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Functional, balance and health determinants of falls in a free living community Amazon riparian elderly

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ABSTRACT

The aim of this study was to investigate socio-economic, clinical, anthropometric, balance and functional fitness factors present in Amazon riparian older persons that can be associated with a risk of falling. A cross sectional study was performed with 637 riverine elderly residents ($\geq$60 years old) in Maués city Amazonas, Brazil. The elderly were grouped in two categories with and without a history of falls in the past six months. The following variables were compared between these groups: self-reported social and health conditions; biochemical and physiological variables related to the control of metabolic diseases; body composition; hand grip strength; functional fitness evaluation using the Senior Fitness Test (SFT) battery, and balance condition using the Berg Balance Test (BBT). The prevalence of at least one fall in the past six months was 24.6% ($n = 157$) and was similar between the sexes. The mean age between males and females with and without a history of falls was also similar (males with falls = 72.67 $\pm$ 8.86; males with no falls = 73.26 $\pm$ 7.58) female falls = 71.78 $\pm$ 8.18, female with no falls = 71.48 $\pm$ 8.17). A history of falls was associated with hospitalization in the last year and to self-health perception to both sexes and presence of chronic morbidity and percentage of body fat (BF) to women. However, the other variables including balance and functional fitness, did not present differences between elderly with and without a history of falls. These results suggest that falls experienced by the riparian elderly are strongly associated to accidents due to environmental conditions related to daily life.

1. Introduction

Brazil has one of the fastest aging populations in the world since the proportion of elderly people increased from 8.8% to 11.1% between 1998 and 2008 (IBGE, 2011; Aquino et al., 2012), in view of the rapid aging of the population, increased chronic diseases and disabilities prevalent that affect the older persons. However, Brazil presents a high ethnic and cultural diversity, as well as socio-economic conditions that have an influence on aging and diseases related to difficulties with the standardized health prevention programs.

Most of today's older Brazilian adults who were born in rural areas but now live in urban centers have endured significant socio-economic adversity throughout their lives. They have received little or no formal education and have worked in poorly paid, unskilled occupations (Aquino et al., 2012). Despite such hard conditions, they live better and have more access to health services than the elderly who remained in rural areas.

This is the case of elderly living in the Amazon rainforest. The Amazon region consists of 7 million km^2 and represents over half of the planet's remaining rainforests. Most of the Amazon River Basin's population is concentrated in small urban settlements localized along the river and its main tributaries (Whitmore, 1998).

The geographic and economic difficulties related to health service access of the Amazon riparian communities contributed to the high maintenance of much of today's older population's high risk of illness during their lifetime mainly through the presence of highly transmissible diseases such as malaria and leishmaniasis as

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well as health problems associated with environmental contamination like exposure to mercury (Cardoso, Navarro, Costa Neto, & Moreira, 2010; Lodenius & Malm, 1999).

However, this situation changed in past decades when the Family Health Program (FHP) was established, creating the Brazilian free public health care program. Currently, the FHP allows access to health information regarding the riparian communities (Brazilian National Health System, 2010; Leite, de Vasconcelos, & Lima, 2011).

A previous cross-sectional investigation that included 3314 older persons selected from Brazilian FHP was performed by Ribeiro et al. (2012). The study compared older people living in the Maués riverbank region (riparian elderly) with those living in the highly urbanized Amazonas State area (Manaus). The city of Maués is geographically located in the middle of the Amazon region and has approximately 50,000 people. Maués's headquarters is located on the right bank of the Maués-Açu River where half of the population and the remaining lives in 175 river villages spread throughout a 39,988-km^2 area along the rivers. When compared with other people living in Manaus, riparian elderly received lower incomes, Maués's elderly had reduced access to reliable healthcare, and additionally, they saw a high frequency of people who died before they reached 80 years. There was also a lower prevalence of morbidities such as obesity, type II diabetes, hypertension, and previous cardiovascular diseases. On the other hand, the riparians presented a higher falling prevalence than urbanized elderly (Ribeiro et al., 2012).

Previous studies described the occurrence of four main socio-economic status risk factors associated with falls in older people: limited accessibility to health and social services, low income, little education, and poor housing environments (Peel, 2011) which are found in riparian elderly. These persons live in environments that encourage falls, things like uneven ground around the house, gullies which hinder access to the river, the habitual use of boats for fishing and transport, wearing shoes that predispose them to falling, such as flip-flops, and also very bad conditions where there is some level of urbanization (Ribeiro et al., 2012) (Fig. 1).

Fig. 1. Local study: Maués, Amazonas-Brazil. (A) Maués headquarter overview. Approximately 50% of the riparian population are concentrated in this locale; (B) riparian elderly couple living in Maués-AM; (C) typical riparian house and its surroundings with irregular relief and difficult river access.

