Chapter

Functional Capacity in Advanced Older Adults

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Abstract

Oldest-old adults are expected to represent 4.8% of the world population in 2030 (400 million). Aging influences functional capacity (FC), which is relevant information for this subpopulation and can be assessed by maximal oxygen uptake (VO2max) with a conventional exercise test (ET). Exercise-based programs for advanced older adults could improve health status and multiple studies support resistance training as an important option. An observational, retrospective study on FC assessment, with VO2max assessment, in the oldest-old adults, is presented. Eighty-six individuals, ≥75 years old, were included. FC was estimated by VO2max obtained with treadmill ET. Two groups with different FC were compared (A group: <24 mg/kg/min and B group: ≥24 mg/kg/min). Most important differences were found in body mass index and heart rate, with a correlation between these variables and both with VO2max. These findings can help the oldest-old adults' health care, once exercise programs provide multiple benefits for this subpopulation improving these specific variables, and other clinical aspects. Pre-participation assessment could promote safety, comfort, adherence, and effectiveness in advanced older adults. Exercise programs, including resistance training, impact quality of life, cognitive status, frailty symptoms, risk factors, and all-cause mortality.

Keywords: older adults, functional capacity, VO2max, exercise test, body mass index, heart rate

1. Introduction

Oldest-old adults may represent 5.5% of Brazilian population in 2030, about 12 million people; at the same time, the world is expected to achieve 400 million (4.8%) older adults with 75 years or more [1, 2]. Population aging is a worldwide concerning issue, as it is associated with the increasing prevalence of non-transmissible chronic diseases (NCD) and cardiovascular risk factors (RF); and the World Health Organization (WHO) adds the notion of functional capacity (FC) as a determinant of the degree of aging. FC varies among individuals, under genetic influences, but is also affected by social, cultural, environmental, and political issues. Determinants of the elderly's capacity are not only the progression of age but also choices, pathological processes, or interventions, at different times in the life. Then, another concept is presented: healthy or active aging, as the "process of development and maintenance of functional capacity that allows well-being in old age" [1]. Elderly-focused exercise programs, resistance training programs (RTP) included, aim to increase functionality, independence, and quality of life [3]. Functional increments have been related to lower cardiovascular and mortality risk rates in the elderly [4].

A paradox is that the growing oldest-old adult group is, unfortunately, less contemplated in elderly studies and, almost always, excluded in general population studies [5–7]. Several studies on obesity in the elderly found controversial results, with unfavorable [8], neutral [9] and favorable [10] results. The natural process of cardiovascular aging involves changes in structure and function that expose individuals to an exponential increase in the incidence and prevalence of cardiovascular diseases, such as coronary artery disease (CAD), heart failure (HF), atrial fibrillation (AF), and stroke [11]. Physical inactivity has been associated with being overweight, poor RF control, development of NCD, lower quality of life, and higher mortality in advanced elderly [12].

2. Functional capacity assessment

The evaluation of pathophysiological conditions, with emphasis on FC, could help in the inclusion, adherence, and safeguarding of resistance training programs (RTP) [13]. Many methods, such as questionnaires about activity or frailty [13], walking and movement tests [14], and tests with associated myocardial ischemia search [15] are useful in this assessment. FC can be affected by aging due to myocardial, blood vessels, and metabolic impairments in the presence or absence of detectable cardiovascular disease. The gold standard for FC assessment is the cardiopulmonary exercise test, with direct determination of maximum oxygen consumption (VO2max) [16, 17]. FC can also be assessed in advanced elderly with a safe, effective, and well-established method; the conventional exercise test (ET), which safeguarded protocols and interpretation, can help to detect diseases, monitor cardiovascular conditions, promote exercise, and reduce the sedentary time for the oldest-old adults [15, 18–22].

Healthy aging identifies a common goal for patients, health professionals, family, and society to optimize FC, with the achievement of five heavily interconnected domains: continuous learning, growth and decision making, mobility, relationship building and maintenance, and contribution for family and society [1]. This study aimed to assess aging, with or without cardiac disease, influences on functional capacity (FC). This assessment is necessary to promote safe, effective, and comfortable exercise for this specific subpopulation. Exercise-based programs for advanced older adults could improve health status, reduce risk factors, and help in managing non-transmissible chronic diseases.

