

## The Impact of Aging and Estimated Training Status on Blood Pressure and Antihypertensive Medicine Consumption

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### ABSTRACT

The purpose of this study was to analyze the effect of aging and the estimated training status (TS) on blood pressure (BP) and antihypertensive medicine consumption (AMC) which are supposed to be high in older people compared with adults. Participants ( $n = 396$ ) performed the following tests: Functional fitness battery test proposed by AAHPERD, BP measurement and a questionnaire about habits of physical exercise and medicine consumptions. In summary, older group presented high level of blood pressure and medicine consumptions compared with adults groups (BP -  $125 \pm$

$5/77 \pm 9$  vs  $119 \pm 12/78 \pm 9$  mmHg and AMC -  $1.8 \pm 0.1$  vs  $1.4 \pm 0.1$  respectively). However, when participants were divided according to TS, good level of TS was associated with low level of BP. These results were not observed in adults group. Thus, the current study contributes to establish the good level of TS as a marker of good level of BP, especially in older group.

**Key words:** Hypertension; Estimated training status; Antihypertensive medicine consumption; Physical exercise; Aging

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### INTRODUCTION

The aging process is usually accompanied by numerous deleterious effects associated with structural changes that affect functional ability which compromise the quality of life of this population<sup>[1]</sup>. Among these effects, it can be observed a reduced functional fitness (muscle strength, coordination, aerobic capacity, flexibility and balance) that have a direct association with reduced performance of daily activities and a greater vulnerability to get any disease, especially cardiovascular disease (CVD), due to the large number of CVD risk factors such as hypertension (HT)<sup>[2-4]</sup>.

Many studies have been reporting a great relationship between age and HT<sup>[5-8]</sup> and it is due to changes in the mechanism of blood pressure (BP) control with advancing age<sup>[6,9-11]</sup>. Moreover, a high consumption of antihypertensive medication has been observed especially in older population<sup>[12,13]</sup>.

On the other hand, physical exercise has been strongly recommended to keep or improve functional fitness and to prevent or treat high level of BP<sup>[14-16]</sup>. Growing evidence characterize physical exercise as a marker of health<sup>[17]</sup> because it can attenuates functional fitness reduction and the high incidence of some disease associated

with aging process<sup>[18]</sup>.

Despite there are a lot of positive indicators about the relationship between active lifestyle and health (such as better control of dyslipidemia, improvement of diabetes, obesity, BP, among others), the sedentary behavior is prevalent in the population<sup>[14,19]</sup>. Moreover, among the elderly who practice physical exercise, the most of them prefer to practice the exercise independently, without supervision (no control of intensity, duration and frequency), which can represent no positive effect for health<sup>[19,20]</sup>.

There are a lot of studies which intend to establish the relationship between different practice of physical exercise and the effects in the human health, however, the majority of these studies establish this relationship through questionnaires which take into account the perception of the individual and not the current status of fitness<sup>[21,22]</sup>. So, it seems reasonable to suggest the evaluation of a physical battery test to estimate the training status (TS) in the cross-sectional study regardless of the type and form in which the physical exercise is practiced. Moreover, there are limited evidences about the relationship between estimated TS, BP and medicine consumption in adults and older.

With this background, the hypothesis of this study was that adult would present better levels of BP and low consumption of antihypertensive medicine compared with older. However, older with good levels TS would demonstrate a better values of BP and low consumption of antihypertensive medicine compared with older with low levels of TS. Therefore, the purpose of this study was to analyze the effect of estimated TS on blood pressure and antihypertensive medicine consumption in adults and older.

## METHODS

### Screening

All procedures were previously approved by Institutional Review Board of University of São Paulo State / Brazil (n° 323.427) which is in accordance with Declaration of Helsinki and all the subjects provided written informed consent before the beginning the experiments.

All subjects were divided according to the age in adults (50-64 years-old) and older (65-80 years-old) and they should meet the following inclusion criteria: not being smoker or alcoholic (< 3 standard drinks per day); age over 50 years-old; non-diabetic; absence of cardiovascular disease (peripheral or cerebrovascular disease, etc.); body mass index < 35 kg/m<sup>2</sup>; not having systolic blood pressure (SBP) > 160 mmHg and diastolic blood pressure (DBP) > 100 mmHg; and, not having other known medical or orthopedic conditions which could affect the ability to successfully participate in a physical exercise battery tests. Volunteers (*n* = 396) were randomly selected from groups which include associations of retirees and programs linked to universities and City Hall of two cities in Brazil (Bauru and Ribeirão Preto) representing the heterogeneous characteristics of the whole population.

### Clinical Assessment

All participants answered a structured questionnaire reporting some information such as number of physical activity that they usually perform, number of medicine consumption and adherence to the treatment. Resting BP was measured after 5 min of seated quiet rest between 07:00-08:00am on three separate days according to VI Brazilian Hypertension Guidelines<sup>[23]</sup> and 2013 ESH/ESC Guidelines for the management of arterial hypertension<sup>[24]</sup>, using an aneroid sphygmomanometer, adequate to the circumference of the arm and a stethoscope placed on the brachial artery. The subjects underwent physical examination to assess the body mass index (BMI) which was calculated by the ratio of weight to the square of height (kg/m<sup>2</sup>) and waist-rip ratio (WHR) as described by Pollock and Wilmore<sup>[25]</sup>.

