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Comparison between Sexes of the Relationships between Body Composition and Maximum Oxygen Volume in Elderly People

Wanesa Onetti-Onetti [1,*], Edgardo Molina-Sotomayor [2], José Antonio González-Jurado [3] and Alfonso Castillo-Rodríguez [4,*]

1 UNIR, Universidad Internacional de la Rioja, 26006 Logroño, Spain
2 Departamento de Educación Física, Universidad Metropolitana de Ciencias de la Educación, Santiago de Chile 7760197, Chile; edgardo.molina@umce.cl
3 Centro de Investigación en Rendimiento Físico y Deportivo, Universidad Pablo de Olavide, 41013 Sevilla, Spain; jagonjur@upo.es
4 Department of Physical Education and Sports, University of Granada, 18011 Granada, Spain
* Correspondence: wanesa.onetti@unir.net (W.O.-O.); acastillo@ugr.es (A.C.-R.); Tel.: +34-958-244-377

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Abstract: Background: Performing physical activity can provide a variety of benefits; for example, it can improve one's physical condition, decrease one's fat mass, and increase one's muscle mass. The objective of the present study was to evaluate the relationships between the cardiorespiratory resistance and physical characteristics of people over 60 years of age. Methods: A total of 31 participants over 60 years of age from the province of Malaga (Spain) joined the study voluntarily. Results: The aerobic capacity test, called the Rockport One Mile, was carried out, and Spearman correlation and linear regression analyses between the volume of oxygen (VO2) and the body weight, body mass index (BMI) and age of the participants were performed. The results indicated that 28% (in women) and 48% (in men) of the maximum VO2 (determined by the Rockport test) was explained by the variable body weight ($p < 0.01$). Conclusions: The main finding of this study is that an individual's physical abilities, specifically resistance and aerobic capacity are directly related to his or her body weight and other variables in males, such as age and BMI.

Keywords: Rockport One Mile test; weight; fat mass; lean body mass; sex; active ageing; sustainability

1. Introduction

Physical activity (PA) is considered to be one of the most important health indicators that benefits individuals of all age groups [1–3]; it is used as an effective intervention to prevent functional loss related to ageing [4–7], and it promotes an improved quality of life and, as a result, greater longevity when coupled with appropriate eating patterns [8–11]. Nutritional habits can affect the mood of a person and therefore can have a broad impact on society [12]. PA also improves individuals' quality of life because it reduces fat mass (FM) and obesity [13,14] and prevents a rapid reduction in the size and number of individuals' muscle fibres [15].

Over time, people experience a decline in their physical condition (less strength, endurance, flexibility, etc.), together with a deterioration in their body composition (increased fat mass and a loss of muscle mass) [16]. These types of inabilities can be reduced or mitigated when people participate in controlled physical activity programs [17–19]. In addition, recent studies suggest that dancing may also benefit cognition and physical health in elderly people, but there are many dance styles and approaches, and intervention studies with rigorous designs are still scarce [20].

Older people can reduce or control their total and central adiposity through aerobic exercise [21–23]. Vascular ageing can be combated when regular exercise is used as a therapeutic strategy [24]. In addition, exercise is reported to be effective in improving people's maximum oxygen consumption (VO2max) and HDL levels and reducing their level of plasma triglycerides [25,26], although resistance training is also recommended for improving muscle mass and strength [27].

Volume of oxygen (VO2) is a physiological variable that decreases progressively with age. An exercise prescription should include aerobic, muscle-strengthening and flexibility exercises [28]. However, Rockport One Mile Walk Test protocol provides a valid sub-maximal assessment to estimate VO2max [29]. Researchers often use the VO2max in the generalized equation in the final test, but the mean VO2 is rarely used in papers. The Rockport Walk Test [29] for a treadmill that was initially created to be able to monitor several subjects; at the same time, it is a laboratory test and a submaximal stress test. The fitness level is considered as a moderator between the effect of regular physical activity and cognitive function [30], in fact, these physiological adaptations, at a cardiovascular level linked to a good fitness level, could explain the association between VO2max and body weight. In this context, it is hypothesized that the relationship between VO2max and body weight is similar between men and women. It is known that women can reach a lower VO2 level than men, but they also have lower physical characteristics. In this sense, the authors think that this relationship is similar.

