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Functional fitness in older people: A population-based cross-sectional study in Borba, Amazonas, Brazil

Aptidão funcional em pessoas idosas: Um estudo transversal de base populacional em Borba, Amazonas, Brasil

Aptitud funcional en personas mayores: Un estudio transversal de base poblacional en de Borba, Amazonas, Brasil

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Abstract. Introduction: Aging has been associated with loss of physical capacity caused by the deterioration of most physiological systems. Objective: To analyze the differences in functional Fitness (FF) associated with gender, age and physical activity (PA), and to compare the FF scores of Borbenses with other populations. Method: A cross-sectional study was carried out, comprising 233 elderly (71,2±8,9 yrs old; range between 60,0 to 95,7 yrs old). The FF was evaluated using the Senior Fitness Test battery and PA was estimated by questionnaire. Result: After controlling for age and PA, sex-related differences in FF were only found in shoulder flexibility (favoring women) and in aerobic endurance (AE, favoring men). There were age-related differences in lower body strength (LBS) and AE in both genders and in agility/dynamic balance in men, and upper body strength in women, only, (favoring the younger age group). PA-related differences in FF were only found in trunk flexibility (favoring the active group). Borba population had higher scores in the trunk flexibility than both samples studied and higher scores in shoulder flexibility than Madeiran, only. Conclusion: Except for flexibility and AE, our results indicated FF homogeneity between men and women. The oldest men and women underperformed in LBS and AE. The rest of the FF components may be more dependent on other related factors such as sex, lifestyles, and the environment. Taking into consideration the reference population from the US and Portugal, Borba population underperformed on the majority of FF components, with the exception of flexibility.
Keywords: Physical Fitness. Motor Activity. Ageing.

Resumo. Introdução: O envelhecimento tem sido associado à perda de capacidade física causada pela deterioração da maioria dos sistemas fisiológicos. Objetivo: Analisar as diferenças na aptidão funcional (AptF) associada ao sexo, idade e atividade física (AF), e comparar os Borbenses com outras populações. Métodos: Foi realizado um estudo transversal, em 233 idosos (71,2±8,9 anos; entre os 60,0 e os 95,7 anos). A AptF foi avaliada usando a bateria Senior Fitness Test e a AF foi estimada por questionário. Resultados: Após controlo da idade e a AF, as diferenças relacionadas ao sexo na AptF foram encontradas apenas na flexibilidade do ombro (favorecendo as mulheres) e na resistência aeróbica (RA, favorecendo os homens). Houve diferenças relacionadas à idade na força corporal inferior (FCI) e RA em ambos os sexos, na agilidade/equilíbrio dinâmico nos homens, e força na parte superior do corpo nas mulheres (favorecendo os mais jovens). As diferenças relacionadas à AF na AptF foram encontradas apenas na flexibilidade do tronco (favorecendo o grupo ativo). A população de Borba apresentou resultados mais altos na flexibilidade do tronco comparativamente às duas amostras estudadas. Conclusões: Com exceção da flexibilidade e RA, os nossos resultados indicaram homogeneidade entre homens e mulheres na AptF. Homens e mulheres mais velhos tiveram um desempenho inferior em FCI e RA. As restantes componentes parecem depender mais de outros fatores (i.e., sexo, estilos de vida e meio ambiente). Levando em consideração a população dos EUA e Portugal, Borba teve um desempenho inferior na maioria dos componentes de AptF, expeto na flexibilidade.
Palavras Chave: Aptidão Física, Actividade Motora e Envelhecimento