3. Functional capacity in advanced older adults: a retrospective study

3.1 Methodology

- Sample: obtained from a retrospective medical record review of patients ≥75 years old age (eligible criteria), which had done an exercise test (ET) between 2013 and 2017, performed in a private clinic in the city of Guarapuava, State of Paraná, Brazil. This sample was divided into two groups, according to VO2max (Group A: VO2max <24 ml/kg/min and Group B: ≥24 ml/kg/min). This cutoff number was chosen as a limit of mortality reduction in older adult subpopulation, according to Kokkinos et al. [6].

- Ethical approval: the study was approved by the ethics committee of the Middle West State University of Paraná, (32250020.6.0000.0106, registered in Brazil's Ministry of Health platform).

Procedures:

- Hypothesis: clinical characteristics may be different in varied levels of functional capacity (FC).

- Main objective: to compare and correlate clinical characteristics with FC in advanced elderly.

- Specific objectives: to report sex differences on VO2max, to report other clinical sex differences, and to describe clinical findings in a series of cases in this specific subpopulation.

- Clinical findings definitions: type of recommendation for ET, symptoms prior to ET, personal and family cardiovascular history, traditional RF (hypertension, diabetes, dyslipidemia, smoking, and stress), previously known heart disease, previously known coronary artery disease (CAD), medications including those suspended for ET, and body mass index (BMI). Definitions of hypertension, type 2 diabetes mellitus (DM2), and dyslipidemia were obtained by reporting on anamnesis and use of specific medication. Smoking and stress status were characterized by anamnesis report. CAD was defined by anamnesis and the report of having performed angiocoronariography or coronary tomography with the finding of obstructions, previous revascularization procedures, or acute myocardial infarction confirmed by the executing, the requesting, or compatible changes on the rest electrocardiogram (ECG). The level of activity was defined by self-report, classifying as sedentary or active, based on the time of physical activity per week [12, 18]. Presence of previous heart diseases (ischemic, hypertensive, and valvular heart disease) was recorded by the information of the examinee, ECG alteration compatible with heart disease, or medication for CAD or heart failure. Sedentary or active heart disease patients were also recorded. BMI (weight/height [2]) was obtained from the test report. The following classification was used for BMI: <20: thin, 20–24.9: normal weight, 26–31: overweight; and ≥ 30: obesity [23]. RF were considered alone and grouped by number of RF present in the same individual, being considered for this group: hypertension, DM2, dyslipidemia, smoking, and stress.

- ET and FC methodology: FC was estimated by calculated VO2max obtained on the ET, with methodology according to the III guidelines of the Brazilian Society of Cardiology on exercise testing [21], using adaptable ramp treadmill protocol on an Inbramed ATL treadmill (ANVISA Registration: 10318090009), with data collected and analyzed in the Micromed ErgoPC-13 system (ANVISA Registration: 10307270007) with posterior checkage by the authors. VO2max was calculated using the formula: VO2max = v x (0.073 ± cc / 100) x 1.8, where cc: slope of the treadmill (%) and v: treadmill speed (meters/min) [22]. The other variables were obtained through formulas found in the above-mentioned guideline [21]. All patients were assessed by an ergometry experienced appraiser, which had manually monitored blood pressure with aneroid sphygmomanometer and HR was monitored by ECG. Rest HR was obtained after five min of dorsal decubitus rest. Then, the patient informed data by anamnesis and a clinical exam was done. Stand and hyperpnea ECG registers were taken. Patients initiate effort phase by walking slowly, following an adaptable ramp protocol calculated to reach at least previewed VO2max. Changes in velocity or inclination were done at any time for patient walk comfort. Blood pressure was registered at minutes 0, 2, 5, 8, 11, and 14, as soon as exercise stopped, and in recovery phase, at minutes 1, 2, 3, and 5. ECG registers were taken at minutes 3, 6, 9, 12, and 15 during the exercise phase and minutes 1, 2, 4, and 6 during recovery phase. Exercise phase was interrupted if there were any of the following: exhaustion, limiting symptoms, high-risk ECG findings (ischemia and arrhythmia), or blood pressure limits for normotensive or hypertensive individuals [21].