However, the presence of other biological and clinical risk factors associated to falls with and/or without serious injury like fractures in riparian elderly is an open question. Since aging, in general, is associated with a decline of functional fitness including exercise capacity, muscle strength and power, balance and/or walking ability (Evans, 2010), the aim of this study was to investigate socio-economic, clinical, anthropometric, balance and functional fitness factors present in Amazon riparian older persons that can be associated with a risk of falling.

2. Subjects and methods

2.1. Subjects and study design

This is a cross-sectional epidemiological study, which analyzes health and functional fitness factors related to falls in the riparian elderly assisted by the FHP in the city of Maués-AM.

We choose to investigate the elderly living in Maués city that is geographically located in the middle of the Amazon region because this city is constituted by Riverine population living in a little urban area and spread in more than 170 riverbanks communities. We also choose to investigated the Maués's elderly because was observed higher frequency of elderly > 80 years old (1%) when compared to Manaus and many other Amazonas cities (0.5%) (IBGE, 2011).

Additionally, Maués, 92% of population was included in the FHP in the moment of the study. The FHP was created to ensure all Brazilians universal, integral, and equal access to health promotion, prevention, treatment and rehabilitation of diseases (Brazilian National Health System, 2010). Each team of FHP is comprised of a physician, a nurse, a nursing assistant, and five or six community health workers. The Maués's FHP help in data collection to perform the present study.

Two logistics to data collection were adopted since Maués presented important population structure differences when compared to urbanized cities as Manaus-AM. (1) We contacted the Municipal Health Department of Maués and the FHP Amazonas State for organization of research. (2) An anthropological pilot study of the health and social characteristics of the Maués elderly was performed to organize the structured interview according to the linguistic and cultural structure of that region, which differs from that of southern and southeastern Brazilian regions (subjects from both urban and riverine-rural regions were interviewed). (3) We validated a structured interview by the application of the survey to 100 seniors participating in the Elderly Community Centre of Maués. (4) Further, health communitarian FHP workers were trained to apply the research instrument. At the time of the study, there were 154 trained health workers. The training was coordinated by a nurse professional who was a specialist in gerontology. (5) The structured interview was implemented and applied by the health team.

The initial sample included in the study consisted of 1805 subjects (male/female = 937/869). The riverine elderly studied here represented 61% of Maués elderly population. To perform the present study, the sample selection considered a prevalence of 23.9% of accidental falls described by Ribeiro et al. (2012) with a 95% confidence interval (CI) and 3% estimation of error resulting in an approximate sample size of 615 individuals to be interviewed. Therefore, the study was conducted in a sub-sample of 637 (342

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female, 295 male). Due to the great difficulty of accessing the elderly who live in riverbank communities existing in the Maués area, the sample investigated in this present study was composed of elderly people living in the Maués headquarters. They were invited to participate in this second phase of research through phone calls and home visits by investigators and/or through contact and invitation by the FHP health-agents. Data were collected at the Maués social service center. All interviewers were previously trained to apply the instruments and consisted: 05 physicians, two nurses, one nutritionist, epidemiologist, physiotherapist and 08 FHP agents. The data used were collected in July 2009.

This investigation included older persons with certain physical conditions who, once they were accepted into the study, chose to move to the location where the data collection was performed. Those who were being treated for disabling diseases or severe cognitive impairment were excluded from this phase of the study. Elderly with cognitive impairment were previously diagnosed by the FHP team by medical records.

In the sub-sample, we compared those riparian elderly who had a history of falls to elderly people without a history of falls in the last six months. The following variables were compared between these two groups: (1) self-reported social and health conditions; (2) some biochemical and physiological variables related to the control of metabolic diseases like type 2 diabetes, metabolic syndrome and hypertension. These procedures indicate the physiological state of the elderly at the moment of the tests (glucose, lipid profile and blood pressure (BP)); (3) body composition; (4) hand grip strength; (5) functional fitness evaluation using SFT battery; and (6) balance condition using the BBT.

Data collection was coordinated and performed by physicians, nurses, physiotherapists, physical educators, social assistants, biologists and by personnel who had previously been trained to collect the information and realize the tests.

2.2. Socio-demographic and health self-report

A structured interview was applied to evaluate the socio-demographics (age, sex, birth location, marital status, education, family income, work status, and type of residence) and the health conditions (falls within the last six months with and without fractures, hospitalization resulting from falls, smoking, chronic diseases like hypertension, diabetes, heart diseases, stroke, other morbidities, number of associated diseases, hearing and visual complaints, daily medication intake, annual immunizations, falls and previous history of hospitalization by other causes of the volunteers. The health data self-report approach has been well documented as a reliable predictor of functional disability and mortality in aged populations (Sun et al., 2007).

