Correlation between the maximal oxygen intake in elderly by indirect assessment with and without physical exercise

Original Article

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ABSTRACT: Objectives: To correlate the maximal oxygen intake (VO₂max) in elderly esteem for the effort Test with that one esteem by a model without exercise, and to observe the agreement level between these two methods of evaluation. Materials and Methods: The sample was composed for 150 senior, both sex, with average of age of 67.1 ± 5.11 years. They were included in the sample the volunteers directed for accomplishment of the test of effort by Bruce’s protocol and they were excluded those that didn’t accomplish the test of effort in consequence of contraindications for such, as well as the individuals with cognitive. The VO₂max then was predicted, without exercise through the application of a questionnaire that if based routinely on the collected clinical data, being these: age, weight, index of corporal mass, cardiac frequency of rest and auto-told physical activity. Later they had carried through the test of effort with the responsible doctor. The correlation was carried through the test spearman rank correlation (α=0.05) and the level of agreement through the test of Kappa. Results: One met a correlation (r=0.77) and a weak general agreement high (Kappa=0.292). Conclusions: Concludes that it had correlation it between the two instruments of prediction of VO₂max and had weak general agreement between them.

Keywords: exercise test, oxygen consumption, physical fitness.

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RESUMO

Correlação entre o consumo máximo de oxigênio de idosos obtido por mensurações indirectas com e sem exercício físico

Objetivos: Correlacionar o consumo máximo de oxigênio (VO₂max) de idosos estimado pelo test de esforço (TE) com aquele estimado por um modelo sem exercício, e observar a concordância entre os métodos. Materiais e Métodos: A amostra compôs-se por 150 idosos, de ambos os sexos, com média de idade de 67,1 ± 5,11 anos. Foram incluídos na amostra os voluntários encaminhados para realização do test de esforço pelo protocolo de Bruce e foram excluídos aqueles que não realizaram o teste de esforço em consequência de contra-indicações para tal, bem como os indivíduos com comprometimento cognitivo. O VO₂max foi então predito, sem exercício através da aplicação de um questionário que se baseou nos dados clínicos coletados rotineiramente, sendo estes: idade, peso, índice de massa corpórea, frequência cardíaca de repouso e atividade física auto-relatada. Posteriormente realizou-se o teste de esforço com o médico responsável. A correlação foi realizada através do teste spearman rank correlation ( =0,05) e o nível de concordância através do teste de Kappa. Resultados: Encontrou-se correlação alta (r=0,77) e concordância geral fraca (Kappa=0,292). Conclusões: Conclui-se que houve correlação entre os dois instrumentos de predição de VO₂max e houve fraca concordância geral entre eles.

Palavras-chave: teste de esforço, consumo de oxigênio, aptidão física.

INTRODUCTION

Since the day of the birth all people experience, daily, the aging process that, as some formulated theories to explain it, is characterized by the progressive loss of the functional aptitudes of the organism, and of the adaptation capacity of the individual to the middle in that he lives. In spite of the a lot of pathologies associated to the aging, this stage of the life is not synonymous of disease, but it is treated of a phase strongly marked by bio-psycho-social changes that weaken the individual and they reduce his adaptability, favoring, like this, the emergence of diseases, mainly the cardiovascular ones.

The life expectation is increasing progressively in Brazil, this phenomenon globally observed, especially in the developed countries, and, because of that, it increases the challenge to guarantee the maintenance of the health of this population since the aging comes accompanied by a decline of the health and the functional capacity, and the organic dysfunctions deriving from these declines have become a public health problem. Consequently, to measure the health condition and the functional capacity it becomes an important measure to know the dimension of the problem.

The physical inactivity and the low cardio respiratory fitness (HRR) have been presented as mortality indicators as relevant as others indicators plenty known, such as hypercholesterolemia, diabetes, obesity and hypertension. Corroborating, Jurca et al. increases that a low cardio respiratory fitness is related with the development of chronic pathologies and mortality as much as other indicators of health.

