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# Anthropometric, functional capacity, and oxidative stress changes in Brazilian community-living elderly subjects. A longitudinal study☆

Priscila Lucelia Moreira[a,*], Camila Renata Correa[b], José Eduardo Corrente[c], Luis Cuadrado Martin[a], Paulo Jose Fortes Villas Boas[a], Ana Lucia Anjos Ferreira[a]

[a] Department of Internal Medicine, Botucatu Medical School, Sao Paulo State University (UNESP), Botucatu, SP, Brazil
[b] Post-Graduation Program in Pathology, Botucatu Medical School at São Paulo State University (UNESP), Botucatu, SP, Brazil
[c] Department of Biostatistics, Botucatu, Institute of Biosciences at Sao Paulo State University (UNESP), Botucatu, SP, Brazil

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ABSTRACT

*Objective:* To examine the changes and relationships among anthropometric, functional and plasma oxidative stress markers in elderly.
*Design:* longitudinal study.
*Setting:* measurements in 2008 and 2010.
*Participants:* 103 community-dwelling men and women aged 67–92.
*Measurements:* Anthropometric parameters [waist, hip, arm and calf circumferences; waist-hip ratio, triceps skinfold thickness and others], basic (ADL) and instrumental activities of daily living (IADL)] and plasma oxidative stress markers ($\alpha$-tocopherol, $\beta$-carotene and malondialdehyde) were assessed in 2008 and 2010.
*Results:* ADL, IADL, body weight, skinfold thickness and circumferences of calf and arm decreased and waist and waist-hip ratio increased from 2008 to 2010. $\alpha$-Tocopherol decreased and malondialdehyde plasma levels increased during the study period. In multiple logistic regression analyses, increased age (OR = 1.12; IC: 1.02–1.23; p = 0.02), female gender (OR = 8.43; IC: 1.23–57.58; p = 0.03), hypertension (OR = 0.22; IC: 0.06–0.79; p = 0.02), arthritis/arthrosis (OR = 0.09; IC: 0.009–0.87; p = 0.04) and depression (OR = 0.20; IC: 0.04–1.03; p = 0.05) were independent risk factors for functional decline.
*Conclusion:* Fat reduction, muscle loss, central obesity increase, functional decline and worsening of plasma oxidative stress were observed during 2-year follow-up. Some of the risk factors that were identified could be modified to help prevent functional decline in elderly. The factors deserving attention include hypertension, arthritis/arthrosis and depression.


## 1. Introduction

The Brazilian aging population has increased rapidly and is expected to reach the rank of the sixth country most elderly populous by 2025 (WHO, 2005). Aging process is characterized by reducing both lean mass (muscle, bone and water) as the fat mass (Marucci, Alves & Gomes, 2011). The process is also accompanied by occurrence of chronic diseases and progressive limitations in functional performance (Alves et al., 2007; Ramirez-Tortosa et al., 2004). Due to the dramatic increase in number of elderly, the prevalence of dependence is expected to increases as well. The prevention or even delay of the independence loss has significant implications in cost to the state and in the quality of old individuals's lives (Guralnik, Alecxih, Branch, & Wiener, 2002). Therefore, it is important to identified modifiable risk factors to avoid functional decline.

Disability is defined as 'any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered for a human being' (WHO, 1980). Functional disability is often measured by self-reports from people who either need help or have difficulty with basic activities (ADL)

☆ Institution address where the work was done: Department of Internal Medicine. Botucatu Medical School, Sao Paulo State University (UNESP), Botucatu, SP, Brazil. CEP: 18618-970, Brazil. Tel./Fax: +55 14 3880 1171/+55 14 3882 2238.
* Corresponding author.
*E-mail addresses:* pri_moreira@yahoo.com.br (P.L. Moreira), correa.camila9@gmail.com (C.R. Correa), jecorren@ibb.unesp.br (J.E. Corrente), cuadrado@fmb.unesp.br (L.C. Martin), pvboas@fmb.unesp.br (P.J.F.V. Boas), ferreira@fmb.unesp.br (A.L.A. Ferreira).

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(Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963) and instrumental activities of daily living (IADL) (Freedman, Martin & Schoeni, 2002; Lawton & Brody, 1969). These validated scales allow exploring a wide range of physical, biological and psychological functions and reflect the level of dependence (Gallucci et al., 2011).

Functional incapacity has been associated with various factors, such as specific chronic diseases (Balzi et al., 2010; Nascimento et al., 2012), sociodemographic characteristics (Nascimento et al., 2012), changes in body composition (Larrieu et al., 2004; Moreira & Boas, 2011; Nam, Kuo, Markides, & Al Snih, 2012) and blood oxidative stress markers (Alipanah et al., 2009; Bartali et al., 2008; Cesari et al., 2006; Saito et al., 2012).

