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Food Intake, Body Mass Index and Body Fat Mass in Elderly

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ABSTRACT
The influence of dietary intake in body composition had not been fully established among elderly people. Previous studies had revealed a controversial association between energy, protein, carbohydrate and lipid consumption with body mass index and body composition. The present study intended to evaluate a possible relationship between antropometric data, body composition and dietary intake in elderly people from a daily care institution. Thirty four individuals sixty five or more years old participated in this cross sectional research. Anthropometric measurements such as weight, height, waist and muscular circumference were obtained and body fat mass was calculated by Brozek formula. Food consumption assessment was conducted through a daily weighting method. Daily lipid intake was significantly associated with weight, muscular and waist circumference as well as body mass index ($p<0.05$). However there was not found any association between body fat mass and daily lipid intake ($p>0.05$) which possible suggest that lipid consumption do not affect body fat mass gain neither body fat mass had seem to be associated with daily food intake ($p>0.05$).

Key words: Older people, nutrition, lipids, body fat mass, anthropometry

INTRODUCTION
Geriatric population had been increasing worldwide. Decades ago, Boss and Seegmiller, (1981) had conducted an intensive review in which the main conclusion was that the aging process affects all organs and human body systems. Immune function and digestive tract motility were considered probably the most affected and those which influence more significantly life quality and could promote specific disorders in elderly (Boss and Seegmiller, 1981; Russell, 1992). Psychological disorders had also been considered a matter of concern (Etemadi and Ahmadi, 2009) and could be possible factors affecting food intake.

Nutritional status could be specially affected by several morphologic, metabolic and behavioural changes frequent in elderly. Studies revealed that these changes could affect not only the nutritional status but also the body composition and anthropometric measurements which were considered important health indicators and used as main parameters in malnutrition screening tools (Harris *et al*., 2008; Perissinotto *et al*., 2002; Vellas *et al*., 1999).

Studies pointed out several changes in body composition and anthropometric measurements. Loss of muscle mass had been frequently found and could be an important cause of disability

(Doherty, 2003; Wells and Dumbrell, 2006). Elmadfa and Meyer (2008) had reported increased body fat levels and Hughes *et al.* (2004) had referred to a redistribution of those body fat deposits. These changes were defined as sarcopenic obesity, which could be associated with the high prevalence of several metabolic disorders in elderly (Zamboni *et al.*, 2008).

Obesity and overweight have a complex aetiology, resulting from a bilateral interaction between caloric consumption and insufficient energy output (Afridi and Khan, 2004). Despite the clear influence of diet in body composition and several anthropometric measurements, the direct influence of specific foods and/or nutrients had not been free of some controversies.

Some studies had associated body composition with energy, lipid, protein and carbohydrate ingestion (Periwal and Chow, 2006; Randi *et al.*, 2007; Slattery *et al.*, 1992; Trichopoulou *et al.*, 2002). Most studies indicated a positive association between body mass index and protein intake (Periwal and Chow, 2006; Randi *et al.*, 2007; Slattery *et al.*, 1992; Trichopoulou *et al.*, 2002) but not with carbohydrate intake (Ahluwalia *et al.*, 2009; Randi *et al.*, 2007; Slattery *et al.*, 1992) which were not associated with waist circumference neither with waist-to-hip ratio (Ahluwalia *et al.*, 2009; Slattery *et al.*, 1992).

Some data (Sharkey *et al.*, 2002) also revealed a lack of association between body mass index and other nutrients such as calcium, magnesium, folic acid, zinc and D, B12, B6, C and E vitamins in 60 or more years old people. In fact, overweight could not despise frequent micronutrient deficiencies in this age. A study conducted in 2003 revealed a considerable deficiency in magnesium, copper and zinc (Slowinska and Wadolowska, 2003). Antioxidant consumption had also been considered a special matter of concern considering their benefits in neurodegenerative diseases prevention (Saeed *et al.*, 2005).