### Estimated Training Status

Estimated training status (TS) was evaluated by a "Functional Fitness Battery Test" proposed by "American Alliance for Health, Physical Education, Recreation and Dance" (AAHPERD). All the tests were performed at least 24h after any exercise session. The AAHPERD battery includes the following tests: Coordination, Flexibility, Muscular strength and endurance, Agility dynamic, and Cardiovascular endurance, as previously described<sup>[26,27]</sup>. The general functional fitness index (GFFI) was calculated using the sum of the percentile score of each test as previously described<sup>[28-30]</sup>. Participants were divided according to the age (adult and older) and the GFFI results in three TS groups: TS1 – regular GFFI (000-199 points); TS2 – good GFFI (200-299 points); and TS3 – very good GFFI (300-500 points). All items included in the AAHPERD Battery Test have demonstrated good reliability and criterion validity for use in this age group. The test-retest reliability coefficients for each item in this battery test have been reported in the range of *r* = 0.80-0.99<sup>[26]</sup>. Furthermore, this battery test was chosen because it includes multitask functional fitness which is in accordance with the recommendation of American College of Sport Medicine<sup>[31]</sup>.

### Statistical analysis

Descriptive analysis (mean and standard deviation) was performed for characterization of the population. The Komogorov-Smirnov and Shapiro-Wilk test were used for normality check in data distribution. One-way ANOVA with Tukey's post hoc test was used to assess statistically significant differences among groups. TS groups and age were considered as independent variable. Categorical variables were expressed as rates and compared by the chi-square test (Yates's correction was applied in 2x2 contingency tables). Significant associations detected by chi-square test were further analyzed by the binary logistic regression, which generated values of odds ratio (OR) and 95% confidence intervals (95% CIs). Associations between the outcome (levels of SBP and DBP) and independent variables (major risk factors) were simultaneously adjusted by potential confounders. All statistical analyses were performed by the software SPSS 17.0 and statistical significance (*p*-value) was set at 0.05.

## RESULTS

Table 1 shows anthropometric characteristics, functional fitness variables and BP values in adults (50-64 years-old) and older (65-80 years-old) groups.

Even though weight, height and waist values were different between adults and older, the range between both groups was small. In addition, BMI and waist-to-hip ratio were not different between ages. These results indicate no influence of anthropometrics characteristics in the others variables.

The functional fitness score (GFFI) was higher in adults compared with older, even groups performing the same number and time per week of physical exercise. All functional fitness variables also presented better results in adults group compared with older groups.

Even though older participants used to take more medicine than adults, their SBP was higher compared with adults, as shown in Table 1.

The table 2 presents the frequency of adults and older according to classification of hypertension and medicine consumption. It can be observed in the adults groups that the majority of the participants were considered as normotensive. However, in the older group, the majority of the participants were classified as hypertensive, even though all of them were taking antihypertensive medicine. The chi-square test appointed differences between groups, as presented in Table 2.

Moreover, it is possible to note the prevalence of medicine combination in advanced age. This result shows a high incidence of HT and medicine consumption, which is considered a characteristic of aging and highlights the need for studies that aim to prevent such developments.

Depending on the individual's lifestyle, adults and older may have different levels of TS. Thereby, to verify if TS has some interference in these overall results, adults and older were separated according to TS subgroups. As expected, TS3 group performed more physical activity with longer time per week compared with TS2 and TS1 in both adults and older groups (table 3). Additionally, with the same classification used in table 2, the higher frequency (58%) was found for normotensive participants with better TS (TS3) in the adults groups. For older group, the higher frequency was found for hypertensive group without medication (62%) with worst TS (TS1).

Regarding to BP (Figure 1), different levels of TS did not change SBP and DBP values, however good level of TS (TS3) represents low consumption of antihypertensive medication compared with TS1 in

the adults group. Different results were observed in the older group: low levels of TS (TS1) were associated with high values of SBP compared with TS2 and TS3. Moreover, older individuals included in TS1 group presented higher level of SBP compared with the respective age group. Figure 1 also suggests that older people should keep very good levels of TS (TS3) to maintain better DBP compared with those included in TS1, TS2 and respective age group. Although the TS3 had lower number of antihypertensive medicine consumption, the TS did not alter this variable in older groups.

According to the number of antihypertensive consumption, it is noteworthy that adult individuals with highest TS are less drug dependent, however, older participants tend to become drug-dependent for BP control.