2.3. Biochemical and BP analysis

Peripheral blood was collected by venipuncture in the morning (20 mL), after an overnight fast of 12 h or more. Snacks and coffee were offered to the subjects following this procedure. The blood samples were collected in lithium-heparin and EDTA. The samples were stored and frozen at −4 °C until the tests were to be carried out by biochemical analyses. The following blood tests were performed: (glucose, total cholesterol, HDL-c, LDL-c, and triglycerides, TG) (Tonks, 1972). Total cholesterol, HDL-c, TG, uric acid and glucose were determined by enzymatic colorimetric methods using commercial kits, total cholesterol Cod-Ana Labtest (Cat.76, Lagoa Santa, Brazil), HDL-c precipitant Labtest (Cat.13, Lagoa Santa, Brazil), TG Gpo-Ana, Glucose PAP Labtest (Lagoa Santa, Brazil), and LDL-c were calculated according to the Friedwald equation: (LDL-c) = (TG) − (HDL-c + TG/5).

We used standard desk mercury sphygmomanometers (Wanross®) and stethoscopes (Littman®) to assess BP. BP was measured 30 min or more after the last caffeine intake or cigarette smoked. Two measurements were taken with an initial rest of 5 min and subsequently at two minute intervals, when an increased diastolic BP (DBP) or systolic BP (SBP) was recorded.

2.4. Body composition

Body mass index (BMI) was calculated at a ratio of weight in kilograms to the height in meters squared. Waist–hip ratio (WHR) was calculated by dividing waist circumference by hip circumference. Grand mean thickness (GMT) was computed by dividing the sum of all skin-fold measurements by the number of sites measured to visualize overall BF. The subcutaneous fat distribution was assessed by subscapular/triceps ratio. For the estimation of the percentage of BF, density was calculated by the method of Durnin and Womersley (1974) for different age groups (60 at 69, 70 at 79, and 80 years old and above). The calculated body density was converted into the percentage BF following the equation given by Siri (1956).

2.5. Hand grip strength

A hydraulic hand dynamometer with adjustable handgrips was used for this measurement. The participant was sitting in a standard chair, their arm resting on a movable table with the dynamometer in an upright position. Two trials of each hand were performed using the best results for the analysis. Handgrip strength is registered as maximum kilograms of force during a trial. The measurement was not performed if the subject had a current flare-up or pain in their wrist or hand, or had undergone fusion, arthroplasty, tendon repair, synovectomy, or related surgery of the upper extremity within the past three months. No handgrip measurement was performed in 12 subjects.

2.6. SFT battery

The SFT consists of seven tests designed to evaluate several components of functional fitness. SFT measurements were used to assess physical fitness and identify whether an older adult might be at risk for loss of functional ability (Rikli & Jones, 2001). In brief, the battery was performed as follows: before the test, all environmental conditions necessary for the implementation of the protocol (isolation of the study area to ensure that the tests were administered effectively and that individuals could move freely during the tests) were defined. This test was performed in approximately 45 min. The SFT comprises six measurements: (1) the "chair-stand" test measured muscle strength for the lower body; (2) the "arm curl" test measured upper body strength; (3) the "2-minute step" test evaluated cardio-respiratory fitness; (4) the "chair sit-and-reach" test evaluated lower body flexibility; (5) the "back scratch" test measured upper body flexibility; and (6) the "8-feet up-and-go" test evaluated agility and balance.

2.7. BBT test

The equipment required for these tests are a stopwatch or watch with a second hand, and a ruler or other indicator of 0–30 cm. Chairs used during testing were of a reasonable height. The subjects were asked to maintain a given position for a specific time. Progressively more points were deducted if the time or distance requirements were not met, if the subject's performance warranted supervision, or if the subject touched an external support or received assistance from the examiner. Subjects understood that they should maintain their balance while attempting the tasks. The choice of which leg to stand on or how far to reach was left to the individual. A digital chronometer, a 30-cm ruler, a 20-cm high stool, a 42-cm high chair with a backrest and no armrest were used for the assessment (Miyamoto, Lombardi, Berg, Ramos, & Natour, 2004).

2.8. Ethical issues

The project was approved by the Ethical Committee of the Universidade do Estado do Amazonas (Process number: 807/04). Since in Maués the vast majority of older people were illiterate, oral consent or fingerprinting was obtained for their participation in the study after the consent form was read to each participant by the researchers. In Manaus, the most elderly sign the consent term to participate of research.

2.9. Statistical

All analyses were completed using the statistical package for social studies (SPSS) version 17.0 (SPSS Inc., Chicago, IL). Chi-squared tests and *t*-tests were conducted to examine differences in the sociodemographic and clinical characteristics of the Maués and Manaus elderly groups. The elderly subjects were divided into two groups: those with a history of falls and those without falls within the last six months. The results were expressed as mean ± standard deviation (SD) or relative frequency percentage. The following risk factors and other biomarkers of aging were compared between groups: (1) age; (2) sex; (3) self-reported morbidities, medications and biochemical markers associated with metabolic disorders (glucose, lipid profile, uric acid); (4) body composition; (5) SFT; (6) hand grip strength; and (7) the BBT. Multivariate logistic regression analysis (*Backward Wald* method) was used to investigate the adjusted odds of having any disability and/or specific chronic diseases, adjusting for sex and age. All variables that showed univariate statistical $p < 0.2$ were included in the logistic regression test. Statistical analyses were performed where all *p*-values were two-tailed, and $p < 0.05$ was considered statistically significant.