It is important to consider that most of these results are based on 24 h recalls and food frequency questionnaires which had been lacking of some accuracy because it depends on the individual memory and could not consider an accurate assessment of food quantities (Sun *et al.*, 2010).

Considering this, the present study intended to establish a clearer association between body composition and other anthropometric measurements with food consumption and specific nutrient intake.

MATERIALS AND METHODS

Sample and ethical approval: The present study was conducted from January to March 2011 and included a sample of 34 elderly people 65 or more years old that were attending a long-term care institution in Sardoal, a Portuguese village.

Study design and procedures were conducted after the ethical commission approval according to Portuguese legislation and the Declaration of Helsinki from World Medical Association. Data were obtained under informed consent.

Anthropometric measurements: Height was measured using a stadiometer with 1 mm precision and a maximum height of 2.10 m with the individuals on their foot with no shoes, equally distributed weight between feet, heels together and natural pending arms aside of the body with open hands with palms close to lateral thigh region and head positioned according to Frankfort's plane.

Individuals were weighted minimally dressed in a portable digital scale with a 150 kg maximum capacity and +/-100 g error margin.

Circumferences were measured with a flexible non-elastic tape while the individuals stood feet together with warms resting by their sides. Waist circumference was measured in the horizontal plane between the lowest rib end and the iliac crest and brachial circumference was measured by encircling the arm midway between elbow and shoulder.

Skinfold measurement was done using Slim Guide calliper with 1 mm error margin, the skinfold measures taken were tricep, bicep, subescapular and suprailiac according to standard procedures (WHO, 1995). All these anthropometric evaluation procedures were conducted separately and there time in all the individuals and the average value was taken.

Body mass index and body fat mass: BMI was calculated by the ratio between weight and square height (WHO, 1995) while Body fat mass was calculated through Brozek formula (Brozek *et al.*, 1963).

Food intake assessment: Food intake was accurately measured. All foods and beverages ingested during a period of 7 days were weighted and registered in the moment and the daily nutritional analysis was done using the portuguese food composition table.

Statistical analysis: All statistical tests were conducted in Statistical Package for Social Sciences (SPSS) version 17.0 for Windows.

Additionally to average, standard deviation and frequency analysis, anthropometric measurements, body composition and food intake data were grouped by sex. To evaluate if there was a significant difference, the parametric test t-student or the non parametric Mann-Whitney tests were conducted.

To evaluate the association between the dependent variables like weight, waist and muscular circumference, body mass index and body fat mass, Pearson correlation test was conducted.

Considering the probable strong associations between these variables, they were grouped in smaller variables using a principal components analysis converting these and allowing a more direct association between the several anthropometric results and the food intake data. All statistical tests were conducted with a significance level of 5%.

RESULTS

Sample general characteristics: Of the individuals present in the sample, 18 were male and 16 female. The overall mean age was 81.1±7.2 years and these distribution is presented in Table 1.

Anthropometric measurements: Weight, height and BMI: There were found significant differences ($p<0.05$) among the several anthropometric measurements between sexes except BMI, as presented in Table 2.

Women had an average weight recorded of 60.0±7.8 kg while the average weight in male was 77.8±12.4 kg.

It is important to note that half the individuals were obese with BMI above 30 kg m^{-2}, these were specially men (32.4%) while the 8.8% of the sample with normal weight were female like presented in Table 3.

Table 1: Sample distribution in age groups

Age	No. of male	No. of female	Total No.	Total (%)
65-69	3	1	4	11.8
70-74	0	1	1	2.90
75-79	3	3	6	17.6
80-84	4	5	9	26.5
85-89	8	5	13	38.2
≥90	0	1	1	2.90

Table 2: General anthropometric measures analysis in the sample in both sexes

	No.	Weight (kg)	Height (cm)	Waist (cm)	BMI (kg m^{-2})	Muscular circumference (cm)	Body fat (%)
Female	16	60.0±7.8	144.2±6.7	90.9±9.9	28.8±3.4	23.5±2.0	40.7±1.8
Male	18	77.8±12.4	157.9±6.4	105.8±8.9	31.2±4.1	25.9±2.9	30.8±2.0
Total	34	69.4±13.7	151.5±9.5	98.8±12	30.1±3.9	24.8±2.7	35.4±5.4

