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The consumption of antioxidants protects against cognitive and physical disabilities in aged with obesity

El consumo de los antioxidantes protege de discapacidades cognitivas y físicas en ancianos con obesidad

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ABSTRACT

Introduction: antioxidants play an important role in the antioxidant defense system. Obesity and the aging process increase oxidative stress. The disruption of the oxidant-antioxidant balance towards oxidant condition could be related to cognitive and physical disabilities.

Objective: to evaluate the consumption of antioxidants, the oxidative stress status and their relationship with cognitive and functional alterations in aged with obesity.

Method: a cross-sectional study was conducted with 94 subjects ≥ 60 years stratified by body mass index (BMI) (76.6% were women). The antioxidants intake as well as cognitive and functional status were evaluated by validated surveys. The oxidative stress markers were thiobarbituric acid reactive substances (TBARS) and lipid-hydroperoxides (LOOH).

Results: the antioxidants consumption of the participants was below the recommended daily intakes (RDI) independently of the BMI group. Especially, a lower consumption of vitamins E and D, selenium and β-carotenes was observed. The concentration of TBARS was higher ($p < 0.05$) in the obese (1.2 µM) *versus* the normal weight group (0.7 µM). The concentration of LOOH in the normal weight group (17 µM) did not show statistical difference *versus* obese group (15 µM). The presence of obesity in aged showed an association with walking difficulties. Multivariable analysis adjusted for several variables showed that the intake of selenium, copper and magnesium is associated with lower risk of cognitive and physical disabilities.

Conclusions: aged with obesity showed a higher concentration of peripheral TBARS, walking difficulties and lower intake of antioxidants. The consumption of copper, selenium, and magnesium seems to protect against cognitive and physical disabilities in aged with obesity.

Key words: Antioxidants. Obesity. Aged. Oxidative stress.

RESUMEN

Introducción: los antioxidantes son indispensables en el sistema de defensa antioxidante. La obesidad y el envejecimiento aumentan el estrés oxidativo. El desequilibrio del balance oxidante-antioxidante hacia una condición oxidante se relaciona con discapacidad cognitiva y física.

Objetivos: evaluar la ingesta de antioxidantes, el estrés oxidativo y su relación con el estado cognitivo y funcional en ancianos con obesidad.

Métodos: estudio transversal en 94 personas ≥ 60 años estratificadas por índice de masa corporal (IMC) (el 76,6% fueron mujeres). La ingesta de antioxidantes, el estado funcional y el estado cognitivo fueron evaluados con pruebas validadas. Los marcadores de estrés oxidativo fueron las sustancias reactivas al ácido tiobarbitúrico (TBARS) e hidroperóxidos lipídicos (LOOH).

Resultados: la ingesta de antioxidantes de los participantes fue menor a la ingesta diaria recomendada (IDR), independientemente del grupo de IMC. La concentración de TBARS fue mayor ($p < 0,05$) en el grupo con obesidad (1,2 µM) en comparación con el grupo de peso normal (0,7 µM). La concentración de LOOH no fue estadísticamente diferente entre el grupo de peso normal (17 µM) y el grupo con obesidad (15 µM). La obesidad en ancianos se asoció a dificultad al caminar. El análisis multivariado ajustado por múltiples variables mostró que la ingesta de selenio, cobre y magnesio se asocia con menor riesgo de discapacidad cognitiva y física.

Conclusiones: los ancianos con obesidad mostraron mayores concentraciones periféricas de TBARS, dificultad al caminar y una ingesta de antioxidantes deficiente. El consumo de cobre, selenio y magnesio parece proteger de discapacidades cognitivas y físicas a los ancianos.

Palabras clave: Antioxidantes. Obesidad. Ancianos. Estrés oxidativo.

INTRODUCTION

The aged is the fastest-growing segment of the population and it is estimated that, by 2050, there will be two billion people over the age of 60 worldwide (1). The aging process is characterized by changes in body composition, especially reduced lean mass (muscle and bone) and water, as well as increment in the fat mass, generally in the abdominal region (2-4). In this respect, the prevalence of obesity has increased in Mexican aged, since the National Survey of Health and Nutrition in Mexico showed a high prevalence of overweight (42.8%) and obesity (28.3%) in adults between 60 and 69 years old (5). The increment in the prevalence of both mentioned conditions has been associated with an increased risk of disability, physical limitations, falls and fractures (2,6). Likewise, an increase in the prevalence of the principal comorbidities of obesity as diabetes, hypertension, metabolic syndrome, cardiovascular disease, and cancer are, in fact, the main pathologies associated to deaths in Mexico nowadays (7).

