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ORIGINAL

VO_2 INDIRECT MAXIMUM AND FITNESS AGE OF SEDENTARY AND NON-SEDENTARY

VO_2 MÁXIMO INDIRECTO Y EDAD FITNESS DE SEDENTARIOS Y NO SEDENTARIOS

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest in relation to this article.

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RESUMEN

El objetivo es: comparar la edad cronológica con la edad fitness obtenida por medio del VO_2 máximo indirecto, de un grupo de personas sedentarias y no sedentarias. Método: 253 personas fueron evaluadas respecto a masa corporal, estatura, perímetro de cintura, frecuencia cardiaca basal y un cuestionario del modelo web "Fitness Calculator". Los resultados demostraron diferencias significativas en las variables antropométricas y fisiológicas entre personas sedentarias y no sedentarias (P<,001). Las personas no sedentarias tienen un mayor VO_2máx en comparación con las personas sedentarias. Las personas sedentarias indican que presentan una edad fitness que se encuentra sobre 12 años cronológicos promedio de lo esperado. Conclusión: Las personas sedentarias tienen una mayor edad fitness, esto permite establecer que su cuerpo se deteriora más rápido que los no sedentarios. El bajo VO_2 máx es un potente predictor de la capacidad cardiorrespiratoria y se establece como un predictor de enfermedades cardiovasculares.

PALABRAS CLAVE: capacidad cardiorrespiratoria, riesgo cardiovascular, sedentarismo, actividad física.

ABSTRACT

The purpose was to compare chronological age with fitness age obtained through indirect VO_2max in a group of sedentary and non-sedentary people. Method: 253 people were evaluated for body mass, height, waist circumference, basal heart rate and a web model questionnaire "Fitness Calculator". The results: showed significant differences in anthropometric and physiological variables between sedentary and non-sedentary people (P <.001). Non-Sedentary people have a greater higher VO_2máx group compared to sedentary people. This indicates that sedentary people have a fitness age 12 years over their expected chronological average age. Conclusion: Sedentary people have a higher fitness age; therefore your body deteriorates faster than the non-sedentary people. A low level of VO_2máx is a powerful predictor of cardiorespiratory capacity and of cardiovascular diseases.

KEYWORDS: cardiorespiratory fitness, cardiovascular risk, sedentary, physical activity.

Abbreviations

VO2max: Maximum amount of oxygen that the body is able to absorb, transport and consume per unit of time.
Fitness Calculator: Web or virtual evaluation model of the VO2max. Created by researchers at the University of Science and Technology of the city of Trondheim, Norway (NTNU).
Fitness Age: Physiological age, which responds to VO2max and indicates the deterioration of the human body in an internal way.
ADL: Activities of daily living.
SAID: Orientation room for academic alternatives in Chile.
FRCmax: Maximum heart rate.
FCB: Basal heart rate.
DM: Diabetes mellitus.
HBP: High blood pressure.
CRC: Cardiorespiratory capacity.

INTRODUCTION

The cardiorespiratory capacity (CRC) of people is a powerful predictor and indicator of diseases and cardiovascular risk factors (1). The most common risk factors in the Chilean population are obesity, hypertension, diabetes, cigarettes and sedentary lifestyle (2) (3) (4).

In addition, CRC is a protective cardiovascular health factor that is easy to enhance through physical activity. This, together with changes in people's lifestyles, such as improving diet, can reduce cardiovascular risk (5).

Therefore, objective assessment of cardiorespiratory fitness is vital to know the physical condition of people. One of the ways to know about CRC is through the analysis of respiratory gases or tests that measure VO2max. These tests are carried out in various clinical centers with a high economic cost, with an average time of completion of 12 minutes and which require trained personnel for their application. Recent studies have shown that CRC can be assessed with reasonable accuracy, by means of predictive models without physical tests (6) (7).

In this study, an evaluation model called "Fitness Calculation" is applied, which allows an indirect evaluation of VO2max, without the need for physical exercise, is easily accessible and can be used in any health center quickly and easily . In turn, the indirect VO2max indicates the fitness age (physiological age) and is obtained from anthropometric and physiological variables: age, waist circumference, weight, height, basal heart rate and level of physical activity. In the case of VO2max being below the normal range expected for age, it is estimated that there is a cardiovascular risk because its physiological capacities are not in accordance with chronological age (7) (1) (8) (9). The objective of the present study was to compare the chronological age with the fitness age obtained by means of the indirect maximum VO2 among a group of sedentary and non-sedentary people, to indicate the age ranges that are most exposed to cardiovascular risk factors.