Smoking (Stuck et al., 1999), low education (Rodrigues, Facchini, Thume, & Maia, 2013), age (Balzi et al., 2010; den Ouden, Schuurmans, Mueller-Schotte et al., 2013; Rodrigues et al., 2009), female gender (den Ouden et al., 2013), depression symptoms (Lêng & Wang, 2013; Rodríguez López, Montero, Carmenate, & Avendano, 2013; Stuck et al., 1999), hypertension (Balzi et al., 2010; Rodríguez López et al., 2013) and arthritis (den Ouden et al., 2013) are factors that have also been linked to functional decline in follow-up studies. However, to the best of our knowledge, the present study is the first to investigate the relationship among anthropometric measurements, functional capacity scores, socioeconomic status, medical conditions and blood oxidative stress markers in community-dwelling elderly. Therefore, the aim of the present study was to examine the changes and relationships among anthropometric, functional capacity (ADL and IADL), plasma oxidative stress markers (β-carotene, α-tocopherol and malondialdehyde), medical conditions, sociodemographic characteristics of elderly from a Brazilian city in 2-year follow-up study.

## 2. Participants and methods

The study was conducted in Botucatu (130,201 inhabitants) (IBGE, 2012) located (22°53′09" south latitude, 48°26′42" west longitude) in the Sao Paulo state, Brazil. The study consisted in a reevaluation in 2010 (Moment 2010) of a community-living elderly group assessed in 2008 (Moment 2008) (Moreira, Corrente, Boas, & Ferreira, 2014). Two-year follow-up was chosen according to previous study with elderly people (Enoki et al., 2007; Ramos, Simoes, & Albert, 2001) whose results showed that functional decline, anthropometric changes and mortality were correlated in a 2-year period.

The 2008 sample (base sample) was obtained from a database of a previous study conducted in Botucatu (Joia, Ruiz & Donalisio, 2007). From the database sample of 365 elderly, 185 subjects were randomly selected to be part of the current study database. Fifty-nine subjects were excluded due to several reasons (refusal to participate in the study, 34; unanswered phone, 13; death, 3; use of vitamins, 3; absence of records on their medical conditions, 3; hospitalization, 2; absence, 1), and therefore, 126 remained in Moment 2008. In Moment 2010, 23 subjects were excluded (refusal to participate in the study, 12; unanswered phone, 7; death, 4) and therefore, 103 subjects were reassessed. Inclusion criteria were pre-defined as follow: residing in a community (city of Botucatu, SP, Brazil), ≥60 years old and agreeing to participate in the study. Data were collected from May to November 2008 (Moment 2008) and from August 2010 to February 2011 (Moment 2010). The initial contact occurred by telephone, followed by a household interview, anthropometric measurements and blood draw. Data collections were done by an only trained interviewer in both moments. All procedures were in accordance with the Helsinki Declaration for human rights, and the study was approved (#374/2009) by the Research Ethics Committee of the Botucatu Medical School at Sao Paulo State University (UNESP). All patients or their legal guardians signed a Free-Consent form.

### 2.1. Laboratorial analyses

Fasting fresh serum was collected for determination of albumin (g/dL), glucose (mg/dL), triglycerides (mg/dL), total cholesterol and its fractions (mg/dL). The analyses were performed on automated equipment by standard dry chemistry methodology (Vitros 950, Johnson & Johnson, Raritan, NJ, USA).

Fasting plasma was obtained and storage at −80 °C until analyses (maximum 6 months) of oxidative stress biomarkers. Alpha-tocopherol and β-carotene (Ferreira et al., 2000; Yeum et al., 1995) and malondialdehyde (MDA) (Karatas, Karatepe & Baysar, 2002; Nielsen, Mikkelsen, Nielsen, Andersen, & Grandjean, 1997) were determined according to previous studies by high performance liquid chromatography (Waters Alliance 2695, Waters, Wilmington, MA, USA). Every procedure was done protected from light. The α-tocopherol, β-carotene and MDA were analyzed in two moments (2008 and 2010). The samples from the two moments were compared using values as a percentage relative to the maximum value (μmol/L) obtained in each moment (Table 1). This procedure was adopted due to the fact that different HPLC systems were used in the two moments. The results from Moment 2008 are presented as real value (μmol/L) (Tables 3 and 4).

