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RESEARCH ARTICLE

HAS OLDER ADULTS BMI A MULTIFACTORIAL AETIOLOGY?

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Abstract

Introduction: Nutritional disorders in older adults are of much concern, especially underweight and obesity among older adults. This study aimed to evaluate prevalence of underweight and obesity and to identify factors associated with nutritional status in community-dwelling Portuguese elders.

Methods: Cross-sectional study involving 337 elders attending day care centers in Lisbon. The data collected included self-perception of health state, chronic diseases, social support and relations as well as sociodemographic variables. Nutritional status was evaluated by Body Mass Index (BMI) classifying participants as underweight (BMI<24 Kg/m²), normal weight (BMI=24 to <29kg/m²) and obese (BMI≥29 kg/m²). Data were compared using chi-square test and multinomial regressions were performed to identify determinants of underweight and obesity, being the normal weight the reference category.

Results: Participants were mainly women (210; 62.3%), aged 66 to 99 years old. Overall prevalence of underweight and obesity was 21.7% and 38.3%, respectively. Of the 210 females, 24.3% presented underweight and 44.3% were obese. Of the 127 male participants, 17.3% were underweight and obesity affected 28.3%. Low BMI and obesity were associated with sociodemographic, health, psychosocial and institution attendance variables. Multinomial regressions revealed significant determinants for BMI status. Underweight was positively associated with age, gender and inability to cook and inversely with hypertension and diabetes. Obesity was positively associated with gender, hypertension and alcohol consumption.

Conclusion Taking into account that health and nutrition are inherently connected, this research highlights the importance of considering all dimensions of health while managing weight and nutritional status of older adults. Health practitioners should set the focus on the underlying factors of the nutritional condition of this vulnerable population.

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Introduction:-

Connection between nutrition and health (defined by the World Health Organization as “a state of complete physical, mental and social well-being and not only the absence of disease”) is well established (Majowicz et al., 2016).

Old people are vulnerable to poor nutritional status because of a variety of physical, economic and psychosocial changes that accompanying aging and also due to chronic diseases (Simsek, Meseri, Sahin, & Ucku, 2013). Nutritional assessment is one area of comprehensive geriatric assessment (Secher et al., 2007) and can be performed using several methods, including anthropometry, which is non-invasive, inexpensive and reliable (WHO, 1995).

Malnutrition in the elderly is underdiagnosed and therefore (de van der Schueren, 2015) as well as geriatric obesity is increasing but its management is a challenge (Inelmen et al., 2003; Porter Starr, McDonald, Weidner, & Bales, 2016). Under and overweight are serious problems among elders and have been a concern (Porter Starr et al., 2016). Thus, early assessment of elderly's nutritional status and identification of factors associated with it are really important in order to promote strategies on the several dimensions of health to prevent elders' disabilities and to improve health and nutritional status (Caroline Boscatto, da Silva Duarte, Silva Coqueiro, & Rodrigues Barbosa, 2013; Zhou, Wang, Wang, & Chi, 2015). Therefore, this study aimed to assess weight status and to explore factors associated with underweight and obesity in community-dwellers in Lisbon aged 65 or over.

Methods:-

This cross-sectional study included 337 community-dwelling elders aged 65 years or more who were attending **seven day care centers in Lisbon**. ICBAS-UP Ethics Committee (Proj. n° 167/2016) approved the investigation and all participants signed an informed consent.

We conducted face-to-face interviews and anthropometric measurements. The Mini Mental State Examination (MMSE) was used to assess cognitive function and baseline characteristics of the sample were surveyed using a structured questionnaire, including information about sociodemographic characteristics, chronic diseases and lifestyle variables.

Nutritional status (dependent variable):-

Weight and height were measured according to Isak procedures (Olds, Ridder, Arthur D., & Marfell-Jones, 2011) and using calibrated tools (portable balance scale, OMRON® BF511; portable stadiometer, Seca®) Using weight and height assessed, BMI was calculated and classified as follows (Hajjar, Kamel, Denson, & Hajjar, 2003): BMI < 24 Kg/m² - underweight; [24-29[kg/m² – normal weight; ≥ 29 kg/m² – obesity.

Explanatory variables:-

Sociodemographic: sex (male/female), age (65-74; 75-84; ≥85), marital status, monthly income.