The obesogenic phenomenon is directly related to the presence of cellular oxidative stress. This condition takes place when more generation of reactive oxygen and nitrogen species (RONS) are produced in a cell or organism, associated or not with a diminished activity or concentration of antioxidants components. Different studies have shown that oxidative stress has a significant contribution in the development of the main comorbidities associated with obesity (8,9).

The human antioxidant system is supported by enzymatic and non-enzymatic antioxidants mechanisms that avoid the occurrence of oxidative stress in the cell (10). The non-enzymatic mechanism is constituted by several antioxidant molecules as vitamins C and E, carotenoids and the trace elements: copper, manganese, magnesium, selenium, and zinc. These vitamins and minerals play an important role working as cofactors of cellular antioxidant enzymes (11-13).

Aging is a process in which oxidative stress is increasing through time, due to several mechanisms as an increased peripheral concentration of proinflammatory cytokines, as well as an impaired uptake of glucose by the cell (14). These phenomena are associated with a reduced antioxidant capacity of the cell, largely by a diminished capacity of elderly cells to produce the adequate amount of antioxidant enzymes, and a lower consumption of antioxidant minerals by individuals (11-13).

Thereby, oxidative stress increases because of the aging process, and is reinforced by the presence of obesity, since the adipose tissue produces proinflammatory adipokines which enlarge the generation of RONS by endothelial cells and phagocytic immune cells (15).

In the present work, we evaluated the consumption of antioxidant minerals and vitamins, the oxidative stress status and their relationship with cognitive and functional impairment in a typical group of aged with obesity from Mexico City.

METHODS

Study design and population

The study was cross-sectional and based on quantitative data. Ninety-two participants were recruited through convenience sampling. The participants included in the study were invited to participate from eight day-care centers located in the Alvaro Obregón administrative area of the city, named as: a) Casa del Adulto Mayor; b) Centro de Desarrollo Social Torres de Potreros; c)

Centro de Atención Integral Zenón Delgado; d) Casa del Adulto Mayor Gloria; e) Casa del Adulto Mayor Amor a la Alegría; f) Casa Jenner; g) Casa Luz de Primavera; and h) Casa La Asunción. All the participants lived in their own homes and attended once a week one of the aforementioned day-care centers to do ludic and recreational activities.

Subjects included in the study were 60 years old and older without history of thyroid disease, autoimmunity, allergies, infectious disease, eating disorders, cancer, edema and kidney, liver or heart failure. After determining their BMI, individuals were classified in the following categories: normal weight (BMI 18.5-24.9; n = 19), overweight (BMI 25-29.9; n = 41) and obese (BMI > 30; n = 34).

All the participants were informed about the study and accepted and signed the appropriate informed consent form. The study followed the principles of the Declaration of Helsinki and the federal norms of the Mexican Health Bureau to develop projects with humans. The project was revised an authorized by the scientific and ethical committee of the Mexican Association of Nutrition Schools.

Anthropometric evaluation and categorization of covariates

Height was measured for all subjects in a standing position after removing the shoes, with an ultrasonic height measuring unit MZ10020 (GmbH & Co, ADE, Hamburg, Germany). Weight measurements were performed with subjects under fasting condition using an electronic floor scale model FG80616 (GmbH & Co, ADE, Hamburg, Germany). Mid-upper arm circumference (MUAC), waist (WC), hip (HC), and calf circumferences (CC) were measured in cm using a Gulick anthropometric tape (Creative Engineering, Plymouth, Mich., USA). All anthropometric measurements followed the guidelines set by the International Society for Advancement of Kinanthropometry (ISAK), with a technical error of measurement less or equal to 1% (16).

