07 - REVIEW OF SOME DIRECT AND INDIRECT METHODS USED TO MEASURE VO2 MAX IN PHYSICAL ACTIVITY AND SPORT

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INTRODUCTION

VO2 max is the maximum oxygen consumption can have the body in absorption, transport and consumption, becoming an important parameter in determining the cardiorespiratory fitness, blood count function links and the muscular system and similarly to evaluate the fitness level of individuals specifically aerobic power (Hadad, H. et al 2011; Shenoy, S. et al 2012).

For determination of VO2max., Should take into account different variables that can be genetic, hormonal, body mass index (BMI), lipid mass and in the case of women's own body processes such as the menstrual cycle least amount of hemoglobin that can occur during this period (Serrato, M, et al. Sf, Gomez, I., et 2011).

Similarly it must take into account the age of the person and the respective maturity development since the younger less developed of the different systems involved in the increase in VO2max. (Andrade, R. et al. 1990), it is important to note that the maximum oxygen consumption is directly related to the level of physical activity or have an individual training as well, more training increased oxygen consumption, which , is directly related to energy expenditure since the body needs oxygen to perform different metabolic processes of obtaining energy through energy substrates (carbohydrates, proteins, lipids), which is equivalent to a Met (metabolic unit) which results in the energy consumption required for maintaining a body vital needs and calculated in 3.5 ml of oxygen per kilogram of body weight per minute (Marquez, S. et al. 2006; Melo, C. 2012).

To determine maximal oxygen consumption were used direct and indirect methods, depending on the availability of equipment, level of staff training, training plan, test objective and availability of time and resources. Direct determinations are made in areas where they should have control of the different variables that may eventually change the results, protocols apply incremental loads and sometimes tilt can be performed on a cycle ergometer or treadmill (Fernández, C. et al.2003-2004), the direct determinations can be replaced by indirect measurements made in the field, even with 90% accuracy; indirect protocols are performed in the environment in which they are normally athletes performing their activity, Through the application of field test, this measurement can be control variables but becomes more difficult to control and are subject to the application of standardized and validated formulas.

The correlation between direct and indirect measures is based on the thermodynamic principle of equivalence between different forms of energy. For every watt of external load carried, the individual consumes between 10 and 12 milliliters of O2. This measure determines the slope of the VO2 / load, which is constant in all individuals, even at altitude. (Serrato, M., Reyes, O., S. F.)

For professionals in different areas related to sport and physical education is important to use reliable methods for the measurement of VO2 max., Allowing obtaining encouraging results in the short and long term, by estimating the genetic potential of an individual to resistance activities. Methods have been developed with different methodological characteristics applied to various populations with particular ethnic types, age, physical condition, etc.., Researchers validated the particular methods that are based on field measurements which are indirect, through comparison with conventional techniques more accurate as the ergospirometry.

You can show through the literature review which methods are standardized, validated or validation process for the determination of VO2 max., Which are part of the alternatives that have different professionals.

METHODOLOGY

For the location of the documents used several bibliographic databases; Scielo, Medline, Redalyc, Ebsco, Science, Proquest, BioMed, Dialnet, in which words were used to describe or allow them to be related to the focus of the review. These descriptive words were: physical activity or aerobic power or VO2 max., Sport or oxygen consumption, physical activity or oxygen consumption, coming to have a result of about 74 items of which 20 were finally selected directly connected with the subject revision. Similarly, we searched in Google Scholar using the same combination of terms to allow search capabilities expand. Documents were selected to demonstrate the application allow direct and indirect evidence in different populations and in sports to describe the protocol used.

1. DIRECT METHODS FOR THE DETERMINATION OF VO2 MAX.

1.1. ERGOSPIROMETRY.

To speak of the method we refer to ergospirometry Leal, J., et al (2006), which analyzed which is a non-invasive procedure used to assess physical performance or functional capacity of an individual, reconciling gas analysis expired and respiratory variables, so, Ergospirometry is a widely used technique to assess the effects of resistance training, both in the sedentary population and in people with moderate fitness (Wasserman, K., Wilmore, JH1994) and sport high performance.

This allows us to define it as a direct method, its main virtue is directly measuring all parameters evaluated (Cremades, D., nd) using sophisticated equipment and software that allow to efficiently control all variables, this helps greatly in athletic performance and the analysis of other heart disease, and as for the verification of the results obtained during the test, the reliability of the equipment depends on creating conditions of homogeneity of the variables and factors that may alter the test when performed by (Benito, PJ., et al. 2007).