MATERIALS AND METHODOLOGY

The type of study is cross-sectional and comparative, since the participants were evaluated at a single moment in time and the VO2max was compared between the two groups (7).

Participants

A total of 253 people, 120 males and 133 females, all healthy, between 18 and 60 years old, of Latin American ethnicity, belonging to the metropolitan region of Santiago de Chile, participated in this study. Exclusion criteria were: anyone with cardiovascular disease or risk factors (DM, BPH and dyslipidemia) and who do not belong to the city of Santiago de Chile.

All the data were obtained and treated at the Bernardo O`Higgins University with visitors from the Chilean academic orientation room (SAID) between February and March 2014, anonymously, to protect the identity of each of the evaluated participants.

Before performing the data recording and being evaluated, each of the participants were explained what the study consisted of and its purpose. For this, the "Declaration of Helsinki" (10), which allows studies in humans, was considered as the central ethical axis. Once this process was carried out, each of them gave informed consent, in accordance with what was approved by the ethics committee of Bernardo O`Higgins University.

Instruments

We evaluated 7 anthropometric and physiological indicators, related to CRC: gender, age, weight, height, waist circumference and basal heart rate (BHR). In conjunction with this, a brief survey was taken from each of the participants, related to the integrated physical activity within the web evaluation model. The questions pointed to frequency, duration and intensity of physical activity practice (8).

Then a brief survey of physical activity was applied, which included 3 questions: Question 1: How often do you do physical activity?, with the answers: (I) Never, (II) Once a week, (III) 2-3 times per week and (IV) Almost every day. Question 2: How do you feel after your physical training? (Related to the intensity of the physical exercise), with the answers: (I) Relaxed, (II) Some difficulty breathing, (III) Totally exhausted after training. Question 3: How long does each physical training session last? With the answers: (I) More than 30 minutes, (II) Less than 30 minutes (1).

The body mass was evaluated with an electronic scale of "Gama" brand, the size by means of wall gauge, the waist circumference taken with a tape measure in the middle point between iliac crest and lower ribs. Finally, the basal heart rate was evaluated with an electronic pulse oximeter (11).

The above parameters were tabulated in a virtual platform called "Fitness Calculator". This method was validated by Dr. Ulrik Wisløff of the University of Norway in 2011 (1) (8). The model calculates the maximum heart rate (HR Max) and the indirect VO2max. From these, we obtain the fitness age that can be compared with established normal age ranges (1) (12).

The criterion used in this study to classify people into sedentary and non-sedentary was to perform physical activity during leisure time. Those who practiced physical activity once or twice during the week were classified as sedentary, those who practiced 2 times or more in the week as non-sedentary. This last one counted on the complete evaluation of three courses of the subject "physical conditioning", facilitated by the school of physical education, sports and recreation of the same institution.

Statistical analysis

Each of the data obtained is tabulated in an excel table. Once this part was listed, the information was transferred to the virtual program "Fitness Calculator" (7).

Subsequently, the population was classified into sedentary and non-sedentary, to then generate a descriptive table with the statistical averages for the variables of interest in the study (Table 1), in order to see how the variables such as VO2max, FRCmax, normal age range of VO2max. Once with these statistical data, the SPSS version V18 was used to apply means difference tests to independent groups by means of "T-Student", to demonstrate the statistical significance of the variables under study. A p-value of less than 0.05 was considered significant.

RESULTS

In Table 1, the description of the anthropometric and physiological characteristics of the 253 sedentary and non-sedentary individuals, anonymously, is presented. For women and men participating in this study, it was observed that sedentary patients presented higher averages of weight, waist circumference, fitness age, resting heart rate compared to non-sedentary ones ($p < .05$). On the other hand, non-sedentary subjects presented higher VO2max, exercise frequency, weekly training time and exercise perception compared to sedentary exercise ($p < .05$).

Table 1. Characterization of study participants in relation to variables, anthropometric and physiological (n = 253). Place unit of measurement.