### 2.2. Anthropometric indicators and dietary intakes

Weight and height were measured and BMI was calculated as weight/height$^2$ (kg/m$^2$) and classified as low weight (≤23), ideal (23–28) and overweight (≥28) (OPAS, 2003). For bedridden, weight and height were estimated according to established formulas (Chumlea, Guo, Roche, & Steinbaugh, 1988; Chumlea & Guo, 1992). Triceps (TSF) and subscapular skinfold thickness (SSF), Waist (WC), hip (HC), arm (AC) and calf (CC) circumferences were measured according to previous reports (Lohman, Roche & Martorell, 1998). The waist-to-hip ratio (WHR) was calculated and the values were utilized to define elevated risk criteria for cardiovascular complication (1.00 for men and 0.85 for women), as suggested by the World Health Organization (WHO, 1997). The

**Table 1**
Anthropometric indicators, functional capacity and oxidative stress markers variation between 2008 and 2010.

| Variables[a] | 2008 Mean (±SD) | 2010 | *p*-value |
|---|---|---|---|
| Weight (kg) | 71.05 (14.96) | 70.59 (15.66) | 0.04 |
| Height (m) | 1.61 (0.09) | 1.61 (0.09) | 0.77 |
| BMI (kg/m$^2$) | 27.21 (4.90) | 27.10 (4.89) | 0.30 |
| CC (cm) | 36.82 (3.38) | 35.99 (3.41) | <0.0001 |
| WC (cm) | 93.85 (12.77) | 95.82 (12.49) | 0.0002 |
| HC (cm) | 104.85 (10.89) | 104.79 (11.26) | 0.77 |
| WHR | 0.90 (0.09) | 0.92 (0.09) | <0.0001 |
| AC (cm) | 32.01 (4.01) | 31.40 (4.19) | 0.004 |
| TSF (mm) | 17.07 (7.17) | 15.67 (6.37) | 0.002 |
| SSF (mm) | 14.86 (3.96) | 14.43 (3.89) | 0.56 |
| AMAc (cm$^2$) | 48.65 (11.96) | 47.55 (12.34) | 0.11 |
| ADL | 5.73 (0.82) | 5.52 (0.89) | 0.0001 |
| IADL | 22.74 (2.68) | 22.10 (3.46) | 0.002 |
| β-carotene (%)[b] | 28.90 (19.96) | 29.79 (22.36) | 0.58 |
| α-tocopherol (%)[b] | 52.74 (18.82) | 26.87 (16.80) | <0.0001 |
| MDA (%)[b] | 31.87 (18.05) | 54.56 (19.70) | <0.0001 |

BMI: body mass index; CC: calf circumference; WC: waist circumference; HC: hip circumference; WHR: waist-to-hip ratio; AC: arm circumference; TSF: triceps skinfold thickness; SSF: subscapular skinfold thickness; AMAc: corrected arm muscle area; ADL: basic activities of daily living; IADL: instrumental activities of daily living; MDA: malondialdehyde

[a]Comparisons between 2008 and 2010 were analyzed by Paired t-Student test.

[b] Percentage relative to the maximum value obtained in 2008 and in 2010.

corrected arm muscle area (AMAc) was calculated by established formulas (Heymsfield, McManus, Smith, Stevens, & Nixon, 1982). The evaluation of estimated daily intake was performed according to previous study (Moreira, Corrente et al., 2014).

### 2.3. Socioeconomic status and medical conditions

Subjects were questioned about current income (2008: basic salary, R$ 415.00, US$ 219.71; 2010: basic salary, R$ 510.00, US$ 301.46), schooling (number of years at school), companion at the home (yes or no), smoking habit (yes: current/former or no: absence) and self-reported diseases (yes or no). The presence of diseases was assessed with a series of questions to the subjects asking if a doctor had told them about medical conditions. Hypertension, arthritis, diabetes mellitus, depression, and arthritis/arthrosis and osteoporosis were the most prevalent self-reported diseases.

### 2.4. Functional status measurements

Self-reported measures of disability included activities of daily living (ADLs) (Katz et al., 1963) and instrumental activities of daily living (IADLs) (Lawton & Brody, 1969). Individuals were defined as presenting difficulty if an affirmative response was given to at least one of the questions referring to difficulties in performing ADL and IADL (Amigues et al., 2013; Balzi et al., 2010; Nam et al., 2012; Ramsay, Whincup, Morris, Lennon, & Wannamethee, 2008; Sánchez-García et al., 2014). The ADL scale (range 0–6) (low value indicates high impairment) was composed by the following tasks: eating, dressing, moving (from/to bed, chair or stand position), personal hygiene, urinary continence and use of toilet. The IADL scale (range 0–24) (low value indicates high impairment) was composed by the following tasks: telephone use, use of transportation, shopping, meal preparation, housekeeping, washing clothes, manual work (as craft, gardening etc.) and responsibility for medication intake.