Table 1
Characteristic baseline of Amazon riparian elderly living in Maués-AM, Brazil.

Variables	*n* (%)
Sex	
Males	295 (46.3)
Females	342 (53.7)
Age (years)	
60–69	277 (43.5)
70–79	254 (39.9)
>80	105 (15.5)
Education	
Illiterate	452 (69.4)
<4 years	121 (19.0)
4–8 years	36 (5.7)
>8 years	38 (6.0)
Marital status	
Married	334 (52.4)
Single	71 (11.1)
Widower	197 (30.9)
Divorced	35 (5.5)
Occupation	
Retired	542 (85.1)
No retired	95 (14.9)
Type of dwelling	
Brick house	315 (49.5)
Wood house	294 (46.4)
Others[a]	28 (4.5)

[a] Towll, earthenware and straw house.

3. Results

The baseline characteristics of riparian elderly are presented in Table 1. The report of at least one fall within the last six months was 24.6% (n = 157) whereas, 75.4% (n = 480) did not report falls in the same period. From the elderly studied here, 4.9% (n = 31) reported an occurrence of fractures as a result of falls, whereas 19.9% (n = 127) reported falls without fractures.

The prevalence of falls was similar between the sexes. In men, the prevalence of falls was 22.7% (n = 67) and in women, 26.3%

Table 2
Morbidities and clinical profile of males and females Amazon riparian elderly with and without falls history in the last six months.

Variables	Males			Females		
	Falls *n* (%)	No falls *n* (%)	*p*[*]	Falls *n* (%)	No falls *n* (%)	*p*
Hypertension	27 (40.3)	98 (43.0)	0.696	51 (56.7)	(48.0)	0.159
Diabetes	06 (9.0)	22 (9.6)	0.865	13 (14.4)	38 (15.1)	0.866
CVD	08 (11.9)	15 (6.6)	0.150	03 (3.3)	16 (6.3)	0.284
Osteo-muscular pain	45 (67.2)	142 (62.3)	0.406	69 (76.7)	179 (71.0)	0.304
Other morbidities	30 (44.8)	80 (35.1)	0.149	32 (35.6)	80 (31.7)	0.509
Hospitalizations	19 (28.8)	24 (10.6)	0.0001	19 (21.3)	27 (10.8)	0.012
Chronic morbidities[a]	52 (77.6)	181 (79.4)	0.754	80 (88.9)	197 (78.2)	0.026
Tropical diseases[b]	25 (37.3)	97 (42.5)	0.445	29 (32.2)	66 (26.2)	0.273
Daily medicine intake	31 (46.3)	108 (47.4)	0.874	52 (57.8)	123 (48.8)	0.144
Health						
Poor	14 (20.9)	18 (7.9)	0.010	09 (10.0)	31 (12.3)	0.030
Regular	41 (61.2)	158 (69.3)		71 (78.9)	163 (64.7)	
Good	12 (17.9)	52 (22.8)		10 (11.1)	58 (23.0)	
Vision						
Poor	34 (50.7)	114 (50.0)	0.990	50 (55.6)	125 (49.6)	0.523
Regular	24 (35.8)	82 (36.0)		33 (36.7)	99(39.3)	
Good	09 (13.4)	32 (14.0)		07 (7.8)	28 (11.1)	
Hearing						
Poor	12 (17.9)	35 (15.4)	0.249	11 (12.2)	22 (8.7)	0.581
Regular	25 (37.3)	65 (28.5)		27 (30.0)	73 (29.0)	
Good	30 (44.8)	128 (56.1)		52 (57.8)	157 (62.3)	
Memory						
Poor	12 (17.9)	24 (10.5)	0.138	20 (22.2)	48 (19.0)	0.623
Regular	30 (44.8)	93 (40.8)		48 (53.3)	130 (51.6)	
Good	25 (37.3)	111 (48.7)		22 (24.4)	74 (29.4)	

[a] Presence of at least one chronic morbidity.
[b] Tropical diseases including impaludism, leishmaniasis, camp fever and dengue.
[*] *p* value from mean comparison by Student *t* test.

($n = 90$) ($p = 0.293$). The prevalence of men who presented fractures as a consequence of falls was 3.4% ($n = 10$) when compared to men who experience falls without fractures and men who did not report falls in the last six months. In the women's group, the prevalence of falls with fracture was 6.1% ($n = 21$) and falls without fractures was 21.6% ($n = 74$).