Among the instruments used for testing are ergospirometry cycle ergometer and treadmill, elements that activate and allow the subject to perform the work and study load. Most protocols for bicycle ergometer and treadmill workloads contemplated under submaximal (Castellanos, P., Sanchez, A. 2010), it is important to note that depending on the conditions and the type of study you want carried out, you can keep the variable duration of the stress tests (Castellanos, P., Sanchez, A. 2010). This test is operated in steps between 2 to 6 minutes and load increases gradually or stepwise. Principally, this test examining the equation are based on test work W = RDF (where W = work, R = resistance (n wheel movement), d = diameter of the wheel and f = frequency of pedaling per minute), controlled by specific software.

Ergospirometry is the method of determination of VO2 max., of greater accuracy than exists today but has the

disadvantage of being expensive for the specific equipment and the availability of standardized laboratories.

2. INDIRECT METHODS FOR THE DETERMINATION OF MAXIMUM VO2

2.1. CONVENTIONAL METHODS

2.1.1. COURSE NAVETTE.

Course Navette test or race 20 meters, designed in 1982 by Leger and Lambert, is a test that determines maximum and progressive cardiorespiratory fitness, measured maximal aerobic power and indirectly maximum oxygen consumption (VO2 max.) , using a validated equation. (Alvarez, J. et al. 2001; Corral J. et al. 2010). The technique used is that evaluated the individual must move from one point to another which is located 20 meters away at a rate that is increasing. The initial speed is eight miles an hour and half a kilometer increases marked by a beep every two minutes when it sounds that signal the individual who is performing the test must have come to the point and change direction to go to the start and get there when the signal sounds again. The time at which the individual test is interrupted indicating their cardiorespiratory endurance, this value is entered along with the age of the subject in a formula which calculates the VO2max. (Corral J. et al. 2010).

In 1984 Leger modify and reduce the test time of each period, so that every minute increase the speed of the beeps in a mile. It validates the test for children and adolescents of both sexes. In 1986 Van Mechelen quoted Jodar (2003), published a study to validate two running test, the Course Navette and endurance test of 6 minutes.

The formula used to calculate the Vo2max present in children was validated in 1996 by Leger et al.: VO2 max. = 31 025 3238 X-3.248A +0.1536 x where x is the speed at which the subject stopped and age. For subjects over 18 always applies the value 18, the formula being VO2 max. = -27.4 +6.0 X, X being the speed at which the subject stood (Jodar, R. 2003).

Berthoin et al in 1996 compared the results obtained with the indirect evidence obtained directly on the treadmill and found that the values were very similar. The Course Navette test has been validated by different authors and different types of populations among which are populations of children between 12 and 14 years, adults between 19 and 47 years, Asian and endurance athletes. The reliability of this study is represented in the comparison made by these authors to studies by others and in various fields of sport where the reference values are very similar, this test is usually used in youth with a medium or training level low, however in 1991 this test is validated by Mombriedo for endurance athletes.

2.1.2. COOPER TEST.

Created by Dr. Kenneth Cooper to determine VO2max., In male athletes. In 1977 it was adapted by Gerchell for use in women. Its main objective is to measure the aerobic capacity of medium duration. It consists of a run of 12 minutes duration, in which the participant must travel the greatest distance (Mouche, M. 2001). To measure VO2max., In dealing with the exhaustion of an individual after an ongoing effort and through the use of formulas that include the mark was obtained, to be used this equation Howald VO2max. (Ml / kg / min.) = Distance walked * 0.02 to 5.4 where that figure should be multiplied by kilogram (Martinez, E., 2004, Mouche, F. sf; Medina, J., et al. 2001). Like the Course Navette test is a widely used, easy to apply in field, validated by the scientific community but are difficult to control variables ignores aspects like; diseases, subjectivity of individuals tested and even assessors the test, so data can be obtained even differentiable in the same population.

2.2. UNCONVENTIONAL METHODS FOR THE DETERMINATION OF MAXIMUM VO2

2.2.1. TIVREBASKET

Reverse, et al., 2007, raises TIVREBasket test for basketball, attempts to simulate the sport activities comparing the results with significant differences were found treadmill because this test is discontinued while loads are continuous treadmill. However this is valid and is a stress test interval that occurs in the recovery periods alternating with 30 second pauses or is progressive because the scrolling speed is increased in each period and maximal effort, because conducting the test remain subject to exhaustion, in which the player performs specific displacements intended to simulate competition requirements. For the analysis of software test design (TIVRE-Basketball) which is responsible for standardizing running speed at every stage through the emission of sound stimuli and / or light, which should coincide with the arrival of players each brand. It takes place in a circuit of 96 m, with twelve separate brands to 8 m distance within the basketball court, to complete a stage players must have completed 3 laps.

This test has several advantages among which stand out in the sport specificity applied also, the calculations are performed manually if the software uses designed for final determination of VO2 max., Ensuring avoid errors calculations, however the variables are not fully controlled.