Group comparison and correlation: groups A and B were compared by sex, BMI, obesity, hypertension, DM2, dyslipidemia, smoking, stress, accumulated RF, activity level, presence of heart disease, presence of known CAD, indication for ET, symptoms till the date of ET, duration of exertion phase, distance covered, symptoms to ET, reasons for interruption of ET, New York Heart Association classification, systolic blood pressure (SBP) in all phases, diastolic blood pressure in all phases, SBP variation (delta), delta SPB/MET, pressure responses to ET, rest HR, HR of the peak of exertion, HR in the sixth minute of recovery, HR reserve, recovery of HR, sum of reserves, gradient of reserves, resting ECG, ECG during exercise phase, ECG in recovery phase, and the presence of arrhythmias, Duke score, and final report. Comparations between some of these factors and correlations between the most highlighted factors were also performed.

- Statistical analysis: for the comparison of continuous values, a two-tailed Student's t-test was used, and, for categorical variables, chi-square test (chi^2) with Yates' correction was performed. Spearman and Pearson's correlation tests were used to associate factors with VO2max and factors with each other. Multivariate regression analysis was performed to evaluate if any factor would have the ability to predict VO2max. The regression analysis was preceded by assessment of variable linearity on the linear graphic, normality by Kolmogorov–Smirnov test, independence by two-sample means t-statistics test, and homoscedasticity with Levène's test. If heteroscedasticity was detected, white test and Breusch-Pagan test were performed for residual analysis. The statistical tests were performed by SPSS Statistics-IBM (2018) software, except the heteroscedasticity tests, which were done by Gretl 2021b (2021) software. Significant results were considered with $p \leq 0.05$. Results related to the same problem, such as the characteristics derived from HR and BP; formulas in which one factor is part of the estimation of another, such as cardiac output and blood pressure, were considered as possible confounders.

3.2 Results

We observed that women were in majority in this study and had more reported dyslipidemia, reported cumulative risk factors (RF) and reported sedentary behavior associated with cardiopathy and rest electrocardiogram (ECG) changes than men. There was trend for more obesity in women, but Yates' correction did not confirm chi2 result. Other baseline findings, such as age, body mass index (BMI), hypertension, diabetes mellitus, smoking, stress, previous coronary artery disease (CAD) recommendations for exercise test (ET), symptoms present before ET, and foreseen and obtained maximal oxygen uptake (VO2máx), did not differ between sexes.

In comparative analysis, Among the categorical variables, there was a difference in the comparison in ET indication, blood pressure responses, and obesity, when comparing A group with B group. ECG changes tended to be more frequent in A group, but chi2 result was not confirmed by Yates' correction. Categorical variables such as activity level, symptoms before ET, cumulative RF, hypertension, diabetes mellitus, dyslipidemia, smoking, and stress were not different in both groups. The continuous variables analysis showed a difference between the groups for BMI and heart rate (HR) reserve. There were no differences in age, blood pressure measures, and other HR measures (**Table 1**).

Rest HR was correlated with BMI with weak intensity, but there was no correlation with peak HR and HR Reserve (**Figure 1**).

Pre-regression analysis was done as reported in **Table 2**., with obtained assumptions: dependent and independent values were continuous, linearity on correlation dispersion graphics, independence with independent samples confidence interval, and normality by the Kolmogorov–Smirnov's test. Variance homogeneity could not be assumed after applying the Levène's test. White and Breusch-Pagan's tests for heterogenicity of variances did not reject homoscedasticity, and regression was proceeded.

	Category	**A (n = 29)**	**B (n = 57)**	**p**
Age (years)	—	79.3 ± 3.4	78.1 ± 3.5	0.114 (t)
ET indication	Symptoms assessment	12(41.4)	13(22.8)	0.034 (chi^2)
	Known CAD	2(6.9)	11(19.3)	
	Risk factors	13(44.8)	31(54.4)	
	Arrhythmias	2(6.9)	2(3.5)	
ECG	Normal	8(27.6)	6(10.5)	0.042 (chi^2, Yates:0.089)
	Discrete changes	18(6.7)	43(75.4)	
	Significant changes	3(11.3)	8 (14.1)	
Rest SBP	Depressed	1(3.5)	5(8.7)	0.008 (chi^2)
	Exacerbated	15(51.7)	11(19.3)	
	Normal	13(44.8)	41(72.0)	
Rest DBP	Exacerbated	2(6.9)	0	0.047 (chi^2)
	Normal	27(93.1)	57(100)	
BMI (kg/m^2)	—	28.4 ± 4.1	26.7 ± 3.4	0.045 (t)
Obesity (BMI ≥ 30)	—	12(41.3)	10 (17.5)	0.017 (chi^2)
HR reserve (bpm)	—	49 ± 17	56 ± 14	0.043 (t)