Overweight and obesity were assessed by BMI, using the cut-off points recommended by the World Health Organization (WHO) (17). Ages, MUAC and CC were taken as continuous variables and the other variables like health status, habits and polypharmacy were taken in the interview by autoreport and were categorized as hypertension (0 = no hypertension, 1 = hypertension), osteoporosis (0 = no osteoporosis, 1 = osteoporosis), diabetes (0 = no diabetes, 1 = diabetes), cerebrovascular disease (CVD) (0 = no, 1 = CVD). Other variables were categorized as smoking (never/former or current), alcohol use (none, light, social, ever), sex (0 = female, 1 = male), and polypharmacy as the number of medicaments intake daily.

Determination of antioxidants consumption frequency

To establish the antioxidant consumption in the study groups, a food frequency questionnaire for antioxidants validated by the National Institute of Public Health was applied. Recalls were coded and transformed to nutrients in mass units, with the use of a food-composition database program named Nutritional Vector Calculation System developed to accommodate the characteristics of the Mexican diet (18). In order to make the questionnaire easier for the participants, a trained dietitian undertook the interviews using measures, portions and comparative models of food.

In addition, the percentage of individuals consuming equal or more than 100% of recommended daily intake (RDI) or suggested daily intake (SDI) was determined, taking the references values for people over 51 years old by Bourges et al. (19). The reference values are the following: vitamin C (mg): men = 84, women = 75; magnesium (mg): men = 340, women = 260; copper (µg): men = 0.73, women = 0.75; zinc (mg): men = 11, women = 11; manganese (mg): men = 2.3, women = 1.8; selenium (µg): men = 48, women = 48; β-carotene (µg): men = 8,760 (730 µgER), women = 6,840 (570 µgER), 1 µgER (vitamin A = 12 µg of β-carotene); vitamin E (µg): men = 13, women = 13; vitamin D (IU): men = 400 (10 µg), women = 400 (10 µg), 1 µg = 40 IU of vitamin D.

Determination of oxidative stress markers in peripheral plasma by lipid hydroperoxides (LOOH) and thiobarbituric acid reactive substances (TBARS)

Total LOOH were determined using the ferrous ion oxidation xylenol orange (FOX) method described by Jiang et al. (20). This method is based on the oxidation of ferrous ion to ferric ion by the LOOH in acid conditions. The ferric ions produced during the reaction react with the orange xylenol reactive generating a chromophore with an extinction coefficient of 560 nm. A standard curve of hydrogen peroxide in concentrations from 0 to 100 µM was used for calculations.

On the other hand, the lipoperoxidation state of peripheral plasma from study and control participants was determined by the thiobarbituric acid technique described by Asakawa and modified by Estepa et al. (21). The product of the reaction of malondialdehyde-thiobarbituric acid was detected spectrophotometrically at 532 nm, and the concentration evaluated in each sample was reported as µM of TBARS.

The coefficients of variation intra and interassay for both techniques were less than 5% and 10%, respectively.

Functionality test

To evaluate the self-care activities of daily life and the ability to move and use stairs, the index of Barthel was applied (22) by a trained nutritionist. Briefly, this test is a ten-item scale of the following objects: feeding, grooming, bathing, toilet use, dressing, walking, transfers, climbing stairs, fecal and urinary incontinence. It has ten questions with a variable number of answering scores: two questions had two scores (0 to 5), six questions had three scores (0, 5, 10), and two had four scores (0, 5, 10, 15). The sum of the score ranges from 0 (totally dependent) to 100 (totally independent).

Definition of falls

Falls were defined as “an event which results in a person coming to rest inadvertently on the ground or floor or other lower level” (23). The occurrence of falls was assessed in a retrospective manner asking the participants whether they had suffered a fall in the last year. The variable was categorized according to the number of falls in the last year (1 = 1-2; 2 = 3-4; 3 = < 5; 4 = never).

Assessment of depression

For depression, the geriatric depression scale (GDS) was applied. This survey has 15 items with “yes” or “no” answers scored as 1 or 0. The score ranges from 0 (no depression) to 15 (established depression), and it was categorized as: normal: 0-5 points; light-depression: 6-9 points; and established-depression: 10 or more points. To evaluate the cognitive deterioration of participants, the Pfeiffer's test was applied. This test scores the number of wrong answers to ten questions, ranging between 0 (no deterioration) to 10 (severe deterioration) (24).