2.2.2. DETERMINATION OF VO2 MAX. AS FROM BODY FAT

Historically researchers have generated different tests based on measurements populations with low levels of physical activity, including ensuring ease of data collection and avoiding risk and cost factor involving current direct methods, these methods to predict VO2 max., used for measurement of physical parameters as variables: age, sex, height, weight, body mass index and body fat percentage.

There is very little available valid models that use the body fat percentage as for obtaining determining VO2max. Shenoy, et al (2012) estimated VO2max., Using the prediction equation for people who practice physical activity sporadic, developed by Jackson and colleagues in 1990, who proposed prediction models that use the body fat percentage of a individual. The study population was based sedentary behavior in young people with a significant lipid mass index, an Indian, important variable as body composition varies by ethnicity.

The VO2 max., Was calculated from the percentage of body fat by three formulas in which stress: N - ExVO2max using% F = 50.513 + 1.589 HAF - 0.289 E - 0.552 (% fat) + 5.863 G. Where N = total number of individuals tested, F = fat or body fat percentage, physical activity history HAF = calculated using test IPAQ (International Physical Activity Questionnaire) ranging from 0 to 7, E = G = age and gender (0: female, 1: male) (Shenoy, et al, 2012).

From the results, the authors found that the higher the body fat percentage lower VO2max value and relative comparisons to other methods supports the development and validation of prediction equations for estimating specific populations of VO2 max., verified by statistical tests, indicating that from body fat can be measured fairly reliably and validation VO2max indirectly. This method has a considerable advantage from the point of view of people who practice measuring low physical activity which prevents the risk of injury, cardiorespiratory problems, subjectivity at the time of data collection, taking into account age, differences ethnic and gender, is an easy to use and inexpensive.

2.2.3. STEP TEST FOR DETERMINING VO2MAX.

According to that described by Gomez et al (2011), measurement of VO2max., Using the step test method or test bank

or steping developed in 1984 by Dr. Manero, to measure VO2 max., Is a submaximal was subsequently tested and validated in 1986 by Fitchett cycle ergometer by comparison with a highly reliable method. These studies using these techniques and changes in a population of women cadets of the Military Academy José Maria Cordoba of Colombia, Gomez, et al, found that this indirect method is valid, but the management of environmental and medical control variables must be strict and fully controlled to avoid bias in the measurements and results.

For this, the maximal aerobic power was determined by step test, and established the classification of aerobic power of cadets under aerobic capacity standard framework of American Heart Association and the relationship between the levels of oxygen consumption of the cadets, age, physical activity sports, and medical control tests correlated: total cholesterol, triglycerides, hemoglobin, hematocrit, and blood glucose (Gomez et al, 2011).

The description of the method outlined below, taking into account the amendments made by Gomez, et al, in 2011: using a wooden step 25 cm high, 50 cm wide, 40 cm deep, a metronome earpower, the participant should be fully up and down the step at the pace set by the metronome, the first load is applied consisting of the step up and down 17 times per minute or take 68 steps per minute for three minutes, immediately heart rate is monitored for 15 seconds and is compared with the maximum value for each participant, if it exceeds the test cycle is suspended, if not subjected to the second load to 104 steps per minute for the next three minutes, following the protocol equal to the first charge. Participants undergo a third charge if not exceed the second to 136 steps per minute for three minutes submaximal heart rate measuring of the third load. The value of submaximal heart rate for the last load tolerated by the participant refers to a matrix taking into account gender and weight and intersects with the value obtained from the test for maximal oxygen consumption by the regulatory framework of Aerobic capacity of American Heart Association used as validation test, apply the correction factor for age and the value obtained corresponds to the VO2 max., or maximal aerobic power (Gomez et al, 2011).

The advantages of this method are determined by a simple test to be applied, taking into account gender, age, low cost is what has facilitated its application in various groups of people and further control variables in the test conducted was quite strict metabolic viewpoint from performing a correlation with these variables. The subjective measure both heart rate and resting times become one of the disadvantages not control all the variables as measurement bias is human.

2.2.4. DETERMINATION OF VO2 IN CHILDREN

In this review we found two proposals for the determination of VO2 max., In children aged 8-12 years, it is well known that the need for specific criteria regarding this parameter is very important because research is determinations focus on adults without appropriate adjustments to age considering metabolic and physiological factors of children ("Bench Step Test" Dean, et al, 2011)

According to Dean, et al, (2011), in children aged 8-12 years is important to determine VO2 max and validation of the prediction of this parameter due to skyrocketing principamente childhood obesity in the last decade and so with this tool help in measurements of cardiovascular fitness. The method was applied to a population of 27 children between men and women, physically active with about an hour of physical activity a day, which were controlled as many variables physiological, physical and environmental potential, in addition to this for development measurements are greatly influenced motivation and verbal encouragement to keep pace step by step through the test. The method called "step test" or "bench stepping test" is the registration of the variables as frequencies maximum heart rate (220 minus age) taken in each cycle, this protocol requires submaximal bench stepping and step up and down on a bench 12 inches at a rate of 24 per minute measured by increases metronome for 3 minutes, completing the cycle, the test ends when the participant registers maximum heart rate (220 minus age) or if they were unable maintaining the step cadence prescribed for more than 10 seconds. Heart rate was recorded continuously at rest for 1 minute before starting the protocol by a Polar monitor.