The mean age between males and females with and without a history of falls was also similar (male falls = 72.67 ± 8.86; male, without falls = 73.26 ± 7.58, $p = 0.597$; female falls = 71.78 ± 8.18, female, without falls = 71.48 ± 8.17, $p = 0.760$). A second analysis was performed to compare the frequency of the most elderly persons (≥85 years old) between the groups with and without a history of falls. The most elderly persons represented 10.8% ($n = 17$) of subjects that experienced falls and 7.7% ($n = 37$) of the subjects without a history of falls in the last six months being not statistically different ($p = 0.223$). The sex of the subjects did not influence this results (male $p = 0.397$; female $p = 0.981$).

Socio-demographic characteristics (education level, marital status, occupation and type of dwelling) were similar when a comparison was made between the riparian elderly with and those without a history of falls.

Health indicators such as chronic diseases prevalent in the elderly, hospitalization history in the last year, daily consumption of medications and self-perception of health, vision, hearing and memory were compared between the riparian older persons who experienced falls and those who did not (Table 2). The prevalence of hypertension, diabetes, CVD, osteo-muscular pain and other morbidities were similar between elderly groups as well as daily medicine intake. The number of daily medicine intake was similar between fallers (2.28 ± 1.6) and no fallers (2.22 ± 1.29) ($p = 0.751$). The occurrence of polypharmacy (>5 medicines/day) was low in both groups (fallers = 2.6% and non-fallers = 3.2%) without statistical differences. The most medicines intake was to treat high BP as diuretics and beta blockers and to treat diabetes type 2 as biguanides (Metformin).

It is important here to note that we added strokes in with other items in the CVD category since a lower number of elderly ($n = 07$, 1.1%) reported a previous stroke history. However, the presence of a minimum of one morbidity was more prevalent in women who experienced a fall in the last six months. In men, this association was not observed.

Hospitalization in the last year and self-perception of health were the two variables definitely associated with a history of falls in both sexes. The elderly who reported falls presented a higher hospitalization occurrence than others. However, only three elderly patients were hospitalized due to fractures caused by falls. Men with a history of falls reported poor health self-perception more frequently, whereas women with a history of falls reported a good health self-perception less frequently.

Metabolic biochemical, BP and body composition variables in the glucose and cholesterol were compared between two elderly groups. As seen in Table 3, no differences in the total LDL-cholesterol, HDL-cholesterol, triglycerides, SBP and DBP levels were identified between the elderly with or without a history of falls in both sexes.

The body composition analysis described in Table 4 showed that men with a history of falls presented a higher percentage of BF than men without a history of falls. However, these results were not observed in women. The other variables that were analyzed related to body composition and were similar between the groups.

In men, the functional fitness comparison using the STF battery between the riparian elderly with and without a history of falls showed a significant association between the falls and a lower flexibility evaluated by the "chair sit-and-reach" test. However, women did not present with an association between STF tests and a fall history in the last six months (Table 5).

Multivariate analysis showed that the association between a history of falls with hospitalization and self-reported health perception were independent of sex and age (Table 6). The association between men with a history of falls and BF percentage was independent of age as well as the presence of chronic morbidities and hospitalization. The lower BF was considered a factor to protect against falls (OR = 0.962, CI 95% 0.921–1.000).

4. Discussion

This study aimed to explore the relationship between functional, balance and health variables and fall events occurring in the last six month in the elderly population living independently in a riparian Amazonian region (Maués-BR).

The prevalence of falls observed in our sample group was slightly lower than the frequencies of falls described in other populations such as China (26.4%) (Chu, Chiu, & Chi, 2008), Turkey (28.5%, Halil et al., 2006) Argentina (28.5%, Reyes-Ortiz, Al Snih, & Markides, 2005) and compared with a Brazilian study that was also performed with the elderly, assisted by FHP who live in the Southern Region (27.1%) (Coimbra, Ricci, Coimbra, & Costallat, 2010). In a Manaus elderly population also assisted by FHP, the prevalence of falls was estimated to be 20.1%, which is lower than what was observed in the riverine region (Ribeiro et al., 2008). Most of the studies investigated the prevalence of falls within one year, not within six months (Coimbra et al., 2010; Ribeiro et al., 2008). However, we asked about falls experienced within six months of the occasion of research, though we did not have a valid instrument to measure cognition and humor disorders, mainly depression, as well as the autonomy in this population. These conditions can affect the memory and the precision of information given about the fallings by the elderly (Peel, 2011).

The two important variables that need to be considered are gender and age. In our study, we did not find any significant association between a history of falls in the last six months and these variables. The results showed no association between a prevalence of falls, and age (mainly over 80 years) was not an expected result since advanced age is considered the major risk

Table 3
Biochemical and BP compassion between Amazon riparian elderly with and without falls history in the last six months.