Analyzing the participants according to the levels of SBP and DBP and major risk factors (table 4), it was found a higher percentage of participants with optimal levels of SBP on female sex (52.4% female vs. 39.5% male;  $p$ -value = 0.050), lower age (60.8% < 65 years vs. 38%  $\geq$  65 years;  $p$ -value = 0.001), less medication use (81.9% none,

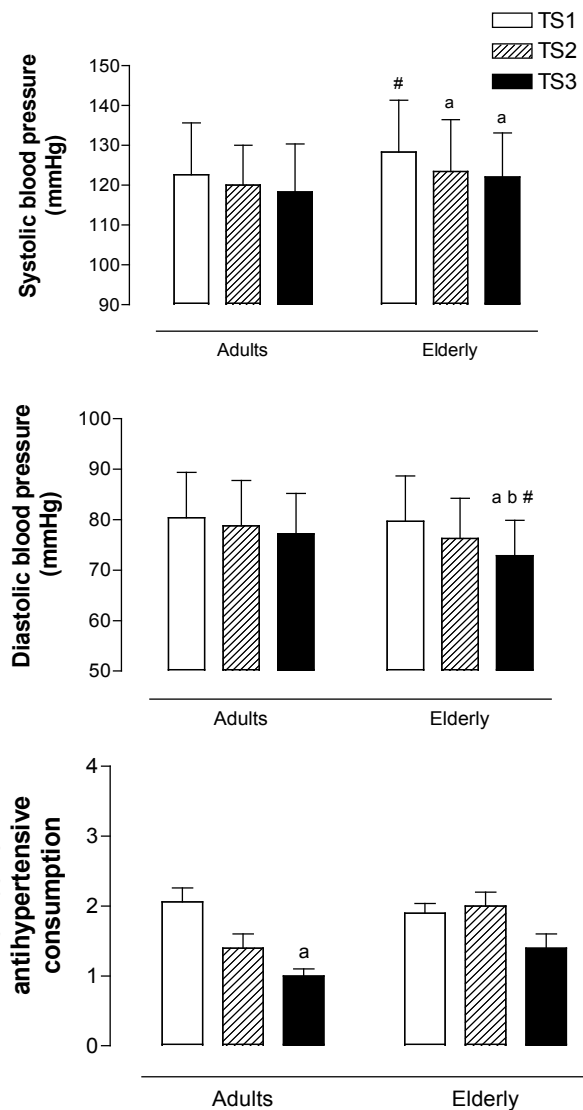
**Table 1** Summary of the participants characteristics according to the age.

	Adults (n = 204)	Older (n = 192)	p
Age (years)	57.4 ± 4.6	71.0 ± 4.8	0
<b>Anthropometrics Characteristics</b>			
Weight (kilograms)	73.0 ± 14	69.8 ± 13	0.026
Height (meters)	1.60 ± 0.08	1.58 ± 0.07	0.029
BMI (kilograms/meters <sup>2</sup> )	28.4 ± 4.9	27.7 ± 4.4	0.19
Waist (centimeters)	90.9 ± 13	93.2 ± 12	0.076
Hip (centimeters)	103.15 ± 11	102.95 ± 0.1	0.854
Waist to hip ratio	0.88 ± 0.1	0.90 ± 0.09	0.051
<b>Training Status and Functional Fitness</b>			
GFFI	289.8 ± 102	212.43 ± 100	0
Coordination (seconds)	11.9 ± 3	13.8 ± 4	0
Flexibility (centimeters)	59.5 ± 11	53.2 ± 12	0
Strength (repetitions)	23.7 ± 6	20.7 ± 6	0
Agility (seconds)	21.7 ± 4	26.5 ± 6	0
Endurance (seconds)	496.4 ± 80	542.9 ± 78	0
Number of physical exercise	1.49 ± 1.1	1.57 ± 1.0	0.425
Time of practice per week (minutes)	179.0 ± 11	182.8 ± 11	0.811
<b>Blood pressure and Medications</b>			
SBP (mmHg)	119.8 ± 12	125.5 ± 13	0
DBP (mmHg)	78.4 ± 9	77.2 ± 9	0.191
Number of medications	1.4 ± 0.10	1.8 ± 0.11	0.005

GFFI: general functional fitness index; SBP: systolic blood pressure; DBP: diastolic blood pressure.

**Table 2** Frequency of adults and older according to classification of hypertension and medicine consumption.

	Adults (n = 204)	Older (n = 192)
Normotensive	109 (53%)	79 (41%)
Hypertensive without medication	17 (8%)	13 (7%)
Hypertensive with medication	78 (38%)	100 (52%)
Chi-square Test - 7.683; P = 0.021		
<b>Category of Medication</b>	<b>n = 78</b>	<b>n = 100</b>
Diuretic	6 (8%)	7 (7%)
Adrenergic inhibitor	13 (17%)	7 (7%)
Calcium channel blocker	0	4 (4%)
ACE inhibitor	14 (18%)	20 (20%)
AT1 blocker	18 (23%)	14 (14%)
Combination of medicine	27 (35%)	48 (48%)



**Figure 1** Systolic blood pressure (panel A), diastolic blood pressure (panel B) and number of antihypertensive consumption (panel C) in adults and older separated according to the estimated training status in TS1 - regular functional fitness (white bars); TS2 - good functional fitness (cross hatched bars); and TS3 - very good functional fitness (black bars). <sup>a</sup> vs respective TS1, <sup>b</sup> vs respective TS2 and, <sup>#</sup> vs respective age group,  $p < 0.05$ .

49.6% one and 43.2% two or more;  $p$ -value = 0.004) and higher training status (73% TS3, 55.9% TS2, 43.5% TS1;  $p$ -value = 0.001). BMI categories were not significantly associated with optimal levels of SBP.