Variables	Sedentary (n=118)		Non sedentary (n=135)		P value*	
	Female X (DS)	Male X (DS)	Female X (DS)	Male X (DS)	Female	Male
Size (cm).	162.01 (7.08)	174.64 (5.87)	159.51 (6.13)	172.70 (5.94)	,038	,055
Weight (kg).	73.05 (12.56)	98.39 (106.19)	66.68 (9.10)	75.36 (10.60)	,002	,041
Waist (cm).	80.86 (12.03)	88.00 (13.87)	73.65 (9.28)	80.91 (8.93)	,001	<,001
Age.	24.38 (10.44)	27.79 (12.56)	21.24 (7.09)	20.09 (5.46)	,022	<,001
Fitness age.	38.38 (14.77)	41.18 (16.90)	22.87 (8.20)	22.72 (8.94)	<,001	<,001
FRCmáx (ppm).	194.92 (6.42)	195.16 (8.08)	196.87 (4.40)	199.30 (3.51)	,023	<,001
FCB (ppm).	83.71 (12.25)	80.77 (14.89)	74.40 (13.42)	70.06 (13.99)	<,001	<,001
Frequency of exercise (times per week).	1.23 (0.42)	1.39 (0.49)	3.26 (0.44)	3.48 (0.50)	<,001	<,001
+ Intensity of exercise	1.38 (0.67)	1.48 (0.66)	1.90 (0.67)	1.90 (0.62)	<,001	<,001
VO_2máx (ml/kg/mint).	38.62 (5.25)	47.20 (7.97)	45.50 (4.80)	56.62 (5.55)	<,001	<,001
Time training (< at 30 min/ > at 30 min).	1.25 (0.44)	1.48 (0.51)	1.87 (0.34)	1.93 (0.25)	<,001	<,001

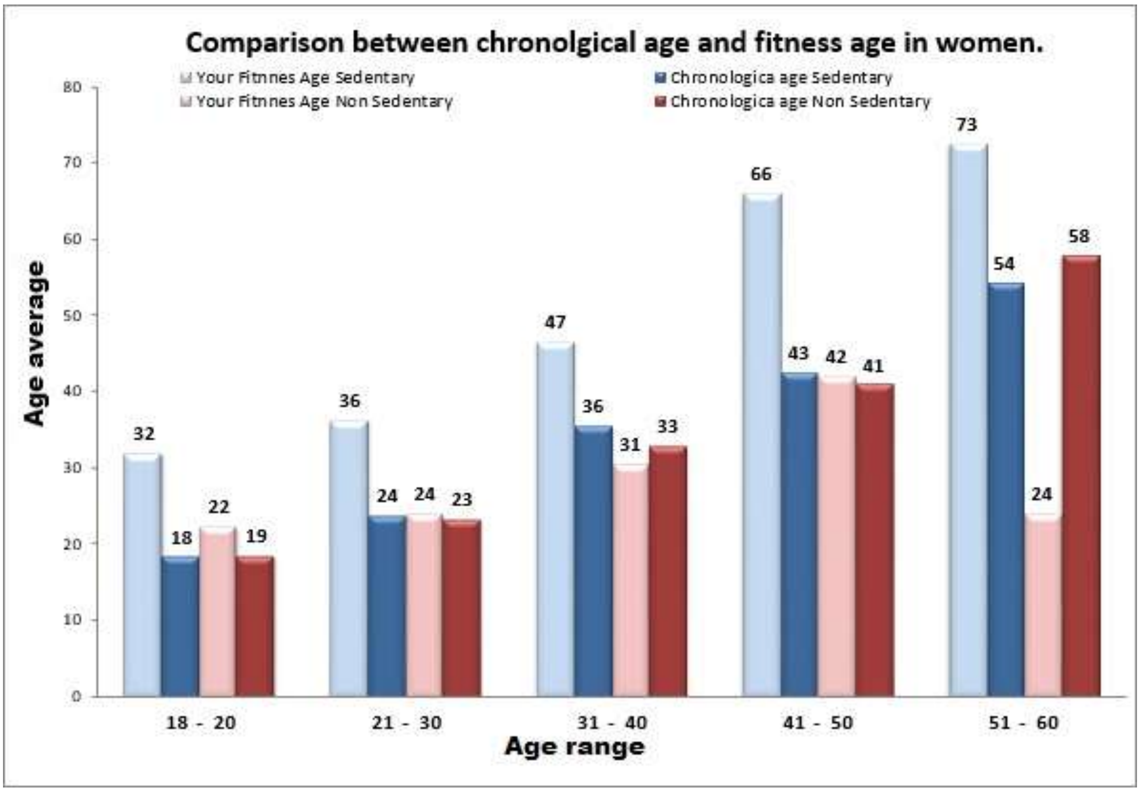
Note: X = average; DS = Standard deviation; FC Max = Maximum cardiac frequency; FC basal = Basal cardiac frequency; VO_2máx = Max volumen oxygen; * t-student. + This question points, as people are after their physical training: I) Relaxed, (II) Some difficulty breathing, (III) Totally exhausted after training.

