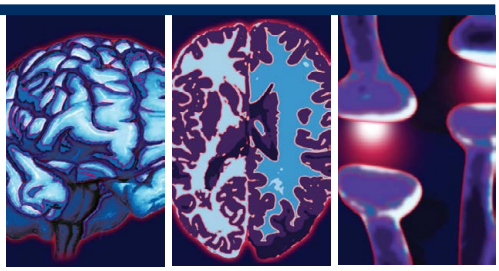

Association between body mass index with cognitive or physical functioning, and depression in Mexican elderly: A cross-sectional study

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ABSTRACT

Objective:

To assess the association, adjusted by sex and age, between the body mass index (BMI) and cognitive or physical functioning, and depression in Mexican elderly.

Method:

Three hundred and ninety five (female: 71.6%) subjects aged ≥ 60 were recruited from three independent senior care centers. Body composition was stratified as underweight, normal, or overweight (World Health Organization criteria). Cognitive functioning (Short Portable Mental State Questionnaire-SPMSQ); independent physical functioning (Barthel Index of Activities of Daily Living - BIADL); and level of depressive symptoms (Geriatric Depression Scale - GDS) were also measured. The independent and interactive effects of BMI, sex, and age on cognitive/physical functioning, and depressive symptoms were analyzed.

Results:

Univariate analyses showed that underweight elderly performed worse (SPMSQ: 4.50[2.84]; BIADL: 55.00[15.99]) than normal (SPMSQ: 6.46[2.86], p≤0.05; BIADL 83.40.00[18.81], p≤0.001) and overweight (SPMSQ: 7.82[2.21], p≤.0001; BIADL: 84.42.00[15.44], p≤.0001) in cognition and physical functioning. Additionally, in underweight elderly, depression level was significantly higher (GDS: 3.90[2.28]) than the scored by overweight (GDS: 2.13[1.68], p≤0.01). Significant differences by sex were only found for physical functioning. Age-related analysis showed that the oldest subgroup was significantly more affected than the young old and the middle old in cognitive and physical functions, besides depression cores. Analysis of the interactions of BMI with sex and age did not show significant effect for any of the studied outcome variables.

Conclusions:

In Mexican elderly people, the presence of underweight was associated to impair cognitive/physical functions and higher depression scores. This seems to be independent to the association between higher age and the same variables.

Keywords

Elderly, Mexican, Body mass index, Cognitive function, Physical function, Depression

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Introduction

Nowadays and for the first time in human history most people can expect to live beyond the age of 60. This increase in life expectancy is the result of large reductions in mortality at younger ages and from infectious diseases, in addition to the declining mortality among those who are older. A worldwide demographic transition to older populations is occurring and actions must be planned in response. Increasing longevity is not necessarily being accompanied by an extended period of good health; evidence in fact suggests that older people today are not in better health than their parents [1].

It must be underlined that health is not merely the absence of disease or infirmity, but a state of complete physical, mental and social well-being [2]. In this framework, efforts have been made to explore possible factors influencing neuropsychological and physical performance in older age in order to prevent deterioration and promote good functioning. Cognitive ageing, though a natural process, can interfere in the individual's functioning and quality of life [3]. Effective interventions have been proposed to prevent and optimize ageing-related cognitive deterioration, considering protective factors such as cognitive training, physical activity, social engagement and proper nutrition [4-6].

As physical and/or cognitive ability decreases in the elderly, care dependence arises to a point where an individual is no longer able to undertake the basic tasks that are necessary for daily life without the assistance of others [1]. The prevalence of dependence increases with age and is related to the presence of prior disease and fragility. Moreover, dependence relates to greater health and social resource utilization, more institutionalization, morbidity, and mortality, increasing overall health costs [7]. It must not be overlooked that dependence in the elderly is the main concern and cause of suffering and poor quality of life [7], and is significantly associated with suicide [8,9]. Despite dependence, an individual might well maintain his autonomy and retain the ability to make decisions and act in consequence on matters that affect him [1].