Resumen. Antecedentes: El envejecimiento se ha asociado con la pérdida de capacidad física causada por deterioración biológica, funcional en la mayoría de los sistemas fisiológicos y eventual muerte. Objetivo: analizar las diferencias en la aptitud funcional (AptF) asociadas con el sexo, la edad y el nivel de actividad física (PA), y comparar las puntuaciones de AptF de los Borbenses con otras poblaciones. Métodos: el estudio transversal se llevó a cabo en 233 personas mayores (71,2±8,9 años; entre 60,0 y 95,7 años). Se realizaron evaluaciones de AptF según los procedimientos de la prueba de aptitud física Senior y se estimó la PA mediante un cuestionario. Resultados: Independiente de la edad y los níveles de AFla mujeres presentaron mejores niveles de flexibilidad en los hombros y los hombres mejor capacidad aerobia (CA). Se presentaron diferencias relacionadas con la edad en la fuerza de en los miembros inferiores (FMI) y CA en ambos sexos, y en la agilidad / equilibrio dinámico en los hombres y en la fuerza en los miembros superiores de las mujeres (con evidencia en personas más jóvenes). Las diferencias relacionadas con PA en AptF se encontraron solo en la flexibilidad del tronco (favoreciendo al grupo activo). La población de Borba presentó resultados más altos en la flexibilidad del tronco en comparación con las dos muestras estudiadas. Conclusión: Con la excepción de la flexibilidad y la CA, nuestros resultados indicaron homogeneidad entre hombres y mujeres en AptF. Los hombres y mujeres mayores tuvieron un rendimiento inferior al de FCI y CA. Los componentes restantes parecen depender más de otros factores (es decir, sexo, estilos de vida y medio ambiente). Teniendo en cuenta la población de EE. UU. Y Portugal, Borba tuvo un rendimiento inferior en la mayoría de las componentes de AptF, a excepción de la flexibilidad.
Palabras Clave: Aptitud Física, Actividad Motora y Envejecimiento.

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Introduction

Ageing has been associated with physical limitation or loss of physical capacity caused by a deterioration in most physiological systems, which leads to loss of adaptability, functional decline and eventual death (Kirkwood, 2017; Sakamoto, Brizon, Bulgareli, Ambrosano, & Hebling, 2019; Tomás, Galán-Mercant, Carnero, & Fernandes, 2018). In Brazil, like other countries in the American and European continents, it has been seen an increase in life expectancy at birth, justified by improvements in sanitary conditions and technological advances in medicine and health care.

The evidence has been shown that there is a normal decline in the functionality in later ages, based on declines in several physiological systems (Enriquez-Reyna, Bautista, & Orocio, 2019; Spirduso, Francis, & MacRae, 2005; Tomás et al., 2018). Aerobic endurance, flexibility, body composition, balance/coordination, and muscle strength are the main physical function attributes, which have been assumed an essential role on the maintenance of physical function, reducing the risk of chronic health conditions, and avoiding age-related incapacities (Roberta E. Rikli, 2013). To better understand FF responses among older ages, several research groups have been published age- and sex- specific normative values (Gouveia et al., 2013; Maressa P Krause et al., 2009; Rikli & Jones, 1999a). Those percentile norms and criterion-referenced fitness standards allows physical fitness instructors to compare scores to others of the same age and sex. For example, Rikli and Jones (1999) presented normative data from a nationwide study involving more than 7183 older Americans from 20 US states.

Another example is the normative data published from Madeira Island by Gouveia et al. (2013) including 802 participants (401 men, 401 women; mean age 69.82 years, *SD*=5.60). Those standards indicate for each FF component the recommended cut-point score needed for independent functioning well into later life.

Another important information that can be extracted from those studies is the pattern of decline in FF parameters in both sexes and in latter ages. In fact, the performance in muscular strength and aerobic resistance decrease between 32% and 44%, from 60 years to 90 years of age in both sexes. Men performed better in muscle strength, aerobic fitness and agility/balance tests than women. On the other hand, women showed better results in the flexibility tests (Roberta E. Rikli, 2013). A deep understanding of those age and sex-associated different patterns is important to define a targeted intervention, with a higher possibility of efficacy at the community level.

Physical activity (PA) levels reflect the improvement of cardiovascular and respiratory functions and the reduction of coronary disease risk factors (Pescatello, Riebe, & Thompson, 2014). The association between FF and PA is reciprocal, since FF allows individuals to engage in a range of physical activities. In fact, PA has an important role in maintain and, in certain cases, improve FF (Calderón & Rodriguez-Hernandez, 2018; Gouveia et al., 2013). In addition, PA decreases has been associated with autonomy loss and, consecutively, with a quality of life reduction (Jackson, Morrow Jr, Dishman, & Hill, 2004; Kirkwood, 2017). Despite the well known benefits of PA, some authors (Gouveia et al., 2013; Jackson et al., 2004; Tomás et al., 2018) have reported a substantial decline in PA levels as people age and the necessity of urgent adequate PA promotion programs.