Table 2. VO_2máx values. Determined by the "Fitness Calculator" program in sedentary and non-sedentary subjects according to the age range.

Age range	VO_2máx.	Sedentary	VO_2máx.	Non sedentary
	Female X(DS)	Male X(DS)	Female X(DS)	Male X(DS)
18-20	40.74 (3.55)	51.53 (4.48)	46.21 (5.34)	58.00 (5.07)
21-30	39.21 (3.26)	46.50 (7.90)	44.07 (3.77)	55.34 (5.66)
31-40	35.80 (5.45)	39.33 (4.80)	41.25 (3.77)	45.00 (0.00)
41-50	28.00 (3.16)	40.33 (6.48)	37.00 (0.00)	52.00 (0.00)
51-60	27.00 (1.00)	37.00 (0.00)	43.00 (0.00)	41.00 (0.00)

Table 2. shows that VO2max increases in both sedentary women and men, despite their age range compared to sedentary women and men.

As can be observed in Figure 1, the "chronological age" of sedentary men is lower than "fitness age", regardless of the age range, having a minimum of 11 years difference, in the age range between 41 to 50 years of age. In the case of non-sedentary men the differences are of a maximum of 7 years in the range of age between 51 to 60 years of age, between the fitness age and the



chronological age. Unlike the sedentary group, there is a category where the actual age is higher than fitness, between 41 and 50 years of age.

Figure 1. Comparison of age chronology and fitness age for sedentary and non-sedentary men.

As can be seen in figure 2, the "chronological age" of sedentary women is lower than "fitness age", regardless of the age range, having a minimum of 11 years difference, in the age range between 31 a 40 years. In the case of non-sedentary women, the differences present a maximum of 3 years, in the age range between 18 and 20 years, between "fitness age" and chronological age. Unlike the sedentary group, there are two categories where the chronological age is superior to fitness between the age ranges 31 to 40 years and 51 to 60 years.