Statistical analysis

The method of descriptive statistics was used to analyze the results of the variables obtained from the participants in the study. Differences between groups were evaluated using one-way ANOVA and Chi-squared for categorical variables and post-hoc tests for nonparametric and parametric variables (Dunnett and Tukey, respectively). The association between TBARS, LOOH, BMI, estimated consumption of antioxidants and cognitive impairment and disability were examined using multivariable logistic regression analysis. Covariates were examined in the logistic regression models.

Multinomial logistic regressions were used for testing the association between the estimated antioxidants intake quartiles with disability for basic activities of daily living, cognitive deterioration, depression, difficulty to walk, and incidence of falls measured as dichotomous variables. The groups without disability for basic activities, without cognitive deterioration, without depression, without difficulty to walk and without incidence of falls were used as the reference category. The highest antioxidants intake quartiles were the reference group for the other antioxidants intake quartiles. Also, the association between the quartiles of oxidative stress status (TBARS and FOX) and the outcome variables of interest were tested, but the reference group was the quartile with the lowest oxidative stress status. Two models were used for the multinomial logistic regressions. Model 1 was without adjustments and model 2 was adjusted for energy intake and BMI.

Both unadjusted and adjusted odds ratios and 95% confidence intervals were obtained for multivariable and multinomial logistic regressions; $p \leq 0.05$ indicated the presence of a statistically significant difference. All statistical analyses were performed using STATA version 11.0 software (StataCorp LP, College Station, TX).

RESULTS

In the present study, we included 94 adults (≥ 60 years of age), 72 participants were women (76.6%) and 22 were men (23.4%). The mean age for total participants was 72.4 ± 8.6 years. When subjects were classified by BMI, 19 were normal weight (20.2%), 41 were overweight (43.6%) and 34 showed obesity (36.2%). Table I describes the health state and the frequency of demographic, anthropometric and clinic characteristics showed by participants classified by BMI.

With respect to the presence of comorbidities of obesity such as diabetes, hypertension, and osteoporosis, there was no statistically significant difference between groups. Also, no differences were identified that were related to physical and cognitive ability alterations such as falls, difficulty to walk, instrumental activities of daily living, depression, cognitive impairment, and smoke and alcohol intake (Table I).

Oxidative stress and antioxidant intake

Despite there is a positive relationship between weight and TBARS marker, a statistical difference has been registered between normal weight and obesity only ($p < 0.05$). On the other hand, the concentration of LOOH did not show any significant statistical difference between groups (Table I).

The statistically significant differences observed in the antioxidant intake was between the overweight and the control (normal weight) group ($p < 0.05$), where the overweight group showed a lower zinc and selenium intake. The other analyzed antioxidants showed no statistically significant differences between groups (Table II). However, the consumption of antioxidant vitamins and minerals was lower than the recommended amounts in all participants, except for vitamin C in men with normal weight, manganese in overweight women, and copper and manganese in men with obesity.

Half the population takes the recommended daily intake of vitamin C, copper, zinc and manganese. However, the intake of vitamins D and E, selenium, and beta-carotenes is low, since only 35% of the men and women from studied groups reached an intake equal or greater to RDI/SDI. In fact, we identified that 0% of participants reached the RDI/SDI dietary recommendation of the aforementioned antioxidants in almost all men and women of the studied groups (Table III).

Loss of physical and mental capacity and its association with studied variables

In the present study, anthropometric variables, oxidative stress markers and antioxidant intake were evaluated, as well as their relationship with the presence of alterations associated with a decrease in physical and mental capacity of the participants.

No relationship was observed in the logistic regression analysis between oxidative stress markers and physical disabilities to perform basic activities, walking difficulties or falls in people studied, even after adjusting for age, sex, CC, HC, and WC. However, a lower risk of disability in basic activities was identified in the normal weight and overweight groups ($p < 0.05$), in contrast to an increased risk in the obesity group, after adjusting for the aforementioned variables (Table IV). The results of our study also indicate higher odds for walking difficulties in the obesity group; the odds increased as the degree of obesity increased.

The results of the logistic regression analysis showed that the intake of selenium was associated with a lower risk of inability to perform basic daily activities. Also, copper showed a positive effect regarding cognitive impairment. The intake of magnesium was associated with a lower risk of walking difficulties. All associations were adjusted for age, sex and caloric intake (Table V).