The FF characterization in Brazilian territory is incomplete. Researchers in Florianopolis and/or Rio Claro (Benedetti, Mazo, Gobbi, Ferreira, & Lopes, 2010), Parana (Maressa P. Krause et al., 2009), in Santa Catarina (Cipriani, Meurer, Benedetti, & Lopes, 2011), in Maringa (Elias, Gonçalves, Moraes, Moreira, & Fernandes, 2012), revealed similar traces to the North American (Roberta E. Rikli, 2013) and the Portuguese (Gouveia et al., 2013). On the other hand, in Amazonas, there are no reference data about FF in older adults. These comparative studies in FF have greater importance since they help to better understand the role of different genetic and environmental backgrounds in FF. It also allows identifying important factors that could affect the ability of older people to function independently for as long as possible.

The main objective of the present study was to characterize the FF of the older people in Borba municipal, Amazonas, Brazil. The specific objectives were: (1) to analyze the differences in FF associated with sex and age; (2) to study the association between FF and PA, and (3) to compare FF in older people from Borba to the North American and Portuguese older population.

Methods

Sample

This cross-sectional study included 233 elderly volunteers, 97 males and 136 females, belonging to the research project «Perfil Morfológico e Aptidão Funcional em Idoso». The sample was divided into 5 age ranges (60–64, 65–69, 70–74, 75–79 years and> 80 years), which were evaluated between May and June 2015. Considering the total number of inhabitants by age and sex, in total, the sample comprised 15% of females and 8.3% of males living in the municipality of Borba, Amazonas. The sample size was calculated considering a confidence level of 95%, a margin of error of 5%, a population proportion of 6%, and the population size of 2064. The minimum number of necessary older people to meet the desired statistical constraints was 84 people, with a margin of error of 2.87%.The following criteria were used to participate in the research: belonging to the municipality of Borba, having the sufficiently autonomy to visit the location of the assessments, absence of medical contraindications regarding the performance of submaximal exercises.

All participants completed questionnaires related to health status and readiness for PA: *Physical activity readiness questionnaire* (PAR-Q) (Gledhill, 2002). Participants signed an informed consent form, informing about the research procedures and risks.

The research was approved by the Research Ethics Committee of the State University of Amazonas (UEA), opinion number 020130/2015. This study did not expose participants to any risk and the procedures met the national guidelines contained in CNS Resolution No. 466/2012

Data collect

All assessments were carried out between May and June of 2015, at the State University of Amazonas (UEA) facilities in Borba. Participation was voluntary and the subjects were recruited through direct contacts by the person responsible for the study in the Basic Health Units - UBS, in the area of residence and in public places such as markets and churches. At the same time, the study was announced on the radio broadcasting in Borba, Amazonas. Before applying the FF tests and the PA questionnaire, the researchers carried out a pilot study involving 50 elderly males and females to minimize errors in the assessments and maximize the uniformity of assessment procedures.

Functional Fitness

FF was assessed using the *Senior Fitness Test* (SFT) battery developed and validated for the older people by (Rikli & Jones, 1999a). This battery includes the evaluation of five components (muscular strength, aerobic endurance, flexibility, agility/dynamic balance and body composition) and six motor tests (30-second Chair Stand; 30-second Arm Curl; 6-minute walk; Chair Sit-and-Reach; Back Scratch and 8-Foot Up-and-Go).

Lower body muscle strength was assessed by 30-second Chair Stand. The participant positioned himself seated in a chair, with a back, and without arms, at the sign of the evaluator the participant gets up, to a fully standing position, and then returns to the sitting position. The score is obtained by the total number of correct executions in 30 seconds.

Upper body muscle strength was assessed by 30-second Arm Curl test. Sitting in a chair, with a back, and without arms, the participant, with his dominant arm close to the side of the body, performed a turn with his palm upwards while flexing the arm in a full range of motion and returning the arm to a fully extended position. The score was obtained by the total number of correct curls performed in 30 seconds.

Lower limb flexibility was assessed by Chair Sit-and-Reach test. The participant positioned himself in a chair, with a back, and without arms, with his preferred leg and slowly leaned forward, keeping the spine as upright as possible and the head aligned with the spine, trying to touch his toes by slipping his hands, one on top of the other, with the tips of the middle fingers, on the extended leg. The score was recorded by evaluating the distance (cm) to the toes (minimum result) or the distance (cm) that was reached beyond the toes (maximum result).