This analysis was repeated for DBP and it was found a higher percentage of participants with optimal levels of DBP on female sex (67.7% female vs. 56.6% male;  $p$ -value = 0.008), with BMI under 25 Kg/m<sup>2</sup> (75.7% BMI < 25 Kg/m<sup>2</sup> vs. 61.4% BMI ≥ 25 Kg/m<sup>2</sup>;  $p$ -value = 0.007) and higher TS (78.4% TS3, 73% TS2, 60.5% TS1;  $p$ -value = 0.005). Age and medication use were not significantly associated with optimal levels of DBP.

Finally, in the multivariate-adjusted model, not all the risk factors remained significantly associated to optimal levels of SBP and DBP. For SBP, males [OR = 1.82 (1.05;3.15)] and older participants [OR =

2.00 (1.29;3.10)] had higher risk to be in the group with non-optimal levels of SBP compared with female sex and younger participants, respectively. On the other hand, participants on the highest TS had 57% less likelihood to have SBP above 120mmHg compared with the lowest TS group [TS3: OR = 0.43 (0.19;0.99)]. For DBP, male sex [OR = 1.84 (1.07;3.14)] and participants with BMI ≥ 25Kg/m<sup>2</sup> [OR = 1.73 (1.04;2.89)] had higher risk to be in the group with non-optimal levels of DBP compared with female sex and participants with BMI < 25Kg/m<sup>2</sup>, respectively. Inversely, participants on the middle and highest TS had 46% and 60%, respectively, less likelihood to have DBP above 80mmHg compared with the lowest TS group [TS2: OR = 0.54 (0.32;0.92); TS3: 0.40 (0.17;0.98)] (table 4).

## DISCUSSION

The main result of the current study was the protective effect of good levels of estimated TS on BP, especially in older population. Table 1 showed the results considering age as an independent variable. Briefly, both adults and older groups performed the same number and time per week of physical exercise into their daily routines; however, the adults group presented higher level of TS. Although the intensity and volume of physical exercise were not considered in this study, but just the current estimated TS, it was observed an impairment in all results related to functional fitness. These results are in accordance with many others studies that pointed out the deleterious effects on physical capacity over the years, such as a decrease in endurance, muscle strength, flexibility and others<sup>[32-36]</sup>.

Moreover, older group presented higher values of SBP, even taking more medicine and practicing the same number and times per week of physical exercise compared with adults group. This result suggests that there are many physiological changes that occur in the human body over the years which can compromise the mechanisms responsible to BP control. Although the present study did not evaluate these factors, a lot of studies have pointed the humoral factors, nervous system and arterial stiffness as the main factor for the impaired BP control among older people<sup>[10,37,38]</sup>.

Regarding to humoral factors studies have shown that aging process is associated with decrease in nitric oxide (NO) concentration<sup>[10,11]</sup> and increase in renin-angiotensin system (RAS) activity

**Table 3** Number of physical exercise practiced and time per week of this practice in adults and older according to the level of training status, and the frequency of people classified according to blood pressure and medicine consumption.

	TS1	TS2	TS3
<b>Adults Group</b>			
Number of physical exercise	1.0 ± 0.14	1.2 ± 0.13	1.8 ± 0.12 <sup>ab</sup>
Time of practice per week (min)	117 ± 16	184 ± 25	208 ± 16 <sup>a</sup>
	N(%)	N(%)	N(%)
Normotensive (n = 109)	20 (18)	26 (24)	63 (58)
Hypertensive with medication (n = 78)	25 (32)	21 (27)	32 (41)
Hypertensive without medication (n = 17)	3 (18)	6 (35)	8 (47)
Chi-square test - 7.261; P = 0.123			
<b>Older Group</b>			
Number of physical exercise	1.2 ± 0.09	1.7 ± 0.12 <sup>a</sup>	2.0 ± 0.17 <sup>a</sup>
Time of practice per week (min)	144 ± 13	199 ± 21	261 ± 24 <sup>a</sup>
	N(%)	N(%)	N(%)
Normotensive (n = 79)	33 (42)	20 (25)	26 (33)
Hypertensive with medication (n = 100)	53 (53)	31 (31)	16 (16)
Hypertensive without medication (n = 13)	8 (62)	2 (15)	3 (23)
Chi-square test - 8.244; p = 0.083			

TS1: very low functional fitness; TS2: regular functional fitness; TS3: very good functional fitness; <sup>a</sup> vs respective TS1, <sup>b</sup> vs respective TS2,  $p < 0.05$ . n(%) - total number of participant in that classification and percentage.

**Table 4** Unadjusted and adjusted analyses between values of systolic and diastolic blood pressure according to major risk factors.