However, although there are validated instruments to measure the maximum reception of oxygen (VO₂max), golden pattern of measure of HRR, it not always is evaluated so much by technical difficulties regarding the equipments and the high costs, as for the many patients’ limitations in accomplishing the test, and the values of VO₂max obtained by the ergospirometry are considered more accurate. Therefore Jurca et al. they proposed a form of measuring VO₂max through an estimate model of HRR without exercise.

This study had as objectives: a) to correlate VO₂max predicted indirectly in elder, through the form to esteem the levels of metabolic equivalent (MET) maximum of the cardio respiratory fitness for the routine clinical data, with VO₂max obtained through the ergometric test; b) to observe the agreement level between the two instruments of VO₂max evaluation.

MATERIALS AND METHODS

This study was approved by the ethics committee in human beings of the State University of the West of Paraná (UNIOESTE) and registered under the protocol 152/2006. The present study if it characterized as traverse observational. This research chose as population objective the seniors that accomplished their effort test in a private Clinic of Cardiology independently of this study, in the city of Cascavel, in the west of Paraná, between the months of September to November of 2006.

The sample was of the intentional type, starting from the scheduling listing of the seniors for the accomplishment of the test, composed by 150 individuals, of both sexes, with same age group or above 60 years. The inclusion criterion for participation in the study was: individuals directed for accomplishment of the test of effort by Bruce’s protocol. The exclusion criteria were: 1) individuals that didn’t accomplish the test of effort as a consequence of contraindications for the accomplishment of the same; 2) individuals with cognitive compromising.

After the accept for participation of the research, the volunteers filled out the form to esteem the value of maximum MET of the
cardio respiratory fitness for the clinical data routinely collected in an individual way, always guided by the same examiner.

This form contained personal information, anthropometrics and hemodynamic as: name, age, weight, height, sex, heart frequency (HF) of rest, besides two stages, being the Stage one for punctuation of the physical activity self-reported, where the individual chose of the level from level one to level five the best activity category which described his pattern of daily physical activity.

Being the level 1: Inactive or small activity different from those usual daily activities; level 2: He participates regularly (≥ 5 days / week) of physical activities that request low levels of effort which results in small increases in the breathing and heart frequencies for a minimum time of 10 minutes; level 3: He participates in aerobic exercises such as fast and intense walks, trots or run, cycling, swimming, vigorous sports with comfortable rhythm or other activities that request similar levels of effort from 20 to 60 minutes a week; level 4: He participates in aerobic exercises such as fast and intense walks, trots or runs in comfortable rhythm or other similar activities that request levels of effort from 1 to 3 hours a week; level 5: He participates in aerobic exercises such as run fast and intense, trots or runs in comfortable rhythm or other similar activities that request levels of effort superior of 1 to 3 hours a week.

In the Stage two the estimate was accomplished, in METs, levels of HRR by the following equation:

Where: R1 = 0 for women and 1 for men x 2.77; R2 = age in years x 0.10; R3 = body mass index (weight/stature)² x 0.17; R4 = rest HR x 0.03; R5 = punctuation of physical activity at the Stage 1. The value of 18.07 was a constant originating from mathematical calculations of the original study that formulated the prediction equation. After the calculation of maximum MET, the value obtained was changed into the unit of maximum consumption of oxygen (VO2max) considering that 1 MET is equal to the value obtained was changed into the unit of maximum consumption of oxygen (VO2max), considering that 1 MET is equal to the value of VO2max , considering that 1 MET is equal to 3.5 mlO₂.Kg⁻¹.min⁻¹. The
table of clinical relevance presented by Jurca et al. 7.

The statistical treatment used for analysis of the variables, through the software Analyze-it, was, besides the descriptive statistics, the test spearman rank correlation with = 0.05, whose correlation coefficient measured the adjustment of the straight line to the points that determined it, and the test of Agreement of Kappa, accomplished in link offered by the Laboratory of Epidemiology and Statistics (LEE) of the Medicine University of São Paulo (USP) and of the Institute Dante Pazzanese of Cardiology, considering that the interpretation values for the kappa agreement were: poor < 0.20; weak < 0.40; moderate < 0.60; good < 0.80; and very good when the kappa index was same to one.