Flexibility of the upper limbs was assessed by Back Scratch Standing test. The subject placed the preferred hand on the same shoulder, palm open and fingers extended, reaching the middle of the back as much as possible. The other arm's hand was placed behind the back with the palm up, reaching up as far as possible to touch or overlap the extended middle fingers of both hands. The score was obtained through the overlap, or the distance between the middle fingers tips, measured at the nearest cm.

Agility and dynamic balance were assessed by 8-Foot Up-and-Go test. The participant started in a sitting position in the chair with an upright posture, hands-on thighs, and feet on the floor with one foot slightly in front of the other. At the sign of the evaluator, the participant got up from the chair, walked as quickly as possible around the cone, returned to the chair, and sat down. The score corresponded to the shortest time elapsed between the «start» signal until the moment the participant sat in the chair.

Aerobic resistance was assessed by the 6-minute walk test. After the evaluator departure's signal, the participant walked as fast as possible (without running) around the course as many times as he/she can within the time limit. The score was the distance (meters) covered in the six-minute interval.

The order of the tests performed was: (1) 30-second arm curl; (2) back scratch: (3) 30-second Chair Stand; (4) 30-second Chair Sit-and-Reach; (5) 8-Foot Up-and-Go, and (6) 6-minute walk. A detailed description of the evaluation procedures, namely, equipment, procedures, scoring, and safety standards can be found in STF Manual (Rikli and Jones, 2013).

Anthropometric Assessment

The height and body weight were measured with an anthropometric scale and coupled stadiometer with a precision of 0.1cm and 0.1kg, by Welmy ® (Marfell-Jones, Olds, Stew, & Carter, 2018). All anthropometric parameters were assessed using protocols defined by the International Society for the Advancement of Kinanthropometry– ISAK (Marfell-Jones et al., 2018).

Physical activity

The modified *Baecke* questionnaire for the elderly (Voorrips, Lemmink, & Bult, 1993) was used to assess habitual PA levels. In this study, we used an adapted a validated version developed by (Ueno, 2013) in Brazilian people. The questionnaire includes items about household activities, sport, and leisure time activities over the past year. To minimize bias, a face-to-face interview was used in the assessements.

Preparation of the Field Team and Pilot Study

The field team consisted of a Physical Education teacher, two community health agents, and seven Physical Education students from the UEA. The preparation of the field team comprised 3 phases: (1) familiarization and application of protocols among the elements of the field team; (2) evaluation of a subgroup of older adults (test; n = 20), and (3) pilot study. In the pilot study, 50 older adults (e» 60 years of age) that did not participate in the main study, were assessed twice with one week apart under similar conditions. Test-retest reliability was calculated using the intraclass correlation coefficient. The intraclass correlation coefficients for the FF tests ranged between 0.873 (in Chair Sit-and-Reach test) and 0.961 (in 30-second Chair Stand), showing a very good reliability

Criterion-referenced functional fitness standards

North American: The study sample of this Criterion-referenced FF standards in American consisted of 7183 participants (5048 women and 2132 men) ages 60 to 94 years old, from 265 test sites in 20 different states.

Portuguese: Participants of this Criterion-referenced FF standards in Portugal are part of the research project entitled «Health and quality of life of older adults from Autonomous

Region of Madeira (ARM), Portugal». In total, 802 community-dwelling elderly active Portuguese, distributed equally over four age cohorts (60–64, 65–69, 70–74, and 75–79 years) were assessed.

Statistical analysis

Descriptive statistics of participants by sex and age (mean, standard deviation) were calculated. Test-retest reliability of FF tests was estimated from the intraclass correlation coefficient in a pilot study. A Kruskal-Wallis test was performed to investigate differences in FF between age groups and physical activity tertiles. In this case, participants were classified separately by age cohort and sex into tertiles of high (active), moderate (average active), or low (non-active) physical activity levels based on their responses to this questionnaire. One-Sample t-test was calculated to compare FF in older people from Borba with North American and Portuguese (Madeiran). Finally, one-way ANCOVA was used to explore differences in FF tests between men and women when controlling for chronological age and PA level. The statistical significance was maintained at 5%. All analyses were performed using the Statistical Package for the Social Sciences - SPSS 26 (Corp, 2019).

Results

Table 1 shows the characteristics of participants. The results of the analyses showed that older women in all age groups had lower body mass and height when compared to older men.