Depressive disorders and depressive symptoms are not uncommon in elder populations. Although less prevalent among the older than among the younger adults, depressive disorders affect about 2-3% of older people living in the community and about 10% of older adults living in long-term care facilities. Furthermore, older adults are more likely (approximately 1 in 10) to suffer sub-threshold depression; that is to experience substantial depressive symptoms without meeting the diagnostic criteria [1]. Main risk factors for depression in the elderly are: female sex, disability, new medical illness, poor health status, prior depression, poor self-perceived health, bereavement, sleep disturbances, somatic illness, cognitive and/or functional impairment, and lack or loss of close social contacts [10,11].

Apart from neuropsychological detriment, a disordered body composition is another expected significant ailment that comes along with age. Through the first 60 years of life weight gradually increases and thereafter it progressively decreases. Nevertheless, due to compression-fracture related wedging of the vertebrae and development of kyphosis as a result of osteoporosis in older age, loss of height also occurs (mostly in women). Thus, even with a decrease in body weight, given a shortening of height, body mass index (BMI) is expected to increase between 1.5 and 2.5 kg/m^2 in both men and women [12]. The association between BMI and cognitive decline in late life, reported by a large series of studies, has revealed a paradox: high BMI in young adults increases their risk for impaired cognition and late onset dementia; conversely, high BMI in elder people is associated with better cognition, whereas being underweight and/or having a decrease in BMI are associated with higher cognitive impairment [13-16]. Apparently, regarding cognitive functioning in late life, high BMI seems a protective factor for the elderly and yet, a risk factor for the young adults. Regarding autonomy, in young adults BMI does not seem to influence daily life functioning [17] however, in older adults this association still remains controversial. Whereas some studies report that higher BMI in elderly is associated to a better daily life functioning, even in those with obesity [18], other studies have found that underweight or obese elderly subjects and also those who had gained weight had more limitations on their daily living activities in comparison to those with a normal BMI and those who maintained their weight [19,20]. BMI has also been studied in relation to depression. In the elderly, depressive symptoms seem related to both, weight loss and weight gain [21,22]. Although some studies have found no sex differences in the association of BMI with depressive symptoms in the elderly [21,23], others have found that obesity increases the

risk for depression in women, while overweight reduces the risk in men [24].

As elderly rates in world population are expected to increase, an active ageing policy framework emphasizes the need for action across multiple sectors to ensure that older people remain a resource to their families, communities and economies [1]. Research has followed this summon, studying possible factors that can predict not only longer living but also living to the full. This study aimed at assessing the association, adjusted by two relevant elderly-related predictors: sex and age, between BMI-approached type of body composition, and cognitive or physical functioning, and depression in Mexican elderly. We expanded upon previous studies, not only by reporting data from a relatively, from a biomedical research viewpoint, unexplored population, but also by simultaneously analyzing the association of BMI with three relevant outcomes in elderly: cognitive functioning and physical functioning, besides depression.

Method

This cross-sectional study was performed at three independent senior care centers, two public and one private; all located in the city of Merida, Mexico. Authorization and ethical approval was received from the Research and Ethics committee of the School of Medicine and Rehabilitation of the Autonomous University of Yucatan. All participants signed informed consent before study entry.

■ Measurements

Forman et al. [25] typology was used to classify the age subgroups of elderly as follows: young old ≤69, middle old ≥ 70 - ≤79; and very old ≥80. The World Health Organization (WHO) criteria [26] were used to classify the status of body composition: underweight ≤18.49 kg/m^2, normal ≥18.50 - ≤24.99 kg/m^2; and overweight ≥25.0 kg/m^2.