### 2.5. Statistical analyses

The variable values (anthropometric indicators, functional capacity, energy [kcal] intake, fruit/vegetable intake, laboratorial analyses, income, education and functional capacity [ADL and IADL]) were described in quantitative variables and expressed as mean and standard deviation (±SD) or median and percentiles (p25–p75). For gender, self-reported diseases, companion at home, income and smoking were described in frequencies and percentages. Comparisons between groups (with and without functional decline) were analyzed by Wilcoxon, Chi-square or Student *t*-test.

Group (Moments 2008 and 2010) differences in anthropometric characteristics, functional capacity and oxidative stress marker were analyzed by paired t-Student test. Chi-square test was used for comparison between proportions.

Multiple logistic regression model was used considering impairment of functional capacity (ADL and IADL) as variable response; and anthropometric, biochemical, socioeconomic, self-reported diseases and oxidative stress as independent variables, using a *stepwise* variable selection method, corrected for BMI, WC, Kcal, smoking and fruits/vegetables intakes. Data were analyzed using SAS for Windows software, v.9.2 (Cary, NC, USA). In all tests significance level was 5%.

## 3. Results

Among the 103 included subjects, 60 (58.2%) were women. The age population ranged from 67 to 92 y (76.3 ± 5.95). Body weight, CC, AC, TSF, ADL and IADL scores decreased and WC and WHR increased from 2008 to 2010. Alpha-tocopherol decreased and the malondialdehyde plasma levels increased during the two moments (Table 1). It was also identified that the percentage of overweight elderly persons (IMC $\geq$ 28 kg/m$^2$) was lower in 2010 (35.6%) than in 2008 (38.8%).

For ADL, 22 subjects (women, 14; men, 8) worsened, 3 improved and 78 maintained the same score between 2008 and 2010. For IADL, 28 individuals (women, 19; men, 9) worsened, 7 improved and 68 maintained the same score between 2008 and 2010. Although the IMC measured in 2008 did not significantly interfere on functional capacity of 2010, it was observed that subjects classified as low weight in 2008 (total, 7; IADL, 40% *vs.* ADL, 6.7%) showed in 2010 a more prevalent IADL compared to ADL (IADL *vs.* ADL). It was also verified for overweight elderly people (IADL, 34.2% *vs.* ADL, 23.7%), although the difference between disabilities (IADL vs. ADL) is low (Table 2).

Subjects who developed impairment for ADL in 2010 were older and had low IADL score in 2008 (Table 3). Elderly who developed impairment for IADL in 2010 were older, had low education, hypertension, depression, arthritis/arthrosis and ADL and IADL low scores in 2008 (Table 4).

In multiple logistic regression analyses, increased age, female gender were independent risk factors for functional IADL decline. Absence of hypertension and arthritis/arthrosis were independent protector risk factors for functional IADL decline. The same was identified for absence of depression, although it was of marginal significance (p = 0.05) (Table 5). Absence of risk factors were identified for ADL (data not shown).

## 4. Discussion

Our results showed that elderly displayed muscle mass loss (AC and CC), adipose tissue reduction (AC and TSF), functional decline (ADL and IADL) and worsening of oxidative stress (decrease in $\alpha$-tocopherol and increase in MDA) in a two-year follow-up. An increase in central obesity (WC and WHR) was also identified. Increased age, being female, absence of hypertension, arthritis/arthrosis and depression were independent risk factors for functional IADL decline.

Several longitudinal studies evaluated Brazilian elderly (Figueiredo, Assis, Silva, Dias, & Mancini, 2013; Lima e Costa et al., 2000; Lebrão & Duarte, 2003; Maciel & Guerra, 2010; Ramos, 2003; Santos, Dantas & Moreira, 2011). However, these studies have not evaluated the association among the variables like the current

**Table 2**
BMI classification in 2008 of the subjects that developed functional decline in 2010.

| Funcional Decline (2008–2010) | BMI classification in 2008 | | | *p*-value[a] |
|---|---|---|---|---|
| | Low weight (n = 15) | Ideal (n = 50) | Overweight (n = 38) | |
| ADL | 1 (6.7%) | 12 (24.0%) | 9 (23.7%) | 0.3234 |
| IADL | 6 (40.0%) | 9 (18.0%) | 13 (34.2%) | 0.1152 |

Values represent number of subjects (percentage); BMI: body mass index; ADL: basic activities of daily living; IADL: instrumental activities of daily living
[a]comparisons among BMI classifications were analyzed by chi-square test.