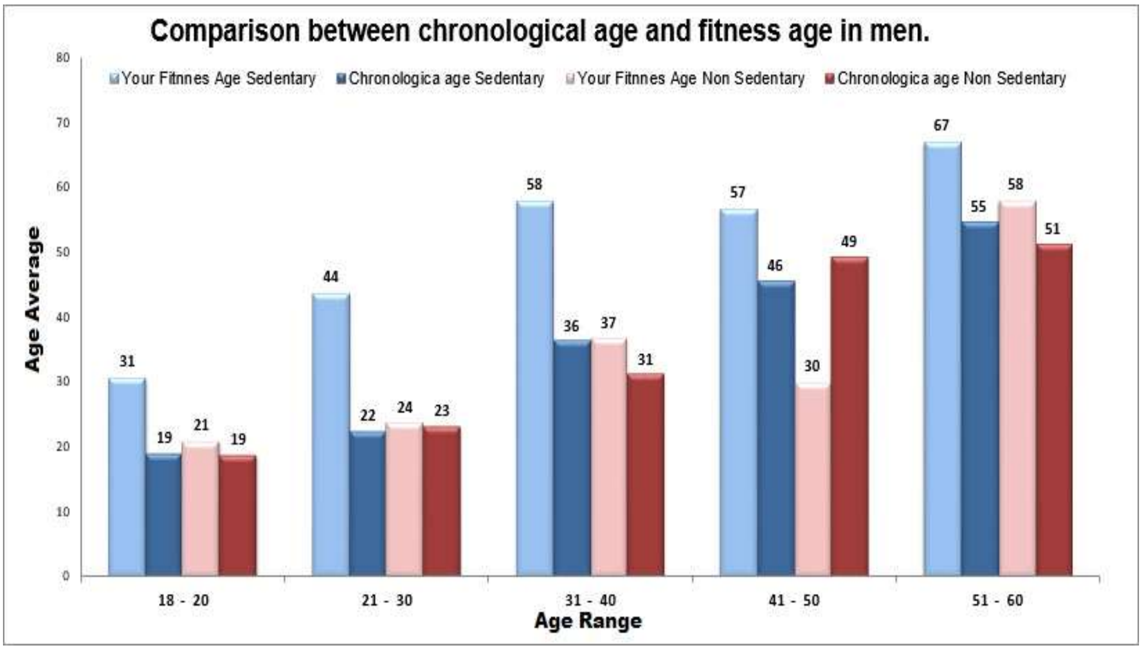


Figure 2. Comparison of chronological age and fitness age for sedentary and non-sedentary women.

Corroborating with the previous results, the chronological age of the fitness was subtracted and a significant difference between sedentary and non-sedentary was identified (Figure 3).

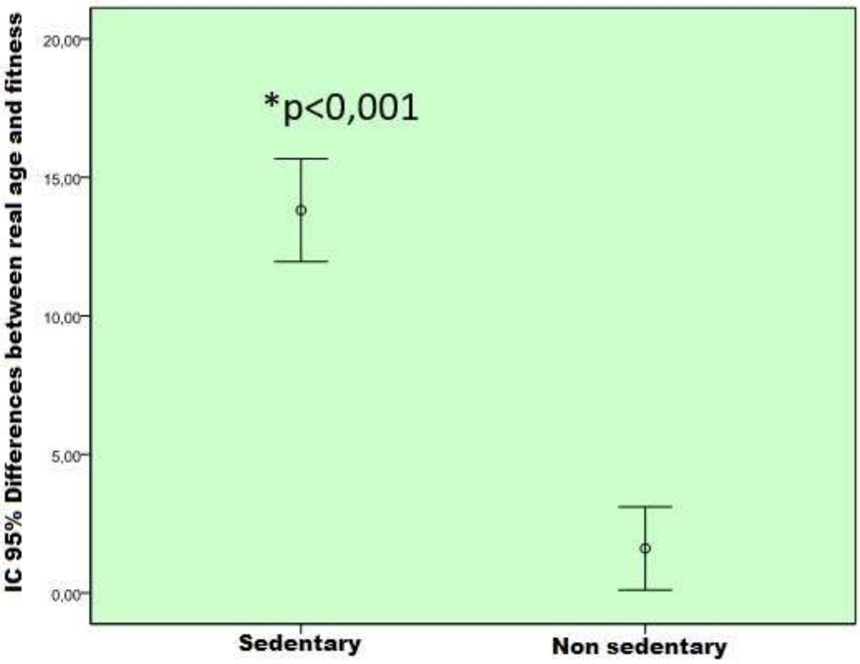


Figure 3. Comparison between sedentary and non-sedentary in relation to the difference between chronological age and fitness age.

DISCUSSION

This study aimed to compare physiological variables between sedentary and non-sedentary. It was identified that non-sedentary people have better physical and physiological conditions than sedentary people.

In this study it was obtained, that non-sedentary people, have a higher VO2max compared to sedentary people. A relevant factor in this increase in VO2max is that non-sedentary people frequently perform physical activity per week, which allows a better and greater delivery of oxygen to the various tissues of the human body, especially muscle tissue, when performing To any physical activity (13). One of the cardiorespiratory physiological effects that is boosted is the Bohr effect, which explains that doing physical activities allows the ph of the blood to fall, due to the lactic acid that the muscles produce, this results in the delivery of 10% More oxygen to the entire human body. This enhanced cardiorespiratory physiological effect can be observed in non-sedentary individuals, regardless of their gender, age range and ethnicity. As the study conducted in the city of Trondheim Norway, in a population of 4631 people, men and women ranging in age ranges between 20 and 90 years respectively. Without diseases: such as type 2 diabetes, dyslipidemia and hypertension among others (14). Another characteristic found in this study, which can be inferred by the increase in VO2max, is that non-sedentary individuals have a higher maximum heart rate and a lower resting heart rate; This means that for each heartbeat, it sends a larger volume of blood to the greater circulation, allowing in this way a greater delivery of oxygen and nutrients to the various tissues of the human body, achieving a better performance in physical activities. This phenomenon is due to the intrinsic adaptive capacity of the heart, when subjected to increasing volumes of blood flow, which responds to Frank Starling's law. This explains that the force of contraction of the heart will increase as it is filled with a larger volume of blood, this has a direct consequence on the tissue of the ventricles, called myocardium, causing eccentric hypertrophy. This increase in the load of the ventricles (especially the left ventricle) intensifies the affinity with troponin c with calcium and in this way increases the contractile force of the heart (15) (16). Consequently, the higher the requirements of the human body, the higher the heart rate; As opposed to lower resting heart rate. In front of a heart with an eccentric hypertrophy of the left ventricle, it will be bigger and stronger. It will beat fewer times per minute to meet the needs of the human body, because with each beat it pumps a larger volume of blood, therefore the heart is more effective and works less (17).