In the multinomial logistic regressions, there were some significant associations between the estimated antioxidants intake quartiles and the outcome variables of interest. The second quartile of manganese was positively associated with disability for basic activities of daily living relative to the highest quartile of the estimated intake of manganese in model 1 (OR 5.359, 95% CI 1.246-23.042, $p = 0.024$) and model 2, (OR 6.151, 95% CI 1.278-29.605, $p = 0.023$). Also, the third quartile of the intake of magnesium was positively associated to walking difficulties in model 1 (OR 3.6, 95% CI 1.007-12.865, $p = 0.049$). In the case of the oxidative stress status, the second and third quartile of FOX were positively associated to difficulty to walk relative to the lowest quartile of FOX in model 1 (second quartile: OR 3.6, 95% CI 1.007-12.865, $p = 0.049$; third quartile: OR 6, 95% CI 1.651-21.801, $p = 0.006$) and model 2 (second quartile: OR 3.624, 95% CI

1.011-12.981, p = 0.048; third quartile: OR 5.772, 95% CI 1.577-21.116, p = 0.008).

DISCUSSION

In our study, we explored the dietary and health situation of a typical non-randomized elderly group with obesity of middle class people living in Mexico City, with the intention of evaluating the antioxidant intake and oxidative stress markers and their relationship with cognitive and functional alterations. We decided to include aged with obesity without chronic or acute medical complications (cancer, autoimmunity, eating disorders, kidney, liver, and heart failures, etc.) with the aim of reducing variables that may skew the results. Particularly, because the physiopathology of these conditions alters some targets studied in the present study (antioxidants and oxidative stress).

In the last decades, changes in the dietary habits have promoted the consumption of high energy foods, rich in simple sugars and fat, and the sedentary lifestyle, which have led to an increase in the prevalence of overweight and obesity. The elderly segment of the population has not been exempt from this phenomenon since, according to the result of the National Health Survey of 2012, the prevalence of overweight and obesity was 71% in the Mexican population (5). In our study, we identified similar values of overweight and obesity (80%) compared with those reported.

Despite the expected (25), our study did not show a difference in the prevalence of comorbidities between the normal, overweight and obesity groups. This might be due to the characteristics of our sample. All the participants were relatively healthy and were able to assist to day-care centers.

In line with the current evidence (9,14), oxidative stress increased as weight increased. The concentration of TBARS was significantly higher in the group with obesity compared to the normal weight group. Although no difference in the prevalence of comorbidities was observed, the increment of oxidative stress promotes chronic low inflammation state and causes a detrimental effect in the long term. Also, the higher concentration of TBARS in people with obesity is closely related to the data observed in the antioxidant consumption. The deficient consumption of antioxidants in the obesity group may be part of the reason for the higher values of TBARS observed in this group, since it has been described that the obesogenic process is associated with a greater production of free radicals and oxidative stress.

When we analyze the percentage of individuals consuming a concentration equal or greater than the suggested RDI/SDI value, we clearly identify in the three groups studied that the percentage of individuals consuming the previously mentioned recommendation is especially low for selenium, β-carotene and vitamins D and E. These results are in line with previous data reported by Da Silva et al., in a study where food consumption in 424 Brazilian elderly men and women aged more than 60 years old was assessed. Their results indicated a dramatically insufficient consumption of vitamins (A, D, B1, B2, B5, B6, B12, C, E) and minerals (phosphorus, magnesium, zinc, copper, iodine, selenium), except for iron (26).

On the other hand, the deficiency in the consumption of antioxidants in the elderly not only has direct effect on the promotion towards oxidative stress, but it may also increase physical and cognitive impairment since low serum carotenoid levels or decreased β-carotene consumption has been reported to be associated with low muscle strength, impairment of physical function, and walking difficulty (27,28). The same has been observed for α-tocopherol (a component of vitamin E with great antioxidant capacity), identifying that a low blood concentration of this molecule is associated with lower strength and physical performance in the geriatric population (29,30). In the case of vitamin D, which also shows deficient consumption in men and women of all studied groups, it has been reported that low levels of this molecule are related to lower muscle strength, increased falls and physical disability in the geriatric population (31,32). However, most of these associations could not be observed in our study.