Health: respiratory diseases, myocardial infarction (if yes, how many times it occurred), liver diseases, high blood pressure, stroke, cancer, diabetes, depression and neuropsychological problems (yes/no), self-perceived health status (in a five point scale ranged from very good to very poor).

Lifestyle: current smoking and alcohol habits (yes/no), psychological stress in the last 3 months and acute illness (yes/no), social net and relationships.

Day care center attendance: reasons to attend and type of services provided.

Statistical Analysis:-

All variables were tested for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. Descriptive analysis was performed and chi-square test was used to examine association between variables and nutritional status.

Multinomial regression models were conducted to assess the significance of sociodemographic, psychosocial, health and day care center attendance factors predicting underweight and obesity. The reference category was normal range, from which the other 2 categories were compared. For statistical analysis SPSS® Statistical Package for Social Sciences (IBM®, version 23) was used and a p < 0.05 was considered significant.

Results:-

Of the 337 participants, almost two-thirds (210; 62.3%) were female, aged between 66 and 99 years. The overall BMI mean was $28.1 \pm 4.4 \text{ kg/m}^2$. BMI mean in the female group was $27.7 \pm 4.9 \text{ kg/m}^2$ and in the male group was $27.3 \pm 3.4 \text{ kg/m}^2$. There was an overall prevalence of underweight of 21.7% (n=73) and obesity of 38.3% (n=129) as shown in Fig.1. In the female group almost a quarter (51) were underweight, almost a third were (66) normal weight and 44.3% were obese. Regarding to males, less than on fifth (17.3%) were underweight, more than half (54.3%) were normal and 28.3% were obese.

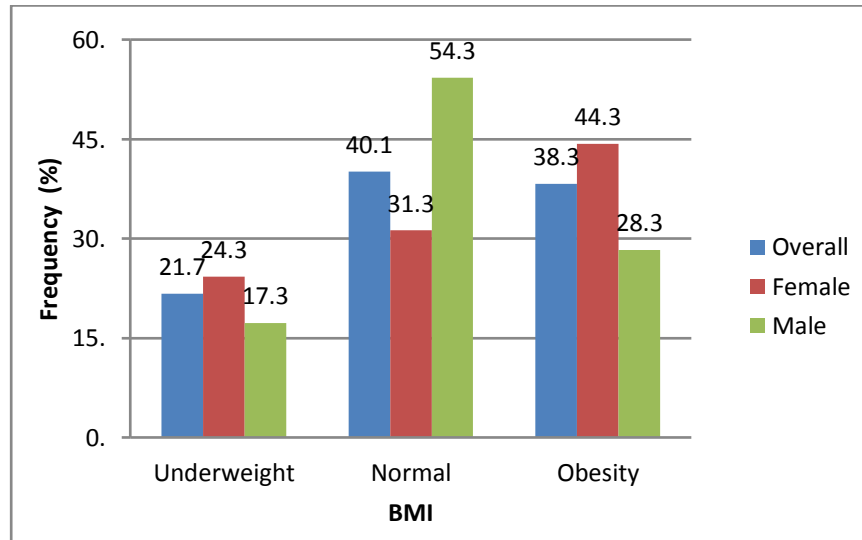


Fig.1:-BMI distributed by all the elderly and by sex.

BMI was associated with the sociodemographic profile of participants (Table1). Between the selected variables, BMI was associated with gender ($X^2=17.386$, $p<0.001$) and age group ($X^2=15.416$, $p=0.003$). Underweight and obesity were more prevalent among females. It was also possible to observe that underweight was more frequent on younger age groups.

Table 1:-Nutritional status of participants according to demographic variables.

Variables		Underweight		Normal		Obesity		Total		χ^2	p
		N	%	N	%	N	%	N	%		
Gender	Female	51	69.90	66	48.90	93	72.10	210	62.30	17.386	<0.001**
	Male	22	30.10	69	51.10	36	27.90	127	37.70	-	-
Age (years)	65-74	18	24.70	46	34.10	47	36.40	111	32.90	15.416	0.003**
	75-84	28	38.40	65	48.10	63	48.80	156	46.30	-	-
	≥ 85	27	37.00	24	17.80	19	14.70	70	20.80	-	-
Marital status	Single	2	2.70	3	2.20	1	0.80	6	1.80	7.788	0.454
	Married	29	39.70	68	50.40	60	46.50	157	46.60	-	-
	Divorced	3	4.10	13	9.60	12	9.30	28	8.30	-	-
	Non-marital partnership	2	2.70	1	0.70	2	1.60	5	1.50	-	-
	Widow	37	50.70	50	37.00	54	41.90	141	41.80	-	-
Income (€)	>1010	3	4.10	6	4.40	7	5.40	16	4.70	5.452	0.708
	505-1010	13	17.80	33	24.40	35	27.10	81	24.00	-	-
	219.75-505	51	69.90	92	68.10	80	62.00	223	66.20	-	-
	219.79-261.95	4	5.50	3	2.20	4	3.10	11	3.30	-	-
	<219.79	2	2.70	1	0.70	3	2.30	6	1.80	-	-