The objective of this study was to evaluate the relationship between the cardiorespiratory resistance and physical characteristics of people over 60 years of age.

2. Materials and Methods

2.1. Participants

A total of 31 people aged over 60 voluntarily participated in this study. In total, there were 13 men (66.23 ± 2.65 years on average) and 18 women (66.00 ± 3.01 years on average), and all of them were residents in the province of Malaga. Their body characteristics are shown in Table 1. None of the participants suffered from a disease or pathology that could affect the results of the tests carried out in this study. All the participants were practicing physical activity in various sports centres in Malaga (Spain). The way to enrol in the study was through an advertisement in various sports centres. The activity they practiced was swimming or dry varied physical activity. In addition, all participants practiced trekking once a week. It has been reported that they practiced regularly in sports centres 120 min per week and went trekking around 180 min per week (approximately). The objectives of the study were explained to the participants, and voluntary consent was provided by them once they were considered to have met the inclusion criteria. These inclusion criteria were an age older than 60 years, and the absence of a pathology related to the musculoskeletal or cardiorespiratory system that could affect the results of the tests. This study complies with the provisions of the Helsinki Declaration [31], and the Ethics Committee of the University of Malaga approved the completion of this study.

Table 1. Body characteristics of the participants.

	Males (n = 13)	Females (n = 18)	*P*
Weight	67.03 ± 10.3	71.46 ± 11.2	Ns.
Height	162.0 ± 7.58	163.5 ± 8.22	Ns.
BMI	25.41 ± 2.05	26.60 ± 2.75	Ns.

Ns.: Non significant.

2.2. Instruments

For the body measurements, a SECA bascule (Hamburg, Germany) with an accuracy of 100 g was used for the assessment of body weight. For the evaluation of the fitness parameters for the Rockport One Mile test, Polar RC3-GPS (Polar, Helsinki) heart rate monitors were used to measure the heart rate, and a GPS was used to measure the maximum speed. This test was carried out on a 400-metre running track, and the circuit consisted of performing four laps over 9.3 metres, which were measured by measuring tape.

The Rockport One Mile walk test is a submaximal test used to estimate an individual's VO2max. This test has been validated for the assessment of functioning in older people [32]. The goal of this test is to walk fast (without running) for one mile in the shortest possible time [33]. To calculate the participant's effort, it is necessary to take into account his or her age in years, height in cm, weight in kg, maximum heart rate (at the end of the test) and test execution time in minutes. The complete equation differs according to the participant's sex.

For women: VO2 = 154,899 − (0.0947 * 2.2046 * weight) − (0.3709 * age) − (3.9744 * time) − (0.1847 * FCM)

For men: VO2 = 116,579 − (0.0585 * 2.2046 * weight) − (0.3885 * age) − (2.7961 * time) − (0.1109 * FCM).

2.3. Procedure

The participants were given an informed consent form explaining the tasks involved in the research study. Once it was signed and understood by them, the participants were administered a medical questionnaire to verify whether they met the inclusion criteria and to collect socio-demographic data (age, sex, work performed, etc.). The action protocol was carried out on the same day, so the participants were scheduled to stay for a longer period of time if necessary for the tests. The order of the tests was as follows: evaluation of the physical characteristics (weight and height), a warm-up session lasting 10 min and including exercises for joint mobility, light-intensity bicycling, and walking. Finally, GPS devices were used during the Rockport One Mile test.

2.4. Statistical Analysis

For the study and statistical analysis of the variables, the Shapiro–Wilk test was performed to test the normality of the data set. After the normality of the data was tested, the nonparametric Spearman correlation coefficients between the Rockport One Mile test variables and physical characteristics, such as body weight, age and BMI, were determined. Finally, we proceeded to perform linear regression tests (stepwise) to determine the coefficients of determination between the dependent variables analysed. For all analyses, the statistical programs SPSS 23 for Windows (SPSS Inc., Chicago) and Microsoft Excel 2010 (Microsoft Corp, Redmond, Washington, DC, USA) were used.