Variables	Males			Females		
	Falls Mean ± SD	No falls Mean ± SD	p^*	Falls Mean ± SD	No falls Mean ± SD	p
Glucose (mg/dL)	122.3 ± 53.1	119.6 ± 50.8	0.708	130.0 ± 59.9	122.8 ± 45.1	0.230
Cholesterol (mg/dL)	220.9 ± 67.8	205.0 ± 52.8	0.135	205.3 ± 52.5	202.9 ± 47.3	0.727
LDL-cholesterol (mg/dL)	146.3 ± 63.0	133.9 ± 50.6	0.145	141.1 ± 44.5	156.0 ± 78.9	0.373
HDL-cholesterol (mg/dL)	50.0 ± 34.4	60.7 ± 37.6	0.145	68.7 ± 18.9	71.4 ± 18.1	0.342
Triglycerides (mg/dL)	161.5 ± 99.6	167.5 ± 90.8	0.842	151.3 ± 73.4	156.0 ± 78.9	0.660
SBP (mmHg)	127.5 ± 24.3	130.1 ± 23.9	0.425	128.9 ± 27.3	128.9 ± 31.3	0.999
DBP (mmHg)	72.3 ± 13.3	74.5 ± 12.9	0.233	72.7 ± 14.4	72.4 ± 16.5	0.889

* p value from mean comparison by Student t test.

Table 4
Body composition and handgrip stretch comparison between Amazon riparian elderly with and without falls history in the last six months.

Variables	Male			Females		
	Falls Mean ± SD	No falls Mean ± SD	p*	Falls Mean ± SD	No falls Mean ± SD	p
BMI (kg/m^2)	24.9 ± 5.9	24.6 ± 4.6	0.609	25.5 ± 4.9	25.9 ± 4.3	0.474
Waist circumference (cm)	90.5 ± 10.4	87.9 ± 13.1	0.086	88.3 ± 14.3	87.8 ± 16.4	0.809
Hip circumference (cm)	95.0 ± 10.0	93.2 ± 11.3	0.258	94.1 ± 9.1	92.3 ± 15.7	0.294
Waist/hip ratio	0.96 ± 0.15	0.96 ± 027	0.986	0.94 ± 0.11	1.01 ± 0.74	0.301
GMT	18.7 ± 5.5	17.5 ± 6.3	0.153	17.5 ± 5.2	18.3 ± 5.9	0.249
Ratio of subscapular to triceps skinfold	1.38 ± 0.48	1.38 ± 0.48	0.994	1.3 ± 0.5	1.4 ± 0.5	0.301
∑ of skinfolds (mm)	168.9 ± 49.2	157.1 ± 5.6	0.153	157.5 ± 46.8	164.8 ± 53.2	0.221
% BF	29.4 ± 5.4	27.8 ± 6.6	0.050*	28.4 ± 5.6	29.0 ± 6.2	0.404
Handgrip right (kg)	21.9 ± 7.7	20.8 ± 7.3	0.292	20.9 ± 7.3	20.7 ± 6.7	0.829
Handgrip left (kg)	20.7 ± 7.4	20.2 ± 7.1	0.673	20.5 ± 7.2	21.2 ± 7.2	0.419

* p value of mean comparison by Student t test.

factor related to falls with a strong scientific significance (Coimbra et al., 2010; Halil et al., 2006; Tinetti, Speechley, & Ginter, 1988; Lucas, Schiller, & Benson, 2004).

We know that aging in general is associated with a decline in exercise capacity, muscle strength and power, lung capacity, balance and/or walking ability. Ultimately these changes in the body may result in a higher risk of falling (Spirduso, Francis, & MacRae, 1995). Therefore, the absence of association between falls and age in riparian populations is in fact, surprising. Environmental causes could explain these results. However, it is very difficult to determine with any precision these variables. In these terms, a longitudinal study investigating the aging of the most elderly of the riparian population could help us understand the contributing reasons related to this result.

The health conditions analyzed by self-reported previous morbidity issues were also evaluated and a comparison made between men and women who had experienced falls and those who had not. Well-documented evidence exists that shows microvascular and other complications of diabetes increased the risk of numerous other complications in older adults, including the risk of falling (Dunican & Desilets, 2011). Recent investigations described a relationship between diabetes and bone disease that could result in falls and fractures, suggesting that diabetes and the complications associated with it can be detrimental to bone health (Fraser et al., 2011; Kurra & Siris, 2011). Despite the evidences previously reported in other elderly populations in our study, we did not find an association among these morbidities and experiences in falling.

Taking the health variables into consideration, hospitalization and self-health perception were the two variables associated with falls in riparian elderly independent of age and sex. We also observed a higher frequency of chronic morbidities and falls in women. Our results agree with the results described in several epidemiological investigations performed by Chang, Yang, and Chou (2010) and Coimbra et al. (2010) that found an association between falls and elderly hospitalization. Literature offers a common description of the association between falls and chronic morbidities. For example, Coimbra et al. (2010) investigated the elderly, and assisted by the Brazilian FHP, found an association between falls with more than eight associated diseases, hearing complaints, and depressive humor.