Table 1.
Characteristics of participants

	Age Group						
	60-64 yrs	65-69 yrs	70-74 yrs	75-79 yrs	> 80 yrs	Total sample	95%CI
Women	n=39	n=31	n=22	n=19	n=25	n=136	
Age (yrs)	62,3 ± 1,8	67,6 ± 1,6	72,4 ± 1,4	76,7 ± 1,6	86,7 ± 5,1	151,5 ± 7,1	69,5-72,5
Heigth (cm)	154,1 ± 7,2	150,4 ± 4,6	151,5 ± 7,7	151,0 ± 8,2	149,1 ± 7,3	60,4 ± 12,2	150,0-152,5
Weigth (kg)	62,4 ± 11,8	59,3 ± 10,4	60,0 ± 12,1	62,8 ± 16,9	57,3 ± 11,0	2,0 ±0,5	58,1-62,4
PF Domestic (n)	2,1 ± 0,4	2,0 ± 0,4	2,0 ± 0,5	1,9 ± 0,7	1,8 ± 0,7	0,0 ±0,0	1,9-2,1
PF Sports (n)	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0	0,1 ± 0,4	0,0-0,0
PF Lt (n)	0,1 ± 0,3	0,0 ± 0,2	0,3 ± 0,8	0,0 ± 0,0	0,2 ± 0,5	2,1 ± 0,7	0,19-0,17
PF Total (n)	2,1 ± 0,5	2,1 ± 0,5	2,2 ± 1,0	1,9 ± 0,7	1,9 ± 0,8	151,5 ± 7,1	1,9-2,2
Men	n=35	n=19	n=15	n=12	n=16	n=97	
Age (yrs)	62,3 ± 1,6	67,3 ± 1,7	72,3 ± 1,1	76,6 ± 1,8	85,4 ± 4,4	160,1 ±8,4	68,7-72,2
Heigth (cm)	161,5 ±8,3	159,3 ± 6,2	159,9 ± 12,1	160,0 ± 7,2	158,2 ± 8,3	67,0 ±12,7	158,5-161,9
Weigth (kg)	69,9 ± 14,0	66,6 ± 11,7	65,3 ± 12,6	63,3 ± 10,8	65,6 ± 12,5	1,6 ±0,6	64,4-69,58
PF Domestic (n)	1,6 ± 0,6	1,7 ± 0,3	1,5 ± 0,6	1,4 ± 0,7	1,6 ± 0,6	0,0 ± 0,0	1,5-1,7
PF Sports (n)	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0	0,0 ± 0,0	0,1 ± 0,7	0,0-0,0
PF Lt (n)	0,2 ± 1,2	0,0 ± 0,1	0,0 ± 0,0	0,1 ± 0,4	0,0 ± 0,0	1,7 ± 0,9	0,04-0,25
PF Total (n)	1,8 ± 1,2	1,7 ± 0,3	1,5 ± 0,6	1,5 ± 1,0	1,6 ± 0,6	160,1 ±8,4	1,5-1,8

Mean and standard deviation; PF Physical activity;

Sex-related differences in FF after controlling for age and PA level are presented in Table 2. After controlling for age and PA, women have better performances in the flexibility of the upper limbs (ps < 0,049) than men, and men have higher values on the aerobic endurance test (ps < 0,002) than women. No other statistically significant differences were found in the remaining functional domains.

PA-related differences in FF were only found in trunk flexibility (favoring the active group; p<0.001)

Table 2.
Sex- related differences in Functional Fitness controlling for age and physical activity level.

	Women n=136		Men n=97		p-value (1)	p-value (2)
	Mean ± SD	95%CI	Mean ± SD	95%CI		
CST (n)	10,9 ± 2,5	10,6-11,5	11,1 ± 2,2	10,7-11,6	0,701	0,442
ACT (n)	9,5 ± 2,4	9,1-9,9	10,1 ± 2,4	9,6-10,6	0,109	0,110
CSAR (cm)	6,1 ± 9,4	5,7-8,7	3,7 ± 10,4	2,4-6,5	0,063	0,204
BST (cm)	-11,9 ± 12,0	-13,7- -9,4	-16,0 ± 12,4	-18,0- -12,7	0,009	0,049
FUG (seg)	10,3 ± 2,8	9,6-10,5	10,2 ± 2,1	9,8-10,7	0,988	0,650
6MWT (m)	385,5 ± 85,1	376,3-405,7	421,6 ± 76,7	407,0-439,4	0,002	<0,001