3. Results

Table 2 shows the results of the Shapiro–Wilk normality test. The variables generally follow a non-normal distribution. Body weight, BMI, maximum heart rate (maxHR) and time are the variables that were subjected to parametric tests.

Table 2. Normality test results for the variables studied.

	Shapiro-Wilk		
	Statistic	**Degree Free**	***P***
Weight	0.938	28	0.099
Height	0.886	28	0.005
BMI	0.929	28	0.060
Age	0.931	28	0.066
maxV	0.849	28	0.001
maxHR	0.973	28	0.676
Time	0.931	28	0.067
meanVO2	0.810	28	0.000
maxVO2	0.888	28	0.006

BMI: Body mass index; maxV: maximum velocity; maxHR: maximum heart rate; meanVO2: mean volume of oxygen (VO2); maxVO2: maximum VO2.

Table 3 shows the Rockport One Mile test results between males and females. It is observed that men displayed the best test results, confirming the natural differences that exist between the genders ($p < 0.05$).

Table 3. Mean and standard deviation of Rockport One Mile test according to the sex.

	Males (n = 13)			Females (n = 18)			*P*	*d*
maxV	7.64	±	7.64	6.89	±	1.08	0.033	0.15
maxHR	152.7	±	152.7	129.3	±	19.7	0.002	0.24
meanVO2	41.81	±	41.81	36.71	±	9.29	0.055	0.18
maxVO2	34.30	±	34.30	27.91	±	11.6	0.046	0.27
Time	14.44	±	14.44	16.51	±	1.03	0.000	0.22

Table 4 shows the correlation coefficients obtained for the relationships between the maximum volume of oxygen and the average volume of oxygen, as measured in the Rockport One Mile test, and between the body weight and BMI variables and the age variable. There are several correlations in the male sex; there is a strong correlation between body weight and VO2max (*rho* = −0.76, $p < 0.01$) and moderate correlations between VO2max and BMI and between VO2med and age in men aged over 60 years (*rho* = −0.61, $p < 0.05$; *rho* = 0.55, $p < 0.05$; respectively).

Table 4. Spearman's rho correlation coefficient for the male sex.

	BMI	Age	Weight
maxVO2	−0.608 *	0.364	−0.757 **
meanVO2	−0.311	0.554 *	0.019

Table footer: * $p < 0.05$; ** $p < 0.01$.

In addition, in the male sex, there were two moderate correlations with the person's age and the variables maximum speed and maximum heart rate, as measured in the Rockport One Mile test (*rho* = 0.62, $p < 0.05$; *rho* = -0.53, $p < 0.05$; respectively).

Table 5 shows the correlation coefficients obtained for the relationships between the maximum volume of oxygen and the average volume of oxygen, as measured in the Rockport One Mile test, and between the body weight and BMI variables and the age variable in the female sex. A moderate correlation between body weight and VO2max was observed (*rho* = 0.51; $p < 0.05$).

Table 5. Spearman's rho correlation coefficient for the female sex.

	BMI	Age	Weight
maxVO2	0.323	0.010	0.507 *
meanVO2	0.350	0.089	0.042

Table footer: * $p < 0.05$.

Next, the relationships between the Rockport One Mile test results and total body weight were studied (Figures 1 and 2). The coefficient of determination suggests that 28% of the variance in the endurance test result (maxVO2) is explained by the variable body weight in women ($R^2 = 0.279$, SEE = 10.188, $p = 0.024$) and 48% is explained by body weight in men ($R^2 = 0.475$, SEE = 3.526, $p = 0.024$). Furthermore, in men, age predicted 21% of the explained variance of the meanVO2 (SEE = 4.344, $p = 0.050$).