Cognitive status was measured using a Spanish version [27] of the Short Portable Mental State Questionnaire (SPMSQ; Pfeiffer questionnaire) [28]. Through 10 open questions this test evaluates short- and long term memory, orientation, information about daily events and the managing of basic mathematic tasks. It is of easy and brief administration, does not require any specific material and it is considered a reliable instrument to detect the presence and the degree of intellectual impairment. The SPMSQ possible score range varies from 0 to 10, with lower scores representing impairment; 3 or more incorrect answers, that is a score ≤ 7 suggests cognitive impairment [27]. The level of independent physical functioning was assessed with the Spanish version of the Barthel´s Index of Activities of Daily Living [29]. This short scale lists 10 daily life activities of self-care (bowel and bladder care, grooming, toilet use, feeding, dressing and bathing) and mobility (transfers, ambulation, and stair climbing). Each item has between 2 and 4 possible scores with 5-point increments (0, 5, 10, 15); its global score range varies from 0 (totally dependent) to 100 (fully independent) [30]. The level of dependence has been classified as: total (0-20), severe (21-60), moderate (61-90), slight (91-99), and non-dependent (100) [29]. Finally, a Spanish version of the Geriatric Depression Scale (GDS) was also used [31]. This instrument was developed specifically to assess the presence and the level of depressive symptoms in elder people. Its original version includes 30 items, although shorter forms (15, 10 or 4 items) have been proposed. A list of sentences describing thoughts and feelings are presented to participants who must respond "yes" or "no" according to the way they felt over the past week. In the 10-item version herein used, scores could range from 0 to 10; higher scores represent more depressive symptoms present, and a cut-off point ≥ 3 diagnoses depression [32].

■ Methods

Through the study period, the three centers were repeatedly visited in order to reach users of age 60 or older and invite them to participate. After they signed the informed consent, basic demographic (age, sex, marital status) and social (having or not a pension, medical insurance, life insurance, testament, bank account, savings, credit card, economic support from relatives, owning a house and/or a car) data were recorded along with weight and height to estimate BMI (kg/m^2). Finally, the three above cited instruments were applied.

■ Statistical analysis

First, descriptive statistics (means, standard deviations, frequencies and percentages) for characteristics of total sample were obtained. Univariate analyses (unpaired t test, or one-way ANOVA) were run for comparing level of cognitive and physical functioning, and level of depressive symptoms between the sex and the pre-established BMI and age subgroups.

Finally, two-way analyses of variance (ANOVAs) were run to examine the level of interaction of BMI, sex, or age on the three studied outcome measures. Data were collected and analyzed with the SPSS v.20 software. All significant values were two-tailed, and statistical significance was established at $p \leq .05$.

Results

Three hundred and ninety nine from 423 potential participants (93.4%) agreed to participate. The reasons to refuse to participate were: "I am not interested" (n=8), "I am too busy" (n=15); whereas some who agreed at first to be interviewed some other time could not be located later (n=5). The final sample was mostly recruited from the two public centers (59.7%); had 283 (71.6%) women and 112 (24.8%) men; was 74.68 mean years old (SD = 8.50; range: 60-98); and had a BMI mean of 27.68 (SD = 5.58; range: 17.26-51.61). There was no difference in mean BMI and age by sex (data not shown). **Table 1** depicts the distribution of BMI and age subgroups according to the pre-established cut off points in addition to the socioeconomic group profile.

Sample distribution by BMI and age subgroups is presented in **Table 2**. Although most subjects (n=260, 65.82%) had overweight, prevalence decreased with ageing: in the young old was 81.8%, whereas in the middle old was 70.1%, and decreased to 43.6% in the very old subgroup. Only 10 subjects had underweight; most of them (n=9) belonged to the very old subgroup. Significant differences in BMI scores were found when age subgroups were compared. Those aged 80 years or older had a lower mean BMI (mean=26.03, SD=5.94) as compared to the other two groups: young old (mean=29.11, SD = 5.32; $p \leq 0.001$) and middle old (mean=27.81, SD=5.19; $p \leq 0.001$).

Regarding the scores of the outcome variables in whole sample, its mean cognitive performance level was slightly above the cut-off point for cognitive dysfunction (mean=7.31, SD=2.56, range 0-10); its mean physical function score was rated as moderately dependent (mean=85.28, SD = 17.37, range 25-100); and its depression mean score was slightly below the cut-off point for depressive status (mean=2.38, SD=1.87, range 0-9).