* $p<0.05$; ** $p<0.01$

Of the health problems considered, respiratory diseases ($X^2=9.562$, $p=0.008$), high blood pressure ($X^2=45.455$, $p<0.001$) and diabetes ($X^2=10.467$, $p=0.005$) were positively associated with BMI (Table2). Obese elders presented higher prevalence of these diseases than underweight or normal ranged elderly. Consumption of alcoholic beverages ($X^2=7.189$, $p=0.035$) is more frequent among the obese elderly and the recent experience of psychological stress or acute illness ($X^2=6.686$, $p=0.035$) is more prevalent among the undernourished elderly.

Table 2:-Nutritional status according to health variables.

Diseases	Underweight		Normal		Obesity		Total		χ^2	p	
	N	%	n	%	n	%	n	%			
Respiratory diseases	5	6.80	20	14.80	30	23.30	55	16.30	9.562	0.008**	
Myocardial Infarction	12	16.40	16	11.90	16	12.40	44	13.10	0.956	0.62	
How many Events?	1	10	83.30	13	81.3	11	68.8	34	77.30	-	-
	2	1	8.30	2	12.50	4	25.00	7	15.90	-	-
	3	1	8.30	1	6.30	0	0.00	2	4.50	-	-
	4	0	0.00	0	0.00	1	6.30	1	2.30	-	-
Coronary heart disease	15	20.50	16	11.90	13	10.10	44	13.10	4.790	0.091	
High blood Pressure	38	52.10	91	67.40	120	93.00	249	73.90	45.455	<0.001**	
Stroke	17	23.30	25	18.50	23	17.80	65	19.30	0.978	0.613	
Cancer	8	11.00	27	20.00	17	13.20	52	15.40	3.780	0.151	
Diabetes	9	12.30	40	29.60	42	32.60	91	27.00	10.467	0.005**	
Liver diseases	1	1.40	1	0.70	1	0.80	3	0.90	0.243	0.885	
Depression	17	23.30	30	22.20	41	31.80	88	26.10	3.511	0.173	
Neuropsychological problems	16	21.90	28	20.70	38	29.50	82	24.30	3.017	0.221	
Self-Perceived health status	Very good	0	0.00	0	0.00	3	2.30	3	0.90	8.146	0.419
	Good	6	8.20	7	5.20	7	5.40	20	5.90	-	--
	Fair	21	28.80	52	38.50	46	35.70	119	35.30	-	-
	Poor	37	50.70	63	46.70	63	48.80	163	48.40	-	-
Very poor	9	12.30	13	9.60	10	7.80	32	9.50	-	-	
Psychological stress last 3 months	36	49.30	50	37.00	40	31.00	126	37.40	6.686	0.035*	
Smoke	6	8.20	10	7.40	7	5.40	23	6.80	0.692	0.708	
Alcohol drinks intake	10	13.70	19	14.10	33	25.60	62	18.40	7.189	0.027*	

BMI varied significantly regarding to institution attendance motives (Table3): inability to cook ($X^2=15.410$, $p<0.001$) was the main motive to underweight among participants.

Table 3:-Nutritional status according to day care center attendance.