Table 3: Body mass index distribution in both sexes

	Body mass index (kg m^{-2})					
	20.0-24.9 (normal weight)		25.0-29.9 (excessive weight)		≥30.0 (obesity)	
	No.	%	No.	%	No.	%
Female	3	8.8	7	20.6	6	17.6
Male	0	0	7	20.6	11	32.4
Total	3	8.8	14	41.2	17	50.0

Table 4: Waist circumference distribution

	Waist circumference (cm)			
Metabolic disorders risk	Female	No.	Male	No.
No risk	<80	1	<94	1
High	≥80	5	≥94	7
Very high	≥88	10	≥102	10
	Total	16	Total	18

Table 5: Body fat mass distribution in the sample

	Female		Male	
Variable	Body fat mass	(%)	Body fat mass	(%)
Excellent	≥19	0	≥15	0
Good	20-23	0	16-18	0
Intermediate	24-32	0	19-25	1
Reasonable	33-35	1	26-28	1
High	≥36	15	≥29	16

Anthropometric measurements: Waist circumference and body fat mass: From Table 4 data it could be especially important to note that among both genres, more than half of the individuals had shown high waist circumference measures which represent an high metabolic risk factor.

Table 6: Average energy and macronutrient intake in both sexes

Sex	n	Energy intake (kcal)	Protein (g)	Lipids (g)	Carbohydrates (g)
Female	16	1527±215	60.1±10.3	46.6±11.7	230.6± 28.0
Male	18	1851±279	75.6±15.6	63.0±12.2	268.4±44.4

Table 7: Recommended energy and macronutrient intakes for older persons

Parameter	Male	Female
Energy (kcal)	2054	1873
Carbohydrates (g)	130	46
Protein (g)	56	130
Lipids	a	a

a: Lipid intake should represent 20-35% of the total energy intake

Table 8: Comparison between intakes and recommended values considering dietary reference intakes for adults of 70 or more year old

	Female		Male	
Parameter	Recommended[1]	Average	Recommended[1]	Average
Energy (kcal)	1873	1509.0	2054	1849.0
Protein (g)	46	59.4	56	73.9
Carbohydrate (g)	130	228.8	130	269.7
Lipids (g)	-	46.1	-	62.7

Table 9: Components from principal components analysis and respective variable weights

	Components	
Variables	Anthropometry	Body fat mass
Muscular circumference	0.915	0.183
Waist circumference	0.943	-0.013
Body fat mass percentage	-0.479	0.866
Body mass index	0.862	0.413
Weight	0.951	-0.102

Additionally, like presented in Table 5, almost all the individuals had also shown high body fat mass indexes which was not significantly different among sexes.

Food intake assessment: Results from food assessment revealed little differences when compared to dietary recommended intakes. Men ingested in average 1851±279 kcal and women calculus had reported an average of 1527±215 kcal. In Table 6 these data could also be compared with recommended dietary intakes for this age (Table 7). There was a significant difference between male and female average caloric consumption ($p<0.05$).

Despite energy intakes were significantly lower ($p<0.05$) than the dietary reference intakes for Older People, macronutrient intake had remained within the recommended values. In fact, values reported for average protein and carbohydrate intake were higher than the reference values. Considering that there was not defined any dietary reference intake for lipids, only the recommended proportion in energy intake (20-35%), values were within this interval but could be slightly higher in order to reach the recommended caloric ingestion values. The comparison between guidelines and reported values had been resumed in Table 8.

Principal component analysis: Through principal component analysis two main components were defined: Component 1: Anthropometry and Component 2: Body fat mass. Principal components definition and relative weights of each variable are presented in Table 9.