Continuous variables are expressed in means. ET: Exercise test, ECG: electrocardiogram, SBP: systolic blood pressure, DBP: diastolic blood pressure, CAD: coronary artery disease, A: A group, VO2max < 24 mg/kg/min, B: B group, VO2max ≥ 24 ml/kg/min, BMI: body mass index, SBP: systolic blood pressure, Delta SBP: peak SBP – rest SBP, HR reserve: peak heart rate – rest heart rate, A: A group (VO2max < 24 mg/kg/min), B: B group (VO2max ≥ 24 mg/kg/min), t = Student's t-test, Chi^2: chi-square test (Source: authors).

Table 1.
Main comparisons between VO2max groups.

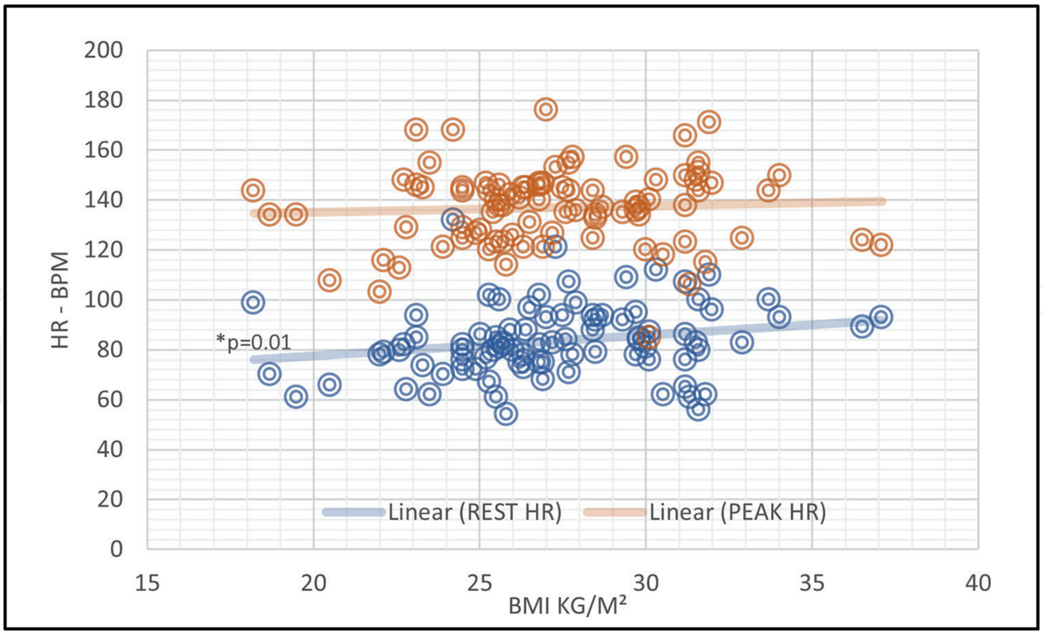

Figure 1.
*Correlation between HR and BMI. HR: Heart rate, BMI: Body mass index (weight/height²), data presented in averages, linear correlation *p = 0.01, Spearman's rho = 0.272. (source: Authors).*

Analysis	Test	Result	Interpretation
Continuous variables	—	three continuous variables: VO2max, rest HR, and BMI	Assumed
Linearity	Graphic analysis	Linear dispersion	Assumed
Independence	Independent Samples Confidence Interval	VO2max/BMI: CI (95%) = 0.9 ± 1.6 VO2max/Rest HR: CI (95%) = 810.6 ± 31.1 Rest HR/BMI: CI (95%) = 809.7 ± 31.1	Assumed
Normality	Kolmogorov–Smirnov	VO2max: K-S = 0.846 p = 0.542 BMI: K-S = 0.056 p = 0.938 Rest HR: K-S = 0.797, p = 0.618	Assumed
Homoscedasticity	Levène	VO2max/IMC: f = 13.192, p˂0.01 VO2max/Rest HR: f = 35.678 p < 0.01 Rest HR/BMI: f = 65.120 p < 0.01	Not assumed
Heteroscedasticity	White Breusch-Pagan	TR^2 = 4.4412, p = 0.488 LM = 6.5943 p = 0.037	Not rejected

VO2max: maximal oxygen uptake. HR: heart rate, BMI: body mass index, CI: confidence interval, K-S: Kolmogorov–Smirnov index, f ratio: Levène index, TR^2: White index, LM: Breusch-Pagan index (Source: authors).