Variables	Systolic Blood Pressure		$\chi^2$ p-value	Adjusted model OR (95%CI)	Diastolic Blood Pressure		$\chi^2$ p-value	Adjusted model OR (95%CI)
	< 120 mmHg	> 120 mmHg			< 80 mmHg	> 80 mmHg		
<b>Sex</b>								
Female	167 (52.4)	152 (47.6)	0.05	1	216 (67.7)	103 (32.3)	0.008	1
Male	30 (39.5)	46 (60.5)		1.82 (1.05;3.15)	43 (56.6)	33 (43.4)		1.84 (1.07;3.14)
<b>Age</b>								
< 65 years	124 (60.8)	80 (39.2)	0.001	1	132 (64.7)	72 (35.3)	0.751	1
> 65 years	73 (38)	119 (62)		2.00 (1.29;3.10)	128 (66.7)	64 (33.3)		1.44 (0.90;2.29)
<b>Body Mass Index</b>								
< 25 Kg/m <sup>2</sup>	63 (54.8)	52 (45.2)	0.224	1	87 (75.7)	28 (24.3)	0.007	1
> 25 Kg/m <sup>2</sup>	134 (47.9)	146 (52.1)		1.20 (0.75;1.92)	172 (61.4)	108 (38.6)		1.73 (1.04;2.89)
<b>Medication use</b>								
None	60 (81.9)	37 (38.1)	0.004	1	68 (70.1)	29 (29.9)	0.324	1
One	60 (49.6)	61 (50.4)		1.39 (0.79;2.44)	79 (65.3)	42 (34.7)		1.16 (0.64;2.10)
> Two	73 (43.2)	96 (56.8)		1.60 (0.93;2.76)	108 (63.9)	61 (36.1)		1.15 (0.65;2.03)
<b>Training Status</b>								
TS1	108 (43.5)	140 (56.5)	0.001	1	150 (60.5)	98 (39.5)	0.005	1
TS2	62 (55.9)	49 (44.1)		0.73 (0.44;1.19)	81 (73)	30 (27)		0.54 (0.32;0.92)
TS3	27 (73)	10 (27)		0.43 (0.19;0.99)	29 (78.4)	8 (21.6)		0.40 (0.17;0.98)

which compromise the peripheral resistance<sup>[38-40]</sup>. As example, Lauer *et al.*<sup>[10]</sup> demonstrated that older groups had lower concentrations of NO compared with young groups, suggesting a decrease in vascular capacity to adapt to any stimulus with physiological aging. Concomitantly, Najjar, Scuteri and Lakatta<sup>[41]</sup> reported that the components of RAS pathway, especially angiotensin II by AT1 receptor, seem to be increased with aging, which will contribute to increase vasoconstriction. Moreover, with advancing age, it has been observed an increase in sympathetic nerve activity (SNA) which is most of the times positively associated with hypertension, especially in women after menopause, mainly because of the role of sex hormones in the BP regulation<sup>[6,42]</sup>. It has also been reported in the literature a lack in the physical integrity of the vessel, a degradation in the elastic component (elastin) and accumulation of collagen fibers<sup>[43,44]</sup> along the aging process. All these factors may contribute to increase arterial stiffness<sup>[24,37,44-46]</sup>. Nilsson<sup>[9]</sup> reported that the main hemodynamic consequences with arterial stiffening are: increased BP variability, decreased heart rate variability, impaired endothelial and baroreflex functions. Several other studies have also reported that arterial stiffening has a direct relationship with endothelial dysfunction<sup>[43,46-48]</sup>, decreased NO concentration<sup>[43,48,49]</sup>, and increased vasoconstriction by RAS activity<sup>[19,46,48]</sup>. Overall, cardiovascular performance and control of BP does not depend only of the cardiac work, but also of the physical structures (elastic components) and functional structure (release of vasoactive substances and nerve system), which appear to be committed with the natural aging process<sup>[9]</sup>. So, all these topics may explain the differences in SBP found in the present study between adults and older groups.

Despite these changes with the aging process, active lifestyle has been considered essential tool for improvement in health and quality of life<sup>[35,36,50,51]</sup>. In fact, keeping good levels of TS may contribute to minimize the deleterious effects of aging. Thereby, in order to verify if good levels of TS can modulate the values of BP in adults and older, both groups were divided according to TS. The results revealed that besides the consumption of medication taken by adults in TS3 was lower compared with TS1, the BP was similar. On the other hand, in the older group, good levels of TS contribute to maintain good levels of BP, even taking different amounts of medication. In addition, the multivariate-adjusted model analysis suggested that good level of TS was associated with low risk to develop hypertension. These results suggest a beneficial effect of good level of TS in association with low level of SBP, DBP and antihypertensive medication consumption in older.

Following the same explanation reported previously, the humoral factors, nervous system and the arterial stiffness probably are still not sufficiently affected in the adults group, thereby, justifying the similar results in the BP among different TS groups. However, in older group, these mechanisms seem to be impaired, but a greater responsiveness was presented as a consequence of better TS.

It is important to highlight in the current study that estimated TS was obtained by a physical battery test instead of a questionnaire. Although these questionnaires have been used in the literature, some controversial results are found. Nakamura *et al.*<sup>[21]</sup> found a good relationship between quality of life and level of physical activity evaluated by questionnaire in male and female adults. However, Sebastião *et al.*<sup>[22]</sup>, exploring the issues associated with measuring physical activity (using the International Physical Activity Questionnaire IPAQ) in adults living in a mid-sized Brazilian city, concluded that IPAQ-long form appears to overestimate the levels of physical activity for both males and females, suggesting that this instrument has problems in measuring levels of physical activity in Brazilian adults. In

complement, Czezelewska *et al.*<sup>[52]</sup> also found no differences in SBP and DBP in men and women with different level of physical activity evaluated by questionnaire. These controversial and different results maybe explained due to subjective answers of the participant using questionnaires, which represent the participant's perception in that moment and not the participant's actual physical condition.