Mean and standard deviation; CST, chair stand test. ACT, arm curl test. CSAR, chair sit-and-reach test. BST, back scratch test. FUG, foot up-and-go test. 6MWT, 6-minute walk test. p-value (1) diferences in FF between men and women after controlling for age; p-value (2) diferences in FF between men and women after controlling for physical activity level;

A Kruskal-Wallis test was performed to identify significant differences in FF between age groups (Table 3). It was identified statistically significant differences between age groups in lower body strength and aerobic endurance in both men and women (ps< 0.044). Women showed statistically significant differences in agility and dynamic balance (p=0.026) and males showed statistically significant differences in upper body strength (p=0.026), only. No other statistically significant difference was seen in both, men and women.

Table 3.
Physical Function by Age Group.

	Age Group					
	60-64 yrs	65-69 yrs	70-74 yrs	75-79 yrs	> 80 yrs	*p-value*
Women						
CST (n)	11,5 ± 2,88	11,3 ± 2,77	11,5 ± 2,11	10,1 ± 1,94	9,4 ±1,47	0,002
ACT (n)	9,5 ± 2,24	10,1 ± 3,14	9,4 ± 1,83	9,1 ± 1,57	9,2 ±2,39	0,796
CSAR (cm)	4,9 ± 8,87	8,3 ± 8,48	7,34 ± 10,36	5,0 ± 7,68	5.0 ±11,26	0,343
BST (cm)	-10,7 ± 12,48	-11,9 ± 11,93	-10,1 ± 11,48	-16,2 ± 11,29	-12,0 ±12,64	0,524
FUG (seg)	9,7 ± 2,58	9,9 ± 2,75	9,8 ± 2,73	11,1 ± 2,78	11,7 ±2,72	0,026
6MWT (m)	412,6 ±94,55	388,7 ± 81,65	396,2 ± 71,99	354.0 ± 75,32	351,4 ±78,18	0,020
Men						
CST (n)	11,2 ± 1,94	12,4 ± 2,65	10,8 ± 2,37	10,6 ± 1,26	9,9 ±1,53	0,021
ACT (n)	10,7 ± 2,72	10,4 ± 1,98	8,9 ± 2,33	10,8 ± 2,11	8,9 ±1,69	0,005
CSAR (cm)	4,4 ± 9,56	2,3 ± 15,14	3,2 ± 10,06	3,8 ± 5,02	4,3 ±9,94	0,994
BST (cm)	-13,2 ± 12,20	-16,9 ± 13,48	-17,3 ± 11,54	-15,6 ± 13,89	-20,1 ±11,14	0,397
FUG (seg)	10.0 ± 2,40	9,9 ± 1,84	10,5 ± 2,37	10,3 ± 1,56	11,0 ±1,43	0,435
6MWT (m)	437,4 ± 81,40	431,8 ± 83,52	417,0 ± 80,75	431,0 ± 62,62	373,4 ±41,98	0,044

SD, standard deviation; CST, 30 second chair stand test. ACT, 30 second arm curl test. CSAR, chair sit-and-reach test. BST, back scratch test. FUG, foot up-and go test. 6MWT, 6-minute walk test –

The results for the comparative study between the Borbense, North American, and Madeiran populations are shown in Table 4. The older people of both sexes from Borba, had lower average scores than the reference population of the United States and Portugal, in muscle strength (lower and upper limbs; ps<0,001), agility/dynamic balance (ps<0,001) and aerobic endurance (ps<0,001). In the trunk flexibility test, men and women from Borba had higher performances than American and Madeiran populations (ps<0,001). In the shoulder flexibility test, women from Borba had lower scores than the North Americans (p<0,001) but no significant differences were seen regarding the Madeiran population. In men, Borba population had lower scores than the North Americans (p=0,004) but higher performances than Madeiran men (p<0,001).

Table 4.
Physical Function from "Borbenses", American and Madeiran Populations.