Table 2.
Pre-regression analysis.

Linear regression analysis observed a linear correlation between rest HR, VO2max, and BMI, with following Pearson's test results (BMI and VO2max, r(84) = −0.214, p = 0.05; HR and VO2max, r(84) = 0.211, p = 0.05; and HR and BMI, r(84) = 0.208, p = 0.05). Although not all assumptions were reached, multivariate regression returned a prediction formula, in which the rest of HR predicts VO2max at different BMI levels (**Figure 2**).

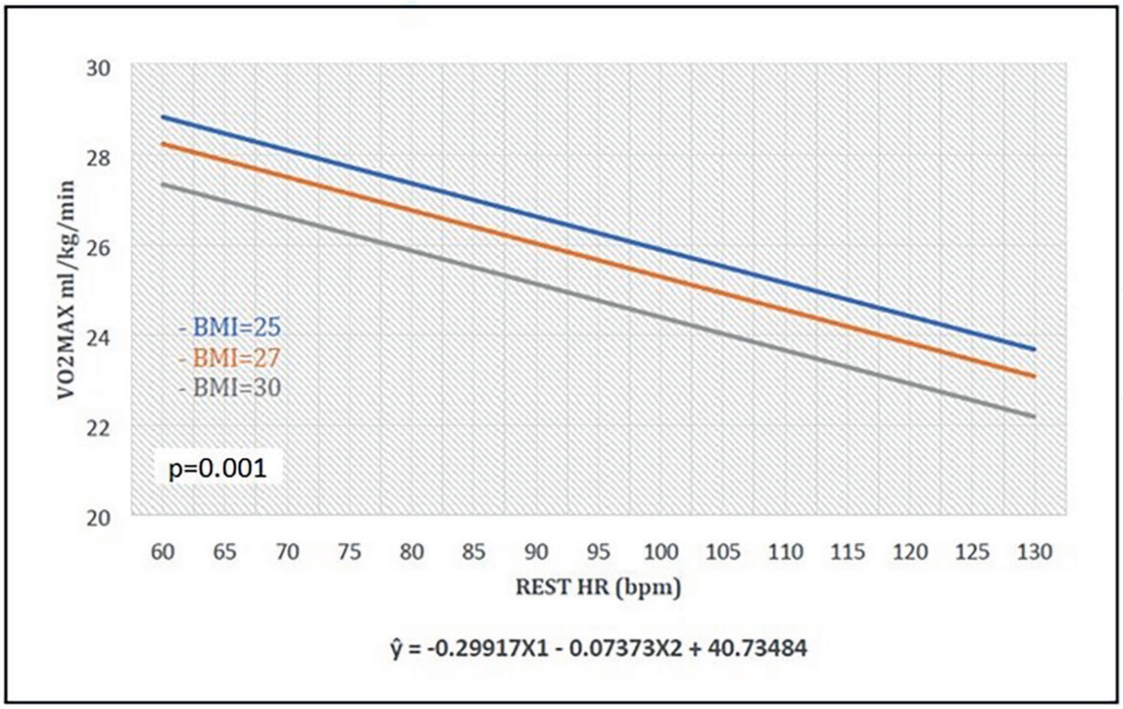

Figure 2.
Multivariate regression equation applied to three BMI value, rest HR, and BMI. Data presented in linear value, bivariate regression analysis p = 0.001. (Source: authors).