Reason	Underweight		Normal		Obesity		Total		χ^2	p
	n	%	n	%	n	%	n	%		
Lack of money	58	79.50	96	71.10	91	70.50	245	72.70	2.151	0.341
Loneliness	18	24.70	28	20.70	25	19.40	71	21.10	0.795	0.672
Inability to cook	10	13.70	7	5.20	1	0.80	18	5.30	15.410	<0.001**
Lack of equipment	1	1.40	3	2.20	1	0.80	5	1.50	0.953	0.62
Socialization	13	17.80	37	27.40	36	27.90	86	25.50	2.924	0.231
Available Services										
Meals	72	98.60	135	100.00	128	99.20	335	99.40	1.624	0.443
Self-hygiene	3	4.10	4	3.00	3	2.30	10	3.00	0.515	0.772
House keeping	1	1.40	2	1.50	0	0.00	3	0.90	1.883	0.39
Laundry	0	0.00	0	0.00	0	0.00	0	0.00	-	-
Nurse	7	9.60	18	13.30	14	10.90	39	11.60	0.755	0.686
Monitoring when requested	10	13.70	18	13.30	10	7.80	38	11.30	2.601	0.272
Meetings, tours and guided	69	94.50	130	96.30	123	95.30	322	95.50	0.371	0.83

tours										
Other available Services	9	100.00	13	100.0	19	100.00	41	100.00	-	-
Sewing workshops	5	100.00	0	0.00	10	100.0	15	100.00	-	-
Handwork workshops	1	100.00	1	100.00	1	100.00	3	100.00	-	-
Gymnastics	4	100.00	13	100.00	9	100.00	26	100.00	-	-

A multinomial regression model was developed and the explanatory variables demonstrated that the model was statistically significant ($G^2(18)=127.742$; $p<0.001$). Table 4 shows the results of the multinomial regression model between BMI and the studied variables.

Diabetes (OR= 0.336, IC95% [0.145-0.776]) and high blood pressure (OR= 0.458, IC95% [0.239-0.878]) decreased the odds to be underweight comparing to normal BMI elders.

The risk of being underweight was higher for those who were 85 years or older comparing with those aged 65-74 years and aged 75-84 years old, these had the lower odds be underweight (OR= 0.321, IC95% [0.136-0.756] e OR= 0.424, IC95% [0.198-0.907]), respectively).

Also being female increased the risk of being underweight (OR= 3.301, IC95% [1.644-6.627]). Likewise, participants unable to cook presented more chances of being underweight (OR= 3.00, IC95% [0.936-9.612]).

Regarding to obesity, being a woman increased the odds (OR= 3.735, IC95% [2.043-6.827]), as well as having high blood pressure (OR= 6.637, IC95% [2.963-14.866]), and consuming alcoholic drinks (OR= 3.243, IC95% [1.523-6.903]), comparatively to those who were non-consumers.

Table 4:-Determinants of underweight and obesity among the sample (n=337).

	Underweight				Obesity			
	B	SE	p-value	Adjusted OR (95% CI)	B	SE	P-value	Adjusted OR (95%CI)
Intercept	-0.249	0.457	0.587		-2.729	0.565	<0.001**	
Gender								
Female	1.194	0.356	0.001**	3.301 (1.644-6.627)	1.318	0.308	<0.001**	3.735 (2.043-6.827)
Age (years)								
65-74	-1.138	0.438	0.009**	0.321 (0.136-0.756)	0.213	0.416	0.608	1.238(0.548-2.796)
75-84	-0.859	0.388	0.027*	0.424 (0.198-0.907)	0.166	0.383	0.664	1.181 (0.557-2.503)
+85	1	.	.		1	.	.	
Respiratory diseases	-0.729	0.565	0.198	0.483 (0.159-1.462)	0.505	0.354	0.153	1.658(0.828-3.317)
High blood pressure	-0.781	0.332	0.019*	0.458(0.239-0.878)	1.893	0.411	<0.001**	6.637(2.963-14.866)
Diabetes	-1.092	0.427	0.011*	0.336 (0.145-0.776)	-0.029	0.299	0.923	0.972(0.54-1.747)
Inability to cook	1.099	0.594	0.064	3 (0.936-9.612)	-1.364	1.101	0.215	0.256(0.03-2.21)
Alcohol consumption	0.651	0.488	0.182	1.918 (0.737-4.992)	1.176	0.385	0.002**	3.243 (1.523-6.903)
Psychological stress last 3 months	0.488	0.325	0.133	1.628 (0.862-3.077)	-0.381	0.288	0.186	0.683 (0.388-1.201)

Cox and Snell: 0.315; Nagelkerke: 0.358; McFadden: 0.178.