The relationship between antioxidant consumption, oxidative stress markers and the presence of physical and cognitive disabilities was analyzed by means of a logistic regression analysis. The analysis of consumption of antioxidants with physical and cognitive disabilities adjusted by age, sex, and caloric intake showed that selenium is associated with a lower risk of disability in basic activities of daily living of elderly. These results are in line with published data, which indicates that selenium plays an essential role in muscle function, and its deficiency has been associated with various muscular diseases affecting both the heart muscle and the skeletal muscle (33,34). Likewise, we also identified a protective effect of magnesium (OR 0.94, IC 95% 0.90-0.98, p =

0.03) on the walking difficulty in the elderly people. The deficiency of this mineral has been associated with alterations in muscle performance as low values of handgrip strength, knee extension strength and physical activity in the elderly (34,35). In the case of cognitive impairment, only copper showed a protective effect in relation to the presence of this alteration. It has been previously reported that this mineral plays a key role in the biochemistry of the nervous system, and its deficiency is associated with cognitive impairment in the elderly (36). When analyzing the data by a multivariate analysis after adjustment for age, gender, calf, waist and hip circumferences, we identified that the presence of normal weight and overweight are protective factors to perform basic activities of daily living such as mobility, bathing, dressing, self-feeding, personal hygiene and grooming. The obesity group was stratified by degrees of obesity I to III (OB-I, -II, -III) according to the BMI, and no relationship with the aforementioned variables in any of the degrees of obesity was observed. However, when analyzing the variable of walk difficulty, a robust predisposition of this disability with all the degrees of obesity was observed.

The study has some limitations which need to be addressed. The population included in the study is from the same city. In addition, the participants were recruited through convenience sampling, therefore, there might be selection bias and our sample might not be completely representative of the elderly population in Mexico City. Likewise, our sample size was smaller than expected due to our inclusion criteria; from 350 candidates, we were able to include 94 subjects. Caution should be taken in the generalization of the results to the entire elderly population.

Nevertheless, the present study reinforces the need to implement effective strategies in the obese aged population, especially in the nutritional area, promoting a higher consumption of antioxidants by their natural sources or by supplements, aiming at improving the health condition of this population group as well as their quality of life.

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Table I. Demographic, anthropometric and health status variables of 94 elderly people

Variables	All (n = 94)	Normal weight (n = 19)	Overweight (n = 41)	Obese (n = 34)	p
Age (years)	72 ± 8.6	76 ± 9.5	72 ± 8	70 ± 7	0.06
Sex, male/female	22/72	7/12	12/29	3/31†	*0.03*
Weight (kg)	64 ± 12	51 ± 8	62 ± 9*	75 ± 8†‡	*0.01*
BMI (kg/m^2)	29 ± 5	23 ± 1	27 ± 1*	33 ± 4†‡	*0.01*
Height (cm)	149 ± 9	148 ± 11	150 ± 10	149 ± 6	0.79
WC (cm)	89 ± 10	80 ± 6	88 ± 8*	96 ± 8†‡	*0.01*
HC (cm)	97 ± 13	87 ± 7	94 ± 12	108 ± 9†‡	*0.01*
MUAC (cm)	28 ± 4	24 ± 2	24 ± 2*	31 ± 3†‡	*0.01*
CC (cm)	35 ± 8	30 ± 3	35 ± 10*	36 ± 5‡	*0.01*
LOOH (µMol)	16 ± 7	16 ± 6	16 ± 6	16 ± 9	0.84
TBARS (µMol)	0.97 ± 0.57	0.68 ± 0.35	0.78 ± 0.36	1.35 ± 0.67†‡	*0.01*
Alcohol drinking (%)	30	7.4	13.8	8.0	0.56
IADL depend. (%)	11	4.2	2.1	4.0	0.16
Walking difficulty (%)	61	11	27	23	0.68
Hypertension (%)	44	12	19	13	0.28
Polypharmacy (%)	24	5.0	10	8.0	0.95
CVD (%)	6.0	1.0	5.3	0.0	0.09
Depression (%)	13	3.2	5.3	4.3	0.90
Osteoporosis (%)	18	4.2	11	3.2	0.20
DM2 (%)	32	7.5	15	10	0.68
Falls (%)	58	12	28	17	0.36

Data are mean ± standard deviation or percentages. BMI: body mass index; CC: calf circumference; CVD: cardiovascular disease; DM2: diabetes mellitus type 2; HC: hip circumference; IADL: instrumental activities of daily living; LOOH: lipid hydroperoxide; MUAC: mid-upper arm circumference; TBARS: thiobarbituric acid reactive substances; WC: waist circumference. Continuous variables by one-way ANOVA. Categorical variables by χ^2-test. "p" value: comparison between normal weight, overweight and obese groups. *p ≤ 0.05, normal weight *versus* overweight. †p ≤ 0.05, overweight *versus* obese. ‡p ≤ 0.05, normal weight *versus* obese.