	"Borbenses" (n = 233)	North-american (n = 7 183)		Madeiran (n = 802)	
	Mean±SD	Mean±SD	$p^{(1)}$	Mean±SD	$p^{(2)}$
Female					
CST (n)	10,4 ± 0,5	12,8 ± 1,9	<0,001	13,3 ± 1,7	<0,001
ACT (n)	9,0 ± 0,0	14,2 ± 1,5	<0,001	15,5 ± 1,7	<0,001
CSAR (cm)	4,7 ± 1,7	3,0 ± 2,9	<0,001	0,1 ± 4,5	<0,001
BST (cm)	-10,4 ± 2,8	-4,7 ± 2,8	<0,001	-11,6 ± 2,9	0,778
FUG (seg)	10,0 ± 0,6	6,3 ± 1,2	<0,001	5,6 ± 0,8	<0,001
6MWT (m)	380,0 ± 23,5	483,0 ± 65,9	<0,001	481,9 ± 65,9	<0,001
Male					
CST (n)	10,9 ± 0,7	14,0 ± 1,9	<0,001	13,8 ± 1,0	<0,001
ACT (n)	9,4 ± 0,9	16,8 ± 1,9	<0,001	16,1 ± 1,4	<0,001
CSAR (cm)	3,0 ± 0,7	-1,6 ± 3,2	<0,001	-4,8 ± 4,4	<0,001
BST (cm)	-16,7 ± 3,8	-12,2 ± 3,1	0,004	-23,1 ± 3,1	<0,001
FUG (seg)	10,4 ± 0,3	5,6 ± 1,0	<0,001	5,3 ± 0,5	<0,001
6MWT (m)	408,0 ± 25,9	526,8 ± 94,3	<0,001	545,9 ± 31,5	<0,001

SD, standard deviation; CST, chair stand test. ACT, arm curl test. CSAR, chair sit-and-reach test. BST, back scratch test. FUG, foot up-and go test. 6MWT, 6-minute walk test
$p^{(1)}$ Borba vs North-american; $p^{(2)}$ Borba vs Madeiran

Discussion

This study aimed to characterize the FF of the older people from Borba, Amazonas, Brazil. In particular, sex-, age-, and PA-related differences in FF were analyzed in detail. This study also provides a comparison in FF between people from Borba, North American, and Portuguese.

Several studies have shown a decline, with age, in muscle strength, aerobic capacity, flexibility, and agility/dynamic balance in elderly Brazilians (Maressa P. Krause et al., 2009), Japanese (Demura et al., 2003), North Americans (Rikli & Jones, 1999b) and Portuguese (Gouveia et al., 2013). These results reinforce the evidence that FF decreases with age, largely justified by the natural degenerative processes of aging, in combination with the increased lack of PA (Gregg, 2003; Tomás et al., 2018). The results of our study, in part, corroborate with this reference framework. The oldest population, men and women, showed lower performances in lower body strength and aerobic endurance in comparison to the youngest group. Similar results were seen for agility and dynamic balance in women only, and in upper body strength in men only. Our results support the theory that physiologic aging does not occur uniformly across the population. It means that individuals of similar chronological age may differ dramatically in their response to exercise, and most importantly, health and functional status are often better indicators of the ability to engage in daily activities than chronological age. It gives us the opportunity to promote PA until the oldest ages.

Regarding sex-related differences in FF, after controlling for age and PA level, women were more proficient in the flexibility of the upper limbs (ps < 0.049) than men, however, men overperformed, on the aerobic endurance test in comparison to women. Interestingly, no other significant differences were seen, for example in agility and dynamic balance nor in any muscular strength test. These results are contrary to those identified in other studies. It has been «regular» to find males more proficient than females in tests of muscle strength and balance/agility (Demura et al., 2003; Gouveia et al., 2013; Maressa P. Krause et al., 2009; Rikli & Jones, 1999b). On the other hand, in the same studies, females were more proficient in all flexibility tests (not only in the flexibility of the upper limbs. Likely, differences associated with environmental affordances can explain some of these particularities of the Borba population. Importantly, the level of PA was higher in women than men, mainly due to household activity scores (data not shown). This important detail can bring some advantages to women in performing FF tests. The other differences in aerobic resistance, favoring men, are partly justified by the better results found in men, in terms of muscular strength during puberty (Malina, Bouchard, & Bar-Or, 2004) and lower losses from 65 years of age, in compared to women (Sakamoto et al., 2019).