*p <0.05; **p <0.01

Discussion:-

Nutritional status is related to clinical status and to different socioeconomic parameters (Donini et al., 2013). Several factors appear to give their contribution to the nutritional status in this sample. Nutritional status was associated with sociodemographic, health and social conditions. According to Pirlich & Lochs (2001), undernutrition in the elderly is a consequence of somatic, psychological and also social problems (Pirlich & Lochs, 2001). Health has been shown to be linked to nutrition (Chen, Cheng, Chuang, & Shao, 2015) and considering WHO definition of health an individualized and careful approach to underweight and obesity is required.

In the current study, females presented higher prevalence of underweight. Similarly, in another research, underweight was significantly more prevalent among female elders compared to males (Reijnierse et al., 2015) and opposite from the results observed by others researchers (Caroline Boscatto et al., 2013).

Obese participants had higher frequencies of diabetes and high blood pressure. These findings are according some reports that mentioned that senior obesity is accompanied by chronic diseases such as high blood pressure, stroke, diabetes and metabolic syndrome (Dhurandhar, 2016; Goldberg & Mawn, 2015). Moreover, obese participants were the most prone to respiratory diseases. In fact, obesity can promote a decrease in respiratory function and respiratory muscle fatigue, as it can reduce chest wall compliance and promote a higher pressure on the diaphragm from the intra-abdominal organs (Porter Starr et al., 2016). One particular respiratory disease is chronic obstructive respiratory disease, which is considered an obesity pathology specially frequent in older adults (Porter Starr et al., 2016).

The deterioration of nutritional status is closely related to lack of food intake, weight loss, chronic diseases, functional status and stress (Oliveira, Fogaça, & Leandro-Merhi, 2009), which is pointed out in the literature as a biopsychosocial factor for nutritional status (Laraia, Leak, Tester, & Leung, 2017). Differently to what the previously reviewed literature shows, psychological stress didn't shown to be a determinant of underweight or obesity among our sample. However, we found a significant association between underweight and psychological stress and acute illness, as mentioned by some authors (Evans, 2005; Hickson, 2006; Stajkovic, Aitken, & Holroyd-Leduc, 2011). Both are threats to homeostasis (Junne et al., 2017), as acute illness promotes catabolism can promote unintentional weight loss. In turn, psychological stress can activate hypothalamic-pituitary-adrenal axis and the sympathetic-adrenomedullary system, with consequences on appetite, food and energy consumption and metabolism (Adam & Epel, 2007; Björntorp, 2001; Junne et al., 2017). It has been reported that a predominant activation of the sympathetic-adrenal-medullary system may promote undereating/hypophagia and thus decrease energy intake, leading to weight loss and consequently elderly could be underweight. Indeed, exposure to stressful situations is usually associated with anorexia and subsequent restriction of food consumption since corticotropin-releasing hormone stimulates the proopiomelanocortin neurons, which produce anorexic signals and increase thermogenesis. Neuro Peptide Y secretion stress-induced suppression is also likely to be involved in the display of anorexia under stressful conditions due to decreases on central orexigenic and anxiolytic actions (Kyro & Chrousos, 2006).

Our findings from multinomial regression suggested that being female was one of the determinants for be underweight among seniors. Similarly, Alzahrani et al. recognised that female gender was a significant predictor for underweight, once female elders may suffer more frequently from lack of appetite and consequent weight lost when comparing to males (Alzahrani, Abdelmoneim, Sayed, & Alshamrani, 2016).

Age is recognised as one of the major risk factors for nutrition in the elderly (Ji, Meng, & Dong, 2012; Simsek et al., 2013) and in this survey we also found an association between age underweight. However, some studies stated that there is no relation between age and nutritional status (Forster & Gariballa, 2005). In contrast, among the participants, the oldest elderly presented the higher risk of underweight and the 75-84 age group was associated with a 57.6% lower risk of be underweight. It has been well documented that several aging factors contribute to poor nutritional condition on elders, namely changes in sensory abilities such as loss of vision, smell and taste and the increased requirements for certain nutrients may predict adverse outcomes on weight decline (Chwang, 2012; Hickson, 2006). No data were collected in this survey to discuss specificity of nutrients.

Other factor that contributed to underweight among the elderly in this study was inability to cook. Accordingly, recent literature on elders reported association between poor nutrition status and inability to shop, prepare and cook food (Donini et al., 2013; Hanandita & Tampubolon, 2015; Vedovato et al., 2016).