3.3 Discussion

This case series (n = 86) has an average age of 78.5 years, which is superior to life expectancy in Brazil (76 years) [2]. Risk factors (RF) incidence in oldest-old adults, when compared with Vivacqua et al. [24], is similar for sedentary behavior (75.5% x 77%); but different for hypertension (83.7% x 21%), dyslipidemia (53.5% x 22%), smoking (9.3% x 3%), and diabetes mellitus (16.3% x 6%). In the Vacanti, Sespedes, and Sarpi [25] series, 50% there were hypertensive, 36% had dyslipidemia, and 14% were diabetics. Sedentary behavior is linked to more than 36 pathological situations [12]. This survey observed 75.6% self-declared sedentary, but this data may be underestimated, as it is obtained by self-report [23]. Sedentary behavior was more frequently declared by patients with cardiac disease, and it is concerning because exercise is a therapeutic resource for almost all types of cardiac diseases [26]. This sample showed 17.4% of known coronary artery disease (CAD) and 14% of ischemia signs on exercise test (ET). Women declared more dyslipidemia, cumulative RF, with a trend for obesity. Hormonal protection seems to disappear a few years after menopause and RF prevalence rises in females [27]. Data about sedentary behavior, BMI, and RF are aligned with epidemiological studies, which report low adherence of older adults to health goals composed by RF control, dietary changes, and physical activity [28]. RF and VO2max have been reported as significant markers of cardiovascular disease and mortality in this age group [18].

Symptoms before ET were reported by 46.5%, more than observed in the Vacanti, Sespedes, and Sarpi [25] study, which found 35% of symptomatic examinees. Recommendations for ET were RF assessment (51.2%), symptoms assessment (29,1%) e CAD follow up (15.1%). Vivacqua et al. [24], in a male-predominant and in hospital laboratory sample, found these recommendations: exercise capacity assessment (61%), therapeutic assessment (22%), post-myocardial infarction

(17%), post-myocardial revascularization (10%), post-angioplasty (5%), and chest pain assessment (1%). Adaptable ramp protocol [20] for treadmill ET was applied in all patients, with 97.7% of cases reaching exhaustion at the end of exercise phase. Another study in the same age group, but with adaptable Bruce protocol, average length of exercise phase was 6.8 ± 2 minutes [25], different from this sample with an average length of 10.3 ± 2,4 minutes. This exercise phase lenght average is recomended by Brazilian guidelines on ET ramp protocol [21]. During ET, few cases presented symptoms, such as angina (1.2%) and dyspnea (3.5%). Only two cases presented exercise-limiting symptoms. These data are like other studies in oldest-old adults [20, 22, 27] and suggest ET is a safe procedure in this subpopulation.

The VO2max average (26.4 ± 6.20) obtained was superior to previewed for men (26.9 x 22.4 ml/kg/min) and women (25.9 x 14.7 ml/kg/min). Vivacqua et al. [24] observed lower values: 20.6 ml/kg/min for men and 19.6 ml/kg/min for women and Vacanti, Sespedes, and Sarpi [25] found average of 23.1 ml/kg/min. When compared to averages of this study, it should be reasonable to think about a functional increase of oldest-old adults in the last decades, on the other hand, studies with in-hospital samples may have included more severe cases. Eriksen et al. [29] evaluated 16,025 individuals, 1077 over 70 years old age, with cycle ET, and found correlation between active time and sedentary time with mortality. They also found average VO2max values closer to the observed in the present study: 29.7 ml/kg/min (men) and 24.1 ml/kg/min (women). Ferrari and Goelzer [20], with an octogenary sample submitted to treadmill ET, found a VO2max range of 20.8–22.7 ml/kg/min (men) and 16.5–19.2 ml/kg/min (women). If considered only individuals ≥80 years, this study found higher averages: 24.6 ml/kg/min (men) e 24.4 ml/kg/min (women). Using cardiopulmonary stress test (CST), Almeida et al. [17] evaluated 103 individuals with more than 70 years old, without cardiac disease, and found average values of 22.06 ± 4.7 ml/kg/min (men) and 17.41 ± 3.7 ml/kg/min (women) in the 70–79 group; and 19.20 ± 3.4 ml/kg/min (men) e 16.56 ± 2.9 ml/kg/min (women) for the ≥80 years old group. The VO2max averages presented here are higher, and this could be explained by method differences, reported by Lima et al. [30], who found that calculated VO2max is overestimated by 15–38% when compared to measured VO2max in a CST. Kokkinos et al. [31], assessing 5314 old men with treadmill ET, observed inverse correlation between mortality and exercise capacity with a VO2max neutral point of 17.5 ml/kg/min. Recently, the same group found VO2max thresholds for 10-year mortality by age groups, the over 70 years old group should have 24% of mortality reduction in the VO2max range 21–28 ml/kg/min [6]. Same findings were observed by Mandsager et al. [32] in a sample of 122,007 older adults. In the same way, Korpelainen et al. [33], with 3,033 older adults on treadmill ET, observed that FC was the strongest indicator of cardiovascular and general mortality.