Table II. Antioxidants intake of 94 elderly people by weight group

Variables	*All (n = 94)*	*Normal weight (n = 19)*	*Overweight (n = 41)*	*Obese (n = 34)*	*p*
Vitamin C (mg)	164 ± 86	168 ± 86	145 ± 82	186 ± 88	0.11
Magnesium (mg)	298 ± 97	322 ± 93	273± 100	313 ± 91	0.09
Copper (µg)	2 ± 1.2	2 ± 0.8	1.7 ± 1.5	2.2 ± 1.3	0.20
Manganese (mg)	19 ± 16	14 ± 12	18 ± 15	24 ± 18	0.11
Zinc (mg)	14 ± 6	17 ± 4	12 ± 7*	15 ± 6	*0.01*
Selenium (µg)	28 ± 17	35 ± 20	24 ± 15*	29 ± 16	*0.05*
β-carotene (µg)	3,064 ± 1,711	2,611 ± 1,307	2,861 ± 1,762	3,563 ± 1,768	0.09
Vitamin D (UI)	205 ± 121	231 ± 129	172 ± 102	230 ± 132	0.06
Vitamin E (µg)	7 ± 4	7 ± 3	7 ± 4	8 ± 4	0.67
Retinol (IU)	2,500 ± 2,016	2,312 ± 1,470	2,216 ± 1,849	2,946 ± 2,409	0.26

One-way ANOVA. "p" value: comparison between normal weight, overweight and obese groups.

*p ≤ 0.05, normal weight *versus* overweight.

Table III. Percentage of participants consuming antioxidant vitamins and minerals according to RDI/SDI recommendation

Variables	*Normal weight*		*Overweight*		*Obese*	
	Men (n = 7)	Women (n = 12)	Men (n = 12)	Women (n = 29)	Men (n = 3)	Women (n = 31)
Vitamin C (mg)	100 (7)	75 (9)	66 (8)	69 (20)	66 (2)	96 (29)
Magnesium (mg)	57 (4)	41 (5)	83 (10)	*51 (15)*†	33 (1)	70 (22)
Copper (µg)	85 (6)	66 (8)	83 (10)	86 (25)	100 (3)	*96 (30)*‡
Zinc (mg)	85 (6)	50 (6)	75 (9)	58 (17)	66 (2)	64 (20)
Manganese (mg)	85 (6)	83 (10)	91 (11)	*100 (29)**	100 (3)	96 (30)
Selenium (µg)	28 (2)	0 (0)	16 (2)	6.9 (2)	0 (0)	22 (7)
β-carotene (µg)	0 (0)	0 (0)	0 (0)	6.9 (2)	0 (0)	6.4 (2)
Vitamin D (IU)	28 (2)	0 (0)	0 (0)	3.4 (1)	0 (0)	6.4(2)
Vitamin E (µg)	14 (1)	8.3 (1)	8.3 (1)	6.9 (2)	33 (1)	9.6 (3)

Data are expressed as percentage of subject with intake over 100% of RDI/SDI; () number of subjects. Comparison between normal weight, overweight and obese groups by Chi-squared test. *p ≤ 0.05, normal weight *versus* overweight. †p ≤ 0.05, overweight *versus* obese. ‡p ≤ 0.05, normal weight *versus* obese.