**Table 3**
Main characteristics of the study sample in 2008 that developed or not ADL decline in 2010.

| Variables | ADL decline | | *p*-value[a] |
|---|---|---|---|
| | Yes (n = 22) | No (n = 81) | |
| Age (y), mean (±SD)[2] | 78.54 (6.60) | 75.64 (5.64) | 0.04 |
| Gender (women), n (%)[3] | 14 (23.3) | 46 (76.6) | 0.56 |
| Hypertension, n (%)[3] | 11 (23.4) | 36 (76.6) | 0.64 |
| Arthritis/Arthrosis, n (%)[3] | 1 (14.3) | 6 (85.7) | 1.00 |
| Diabetes mellitus, n (%)[3] | 4 (18.2) | 18 (81.8) | 0.68 |
| Osteoporosis, n (%)[3] | 2 (16.7) | 10 (83.3) | 0.67 |
| Depression, n (%)[3] | 5 (35.7) | 9 (64.2) | 0.15 |
| Living alone, n (%)[3] | 3 (21.4) | 11 (78.6) | 0.99 |
| Smoking n (%)[3] | 1 (9.1) | 10 (90.9) | 0.41 |
| Income (<4 BS), n (%)[3] | 8 (16.3) | 41 (83.6) | 0.23 |
| Schooling years, mean (±SD)[2] | 6.77 (5.03) | 6.35 (4.78) | 0.71 |
| BMI (Kg/m$^2$), mean ± SD[2] | 28.29 (6.00) | 26.91 (4.54) | 0.24 |
| WC (cm), mean ± SD[2] | 94.70 (15.44) | 93.61 (12.04) | 0.72 |
| WHR, mean ± SD[2] | 0.88 (0.08) | 0.89 (0.09) | 0.49 |
| AC (cm), mean (±SD)[2] | 32.45 (4.66) | 31.89 (3.84) | 0.56 |
| TSF (mm), mean (±SD)[2] | 17.27 (6.63) | 17.01 (7.34) | 0.88 |
| AMA (cm$^2$), mean (±SD)[2] | 48.29 (11.45) | 48.74 (12.15) | 0.87 |
| CC (cm), mean (±SD)[2] | 37.84 (3.62) | 36.49 (3.25) | 0.10 |
| Kcal, mean (±SD)[2] | 2280.7 (626.2) | 2382.7 (801.6) | 0.58 |
| Fruit/veget intake (g), mean (±SD)[2] | 687.70 (277.40) | 664.50 (331.70) | 0.57 |
| ADL, median (25th–75th)[4] | 6 (6–6) | 6 (6–6) | 0.27 |
| IADL, median (25th–75th)[4] | 24 (21–24) | 24 (24–24) | 0.002 |
| Albumin (g/dL), mean (±SD)[2] | 3.96 (0.33) | 3.98 (0.33) | 0.81 |
| Total chol (mg/dL), mean (±SD)[2] | 179.9 (28.73) | 194.6 (36.23) | 0.08 |
| HDL-chol (mg/dL), mean (±SD)[2] | 48.65 (14.59) | 48.97 (14.62) | 0.93 |
| LDL-chol (mg/dL), mean (±SD)[2] | 104.5 (29.63) | 114.4 (32.79) | 0.22 |
| Tg (mg/dL), mean (±SD)[2] | 125.5 (54.64) | 150.2 (81.58) | 0.20 |
| Glucose (mg/dL), mean (±SD)[2] | 90.90 (18.11) | 99.82 (43.28) | 0.15 |
| β-carotene (μmol/L), mean (±SD)[2] | 0.10 (0.07) | 0.11 (0.08) | 0.47 |
| α-tocopherol (μmol/L), mean (±SD)[2] | 12.66 (3.74) | 13.07 (4.86) | 0.71 |
| MDA (μmol/L), mean (±SD)[2] | 0.84 (0.46) | 0.83 (0.47) | 0.95 |

y: years; BS: basic salary; BMI: body mass index; WC: waist circumference; WHR: waist-to-hip ratio; AC: arm circumference; TSF: Triceps skinfold thickness; AMAc: corrected arm muscle area; CC: calf circumference; veget: vegetables; ADL: basic activities of daily living; IADL: instrumental activities of daily living; chol: cholesterol; HDL: high density lipoprotein; LDL: low density lipoprotein; Tg: triglycerides; MDA: malondialdehyde; [2,3,and4]: analyzed by Student *t* (2), chi-square (3) and Wilcoxon tests (4).
[a] Adjusted by BMI, WC, Kcal, ingestion of fruit/vegetable and current smoking.

study and none of them assessed oxidative stress. To the best of our knowledge, this is the first study to evaluate jointly the anthropometric variables, functional capacity (ADL and IADL), socioeconomic status, health habits and oxidative stress markers (β-carotene, α-tocopherol and MDA) in Brazilian community-dwelling elderly.