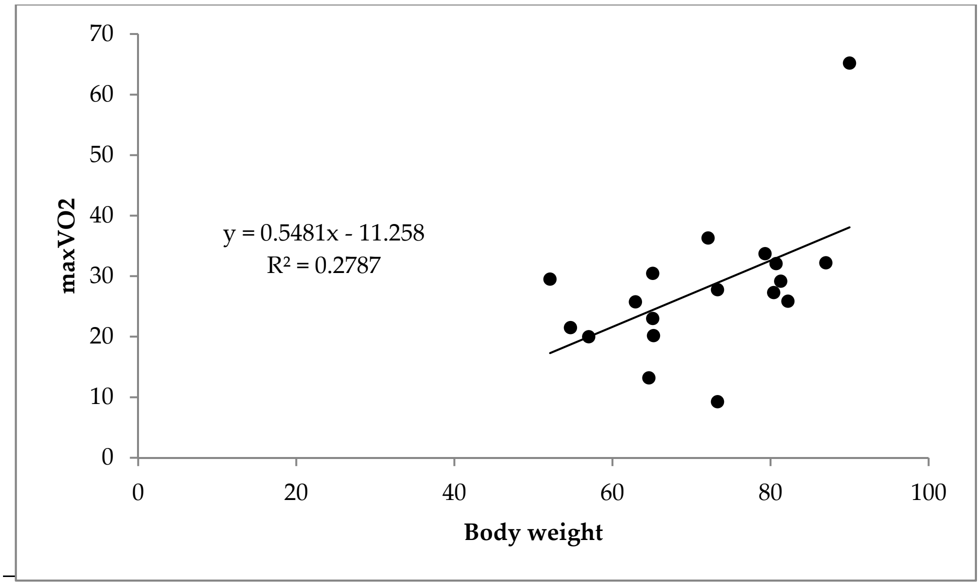

Figure 1. Relationship between maximum VO2 and body weight in women.

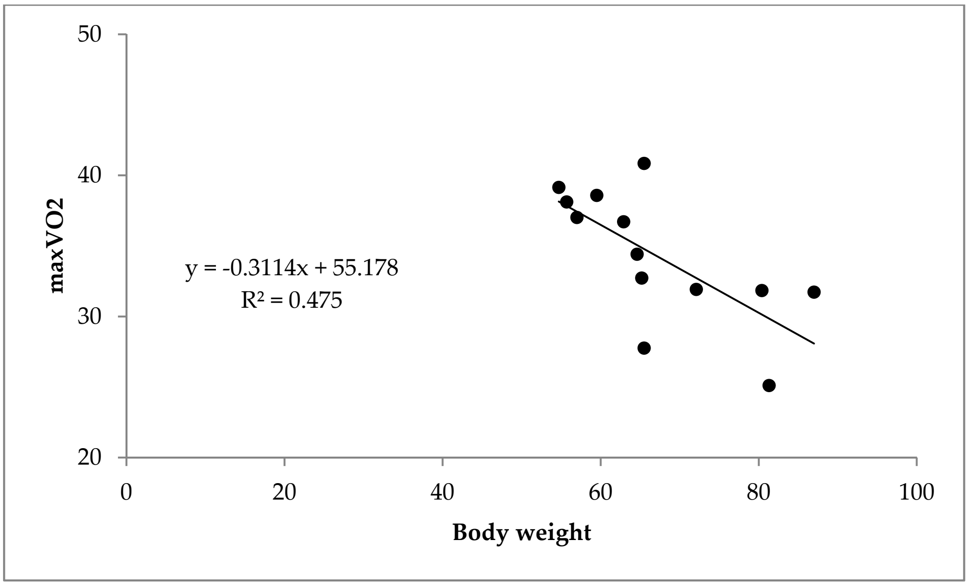

Figure 2. Relationship between maximum VO2 and body weight in men.