Table 3 shows the results of the Univariate analysis comparisons between the predictor (BMI, sex, and age) and the outcome (cognitive and physical function, level of depressive symptoms) variables. Underweight elderly being below the cut-off point for cognitive functioning and in the range of severe dependence performed worse than both, the normal- and the overweight. Although underweight elderly depression score was the only one above the cut-off point and higher than those of the normal and overweight elderly, the difference was only significant when comparing underweight and overweight groups. The normal weight group significantly displayed a poorer cognitive functioning and more depressive symptoms than the overweight group; difference was not significant in regard to their physical functioning. On the other hand, significant differences by sex resulted from women being more dependent and reporting more depression. Finally, the analysis by age subgroups showed an age dependent decrement in cognition and physical functioning, in addition to an increase for the depression score. The very old group was significantly more affected than the young old and the middle old in all three studied outcome variables, presenting cognitive impairment, moderate dependence and depression, according to the corresponding cut-off criteria. No statistical difference was found for any compared variable between the young- and the middle old subgroups.

Analysis of the interactions of BMI with sex and age did not show a significant effect for any of the studied outcome measures. Although the effect of BMI was independent of the effect of age, the specific features of those who were underweight and very old (i.e. the two most affected groups) were analyzed. The group included 9 persons, all of them female, from 80 to 94 years old (mean=87.67, SD=3.87), BMI ranged from 17.31 to 18.37 kg/m^2 (mean=17.92, SD=0.35). Mean cognition score was 4.00 (SD=2.56), mean independent functioning score was 55.56 (SD=16.85) and mean depression score was 3.78 (SD=2.39); that is, this group is very vulnerable as it presents impaired cognitive functioning, severe dependence for physical daily activities, and higher depressive scores.

Discussion

World population is ageing and most people will live longer than 60 years. Public policies responding to this tendency must consider

not only approaches to ameliorate the losses associated with older age but also those that may reinforce recovery, adaptation and psychosocial growth [1]. Research can collaborate on the development and implementation of new policies by unveiling the risk and protective factors for adequate health in late life. This study explored, in a sample of Mexican elderly, the association between BMI and cognitive and physical functioning, and depression, adjusted by sex and age. The main finding was that underweight BMI was associated with poorer cognitive and physical functioning and more depression; moreover, this association was independent of sex and age.

Whereas some authors by review or meta-analysis concluded that underweight, overweight and obesity in midlife increase dementia risk [14,15], others found overall no association between underweight and risk for late cognitive deterioration and that overweight was sometimes related to higher and other times to lower risk [13]. Findings on late life samples are also inconsistent; the risk for cognitive impairment increases [13], decreases [13,15], or has no association with higher BMI [13,14]. Study designs, base line age of participants and the duration of follow up are factors that might contribute to these differences. In late life it seems that overweight, and to a lesser extent obesity, is indicative of better health status, at least in regard to mortality. However, naturalistic observations, either cross-sectional or longitudinal, are always biased by the relatively low numbers of underweight participants. The present study found higher BMI related to better cognitive functioning; this concurs with others reporting that individuals with dementia have, on average, a lower BMI than those without dementia [13].

Regarding physical functioning underweight elderly were more dependent on others to perform their daily activities. Some previous studies suggest low BMI and some others suggest high BMI to be a risk factor for functional dependency; it could be the case that the more extreme BMI is (either higher or lower), the greater the risk for functional impairment is [18]. Opposite to previous research, this study did not find any interaction of BMI with sex [18,33]. Also, previous studies suggest that lower BMI is associated with better functional status [18,34,35], though only in subjects with normal nutrition and not in subjects with malnutrition risk or malnutrition [35]. These contradictory findings call upon further research considering, among other factors, healthy nutritional status that does not necessarily corresponds to a normal BMI [18].

Table 1: Classification in BMI and age related subgroups, besides the prevalence of the socioeconomic collected variables for the whole group (N=395).

	n (%)
BMI:	
Underweight	10 (2.53)
Normal	125 (31.65)
Overweight	260 (65.82)
Age group:	
Young old	121 (30.63)
Middle old	157 (39.75)
Very old	117 (29.62)
Marital status:	
Married	124 (31.39)
Never married	67 (17.00)
Widowed	193 (48.83)
Divorced/separated	11 (2.78)
With a pension	226 (57.21)
With medical insurance	309 (78.22)
With life insurance	104 (26.29)
With a testament	105 (26.58)
With a bank account	143 (36.20)
With savings	165 (41.77)
With a credit card	87 (22.02)
With economic support from relatives	246 (62.27)
Owns a house	222 (56.20)
Owns a car	109 (27.59)