Since the prevalence of metabolic morbidities like hypertension, diabetes, obesity and metabolic syndrome increase in the elderly population when compared with younger persons, it is currently accepted that some clinical symptoms, complications or pharmacological therapy for these morbidities can contribute to the risk of falls in older persons (Peel, 2011). This probable association that occurs is due to the fact that in the course of aging, degenerative changes occur in the body, mainly in the musculoskeletal system that coexists with chronic diseases. Therefore, the control of these morbidities represents an additional factor that can accelerate or decelerate the reduction in physical capacity increasing the risk of falls (Cameron, 2012). For these reasons, we analyzed the potential association between falls and morbidities and biochemical variables that notify us if some of those diseases like diabetes, hypertension and metabolic syndrome are being controlled. However, in our sample we did not find a positive association between the biochemical variables like glucose and lipid profile and a fall experience.

BP was another variable evaluated that previous studies have associated with falls due to the occurrence of orthostatic hypotension which causes syncope in older people (Ungar et al., 2009). Therefore, we analyzed the possible contribution of hypertension as well as BP at the moment of data collection. Gangavati et al. (2011) found that individuals with uncontrolled hypertension presented a higher risk of falling when compared to subjects with controlled hypertension. We are unable to find any positive association between hypertension history as well as BP level and falls in riparian older persons.

A strong association with falls observed in the riparian elderly population was their health self-perception. The relationship

Table 5
SFT and BBT tests comparison between Amazon riparian elderly with and without falls history in the last six months.

Variables	Male			Females		
	Falls Mean ± SD	No falls Mean ± SD	p*	Falls Mean ± SD	No falls Mean ± SD	p
Chair-stand test (repetitions)	17.2 ± 4.7	17.9 ± 8.5	0.519	17.6 ± 4.6	17.4 ± 4.6	0.690
Arm curl (repetitions)	12.4 ± 5.6	12.4 ± 8.2	0.993	13.5 ± 3.664	13.8 ± 4.3	0.690
2-Min step test (repetitions)	83.4 ± 18.5	86.3 ± 20.5	0.552	83.1 ± 22.5	86.7 ± 21.0	0.198
8-Foot up-and-go test (s)	7.5 ± 1.9	8.5 ± 4.2	0.807	8.2 ± 2.2	7.8 ± 2.5	0.629
Back scratch (cm)	11.3 ± 10.2	−10.9 ± 9.87	0.178	−11.5 ± 10.4	−11.7 ± 10.7	0.999
Chair sit-and-reach (cm)	10.6 ± 10.6	6.2 ±	0.976	6.7 ± 13.1	5.8 ± 12.2	0.553
BBT (points)	51.6 ± 4.5	50.7 ± 6.9	0.350	50.1 ± 7.5	50.7 ± 6.1	0.432

* p value of mean comparison by Student t test.

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Table 6
Multivariate analysis of Amazon riparian elderly with and without falls history in the last six months.

Variables	Odds ratio	C95%	Wald	p*
Hospitalization	3.147	1.929–5.136	17.732	>0.001
Self-reported health perception	1.535	1.086–2.169	6.789	0.009
Sex	0.808	0.556–1.176	1.238	0.266
Age	0.995	0.972–1.018	0.200	0.654

* *p* value of logistic regression (Backward Wald method).

between self-perception of the aging and their future functional health has also been previously studied (Levy et al., 2002). Evidence showed that the negative self-perceptions of health, age, and aging are predictors of worsening health and mortality (Demakakos, Gjonca, & Nazroo, 2007; Gunn et al., 2008; Kuper & Marmot, 2003; Levy & Myers, 2004; Uotinen, Rantanen, & Suutama, 2005). Therefore, our data agree with previous studies that described the relevance of health self-perception of the elderly related to the presence of morbidities or other conditions including a history of falling.

We also observed that men with a history of falling presented with a higher percentage of BF than men without a history of falling. Advancing adult age is associated with profound changes in body composition, the principal component of which is a decrease in skeletal muscle mass. Additionally, aging predisposes the occurrence of an excessive amount of adipose tissue that may contribute to sarcopenia (Evans, 2010). Our data therefore indicated that, especially in riparian elderly men, a lower percentage of BF decreased the risk of falls. The relevance of BF condition is very important to elderly health and autonomy as shown in a recent study performed by Koster et al. (2011) in 2307 men and women aged 70–79 years old who were followed for seven years. In this investigation, total fat mass was acquired from dual energy X-ray absorptiometry and the researchers found that a high percentage of fat was associated with lower muscle quality, predicting an accelerated loss of lean mass.