On the other hand, higher levels of physical activity, evaluated by pedometer, were significantly associated with lower use of medication in women engaged in a physical-activity program and public healthcare users. These findings suggest that involvement in physical activity can help to reduce medicine usage among older women who are functionally independent<sup>[53]</sup>. Although this study found some positive results, the pedometer evaluation involve just one variable. According to ACSM, a multicomponent task should be prioritized in older population.

So, the TS, evaluated by physical functional battery, not only characterizes general physical capacity, but also acts as a marker of current and future health<sup>[17]</sup>. A lot of studies have been reported many health benefits associated with physical function<sup>[18]</sup>, however it is important to highlight that the current study used a multicomponent evaluation to establish these association, as presented in table 4, high level of estimated TS represent low chance to be hypertensive.

## CONCLUSION

In summary, the present study revealed that older group present high levels of BP even though are taking a large amount of antihypertensive medication. In addition, when participants were divided according to estimated TS, the adults group presented no differences of BP. Nevertheless, in the older group, although the consumption of medication was not different between TS groups, good level of TS was associated with low level of BP. So, the current study contributes to establish that good level of TS may be considered as a marker of good level of BP, especially in older.

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## REFERENCES

1. Matsudo SMM, Matsudo VKR, Neto TLB. The impact of aging on anthropometric, neuromotor, and metabolic variables of physical fitness. *Rev Bras Ciên e Mov.* 2000; **8**(4): 21-32.
2. Aida FJ, de Oliveira RJ, Silva AJ, de Matos DG, Carneiro AL, Garrido N, et al. The influence of the level of physical activity and human development in the quality of life in survivors of stroke. *Health and quality of life outcomes.* 2011; **9**: 89. [PMID: 21992748]; [PMCID: 3203027]. Epub 2011/10/14. eng.
3. Balboa-Castillo T, Leon-Munoz LM, Graciani A, Rodriguez-Artalejo F, Guallar-Castillon P. Longitudinal association of physical activity and sedentary behavior during leisure time with health-related quality of life in community-dwelling older adults. *Health and quality of life outcomes.* 2011; **9**: 47. [PMID: 21708011]; [PMCID: 3142200].
4. Pauli JR, Souza LS, Zago AS, Gobbi S. [Influence of a 12-years supervised physical activity program for the elderly]. *Rev Bras Cineantropom Desempenho Hum* 2009; **11**(3): 255-60.
5. Povoia R, Barroso WS, Brandao AA, Jardim PC, Barroso O, Passarelli O, Jr., et al. I brazilian position paper on antihypertensive drug combination. *Arq Bras Cardiol.* 2014; **102**(3): 203-10. [PMID: 24714792]; [PMCID: 3987325].
6. Barnes JN, Hart EC, Curry TB, Nicholson WT, Eisenach JH, Wal-