The variables of this study, in the in case of VO2max values obtained by both methods, they were classified and maintained as continuous for the correlation test and transformed in categorical for the agreement test. Like this, they were created three categories which correlated the values of VO2max with the clinical meaning, as it can be observed in the table 1.

### RESULTS

The data of the sample regarding the sex and the level of physical activity self-reported they revealed that 46.7% of the volunteers belonged to the masculine sex and 53.3% to the feminine sex; 42.6% classified themselves with activity level described by the category five, 53.3% for the category four, 16.6% for the category three and the 17.3% and 2.7% remaining classified themselves respectively with level of compatible physical activity with that described by the category two and one.

The data regarding to the weight, height, HR rest, age and BMI can be visualized in the table 2.

The descriptive statistical treatment for the values of VO2max obtained by the two evaluation instruments, as well as the dispersion diagram can be observed in the table 3 and in the graph 1, respectively. By the spearman rank correlation test was r=0.77 and p = <0.001. As adding the tendency line to obtain the lineal regression, the equation (y = 0.5433x + 10.205) with R²=0.57 was found.

The relative data to the test of Kappa concordance can be observed in the tables 4 and 5.

These results suggested that the questionnaire was shown low sensitive to esteem values of VO2max compatible with the category C, besides presenting average of VO2max smaller than found by the ergometric test.

One of the adaptations realized in the table of clinical relevance was the decrease of the VO2max value in order to classify the individual in the category C. This value was reduced from 45.5, as proposed by the original table, to 39.0. This was necessary because the questionnaire didn’t identify any individual in the category C when the values stayed as the original table, not being possible, in this way, to calculate the kappa index.

### Table 1 - Clinical relevance of VO2max selected in the levels of cardio respiratory fitness.

<table>
<thead>
<tr>
<th>class</th>
<th>value of vo2max (ml.kg-1.min-1)</th>
<th>clinical relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.5 a 17.5</td>
<td>Metabolic rates of rest (quietly sitting in a chair); Functional capacity severely limited a criterion for heart transplant; Poor prognostic in patients with coronary diseases; high level of not conditioning.</td>
</tr>
<tr>
<td>B</td>
<td>17.6 a 38.9</td>
<td>Good prognostic in patients with coronary diseases under pharmacotherapy; approximate maximum capacity closed to the one expected in regular activities for men and women of middle age.</td>
</tr>
<tr>
<td>C</td>
<td>≥ 39.0</td>
<td>Excellent prognostic independent of the disease status; Athletes of elite endurance; Athletes of world level.</td>
</tr>
</tbody>
</table>

Maximum consumption of oxygen (VO2max) source: adaptation of the table of clinical relevance of VO2max presented by Jurca et al. 7.
DISCUSSION

The measures of VO2max have been considered as the values of reference of the cardio respiratory fitness (HRR) and, it seems there to be a consensus in the literature that low levels of HRR are related with such as the development of chronic diseases with the increase of the mortality tax.

Of the several existent chronic diseases, the cardiovascular ones are among the more common. Still, among the cardiovascular system diseases more common in the elderly, the coronary artery disease is the responsible for 70 to 80% of the deaths between men and women and the congestive heart failure is the principal factor of internments, morbidity and death among the elderly population.

In a research that evaluated the efficiency of the oxygen peak declivity (VO2peak) and compared this measured with the data obtained by the effort test through Bruce’s protocol modified with an additional phase (phase 0 - 3min with speed of 1 mph and gradient of 5%), the authors justified the accomplishment of the study in function that, although there are high mortality and morbidity result from chronic failure of the heart, predict measurement for tests with metabolic supervise during exercises which request from the cardiovascular system not always they are easy because of the limitations imposed by the exercise and/or of the high costs.

As many of the routine activities demand integrated efforts of the heart, lung and circulation to take oxygen to the active muscles, and this integration is directly related to the individual’s functional capacity, the evaluation of the functional capacity, through the fitness cardio respiratory, for the time of aerobic exercise or peak of oxygen is valuable to diagnose and to predict a series of clinical situations.