Another important change related to aging is body balance. Literature presents a great amount of evidence that suggests deficits in postural control and muscle strength associated with aging, which also represents an important intrinsic fall risk-factor (Peel, 2011). Previous studies on falls experienced by the elderly have pointed to the fact that balance-related problems constitute the primary factor in fall experiences (Duncan, Schmidt, Schmitz, & Ott, 1992; Lajoie, Girard, & Guay, 2002). Maki, Holliday, and Topper (1994) and have showed that postural balance was related to the risk of falling (Maki et al., 1994). Several studies as performed by Rogers and Mille (2003) suggested that the ability to balance in a standing position on a single leg can predict falls in advance. Therefore, the results described here apparently are contradictory since we did not find an association between a history of falling and balance using the BBT assessment.

A possible explanation of these observed results is related to a limitation of the test used to evaluate the elderly (BBS). A previous investigation that systematically reviewed the ability of the BBS to predict falls in the elderly did not consider this test very useful in predicting falls in the elderly with and without pathology. The study recommended research to formulate a scoring algorithm that can further enhance the clinician's ability to predict falls in older adults. Unfortunately, it is still very difficult to a perform balance evaluation using advanced technology methods because of the difficulties in gaining access to the riparian population.

We also did not find an association between a history of falls in the last six months and functional fitness evaluated by STF battery. There are few studies correlating the STF battery. An investigation that evaluated the association between the STF battery and the risk of falling performed by Toraman and Yildirim (2010) observed that the risk increased with the declining of upper and lower extremity muscle strength, aerobic endurance, agility and dynamic balance performance in the elderly. We did not find similar results in our population indicating that probable ethnic, health and environmental variables act on these associations. Specifically, the TUG test has been used to evaluate the risk of falls in the elderly. A systematic review of 92 selected studies showed that although retrospective investigations found that the TUG time performance is associated with a past history of falls, its predictive ability for future falls remains limited (Beauchet et al., 2011).

A possible explanation of these results having little to no association between balance, functional fitness and a history of falls is the influence of environmental conditions of daily activity of riparian elderly that might positively influence the balance and fitness condition. Habitually, the riparian elderly use the river as transportation as well as to accomplish several daily activities such as bathing, washing clothes, and fishing. The use of boats as a means of transport and long walks on uneven ground probably contribute to the need for strength maintenance of the lower extremity as described by Maia-Ribeiro et al. (2012) and balance conditions of the riparian elderly. However, it is difficult to measure these variables due the occurrence of multi-causal risk factors related to falls in elderly (Rubenstein & Josephson, 2006). In these terms a complementary prospective study to evaluate the balance and functional fitness in this population must be performed.

Finally, it is important to comment that the study described here had some methodological limitations. This is a cross-sectional investigation, and therefore, it is not possible to establish a cause and effect association. Data from important variables such as cognitive abilities, depression and the autonomy of the riverine elderly, which could also influence health status, were not obtained. However, we chose not to collect this information because we could not be sure how these issues would be interpreted by the elderly and the caregivers. The environmental and cultural conditions of the riverine communities are different from other urbanized populations.

Other bias that can to influence some results observed here is related to under estimative of some chronic diseases. This is the case of diabetes type 2 that we investigated using blood glucose levels. Nowadays, other diagnostic tool detect diabetes type 2 is HbA1c. There are recommendations to use HbA1c $\geq$ 6.5% (48 mmol/mol) as a diagnostic tool to detect type 2 diabetes based on the International Expert Committee (IEC) in 2009, the Sacks et al. (2011) and the World Health Organization (WHO) in 2011. Despite we take care to obtain a realistic elderly sample living in Amazon riparian region we cannot discard the presence of other biases (reliability, selection bias, ecological fallacy.

If tests of autonomy such as Katz and Barthel's scales were to be applied, the conditions under which daily tasks like dressing and preparing food are performed would be assumed similar to other populations. Unfortunately this is not the reality of the riverine communities. For example, when we asked if an elderly person could bathe alone, we were assuming that this elderly individual had a house with one bathroom and which meant he would go into the bathroom, undress, bathe and re-dress. For those in the forest, this condition means leaving the house alone to go to the river, entering the river, bathing and returning to the home usually by a very steep, rugged path. For this reason, the analysis of the cognitive, humor and autonomy indicators are more complex and we cannot estimate the real interference of the same in the results described here.

Considering these, we were not able to find an association between elderly riparian history of falls and sex, age, balance and

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functional fitness as described in other populations. These results suggest that the experience of riparian elderly falls is strongly influenced by accidents due to environmental conditions related to daily life. However, these environmental factors and the potential occurrence of other variables associated with the risk of falling need to be identified in this population since falls are an important public health problem for older adults, resulting in significant morbidity and mortality, as well as healthcare costs.

Conflict of interest

The authors declare that they have no conflict of interest related to any financial and personal relationships with other people or organizations that influenced this work.

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