- lin BG, et al. Aging enhances autonomic support of blood pressure in women. *Hypertension*. 2014; **63**(2): 303-8. [PMID: 24324040]; [PMCID: 3893094].
7. Lee SJ, Park SH. Arterial ageing. *Korean circulation journal*. 2013; **43**(2): 73-9. [PMID: 23508642]; [PMCID: 3596666].
  8. Wang H, Cao J, Li J, Chen J, Wu X, Duan X, et al. Blood pressure, body mass index and risk of cardiovascular disease in Chinese men and women. *BMC public health*. 2010; **10**: 189. [PMID: 20384993]; [PMCID: 2873578].
  9. Nilsson PM. Hemodynamic Aging as the Consequence of Structural Changes Associated with Early Vascular Aging (EVA). *Aging Dis*. 2014; **5**(2):109-13. [PMID: 24729936]; [PMCID: 3966669].
  10. Lauer T, Heiss C, Balzer J, Kehmeier E, Mangold S, Leyendecker T, et al. Age-dependent endothelial dysfunction is associated with failure to increase plasma nitrite in response to exercise. *Basic research in cardiology*. 2008; **103**(3): 291-7. [PMID: 18347836].
  11. Di Massimo C, Scarpelli P, Di Lorenzo N, Caimi G, di Orio F, Ciancarelli MG. Impaired plasma nitric oxide availability and extracellular superoxide dismutase activity in healthy humans with advancing age. *Life sciences*. 2006; **78**(11): 1163-7. [PMID: 16214176].
  12. Cogolludo A, Perez-Vizcaino F, Tamargo J. New insights in the pharmacological therapy of arterial hypertension. *Current opinion in nephrology and hypertension*. 2005; **14**(5): 423-7. [PMID: 16046899].
  13. Pescatello LS, Franklin BA, Fagard R, Farquhar WB, Kelley GA, Ray CA, et al. American College of Sports Medicine position stand. Exercise and hypertension. *Medicine and science in sports and exercise*. 2004; **36**(3): 533-53. [PMID: 15076798].
  14. Hamer M, Stamatakis E. Physical activity and risk of cardiovascular disease events: inflammatory and metabolic mechanisms. *Medicine and science in sports and exercise*. 2009; **41**(6): 1206-11. [PMID: 19461547].
  15. Kemmler W, Von Stengel S, Engelke K, Kalender WA. Exercise decreases the risk of metabolic syndrome in elderly females. *Medicine and science in sports and exercise*. 2009; **41**(2): 297-305. [PMID: 19127197].
  16. Zago AS, Park JY, Fenty-Stewart N, Kokubun E, Brown MD. Effects of aerobic exercise on the blood pressure, oxidative stress and eNOS gene polymorphism in pre-hypertensive older people. *European journal of applied physiology*. 2010; **110**(4): 825-32. [PMID: 20614130].
  17. Hansen AM, Andersen LL, Skotte J, Christensen U, Mortensen OS, Molbo D, et al. Social class differences in physical functions in middle-aged men and women. *Journal of aging and health*. 2014; **26**(1): 88-105. [PMID: 24584262].
  18. Brown RE, Riddell MC, Macpherson AK, Canning KL, Kuk JL. The association between frequency of physical activity and mortality risk across the adult age span. *Journal of aging and health*. 2013; **25**(5): 803-14. [PMID: 23836844].
  19. Zaitune MPAB, M. B. A.; César, C. L. G.; Carandina, L.; Goldbaum, M. Fatores associados ao sedentarismo no lazer em idosos, Campinas, São Paulo, Brasil. *Cad Saúde Pública*. 2007; **23**(6): 1329-38. Epub 20/Dez/2006.
  20. Todde F, Melis F, Mura R, Pau M, Fois F, Magnani S, et al. A 12-Week Vigorous Exercise Protocol in a Healthy Group of Persons over 65: Study of Physical Function by means of the Senior Fitness Test. *BioMed research international*. 2016; **2016**: 7639842. [PMID: 27243035]; [PMCID: 4868891].
  21. Nakamura PM, Teixeira IP, Smirmaul BP, Sebastiao E, Papini CB, Gobbi S, et al. Health related quality of life is differently associated with leisure-time physical activity intensities according to gender: a cross-sectional approach. *Health and quality of life outcomes*. 2014; **12**: 98. [PMID: 25135321]; [PMCID: 4262226].
  22. Sebastiao E, Gobbi S, Chodzko-Zajko W, Schwingel A, Papini CB, Nakamura PM, et al. The International Physical Activity Questionnaire-long form overestimates self-reported physical activity of Brazilian adults. *Public health*. 2012; **126**(11): 967-75. [PMID: 22944387].
  23. SBH SBdH. VI Diretrizes Brasileiras de Hipertensão. *Revista Hipertensão*. 2010; 13(1).
  24. Mancia G, Fagard R, Narkiewicz K, Redon J, Zanchetti A, Bohm M, et al. 2013 ESH/ESC Guidelines for the management of arterial hypertension: the Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *Journal of hypertension*. 2013; **31**(7): 1281-357. [PMID: 23817082].
  25. Pollock ML, Wilmore J. Exercise in health and disease: evaluation and prescription for prevention and rehabilitation. Philadelphia: Saunders; 1990.
  26. Osness W, Adrian M, Clark B, Hoegar W, Raab D, Wiswell R. Functional Fitness Assessment For Adults Over 60 Years - A Field Based Assessment: AAHPERD - American Alliance for Health, Physical Education, Recreation and Dance, 1990; 37 p.
  27. Osness WH. The AAHPERD Fitness Task Force: History and Philosophy. *Journal of Physical Education, Recreation and Dance*. 1989; **60**(3): 64-5.
  28. Mazo GZ, Benedetti TRB, Gobbi S, Ferreira L, Lopes MA. Normative values and functional fitness in 60-to-69 year-old men. *Rev Bras Cineantropom Desempenho Hum*. 2010; **12**(5): 316-23.
  29. Zago AS, Gobbi S. [Normative values of functional fitness in 60-to-70 year-old women]. *R Bras Ci e Mov*. 2003; **11**(2): 77-86
  30. Benedetti TRB, Antunes PC, Rodriguez-Añez CR, Mazo GZ, Petroski EL. Reproducibility and validity of the International Physical Activity Questionnaire (IPAQ) in elderly men. *Rev Bras Med Esporte*. 2007; **13**(1): 11-6.
  31. American College of Sports M, Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, Minson CT, Nigg CR, et al. American College of Sports Medicine position stand. Exercise and physical activity for older adults. *Medicine and science in sports and exercise*. 2009; **41**(7): 1510-30. [PMID: 19516148].
  32. Carvalho MJ, Marques E, Mota J. Training and detraining effects on functional fitness after a multicomponent training in older women. *Gerontology*. 2009; **55**(1): 41-8. [PMID: 18562788]. Epub 2008/06/20. eng.
  33. Cavani V, Mier CM, Musto AA, Tummers N. Effects of a 6-week resistance-training program on functional fitness of older adults. *Journal of Aging and Physical Activity*. 2002; **10**: 443-52.
  34. Matta J, Mayo N, Dionne IJ, Gaudreau P, Fulop T, Tessier D, et al. Interrelated factors favoring physical performance and activity in older adults from the NuAge cohort study. *Experimental gerontology*. 2014; **55**: 37-43. [PMID: 24681042].
  35. Trape AA, Sacardo AL, Cássia AF, Monteiro HL, Zago AS. Relationship between the practice of unsupervised walking and risk factors for cardiovascular disease in adults and elderly. *Medicina (Ribeirão Preto)*. 2014; **47**(2): 165-76.
  36. Yamada Y, Noriyasu R, Yokoyama K, Osaki T, Adachi T, Itoi A, et al. Association between lifestyle and physical activity level in the elderly: a study using doubly labeled water and simplified physical activity record. *European journal of applied physiology*. 2013; **113**(10): 2461-71. [PMID: 23801238].
  37. Coutinho T. Arterial stiffness and its clinical implications in women. *The Canadian journal of cardiology*. 2014; **30**(7): 756-64. [PMID: 24970788].
  38. Rush JW, Aultman CD. Vascular biology of angiotensin and the impact of physical activity. *Appl Physiol Nutr Metab*. 2008; **33**(1): 162-72. [PMID: 18347668]; [DOI: 10.1139/H07-147]
  39. Channon KM, Guzik TJ. Mechanisms of superoxide production in human blood vessels: relationship to endothelial dysfunction, clinical and genetic risk factors. *Journal of physiology and pharmacology: an official journal of the Polish Physiological Society*. 2002; **53**(4 Pt 1): 515-24. [PMID: 12512689].
  40. d'Alessio P. Aging and the endothelium. *Experimental gerontology*. 2004; **39**(2): 165-71. [PMID: 15038389].