Table IV. Logistic regression of oxidative stress markers, body mass index and disability variables

	OR (unadjusted) 95% CI	*p*	*OR (model 1) 95% CI*	*p*
Basic activities of daily living				
FOX (µM)	1.09 (0.40-2.9)	0.87	1.05 (0.96-1.2)	0.27
TBARS (µM)	1.03 (0.95-1.1)	0.49	1.63 (0.39-6.7)	0.49
Body mass index				
18.5-24.9 (kg/m^2)	0.28 (0.09-0.82)	0.02	0.16 (0.04-0.67)	*0.02*
25-29.9 (kg/m^2)	0.33 (0.10-1.1)	0.07	0.16 (0.03-0.85)	*0.05*
30-34.9 (kg/m^2)	0.41 (0.11-0.4)	0.17	0.19 (0.01-2.6)	0.21
35-39.9 (kg/m^2)	0.45 (0.08-7.1)	0.65	0.35 (0.02-8.03)	0.62
≥ 40 (kg/m^2)	0.68 (0.29-0.8)	0.77	0.24 (0.01-13.5)	0.49
Depression	1.65 (0.44-63.1)	0.44	1.4 (0.31-24.7)	0.65
Cognitive impairment	2.51 (0.51-12.1)	0.25	3.0 (0.36-24.8)	0.31
Walking difficulty				
FOX (µM)	1.00 (0.93-1.1)	0.95	1.01 (0.92-1.1)	0.80
TBARS (µM)	0.77 (0.32-1.9)	0.58	0.40 (0.10-1.5)	0.18
Body mass index				
18.5-24.9 (kg/m^2)	1.7 (0.64-4.7)	0.28	3.2 (0.86-11.6)	0.08
25-29.9 (kg/m^2)	1.4 (0.47-4.2)	0.55	2.4 (0.43 -13.6)	0.31
30-34.9 (kg/m^2)	1.4 (0.43-4.7)	0.60	1.9 (1.1-3.3)	*0.03*
35-39.9 (kg/m^2)	3.6 (0.33-38.4)	0.30	5.2 (1.3-21)	*0.05*
≥ 40 (kg/m^2)	1.8 (0.13-23.4)	0.65	9.6 (1.6-57.6)	*0.02*
Cognitive impairment	0.45 (0.09-2.2)	0.33	0.54 (0.07-3.9)	0.55

CI: confidence interval; FOX: ferrous ion oxidation xylenol orange; OR: odds ratio; TBARS: thiobarbituric acid reactive substances. Model 1: adjusted by age, sex, calf, waist and hip circumference.

Table V. Logistic regression of antioxidant intake with disability variables

Variables	*OR (95% CI)*	*p*
Basic activities of daily living		
Vitamin C (mg)	1 (0.99-1)	0.73
Magnesium (mg)	1 (0.99-1.01)	0.90
Copper (µg)	1.12 (0.87-1.6)	0.27
Manganese (mg)	0.98 (0.94-1.01)	0.21
Zinc (mg)	0.97 (0.87-1.09)	0.65
Selenium (µg)	0.92 (0.80-0.98)	*0.02*
β-carotene (µg)	1 (0.99-1)	0.585
Vitamin D (UI)	1 (0.99-1)	0.69
Vitamin E (µg)	1 (0.88-1.15)	0.95
Retinol (IU)	1 (0.91-1.1)	0.99
Cognitive impairment		
Vitamin C (mg)	1 (0.99-1.01)	0.96
Magnesium (mg)	0.99 (0.98-1.01)	0.44
Copper (µg)	0.13 (0.18-0.91)	*0.04*
Manganese (mg)	0.99 (0.93-1.04)	0.63
Zinc (mg)	1.04 (0.87-1.24)	0.63
Selenium (µg)	0.96 (0.90-1.03)	0.27
β-Carotene (µg)	1 (0.99-1)	0.69
Vitamin D(UI)	0.99 (0.99-1)	0.350
Vitamin E(µg)	1.1 (0.91-1.33)	0.32
Retinol (IU)	1.07 (0.93-1.29)	0.33
Walking difficulty		
Vitamin C (mg)	1 (0.99-1.01)	0.50
Magnesium (mg)	0.94 (0.90-0.98)	*0.03*
Copper (µg)	0.99 (0.75-1.32)	0.97

Zinc (mg)	0.99 (0.91-1.09)	0.97
Selenium (µg)	0.99 (0.96-1.03)	0.87
β-carotene (µg)	1 (0.98-1.0)	0.37
Vitamin D (UI)	1 (0.99-1)	0.32
Vitamin E (µg)	1.02 (0.90-1.15)	0.79
Retinol (IU)	1.01 (0.92-1.09)	0.88

OR: odds ratio; CI: confidence interval. Adjusted for age, sex and caloric intake.