Additionally, according to Holland, Tanaka, Shigematsu, and Nakagaichi (2002), the better results seen in women in flexibility, seems to result from differences in external morphology, especially in soft tissues and bone tissue. In our study, men are taller, heavier and have more fat-free mass when compared to women of the same age.

There is scientific evidence that high levels of PA are associated with better scores on FF tests (Gouveia et al., 2013; Jackson et al., 2004; Laukkanen, Kauppinen, & Heikkinen, 1998; Pescatello et al., 2014; Sawatzky & Naimark, 2002; Tomás et al., 2018; Voorrips et al., 1993). In the Netherlands (Voorrips et al., 1993) and in Finland (Laukkanen et al., 1998), observed that active participants, compared to less active ones, had higher flexibility and walking test mean scores. In Canada, Sawatzky and Naimark (2002) found healthier cardiovascular profiles in older adult females with higher levels of PA, especially moderate or vigorous PA. In Portugal, in the Autonomous Region of Madeira, elderly males and females (60-79 years) who were more active, obtained better performances in FF tests, compared to their less active peers (Gouveia et al., 2013).

This scientific evidence reinforces the positive association between PA and maintenance and/or improvement of FF (Calderón, Rodriguez-Hernandez, 2018). This means that PA can play a decisive role in functionality, mobility, autonomy and well-being of the elderly (Fleg et al., 2005). Also, high values of FF, especially in terms of aerobic capacity, have been associated with a lower risk of general mortality and cardiovascular problems (Kodama, 2009; Pescatello et al., 2014; Sui, LaMonte, & Laditka, 2008). Although the positive role of PA in FF is well documented, in our study, we did not find a strong association between PA and FF. Only in trunk flexibility tests, was found a significant positive association between PA and FF. One possible reason for the lack of association between PA and FF can be by the fact that Borba is a rural municipality, isolated, from the interior of the State of Amazonas, where the population is mostly linked to the primary sector (agriculture). This means that this population has very similar and particular levels of PA and lifestyle.

The third purpose of this study was to compare FF in older people from Borba to the North American and Portuguese older population. Both, men and women from Borba underperformed in muscle strength, agility/dynamic balance, and aerobic endurance, and in the other hand, overperformed in the flexibility in comparison to American and Madeiran populations. Differences in lifestyles and external morphology may partly justify the differences found between the Brazilian, North American and Portuguese samples.

Our results must be analyzed considering the sample characteristics and the adopted study design. First, although we have a representative sample of the municipality of Borba, the analysis by different age groups may limit the generalization of the results to similar age-specific larger group. Second, the cross-sectional design is inadequate to capture the age related changes that occur throughout life, and this approach precludes inference of causality between physical activity and FF. Finally, we ackowledge that all participants must have been able to walk without assistance or aid of other persons and were therefore in good overall health. Generalizability of our findings to less active populations of Borba and less healthy or institutionalized groups is not possible.

The present study also presents important strengths and practical implications. The sample includes older people males and females from the municipality of Borba and was the first study to investigate the PA and FF characteristics in

this specific population. On the other hand, this study contributes to developing new research venues in Borba, for example, our data set can provide baseline scores for longitudinal or prospective studies. In addition, this data can help PA instructors to evaluate participants comparing with other populations of the same age and sex. This is very important to individualize exercise programs, maximizing the program's effectiveness and participant safety.

Conclusion

This study provides relevant and specific data from the municipality of Borba's population that is useful to provide further knowledge for this region of Brazil. After controlling for important variables (i.e., age and PA level), we confirmed that women overperformed in flexibility tests and men in aerobic endurance. Interestingly, no other differences were seen in muscle strength, neither agility, and dynamic balance, indicating some homogeneity between men and women. The oldest men and women underperformed in lower strength and aerobic endurance. In agility and dynamic balance, upper body strength and flexibility the differences between age groups may be more dependent on other related factors such as sex, lifestyles, and environment. This information is important to better design exercise programs to improve functional mobility in this specific population. Taking into consideration the reference population from the United States and Portugal, Borba population underperformed on the majority of FF components. However, in the flexibility domain, older people from Borba overperform those reference populations. Longitudinal research, more detailed information on lifestyles, and the constraints of involvement, as well as more objective measures to assess PA are essential to achieve a deeper understanding of these relationships on this specific population.

Conflict of interest

The authors declare that they have no competing interests

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