Graph 1 - Dispersion diagram among the VO2max values collected by the ET and by the QUEST

The conference Beyond Secondary Prevention: Identifying the High-Risk Patient goes Primary Prevention, of responsibility of American Heart Association (AHA), it had as objective, the creation of strategies to identify patient with high risk without evident cardiovascular disease (CVD). Among the several prognostics factors showed, the age was considered as a strong indicative of the absolute risk and so much the obesity risk as for the inactivity they were pointed for the strong correlation with the development of CVD.

The regular practice of physical activity has positive impact in several aspects of the health in the population in general and in the elderly, reducing the morbidity risk and mortality as well as increasing the longevity.

Although the physical activity doesn’t prevent the factors that conduce to the decrease of the physical capacity, as the decrease of the muscular and bone mass, decrease of VO2max, alterations cardiopulmonary and neurological, it can minimize and to delay in an important way those facts. For consequence, the indications of the physical activities and exercises for elderly have been extrapolating that traditional concept of inserting a healthy style for this population, but it represents a critical point to know the intervention for the physical activity can be adapted to modify the risk of development of diseases.

Thus it is also necessary to quantify the results of the usual physical activities to enable understand how they contribute to health and functional capacity of the elderly. The result of the habitual physical activity is defined as physical fitness.

Based on the relationships among fitness, health and physical activity, a new fitness concept has been proposed: the fitness of health reported. It refers to the components of the fitness (cardio respiratory, motor, skeletal muscle, metabolic, among others) that are influenced by the habitual physical activity and they intervene in the individual’s health.

The work of Jurca et al. they expanded and spread a previous estimate model of HRR, in METs, without exercises, which it had as one of their pillars the self-report of the physical activity level. In referred work the analyses were accomplished starting from three great cohort studies, in which all the participants were submitted to maximum effort tests and sub maximum complemented by the ventilator measurement of the analysis of gasses.

All of the bases of data included sex, age, body mass index, rest HR and levels of physical activity for self report. The correlation between HRR and all the independent variables of each study were statistically significant and the principal correlation was between HRR and the level of self report physical activity. The authors concluded that HRR can be predicted appropriately by a model.
as in populations with CVD. Traditionally the effort test is the test investigated forms of indirectly esteeming as for elderly in this work was expressed in (ml.kg\(^{-1}\).min\(^{-1}\)) and those obtained (ml.kg\(^{-1}\).min\(^{-1}\)). Considering that the values of the effort tests used two ways: in reference to an expected value by equations for age, Society of Cardiology, it is that this data should be expressed in correction for differences of ages or sex and the recommend-
dation of the consensus, proposed by the guidelines of the Brazilian Superiors (Sup); Inferiors (Inf)

| Table 4 - Concordance values by the coefficient of Kappa for the categories A, B and C. |
|---------------------------------|-----------------|-----------------|
| **CATEGORY**                    | **A**           | **B**           | **C**           |
| Kappa of the category           | 0.52            | 0.248           | < 0.21          |
| P-value of Kappa category       | < 0.001         | 0.00010         | < 0.001         |
| Interval of 95% of trust of Kappa’s category | Sup: 0.68       | Sup: 0.388      | Sup: 0.319      |
| Superior (Sup); Inferior (Inf)  | Inf: 0.36       | Inf: -0.108     | Inf: -0.101     |

| Table 5 - General values for the levels of Kappa concordance |
|--------------------------------|-----------------------------|
| **General Kappa**              | 0.292                       |
| P-General Value                | < 0.001                     |
| Interval of 95% trust of Kappa | Sup: 0.394 / Inf: 0.191     |
| Superior (Sup); Inferior (Inf) |                             |

without exercise which contains such independent variables, but additional works are necessary to evaluate the viability of to apply the questionnaire in primary cares and to verify the validation of the instrument.