Component 1 explains 72,07% of the total variance while Component 2 had been responsible for 19,30% of the total variance, both represent 91,37% of total variance.

Anthropometric measurements and food intake: After principal component analysis had been done, the multiple linear regression analysis had shown that only lipid ingestion was a significant predictable factor for Anthropometry.

The resulting final adjusted model was ($F(1.32) = 10.4$; $p = 0.003$; $R^2_a = 0.222$):

$$\text{Anthropometry} = -1.930+0{,}35\times\text{Lipid intake/day}$$

Thus, a higher lipid intake had been associated with Anthropometry variable increases with possibly higher muscular and waist circumference, BMI and weight.

However, the same analysis did any significant model for Body fat mass ($p>0.05$) and food intake variables.

DISCUSSION

Anthropometric data from the chosen sample had revealed a high frequency of excessive weight and higher waist circumferences than recommended, these features had been proven to be independently associated with hypertension in elderly (Latiffah and Hanachi, 2008).

Results from the present study had also shown a strong association between lipid intake and anthropometric measures like body mass index, muscular and waist circumferences but not with body fat mass which was in accordance with experimental data obtained by Vahdatpour *et al.* (2008).

Anthropometric measures in these individuals had shown similarities with previous studies about nutritional status of elderly populations (Odenigbo *et al.*, 2010). In the present study energy intakes were lower than recommended for this age but the excessive weight observed could also be due to insufficient energy expenditure, quite frequent in elderly and possible associated with increased risk of cardiovascular risk factors like dyslipidemia (Gharouni *et al.*, 2008).

The association between BMI and specific macronutrient intake was only found on studies with diverse age groups (Randi *et al.*, 2007; Trichopoulou *et al.*, 2002) and non elderly people (Ahluwalia *et al.*, 2009).

Most studies had used only BMI as a variable which could be an important limitation considering that there had been reported significant height declines during aging. Factors like vertebra compression, vertebral disc morphologic changes and muscular tone loss were the main reasons for height decline (Corish and Kennedy, 2003). Perissinotto *et al.* (2002) reported an average height decrease of 2 to 5 cm each 10 years of age. Considering these factors, age had been considered an important co variation factor in BMI (Aslam *et al.*, 2010).

Odenigbo *et al.* (2011) had considered waist circumference as a best indicator for obesity than BMI in adults. Previously Halkjaer *et al.* (2006) results had shown that only protein had a significant effect in waist circumference.

Body fat mass and waist circumference had been considered better indicators for cardiovascular disease risk (Lee *et al.*, 2008). In the present study both these variables were separated by the principal component analysis procedure. While waist circumference was considered in Component 1 that was associated with lipid intake but fat mass, included in Component 2, did not show a strong association.

Dietary fat had become a complex paradox in human nutrition. Despite being energy dense, previous studies revealed a weak or inexistent association between fat intake and body weight gain (Lee *et al.*, 2008) while excessive energy intake itself, from fat or other macronutrient, had shown to be determinant for weight gain and could probably explain the increasing prevalence of obesity (Swinburn *et al.*, 2009).

In the present study, energy intake was lower than the recommended for this age group and lipid intake was found to be within the desired range which means there was not an excessive fat consumption.

CONCLUSION

The present study had shown that excessive weight and high body fat mass had started to affect seriously elderly people.

There was found a significant association between lipid intake and anthropometric measures but had not seem to contribute do body fat mass. Dietary lipids have a crucial role in adult nutrition, including in elderly people despite the lower energy expenditures. In one hand, fat intake should accomplish the recommended guidelines in order to satisfy the essential fatty acids needs in this population, on the other hand should not be excessively consumed in order to maintain a balanced energy intake and prevent weight gain.

Considering the possible lower food intake and the high risk of malnutrition, fat could also help to accomplish the needed and recommended energy intakes in elderly people and by this way prevent unwanted weight-loss.

Further studies should be conducted in order to evaluate the role of the different fat types and specific food group consumption on body composition.

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