (10.5)	8 (10.7)	10 (10.3)	
Nutritional status				
Normal	78 (45.4)	28 (37.3)	50 (51.5)	0.102
Risk of malnutrition	85 (49.4)	44 (58.7)	41 (42.3)	
Malnutrition	9 (5.2)	3 (4.0)	6 (6.2)	

SD: Standard deviation

Table 2: Baseline characteristics according to cognitive function

	Total *n*=172	Normal *n*=52 (30.2%)	Cognitive impairment *n*=120 (69.8%)	*P* value
Gender				
Females *n* (%)	75 (44%)	12 (23.1%)	63 (52.5%)	<0.001
Males *n* (%)	97 (56%)	40 (76.9%)	57 (47.5%)	
Age				
Mean±SD	67.53±7.53	65.87±6.45	68.26±7.87	0.208
Living place				
Free living *n* (%)	96 (55.8%)	34 (65.4%)	62 (51.7%)	0.096
In nursing home *n* (%)	76 (44.2%)	18 (34.6%)	58 (48.3%)	
Education				
Low *n* (%)	147 (85.5%)	38 (73.1%)	109 (90.8%)	<0.001
Intermediate *n* (%)	22 (12.8%)	13 (25.0%)	9 (7.5%)	
High *n* (%)	3 (1.6%)	1 (1.9%)	2 (1.7%)	
Marital status				
Married *n* (%)	81 (47.1%)	32 (61.5%)	49 (40.8%)	0.065
Single *n* (%)	38 (22.1%)	9 (17.3%)	29 (24.2%)	
Divorced *n* (%)	17 (9.9%)	5 (9.6%)	12 (10.0%)	
Widowed *n* (%)	36 (20.9%)	6 (11.5%)	30 (25.0)	
Children's numbre				
Mean±SD	2.77±2.62	2.90±2.45	2.72±2.70	0.575
kind of profession				
Free *n* (%)	104 (60.5%)	35 (67.3%)	69 (57.5%)	0.015
Public sector *n* (%)	13 (7.6%)	7 (13.5%)	6 (5.0%)	

(Contd...)

Table 2: *(Continued)*

	Total *n*=172	Normal *n*=52 (30.2%)	Cognitive impairment *n*=120 (69.8%)	*P* value
Private sector *n* (%)	14 (8.1%)	5 (9.6%)	9 (7.5%)	
Never had a profession *n* (%)	41 (23.8%)	5 (9.6%)	36 (30.0%)	
Pension				
Yes *n* (%)	19 (11.1%)	11 (21.2%)	8 (6.7%)	0.005
No *n* (%)	153 (88.9%)	41 (78.8%)	112 (93.3%)	
Dental problems				
Yes *n* (%)	90 (52.3%)	22 (42.3%)	68 (56.7%)	0.083
No *n* (%)	82 (47.7%)	30 (57.7%)	52 (43.3%)	
Smoking				
Yes *n* (%)	30 (17.4%)	8 (15.4%)	22 (18.3%)	0.640
No *n* (%)	142 (82.6%)	44 (84.6%)	98 (81.7%)	
Alcohol consumption				
Yes *n* (%)	3 (1.7%)	1 (1.9%)	2 (1.7%)	1.000
No *n* (%)	169 (98.3%)	51 (98.1%)	118 (98.3%)	
Diabetes mellitus				
Yes *n* (%)	34 (19.8%)	10 (19.2%)	24 (20.%)	0.907
No *n* (%)	138 (80.2%)	42 (80.8%)	96 (80.0%)	
Hypertension				
Yes *n* (%)	63 (36.6%)	18 (34.6%)	45 (37.5%)	0.718
No *n* (%)	109 (63.4%)	34 (65.4%)	75 (62.5%)	
Osteoporosis				
Yes *n* (%)	25 (14.5%)	6 (11.5%)	19 (15.8%)	0.463
No *n* (%)	147 (85.5%)	46 (88.5%)	101 (84.2%)	
Anemia				
Yes *n* (%)	4 (2.3%)	2 (3.8%)	2 (1.7%)	0.585
No *n* (%)	168 (97.7%)	50 (96.2%)	118 (98.3%)	
Cardiac diseases				
Yes *n* (%)	35 (20.3%)	7 (13.5%)	28 (23.3%)	0.140
No *n* (%)	137 (79.7%)	45 (86.5%)	92 (76.7%)	
Medications use				
Mean±SD	1.07±1.34	1.08±1.34	1.06±1.35	0.792
Physical activity level				
Low *n* (%)	65 (37.8%)	12 (23.1%)	53 (44.2%)	<0.001
Moderate *n* (%)	39 (22.7%)	22 (42.3%)	17 (14.2%)	
High *n* (%)	68 (39.5%)	18 (34.6%)	50 (41 .7%)	
Depression				
Normal	46 (26.4%)	21 (40.4%)	25 (20.8%)	0.012
Slight depression	108 (62.8%)	29 (55.8%)	79 (65.8%)	
Severe depression	18 (10.5%)	2 (3.8%)	16 (13.3%)	
Nutritional status				
Normal	78 (45.4%)	34 (65.4%)	44 (36.7%)	0.002
Risk of malnutrition	85 (49.4%)	16 (30.8%)	69 (57.5%)	
Malnutrition	9 (5.2%)	2 (3.8%)	7 (5.8%)	