In spite of the difficulties of evaluating VO\(_{2\text{max}}\) in direct way, several researches investigated forms of indirectly esteeming as for elderly as in populations with CVD. Traditionally the effort test is the test for indirect prediction of VO\(_{2\text{max}}\) more used and it has as objective submits the patient to a physical stresses programmed and personalized with the intention of evaluating the clinical answer, hemodynamic, electrocardiograph and metabolic to the effort.

Regarding the applicability of the ergometric test in elderly, Vacanti et al.\(^{17}\) they verified that, in spite of the limitations of the test in very elderly populations, it showed safe and effective. However, even the ergonomic being safe and effective for the oldest part of the population, this instrument also demands a minimum of technical and human resources that makes unfeasible the prediction of VO\(_{2\text{max}}\) in several places, such as consultation and clinics.

Other models of prediction of simpler VO\(_{2\text{max}}\) have been studied such as the walking test of six minutes\(^{18}\) and the walking graduate test\(^{19}\), although those models are still questioned and serve basically to evaluate the capacity cardiopulmonary. A systematic revision of the Germanic literature suggests that some tests used for evaluation bioenergetics based in the acting are shown weak, because, the number of mathematical transformations that those models suffer to arrive until the prediction values increases the chance of error \(^{20}\).

The VO\(_{2\text{max}}\) predicted by the ergometric test is, classified, expressed in units of volume (L or ml) in relation to the body mass (Kg) in function of the time (min) and it has been used as a prognosticator of inadequacy heart congestive\(^{21}\). However, according to the guidelines of the Brazilian Society of Cardiology on the ergometric test, this way of expressing VO\(_{2\text{max}}\) cannot have a prognostic value such appropriate for all of the individuals\(^{22}\).

The problem of VO\(_{2\text{max}}\) to be expressed this way it is that it doesn’t allow corrections for differences of ages or sex and the recommendation of the consensus, proposed by the guidelines of the Brazilian Society of Cardiology, it is that this data should be expressed in two ways: in reference to an expected value by equations for age, weight and sex (% of the foreseen) and in relation to the weight (ml.Kg\(^{-1}\).min\(^{-1}\)). Considering that the values of the effort tests used in this work was expressed in (ml.Kg\(^{-1}\).min\(^{-1}\)) and those obtained by the questionnaire took into account in an important way the factor age, that might have intervene in the results.

When appraised the concordance among the two instruments a weak quality was observed in the general concordance (Kappa = 0.292). The kappa index found for each one of the categories allowed to consider that the concordance for the category A was moderate (Kappa = 0.52) and for them category B and C was weak (Kappa = 0.248 and 0.21 respectively). Such result reinforces the hypothesis that the questionnaire is more sensitive to identify the levels of lower VO\(_{2\text{max}}\) than the high ones, suggesting caution in its use. A possible explanation for this lowers concordance among the levels of higher VO\(_{2\text{max}}\) can be that, in this study they were appraised two indirect methods to predict VO\(_{2\text{max}}\). Studies evaluating the concordance level between the form and the ergospirometry would be more appropriate to recognize this instrument as applicable in the clinical use.

In spite of the low concordance, the analysis of the data revealed that these presented a strong correlation among the absolute values of VO\(_{2\text{max}}\) obtained by the two methods. Maybe, the reproduction of this study in a larger sample can find closer concordance levels.

The necessity to standardize methods which will be with easy execution, however, that gives with fidelity the maximum reception of oxygen, or at least allow to stratify the population regarding the death risks and morbidity, it continues being a challenge. The possibility to predict VO\(_{2\text{max}}\) without submitting the individual to considerable physical efforts as happen for the traditional methods, it can be a pertinent option so this important clinical data be evaluated more frequently than is it now. But the need to validate such instrument, as well as to evaluate its reproducibility, accuracy, feasibility and effects in the clinical decisions and in the endings they stay sovereign.

**CONCLUSION**

It was concluded starting from the data presented that there was high correlation among the two instruments of prediction of VO\(_{2\text{max}}\), but the general concordance between the instruments was weak. However, when analyzed the categories separately, the concordance between the two instruments found for the category A, that predicted lower values of VO\(_{2\text{max}}\), it was moderate.

**REFERENCES**