A noteworthy result was regarding to diabetes and high blood pressure, which were found to decrease underweight risk among participants in 66.4% and 54.2%, respectively. Given the fact that these two conditions can promote the development of metabolic syndrome and thus increase morbidity and mortality, one might speculate that close follow-up of diabetic and hypertensive elders on primary care services may promote more disease knowledge and more effectiveness on these pathologies management among this subpopulation.

Weight may have a protective role on elders and although geriatric obesity definition is still controversial and the appropriated BMI cut-off values for the elderly aren't yet defined (Cetin & Nasr, 2014; Reijnierse et al., 2015), previously published works suggested that ideal elderly BMI may increase with age (Schrock et al., 2017). Higher BMI may be a protective outcome due to promote greater reserves of body fat for stressful situations on elders and also lower rates of injury from falls (Cassell & Gleaves, 2006). Regarding to obesity, an association with gender was found and it was consistent with reports from others researchers. In fact, being a female was also a determinant for obesity among the sample. Menopause may be one of the main causes of the higher risk of overweight in female (Inelmen et al., 2003). Post-menopause period is accompanied by decreased 17β estradiol concentrations and increased visceral fat tissue (Björntorp, 2001). Also, female geriatric subjects suffer frequently from osteoarthritis, which together with changes in the body composition of female aging (more adipose tissue and reduction of free-fat mass) can lead to impaired functionality and increased weight (Inelmen et al., 2003; Kyle, Genton, Hans, & Karsegard, 2001).

The relation between obesity and high blood pressure is pointed out on literature (Cetin & Nasr, 2014; Gill, Bartels, & Batsis, 2015; Porter Starr et al., 2016). High blood pressure was associated with higher odds of having obesity in our sampled population. Since both obesity and hypertension are diet-related illnesses, a possible explanation is that due to economic constrains and to physiological loss of taste, elders may prefer palatable cheaper food with more sodium and sugar content as well as energy density. These foods are plenty of energy which together with sedentary lifestyle characteristic from this age group may increase risk of obesity (Dhurandhar, 2016). But other reasons are possible: with aging there is a predominant loss of skeletal muscle and a progressive increase in body fat tissue, especially over age 70 and also a central fat redistribution to the body trunk (Gill et al., 2015). Indeed, hypertension is frequent in elderly who have higher waist circumference (Cetin & Nasr, 2014). Taking into account the above, we hypothesise that probably this possible underlying centripetal adiposity may lead to high blood pressure. Although the paucity of studies about the complex relation between obesity and hypertension, there's evidence that imbalances in leptin hormone levels may exacerbate sympathetic nerve activity and increase blood pressure (Rahmouni, Morgan, Morgan, Mark, & Haynes, 2012; Xie & Bollag, 2016), as well as plasma renin activity, higher plasma levels of angiotensinogen and aldosterone and bigger tissue-conversion enzyme activity in obese, may enlarge arterial stiffness and resistance to blood flow through the vessels (Fares, Barbosa, Borgatto, Coqueiro, & Fernandes, 2012; Rodrigues Barbosa, Balduino Munaretti, Da Silva Coqueiro, & Ferreti Borgatto, 2011).

It is still debated the association between alcohol consumption and body weight (Fares et al., 2012; Liangpunsakul, Crabb, & Qi, 2010). Drinking alcoholic drinks was found more frequent among obese and it was the only lifestyle factor identified as a determinant for high BMI. Beyond fat (9kcal/g), ethanol has the highest energy density (7.1kcal/g) and can increase daily energy intake, and thus playing an important role on obesity, by representing "empty calories" and leading to weight gain (Liangpunsakul et al., 2010). Another hypothesis is that alcohol consumption can influence satiety hormones via central mechanisms, with effects on opioid, serotonergic and GABAergic brain pathways and therefore increasing appetite (Traversy & Chaput, 2015). However, when interpreting the results of the current research the cross-sectional design of the study should be considered, once it constrains to determine causality.

In conclusion, this research may contribute to the knowledge on elderly's weight and nutritional status by identifying factors influencing it. These data support the fact that an BMI in older adults has a multifactorial aetiology and poor nutrition status was found to be related to social and health circumstances. Thus, the evaluation of seniors should integrate a holistic approach and consider all dimensions of the concept of health and not only weight status and their classification.

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The authors declare no conflict of interest.

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