41. Najjar SS, Scuteri A, Lakatta EG. Arterial aging: is it an immutable cardiovascular risk factor? *Hypertension*. 2005; **46**(3): 454-62. [PMID: 16103272].
42. Hart EC, Wallin BG, Barnes JN, Joyner MJ, Charkoudian N. Sympathetic nerve activity and peripheral vasodilator capacity in young and older men. *American journal of physiology Heart and circulatory physiology*. 2014; **306**(6): H904-9. [PMID: 24414063].
43. Aroor AR, Demarco VG, Jia G, Sun Z, Nistala R, Meininger GA, et al. The role of tissue Renin-Angiotensin-aldosterone system in the development of endothelial dysfunction and arterial stiffness. *Front Endocrinol (Lausanne)*. 2013; **4**: 161. [PMID: 24194732]; [PMCID: 3810594].
44. Coutinho T, Bailey KR, Turner ST, Kullo IJ. Arterial stiffness is associated with increase in blood pressure over time in treated hypertensives. *Journal of the American Society of Hypertension: JASH*. 2014; **8**(6): 414-21. [PMID: 24952654]; [PMCID: 4103613].
45. Bassett DR, Jr., Howley ET. Limiting factors for maximum oxygen uptake and determinants of endurance performance. *Medicine and science in sports and exercise*. 2000; **32**(1): 70-84. [PMID: 10647532]. Epub 2000/01/27. eng.
46. Hausvater A, Giannone T, Sandoval YH, Doonan RJ, Antonopoulos CN, Matsoukis IL, et al. The association between preeclampsia and arterial stiffness. *Journal of hypertension*. 2012; **30**(1): 17-33. [PMID: 22134391].
47. Ulu SM, Yuksel S, Altuntas A, Kacar E, Ahsen A, Altug A, et al. Associations between serum hepcidin level, FGF-21 level and oxidative stress with arterial stiffness in CAPD patients. *International urology and nephrology*. 2014; **46**(12): 2409-14. [PMID: 24908281].
48. Wu J, Xia S, Kalionis B, Wan W, Sun T. The role of oxidative stress and inflammation in cardiovascular aging. *BioMed research international*. 2014; **2014**: 615312. [PMID: 25143940]; [PMCID: 4131065].
49. Tordi N, Mourot L, Colin E, Regnard J. Intermittent versus constant aerobic exercise: effects on arterial stiffness. *European journal of applied physiology*. 2010; **108**(4): 801-9. [PMID: 20187285].
50. Cornelissen VA, Buys R, Smart NA. Endurance exercise beneficially affects ambulatory blood pressure: a systematic review and meta-analysis. *Journal of hypertension*. 2013; **31**(4): 639-48. [PMID: 23325392].
51. Pang MY, Charlesworth SA, Lau RW, Chung RC. Using aerobic exercise to improve health outcomes and quality of life in stroke: evidence-based exercise prescription recommendations. *Cerebrovascular diseases*. 2013; **35**(1): 7-22. [PMID: 23428993].
52. Czezelewska E, Czezelewski J, Wasiluk A, Saczuk J. Evaluation of the Usability of Selected Questionnaires Assessing Physical Activity in the Prophylaxis of Cardiovascular Diseases. *Advances in clinical and experimental medicine: official organ Wroclaw Medical University*. 2016; **25**(1): 59-67. [PMID: 26935499].
53. Silva LJ, Azevedo MR, Matsudo S, Lopes GS. Association between levels of physical activity and use of medication among older women. *Cadernos de saude publica*. 2012; **28**(3): 463-71. [PMID: 22415178]. Epub 2012/03/15. eng.

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