Table 2: Prevalence of body composition type (according to the WHO's criteria) by age subgroup*

	Age subgroup		
	Young old (n=121)	Middle old (n=157)	Very old (117)
Underweight	0 (0)	1 (0.6)	9 (7.7)
Normal	22 (18.2)	46 (29.3)	57 (48.7)
Overweight	99 (81.8)	110 (70.1)	51 (43.6)

*Percent prevalence of body composition subgroups is between brackets.

In this sample of Mexican elderly depression seemed to increase as BMI decreased; the normal and the underweight were more depressed than the overweight. Although overweight might seem a protective factor for depression, interpretations of causality cannot be drawn from these data. Research has repeatedly found associations between depression and weight though with varying results, with some concluding individuals have increased risk of depression and others concluding the converse to be true [22]. Findings suggest that depression might rather be associated with extreme weight (either under or over normal)

Table 3: Comparison between BMI values, sex and age subgroup with the level[¶] of neuropsychological and physical functioning, and depressive symptoms (N=395).

	BMI			
	Underweight n=10	Normal n=125	Overweight n=260	
SPMSQ score $F_{(2,392)=}$ 19.62, p≤0.001	4.50 (2.84)	6.46 (2.86)	7.82 (2.21)	U *v.s.* N: p≤0.05 U *v.s.* O: p≤.0001 N *v.s.* O: p≤0.001
Barthel´s Index score $F_{(2,392)=}$ 19.76, p≤0.001	55.00 (15.99)	83.4 (18.81)	87.42 (15.44)	U *v.s.* N: p≤0.001 U *v.s.* O: p≤0.001
GDS score $F_{(2,392)=}$ 8.59, p≤0.001	3.90 (2.28)	2.77 (2.10)	2.13 (1.68)	U *v.s.* O: p≤0.01 N *v.s.* O: p≤0.01
	Sex			
	Male n=112	Female n=283		
SPMSQ score $t_{(393)=}$ 0.68, p>0.05	7.45 (2.85)	7.25 (2.45)		
Barthel´s Index score $t_{(393)=}$ 3.39, p≤0.001	90.63 (14.00)	83.16 (18.12)		p≤0.001
GDS score $t_{(393)=}$ -2.29, p≤0.05	2.04 (1.59)	2.51 (1.96)		p≤0.05
	Age subgroup			
	Young old n=121	Middle old n=157	Very old n=117	
SPMSQ score $F_{(2,392)=}$ 21.47, p≤0.001	7.90 (2.33)	7.77 (82.19)	6.07 (2.84)	V *v.s.* Y: p≤0.001 V *v.s.* M: p≤0.001
Barthel´s Index score $F_{(2,392)=}$ 25.46, p≤0.001	91.49 (13.81)	86.88 (15.92)	76.71 (19.20)	V *v.s.* Y: p≤0.001 V *v.s.* M: p≤0.001
GDS score $F_{(2,392)=}$ 18.00, p≤0.001	1.88 (1.67)	2.15 (1.77)	3.20 (1.95)	V *v.s.* Y: p≤0.001 V *v.s.* M: p≤0.001

SPMSQ: short portable mental state questionnaire; GDS: geriatric depression scale; U: underweight; N: normal; O: overweight; Y: young old; M: middle old; V: very old

[22,23,36]; though underweight elderly seem the most affected [21,36,37]. Even though women reported more depression than men, our results concurred with those that have found no sex differences in the association of BMI with depressive symptoms [21,23]. Further research, both cross-sectional and longitudinal, is needed to understand causal pathways, clarifying whether weight loss or gain precedes or follows (sub-threshold) depression.