Another key finding found in this study was that sedentary individuals, both for men and women, had an older fitness and a lower VO2 max in all age ranges. This means that their aerobic capacity behaves like an elderly age group (7). It was observed that this pattern of cardiorespiratory capacity is repeated in all the age ranges of the sedentary people. All of the above demonstrates that at less physical activity the human body ages faster.

In contrast, non-sedentary individuals presented a lower fitness age and a higher VO2 max in all age ranges. This indicates that their aerobic capacity is higher, at their average age ranges, according to standardized VO2 max tables (18). Just because these people perform physical activity, gives your human body the ability to age slower. They are therefore younger than sedentary people (19).

So far, this is the first Chile study, using this type indirect estimation methodology of VO2 max. Due to its easy access, quick applicability, high degree of value and low economic cost. It allows the future to be used for subsequent epidemiological studies at the national level. Allowing to estimate the cardiorespiratory health of the people, to detect and to prevent future risk factors and cardiovascular diseases. This innovative method of indirect evaluation of VO2max has been studied and applied mainly in Norway with cohort studies by doctors Aspenes et al. (2011) and Nilsen et al. (2011) (8). Although in this country there are different characteristics (anthropometric measures, physical condition and sociocultural factors, such as food, education and economic), the cellular functioning of the human body explained by physiology is the same for all people.

CONCLUSIONS

There were significant differences between sedentary and non-sedentary individuals for anthropometric and physiological variables: weight, waist circumference, chronological age, fitness age, HR max, FCB, VO2 max, exercise frequency, exercise intensity and training time, ($P <.001$). Non-sedentary people have a higher VO2 max compared to sedentary people. The latter have a fitness age between 11 to 23 years over their chronological age. As for non-sedentary people, these have a fitness age between 1 and 6 years over their chronological age. Therefore the group of non-sedentary people, who practice regular physical activity are younger physiologically than sedentary people. Having an increased VO2 max allows the cardiorespiratory system to perform less work to meet the various demands of the organism both biologically and physiologically, in any type of physical activity. This allows non-sedentary people a powerful protective factor against various cardiovascular risk factors.

On the other hand, the group of sedentary people not having physical activity, have an important cardiovascular risk factor. This is reflected by the increase in their fitness age over 12 years, from the 18 chronological. In men, the most vulnerable age range of any cardiovascular event is between the ages of 21 and 40. And the women between 41-60 years, since their fitness ages is about 22 chronological years of the normal average. Therefore, it is suggested to take preventive measures within the established ranges, such as educating people about the benefits of regular and dosed physical activity, in conjunction with a healthy lifestyle, with the aim of decreasing the fitness age among sedentary people (twenty).

The relevance of this study is characterized by producing data such as VO2 max, without the need to evaluate participants through costly clinical laboratory methods and physical tests. This makes it accessible to all people, and allows you to know your cardiorespiratory capacity through indirect VO2 max and thus know your health status. In turn, it is the first national-level study of this validated web-evaluation system in the country of Norway (8) (16).

Strength

The indirect VO2 max evaluated in this study is a powerful predictor of cardiorespiratory health, from which it can be inferred, the health status of the people by means of the standardized ranges of VO2 max, established according to the chronological age of each person. It is easy to access, quick evaluation and does not require the application of some physical test. VO2 max is estimated with reasonable accuracy, since it is a method validated through regular publications to date (7) (16).

Limitations

The evaluation of the maximum VO2 was performed indirectly, which means that it is only an estimate of the reality of each one evaluated. Against this background exist scientific publications, realized by University of science and technology of the city of Trondheim, Norway. Where the value obtained from VO2maximum indirect was standardized, according to the age range of the people (7).

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