The decrease in weight, BMI, CC (Almeida et al., 2013), TST (Almeida et al., 2013; Hughes et al., 2004), SSF (Hughes et al., 2004), AC (Almeida et al., 2013; Enoki et al., 2007; Hughes et al., 2004) and AMB (Almeida et al., 2013; Enoki et al., 2007) were also identified in other follow-up studies, corroborating our findings. The decrease in AMA ($p > 0.05$) and TSF ($p < 0.05$) presently observed were predictors of mortality in 2-y follow-up in Japanese population (Enoki et al., 2007). The decrease in AC seen in our results was associated with mortality from all causes in 6-y follow-up study of European population (Hollander, Bemelmans & Groot, 2013). The increased WC and WHR also identified by other researchers (Almeida et al., 2013; Genton et al., 2011), amplified the chance of functional decline for both ADL and IADL in 9-y follow-up in older Americans (Houston, Stevens, & Cai, 2005). However, a study conducted in São Paulo-SP (6-y follow-up) showed reduction in WC and WHR (Almeida et al., 2013). The fact that we found increasing values of these anthropometric variables (WC e WHR) can be partly explained by the redistribution of body fat that occurs in aging (Ding et al., 2007; Chang, Beason, Hunleth, & Colditz, 2012; Michalakis et al., 2013). BMI maintenance for two years [2008 (27.21 ± 4.90) vs. 2010 (27.10 ± 4.89), $p = 0.30$] and the lack of association between the index and functional decline (ADL and IADL) suggest that the maintenance of weight within the normal range (BMI 23–28 kg/m$^2$) should be encouraged among elderly (Moreira, Boas & Ferreira, 2014). Another longitudinal study (5-y follow-up) examining older French also found similar results where the lowest functional decline (IADL) was associated with adequate BMI (23–27 kg/m$^2$) (Deschamps et al., 2002).

The functional decline observed for both ADL and IADL parameters was previously identified by follow-up studies in 6 months (Figueiredo et al., 2013), 2 years (Lee, Kim, Back, Kim, & Ryu, 2013; Menezes, Bachion, Souza, & Nakatani, 2011), 3 years (Balzi et al., 2010; Bartali et al., 2006), 4 years (Amigues et al., 2013) and 6 years (Alexandre et al., 2012). In contrast, longitudinal Brazilian study found improvement in functional capacity (measured by the 100-m walking test) in the elderly from several cities analyzed by the National Research by Household Sample (Pesquisa Nacional por Amostras de Domicílio, PNAD) from 1998 to 2003. Some factors that may have contributed to this result were improvement of education, health service accessibility, medical technology development and socioeconomic conditions (Parahyba & Veras, 2008).

Little is known about the diet role on preventing functional disability, although the effect of diet on chronic disease prevention is well established. We identified lower fruit and vegetable intake [mean (± SD), g/day] in individuals who have experienced IADL decline [607.3 (258.7)] as compared to those who didn't have it [671.0 (340.2)], even though this difference was not significant ($p = 0.37$). Antioxidants in fruits and vegetables may prevent oxidative stress damage and, thus, decrease the risk of functional decline (Cesari et al., 2004). Examining 787 older Koreans, recent cross-sectional study showed that high fruit and vegetable intake was associated with low risk for ADL and IADL disability (Kim et al., 2013). Similar results were observed in a biracial cohort study