Although a decline in cognitive and physical functioning, as well as depressive symptoms, is common in older adults, our results suggest that underweight women at very old age are the most vulnerable group. All people aged 60 years or older are considered elderly; however, it is easily seen that health and ageing pathways are quite diverse. Population is expected to live longer, particularly women; thus, prevention as well as intervention programs must respond to the needs of this markedly vulnerable group in order to guarantee decency and dignity in the last years of their living. For instance, early psycho-educational workshops could be designed for women entering elder ages so they learn about the physical (body mass distribution, nutritional needs, age-related diseases), psychological (self-perception, self-esteem, mood changes, sense of loss, decline in cognitive capacity) and social (occupational status, family interactions, receiving support to perform daily activities, management of home/individual expenses) changes that usually occur along with ageing, being provided with adequate information about these issues and where and how to reach for support. Furthermore, relatives of this targeted group might well turn out to the workshops to be educated and sensitized about life in elder years. As life expectancy increases, society inevitably is challenged to provide the fast growing group of the elder with resources to live life to the fullest, acknowledging that this age group is not as homogeneous as one might think and designing specific programs to meet their needs. For instance, physical activity classes, cognitive rehabilitation sessions and

healthy diet plans required by underweight women at very old age would not be the same that those required by elder women of younger age and with overweight.

It is also worth to comment that although, as expected, BMI decreased with age, overweight was most prevalent in total sample and in all age subgroups. Overweight and obesity have become a serious epidemic for its association to multiple health disorders (e.g. coronary heart disease, high blood pressure, diabetes). In Mexico this is an alarming issue as the country is first in the world on childhood obesity and second, following the United States, on adult (20+) obesity [38,39]. Mexican elderly (60+) are also part of this picture with 34.0% to 67.9% prevalence of overweight and 15.1% to 33.65% prevalence of obesity, being more frequent in females and in the 60 to 69 age group [40]. The Mexican government has implemented national strategies to counteract this epidemic with awareness media campaigns, improvements in public health and surveillance, better medical care for people with chronic diseases and regulation and fiscal measures [39]. Yet, targeted strategies for the elderly still need to be designed and implemented considering the particular physical, social and environmental conditions of this specific age group.

Discrepancies have aroused by the so-called obesity paradox in late life with a more favorable prognosis for certain diseases in the presence of overweight compared to normal or reduced body weight [41]; thus, some authors have questioned whether standards for ideal weight (≥18.50 - ≤24.99 kg/m^2) may be overly restrictive as they apply to the elderly [12,42]. However, caution is recommended with interpretations; overweight and obesity, even in the elderly, imply worse health outcomes and more lifetime health care expenditures [41,43]. Finer analyses in relation to BMI must consider sub-classifications of overweight and compare their possible association with physical, psychological and emotional health, and debate the suitability and/or adaptation of BMI criteria in the elderly.

Being a cross-sectional study no direction of the resulting association can be inferred. Underweight might be cause or consequence of poor cognitive functioning, limited physical functioning and/or depressive symptoms. Moreover, all these conditions might be influenced by other factors such as normal age-related deterioration and/or comorbidities. The present study offers unique data regarding simultaneously three relevant outcomes in elderly from a relatively unexplored population. Outcome variables were assessed with scales validated and widely used in geriatric samples, and although other factors might influence outcome, the effects of sex and age were considered. It must be brought to notice that sample included mostly women (71.6%) and that might have influenced our findings. National census for 2010 in Mexico indicated that 53.5% of people aged 60 or older were women, and up to 57.5% of those aged 85 or older [44]. Beyond a higher percentage of women in the general population and the fact that they are expected to live longer other possible reasons could contribute to this unbalanced distribution; for instance women might be more likely to attend senior care centers as the ones were the study was performed, perhaps as they survive their spouses, do not have someone to look after/accompany them and/or are more open than men to social activities.

Despite its limitations this study provides evidence of the association between a disordered body composition, particularly an underweight BMI, and poor cognitive and physical functioning, and more depressive symptoms. This association was independent from sex and age; yet, women and very old participants showed poorer outcome. Subsequent studies relying upon prospective designs and including other possible interfering factors would provide more reliable data to corroborate this association and support interpretations regarding its directionality, which would contribute to the development and implementation of targeted prevention and intervention strategies. Further research, particularly in a longitudinal fashion, shall expand this cross-sectional study by exploring the long-term effects and the vulnerability factors of the associations that were found.

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