Rest HR average was 83.7 bpm, the exercise peak was 137 bpm, and HR reserve was 53.3b pm, like Vacanti, Sespedes and Sarpi [25], which found 82.6 bpm at rest, 134.2 bpm at exercise peak, and a HR reserve of 51.6 bpm. In the present study, 16.3% had normal ECG, 70.9% had discrete changes, and 12.8% had significant changes. Women's rest ECG had more changes than men's rest ECG. Only 7.0% of all samples presented significant ST changes during ET, contrasting with Vivacqua et al. [24] in-hospital samples, which found significant ST changes in 22%.

Comparison of two VO2max groups showed some significant differences. Recommendations for ET to assess symptoms, lower HR reserve, abnormal blood pressure response, and higher BMI were more frequent in A group, with lower VO2max (**Table 1**). Fernandes-silva et al. [34], in a populational study, found a direct and independent correlation between BMI and arterial stiffness in older adults, which is a marker of future cardiac disease. A Chinese study with oldest-old adults showed that low weight was associated with higher mortality, and overweight was associated with lower mortality rate than normal weight [35]. Park et al. [36] associated older adults' weight maintenance with low mortality rate; great loss of weight was associated with higher mortality and weight gain was associated with mild elevation of mortality. Abnormal blood pressure responses, systolic and diastolic, were higher in the A group (**Table 1**), this abnormal response has been linked to future hypertension, atherosclerosis, cognitive disorders, and mortality [30].

A weak correlation between BMI and rest HR was observed, but not with peak HR or HR reserve (**Figure 1**). Rest HR and obesity have been associated with development of cardiac disease [37] and atrial fibrillation, as well as mortality, in older adults [38, 39].

Multivariate regression showed interrelation between BMI, rest HR, and VO2max indicating that for higher rest HR and higher BMI, lower levels of VO2max are expected. These results, however, should be seen with caution, because of some statistical limitations, such as the non-homogeneity of variance in these sample values. Since the White and Breusch-Pagan tests had not rejected homoscedasticity (**Table 2**), the regression is presented (**Figure 2**) but considered unable to purpose a prediction model. Forman et al. [20] suggest that exercise capacity remains a target for therapeutic management in the elderly, emphasizing hemodynamic strategies, such as rest HR and metabolic approach, including BMI, with simple approaches, such as dietary intervention and physical activity.

This study has many limitations: VO2max was calculated, not measured, so values may be overestimated. The ex-post-fact context is limiting because clinical characteristics were self-related and there was no possibility to apply validated questionnaires. Sample size may not allow to demonstrate more significant results, and there is possible bias in regression results caused by sample heteroscedasticity. In this study, it was impossible to establish prediction of VO2max based on resting heart rate or body mass index, but it could be an idea for future research. Despite limitations, this study suggests a practical implication: this subpopulation can benefit from a pre-participation assessment of clinical and functional capacity features, followed by exercise prescription, another one is that it could support the development of strategies for active aging programs [1, 40] and healthcare delivery to oldest-old adults [19, 24].

4. Promoting physical activity for advanced older adults

The practice of health-promoting and therapeutic physical activity, with minimal risks, is also a factor in the development of autonomy, self-esteem, and comprehensiveness of care. Such a measure can aid in sociability when adopted in therapeutic groups [41], helps in psychomotricity [42], improves cognitive performance [43], promotes the control of various cardiovascular risk factors [44], reduces the cancer risk [45], and favors lower risk of falls and fractures [46]. There is also evidence that regular physical activity can attenuate the effects of aging on the cardiovascular system [47, 48]. Therefore, it is necessary to approach interdisciplinary and create simple and reproducible and easy-expanding programs to promote physical activity for this subpopulation. These programs should consider the natural aging process and the fact that these people reach advanced ages bringing with them diseases, sequelae, cultural and environmental issues, preferences, and social conditions obtained throughout a lifetime. Exercise in the elderly is considered as promoter of quality of life with improvement of physical, social, and emotional aspects; mortality reduction, especially cardiovascular mortality; reducing the risk of cancer; and prevention of falls. There is, therefore, the need for reception, equity, attention to cultural aspects, and care for psychosocial situations, aiming for adherence and effectiveness [40].