**Table 4**
Main characteristics of the study sample in 2008 that developed or not IADL decline in 2010.

| Variables | IADL decline | | p-value[a] |
|---|---|---|---|
| | Yes (n = 28) | No (n = 75) | |
| Age (y), mean (±SD)[2] | 79.25 (4.67) | 75.14 (6.01) | 0.001 |
| Gender (women), n (%)[3] | 19 (31.6) | 41 (68.3) | 0.22 |
| Hypertension, n (%)[3] | 18 (38.3) | 29 (61.7) | 0.02 |
| Arthritis/Arthrosis, n (%)[3] | 5 (71.4) | 2 (28.6) | 0.006 |
| Diabetes mellitus, n (%)[3] | 8 (36.3) | 14 (63.6) | 0.27 |
| Osteoporosis, n (%)[3] | 2 (16.7) | 10 (83.3) | 0.38 |
| Depression, n (%)[3] | 7 (50) | 7 (50) | 0.03 |
| Living alone, n (%)[3] | 1 (7.1) | 13 (92.9) | 0.10 |
| Smoking n (%)[3] | 2 (18.2) | 9 (81.8) | 0.74 |
| Income (<4 BS), n (%)[3] | 15 (30.6) | 34 (69.4) | 0.46 |
| Schooling years, mean (±SD)[2] | 4.61 (4.23) | 7.12 (4.86) | 0.02 |
| BMI (Kg/m$^2$), mean ± SD[2] | 27.72 (5.85) | 27.01 (4.51) | 0.51 |
| WC (cm), mean ± SD[2] | 95.75 (14.09) | 93.14 (12.26) | 0.35 |
| WHR, mean ± SD[2] | 0.89 (0.08) | 0.89 (0.09) | 0.94 |
| AC (cm), mean (±SD)[2] | 31.87 (4.40) | 32.06 (3.88) | 0.83 |
| TSF (mm), mean (±SD)[2] | 17.88 (8.06) | 16.75 (6.82) | 0.47 |
| AMA (cm$^2$), mean (±SD)[2] | 47.99 (12.79) | 48.90 (11.70) | 0.73 |
| CC (cm), mean (±SD)[2] | 37.18 (4.29) | 36.66 (2.92) | 0.57 |
| Kcal, mean (±SD)[2] | 2395.3 (747.9) | 2348.1 (777.0) | 0.78 |
| Fruit/veget intake (g), mean (±SD)[2] | 607.3 (258.7) | 671.0 (340.2) | 0.37 |
| ADL, median (25th–75th)[4] | 6 (5–6) | 6 (6–6) | 0.002 |
| IADL, median (25th–75th)[4] | 22 (19.5–24) | 24 (24–24) | <0.001 |
| Albumin (g/dL), mean (±SD)[2] | 3.90 (0.40) | 4.01 (0.29) | 0.18 |
| Total chol (mg/dL), mean (±SD)[2] | 181.1 (32.61) | 195.4 (35.49) | 0.06 |
| HDL-chol (mg/dL), mean (±SD)[2] | 47.07 (15.05) | 49.62 (14.38) | 0.44 |
| LDL-chol (mg/dL), mean (±SD)[2] | 105.8 (29.46) | 114.9 (33.15) | 0.21 |
| Tg (mg/dL), mean (±SD)[2] | 145.0 (62.33) | 145.1 (82.65) | 0.99 |
| Glucose (mg/dL), mean (±SD)[2] | 100.8 (39.7) | 96.86 (39.47) | 0.65 |
| β-carotene (μmol/L), mean (±SD)[2] | 0.09 (0.06) | 0.11 (0.08) | 0.16 |
| α-tocopherol (μmol/L), mean (±SD)[2] | 12.57 (4.99) | 13.14 (4.51) | 0.58 |
| MDA (μmol/L), mean (±SD)[2] | 0.81 (0.46) | 0.84 (0.47) | 0.80 |

y: years; BS: basic salary; BMI: body mass index; WC: waist circunference; WHR: waist-to-hip ratio; AC: arm circunference; TSF: Triceps skinfold thickness; AMAc: corrected arm muscle area; CC: calf circunference; veget: vegetables; ADL: basic activities of daily living; IADL: instrumental activities of daily living; chol: cholesterol; HDL: high density lipoprotein; LDL: low density lipoprotein; Tg: triglycerides; MDA: malondialdehyde; [2,3,and4]: analyzed by Student *t*-test (2), chi-square (3) and Wilcoxon (4).
[a] Adjusted by BMI, WC, Kcal, ingestion of fruit/vegetable and current smoking.

(9-y follow-up) with American men and women (45–64 y) (Houston, Stevens, Cai, & Haines, 2005). The lack of significance in the present study can be partly explained by short interval between the two analyses.

There was no association between functional decline and socioeconomic indicators, blood glucose, lipid profile, albumin and oxidative stress markers in our analyses. On the other hand, previous study described that low levels of serum albumin and total cholesterol were associated with mortality and ADL decline in a longitudinal study (12-y follow-up) conducted in older Japanese

**Table 5**
Multiple logistic regression of promoting factors for IADL decline.

| Variables[a] | IADL[b] | | p-value |
|---|---|---|---|
| | OR | IC 95% | |
| Age | 1.12 | 1.02–1.23 | 0.02 |
| Sex | 8.43 | 1.23–57.58 | 0.03 |
| Hypertension | 0.22 | 0.06–0.79 | 0.02 |
| Arthritis/Arthrosis | 0.09 | 0.009–0.87 | 0.04 |
| Depression | 0.20 | 0.04–1.03 | 0.05 |

[a] Adjusted by BMI, WC, smoking, and ingestion of fruit/vegetable and Kcal.
[b] Model containing all variables in Table 2; age: the older the subject, the greater the risk for the development of IADL decline; sex: being female means increased odds ratio for the development of IADL decline; Hypertension, Depression, arthritis/arthrosis (absence *vs*. presence of disease): absence of the condition means lower odds ratio for the development of IADL decline.