4. Discussion

The aim of this study was to relate the results of the Rockport One Mile aerobic endurance tests with the participants' body weight, BMI and age. The results showed that there is a strong relationship between these variables, and the relationship between VO2max and total body weight in particular was statistically significant. This relationship was stronger in men than women, mainly due to the biological differences between the sexes, which lead to greater aerobic capacity in males. In addition, age and BMI in men were related to VO2. This fact is mainly due to the effect achieved by a lower body mass (in the equation for the calculation of BMI) on the parameters of aerobic resistance, which translates into less time spent on the test. However, the directionality of the results suggests that sex can affect this relationship. In males, this relationship is negative, and in females, it is positive. According to various studies, if people participate in fitness programmes, this aerobic capacity increases [34]; however, taking into account that all the participants carried out regular practice of physical activity, the attendance rate could have been taken into account since 120 min of physical activity per week is somewhat limited and the absence of a day subtracts 60 min of weekly physical activity. Therefore, it is presented as a limitation of the study.

The relationship with body weight is negative for males. This fact could confirm that people who perform less physical activity have a less favourable overall condition, weigh more, and are more likely to be obese [35,36], leading to a considerable decrease in function [37]. Furthermore, the physical activity practiced by men and women is identical because the recruitment of participants occurred in the same sports centers, where activities focused on older people are practiced by both men and women. These physical activities could cause more effort in women and less effort in men. It could have been controlled with variables as subjective rating of perceived exertion, since it has been proven that physical activities that do not oscillate at 90% of the maxHR do not lead to an improvement in the organism [38]. This may explain the discrepancy with this study [39]. On the other hand, Figures 1 and 2, suggest that skeletal muscle mass of both sexes could be the key to finding these relationships. Skeletal muscle mass is related positively with the maxVO2, although this should be by controlling the body weight, because it could contaminate these relationships. In addition, the capacity for strength and balance are also related to the body composition of older people (specifically, fat-free mass) [40].

On the other hand, aerobic capacity seems to be related to age, which suggests that these results may be influenced by the duration of physical activity that a person performs; this issue is presented as a study limitation. A better time on the Rockport One Mile test is associated with higher values of VO2, which means that a person who has performed regular physical activity for 5–10 years can perform better on the test than a person who has performed regular physical activity for 1–2 years.

In a pilot study, it was found that older people improved aerobic capacity, assessed through the Rockport test. However, this improvement should be taken into account due to the sample size [19]. Other studies confirmed the improvement of VO2 through physical activity programs [41]. Several studies confirm that the Rockport test is an excellent test for the evaluation of aerobic capacity in the elderly [42–44]. However, there are no studies that have investigated the relationship between body weight and aerobic capacity assessed through Rockport in older people. These relationships have been proven to differ according to sex and therefore, the starting hypothesis is rejected.

This study presents a series of limitations, in addition to those already mentioned above. First, the adherence to the Mediterranean diet and the nutritional styles or habits of the participants was not controlled, so they may have affected the results in this study. In addition, the motivational strategies used by the instructors or sports coaches who were involved in the physical activities performed by the participants were not taken into account. This factor may have influenced the results because it is one of the most important pillars in terms of the valuation of exercise services and is directly related to the adherence and maintenance of these practices [45]. Finally, body composition can be evaluated in the future for more information about the effect that this factor has on the aerobic capacity of a person and to determine whether this effect differs by sex.

5. Conclusions

The main finding of this study is that an individual's physical abilities, specifically endurance or aerobic capacity, are directly related to his or her body weight, age and BMI. This relationship is evident in males, with only a moderate relationship between body weight and maxVO2 in women. This difference in the effects may be due to various factors, such as adherence to the Mediterranean diet and years of experience performing physical activity, since the selected study population did not have a history of consuming medications. For these reasons, the population over 60 years of age is encouraged to participate in physical activity programs to improve their physical abilities and therefore prevent obesity and the related risk factors.

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writing—original draft preparation, W.O.-O. and A.C.-R.; writing—review and editing, E.M.-S.; visualization, J.A.G.-J.; supervision, A.C.-R.; project administration, E.M.-S.

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