Exercises of the most varied modalities can bring benefit to the health of the elderly, such as aerobic, resisted, or combined [48]. Smolarek et al. [49], observed that, in old women trained for 12 weeks with strength exercises, there was an improvement in both the strength of the limbs and the cognition indexes. It is possible to improve functional capacity with training even in the elderly; a systematic review showed that most studies found favorable results in physical capacity and psychological aspects in the elderly undergoing various forms of structured training [50].

Health system structure, and society in general, should be aware of the growing demands of this population on physical activity and requires clinical and complementary evaluation, where the ET is included as a tool capable of giving prognostic information, functional data, and motivation for the mobilization of the elderly because there is a high prevalence of sedentary lifestyle among the elderly, which remains unchanged for decades [28]. Exercise should be focused on the improvement of FC [1]. Managers and health professionals who work with the elderly cannot be satisfied with only accepting the nonadherence to exercise but should look for the causes of nonaccess and break these barriers [40].

5. Resistance training in older adults

The more obvious benefit of resistance training for advanced older adults is the prevention of muscular decline, which is achieved by gene and protein expression in muscle cells, with individual heterogeneity, delivering shift in the muscle fibers, muscle mass gain, force, power, mobility, and balance improvement [51]. Studies with resistance training programs (RTP) for older adults have been published in last three decades, and main results were compiled in a meta-analysis by Liu and Latham [52], with 121 studies and 6700 patients. They observed a favorable result for resistance exercise in physical function improvement in older adults. RTP is considered safe and is associated with retarding aging of muscle mass, muscle strength improvement, and reducing chronic inflammation [53]. RTP is recommended for healthy and frail individuals, with limits and technics personalization [51]. These results, achieved by neuromuscular and neuroendocrine adaptations, can help patients to improve mobility, functional capacity, performance in activities of daily living, and preserve the independence, with a dose–response effectivity relationship [54, 55]. RTP have been associated to better quality of life [56], reducing frailty symptoms [57], retarding cognitive decline [58], preventing sarcopenia and falls [59], and lowering risks of cardiovascular disease and all-cause mortality [60], with significant impact of BMI on these two major events [61]. The use of RTP can even reduce social and geographic barriers that affect elderly [62]. Cardiovascular benefits have been described, as reducing arterial stiffness [63] and blood pressure [64]. RTP can also help to improve FC in older adults, a meta-analysis with 22 studies reported that within 24-week programs, there was a 2.57 ml/kg/min mean gain in VO2max, assessed by ET [65]. In heart failure patients, RTP achieved an improvement of muscle strength, quality of life, and FC [66]. There is a recent report of FC gain in older women survivors of breast cancer, which is an important aim because quality of life and insulin resistance are associated with recidivism [67]. Even advanced pulmonary cancer patients have been trained with RTP with favorable results in quality of life and physical function [68, 69]. A systematic review observed quality of life and survival improvements in cancer survivors with regular exercise practice, most of studies were on RTP programs [70]. In order to assist the elderly in achieving FC improvements, therefore, an interdisciplinary approach, involving various health professionals, a support team, and health managers could be very helpful [71].

6. Conclusions

This study allowed us to conclude that advanced older adults, compared by functional capacity (VO2max cutoff = 24 mg/kg/min), had significant differences in important factors: heart rate reserve, body mass index, recommendation to assess symptoms, and abnormal blood pressure response. We also found a correlation between resting heart rate and body mass index, and both to functional capacity. Since these variables have been associated with higher risks of disease and mortality in older adults in a great number of studies. As a practical implication, we reinforce that oldest-old adults can benefit from a pre-participation assessment of clinical and functional capacity features, followed by exercise prescription to get the final objective of active aging. These findings can also support exercise programs, resistance training included, which are important tools to achieve this objective.

Author notes

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