SD: Standard deviation

Table 3: Binary logistic regression for subjects with cognitive impairment

	ORa	CI 95%	*P*
MNA			
Malnutrition versus normal	3.03	[1.34–6.85]	0.008
Gender			
Females versus males	2.22	[1.03–5.71]	0.043
Physical activity			
Average versus limited	0.19	[0.06–0.54]	0.002
Education			
Limited versus hight	8.35	[1.32–52.82]	0.024

MNA: Mini nutritional assessment, ORa: Adjusted odds ratio

(Kenitra and Sidi Kacem city) known to have low income for their habitat. In our study, 88.9% had no pension and we found a significant association between pension and cognitive function ($P = 0.005$), in fact, low income can indirectly affect cognitive function by affecting the nutritional status of a subject by limiting their capacity to buy aliments in terms of quality and quantity.

The objective of the present study was to determine the relationship between malnutrition and cognitive function. In multivariate regression analysis, the malnutrition was a risk factor for CI (OR = 3.03, 95% CI: 1.34–6.85). This result was similar to other cross-sectional study performed by Mohamad *et al.*, in three long-stay elderly institutions in Beirut among 111 elderly (55 men and 56 women), malnutrition (ORa = 3.03; 95% CI [1.41–6.53]), and low education (ORa=1.72; 95% CI [1.16–2.56]) were the only risk factors for cognitive impairment.[6] Similar other study performed by Shan *et al.*, among 580 elderly residents aged 90 years or more in China. In the multivariate model, malnutrition (OR = 4.24, 95% CI: 1.89–9.52) was the risk factor for cognitive impairment after adjustment for other confounders factors.[24]

Aging outside of the presence of pathology is often accompanied by loss of appetite caused by disturbance of taste and smell which lead to changes in eating behavior with a decrease in total energy intake and more particularly a reduction in protein and fat intake.[35,36] When lipids are essentials elements of axons myelination (78–81% of the dry weight) involved in the nerve impulses transmission.[37] Monounsaturated fatty acids (MUFA) are rich in olive oil, nuts, avocado, and polyunsaturated fatty acids (PUFA) can be found mostly in fish and nuts. MUFA and PUFA are both important elements for brain function. Number of cross-sectional and longitudinal studies has confirmed the link between MUFA, PUFA intake, and cognitive function and that both could play a protective effect against cognitive decline.[38-41] Moreover, the brain has high energy requirements, since this cerebral orange represents only 2% of the total body mass, consumes 20% of the oxygen and 25% of the glucose consumed by the total human body.[42]

The brain is a complex organ with high metabolism which by aging becomes more vulnerable to oxidative stress. Vitamin B-9, B-12, and Vitamin E are most recognized to act as anti-oxidative stress process. Vitamin B-9 which exist in a variety of plant foods and Vitamin B-12 that can be found exclusively in animal foods are found in some studies not all to have link in slowing cognitive decline by supplementation or dietary intake. Likewise, Morris *et al.* found that persons in the highest quintile of total Vitamin E intake had a 36% reduction in the rate of decline in cognitive score tests.[43] Vitamin E is found in a variety of green vegetables, nuts, and seed oil to have antioxidant and anti-inflammatory properties.[44]

The multivariate analysis showed that low education (OR = 8.35, 95% CI: 1.32–52.83) was risk factor for cognitive impairment and PA (OR = 0.19, 95% CI: 0.06–0.54) was a protective factor. Mohamad *et al.* also found that education was risk factor for CI in multivariate analysis.[6] In fact, it is not still clear whether education affects cognitive function or cognitive score of MMSE, further study taking into account education, gender, and age in cutoff classification is needed. PA induces structural and functional changes in the brain that could have biological and psychological benefits.[45] Lochbaum *et al.* have demonstrated that aerobically trained or active participants performed significantly better on the fluid intelligence task than aerobically untrained or inactive participants.[46] This study has some limitation as mentioned above we did not take into account sex, age, and education different in cutoff classification which could classed some normal illiterate persons as having CI. Furthermore, the kinds of cross-sectional study do not take the association between cognitive function and nutritional status according to time.

CONCLUSIONS

Our study supported past literature that malnutrition is a risk factor of cognitive impairment which signified that nutritional status monitoring can prevent it's leading to AD.

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