(Okamura et al., 2008). In addition, smoking (Stuck et al., 1999) and low education (Rodrigues et al., 2009) have been associated with ADL and IADL declines in systematic reviews.

Defined as an event resulting from an imbalance between reactive species (reactive oxygen species, ROS and reactive nitrogen species, RNS) and antioxidant system, the oxidative stress has been appointed as an important mechanism associated with aging. Several markers measure the oxidation level in lipid, protein and DNA and others assess the antioxidant system content (Moreira, Boas et al., 2014). In the current study, it was evaluated the liposoluble antioxidants (β-carotene and α-tocopherol) and a lipid peroxidation product (MDA) in plasma. Oxidative stress, shown by the reduction of α-tocopherol and increase of MDA, occurred at 2 year-follow-up. The lack of studies analyzing this issue in follow-up trials prevents further comparisons. Examining different age groups, previous studies have also identified the drop of α-tocopherol (Mecocci et al., 2000) and the increase in MDA (İnal, Kanbak & Sunal, 2001; Mezzetti et al., 1996; Mutlu-Türkoğlu et al., 2003; Massudi et al., 2012; Ozbay & Dulger, 2002; Rizvi & Maurya, 2007).

Association between functional decline and changes in plasma oxidative stress markers (MDA, α-tocopherol and β-carotene) was not currently identified. Using larger interval between analyses, longitudinal studies have identified inverse association between functional decline and blood concentrations of carotenoids (Alipanah et al., 2009; Lauretani et al., 2008; Semba et al., 2007) and vitamin E (Bartali et al., 2008).

In multiple logistic regression analyses, increased age, female gender, hypertension, arthritis/arthrosis and depression were independent risk factors for functional IADL decline. No risk factors were identified for ADL decline in our study. Longitudinal trials and systematic reviews also identified predictive or risk factors for functional decline related to increased age (ADL, IADL) (Balzi et al., 2010; den Ouden et al., 2013; Rodrigues et al., 2009), female gender (ADL) (den Ouden et al., 2013), depression symptoms (Lêng & Wang, 2013; Rodríguez López et al., 2013; Stuck et al., 1999), hypertension (ADL, IADL) (Balzi et al., 2010; Rodríguez López et al., 2013) and arthritis (ADL) (den Ouden et al., 2013).

In summary, our study showed that, elderly living in community presented muscle mass loss (AC and CC), reduction (AC, TSF) and redistribution (WC and WHR) of fat, functional decline (ADL and IADL) and worsening of oxidative stress plasma markers (decrease in α-tocopherol and increase in MDA) in two year-follow-up. Additionally, increased age, female gender, hypertension, arthritis/arthrosis and depression were independent risk factors for functional decline (IADL).

The limitations of this study included its small sample size and short follow-up. The original base sample was 365 elderly and 185 were randomly selected. After exclusion, 126 participated on the Moment 2008 and 103 on the 2010. The short interval between assessments was chosen due to the quick nutritional and functional changes, the possibility of sample loss (as shown in our study where 3.2% of population died in the period) and therefore an urgency in the data analysis. On the other hand, longer evaluation interval might have helped to increase the significance of a some borderline associations. However, the observed associations were strong despite the short follow-up. New evaluations of the same population are needed in order to prevent worsening by applying specific health and social policies.

In spite of the limitations, the current study represents a contribution for the understanding of the effect of time on the functional capacity, anthropometric characteristics and oxidative stress markers and as well as the identification of associations among variables in the elderly living in the community. Researches with a larger number of individuals are needed to confirm these results and thus identify what are the most appropriate measures to prevent the institutionalization. Some of the risk factors, that we identified, could be prevented, treated or better controlled, so as to help decelerate functional decline in older. The factors deserving attention include hypertension, arthritis/arthrosis and depression.

## Conflicts of interest

There is no conflict of interest declared.

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PLM performed the data collection. CRC advised laboratory methods. JEC and PLM worked on data analysis and interpretation, and statistical analysis. PJFVB, CRC, PLM, JEC, LCM and ALAF wrote the final version of the manuscript. All authors evaluated the results, contributed their comments, and approved the final version of the manuscript before submission for publication.

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