As a contribution to the research was developed a formula to predict VO2 max., From the height, resting heart rate and heart rate during submaximal "bench stepping test". This formula represents 71% of the variability in peak oxygen consumption and is the first step in verifying the validity of the "bench stepping test" as a test to predict VO2max in children. VO2 max = -2.354 + (0.065 * Height in cm) + (resting heart rate * 0.008) + 0.870 (Exhibit "Step Test" Average heart rate as a percentage of resting heart rate * -0.870).

Final determination indicates that the protocol used was reliable for the study population but it is advisable validated by future studies using a larger and more diverse population, (Dean 2011).

One of the biggest advantages is having the specific method for children aged between 8-10 years, in addition to this Polar equipment use, allows control of cardiovascular variables as maximum heart rate, resting heart rate, temperature, exercise intensity, avoiding the subjectivity of the individual measurements measured and the person applying the method.

As this review final conclusion we can say that the longer be controlled internal and external variables that affect the measurements, the greater the accuracy of the method which would allow the subsequent validation thereof, on the other hand the specificity in the type or types of stocks studied as age, gender and ethnic differences, physical activity, metabolic factors and medical monitoring, environmental factors, will test an efficient method in determining the strength and aerobic capacity or VO2 max.

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REVIEW OF SOME DIRECT AND INDIRECT METHODS USED TO MEASURE VO2 MAX IN PHYSICAL ACTIVITY AND SPORT

ABSTRACT

A bibliographical revision was made, with the purpose of analyzing some of the direct and indirect methods that are used like tests or test, for the obtaining of the VO2 máx., being a this one fundamental variable in the scope of the clinical and sport medicine. Within the analysis of the direct methods, one is the Ergoespirometría, that it provides information to near the functional capacity of the individual and the VO2 máx., this test of effort is possible to be measured from the work made in a Cicloergómetro or Rolling Tape. In the conventional indirect methods, they appear the one of Course Navette, a maximum and progressive test that determines the aptitude cardiorespiratoria (Alvarez, J. ET to. 2001; Corral J. ET to. 2010), also, the test of Cooper is described who measures Maxima the aeróbica capacity of average duration in 12 minutes commonly used in the physical education. In the analyzed nonconventional methods they appear: the TIVREBasket, determination of VO2 máx., from the corporal fat, proves stepped and determination of VO2 in children. It is important to know, to apply and to develop to new methods for the obtaining of the VO2 máx., in the area of the sport, the physical activity and the physical education, for the validated determination of the yield and aeróbica power in different populations, considering different variable. Some methods like the one of Course Navette and test of Cooper, provide reliable information, are accepted by the scientific community and widely are used, other methods in process of specific validation have the advantage of being considering variable like the age, the IMC, the lipídico index, type of physical activity, deports and the ethnic differences marked by genetic differences.

KEY WORDS: Vo2 máx., Methods. Physical activity

EXAMEN DE CERTAINES METHODES DIRECTES ET INDIRECTES UTILISEES POUR MESURER LA VO2 MAX A L'ACTIVITE PHYSIQUE ET LE SPORT

RÉSUMÉ

Nous avons effectué une revue de la littérature pour analyser quelques-unes des méthodes directes et indirectes sont utilisés comme tests ou d'essais, pour l'obtention de la VO2 max., Ceci étant une variable clé dans le domaine de la médecine clinique et sportive. Dans l'analyse des méthodes directes est ergospirométrie, qui fournit des informations sur la capacité fonctionnelle de l'individu et de la VO2 max., Ce stress test peut être mesurée à partir du travail effectué sur un tapis roulant ou bicyclette ergométrique. Dans les méthodes classiques indirects apparaissent la Navette cours, un test de fitness cardio détermine maximale et progressive (Álvarez, J. et al, 2001;.. Corral J. et al 2010), décrit également le test de Cooper maximum de la capacité aérobie mesurée en moyenne 12 minutes de longueur couramment utilisés en éducation physique. Dans les méthodes classiques sont analysés: la TIVREBasket, la détermination de la VO2 max, à partir de la graisse du corps détermination de test VO2 étape et les enfants.. Il est important de comprendre, d'appliquer et de développer de nouvelles méthodes pour l'obtention de la VO2 max., Dans le domaine du sport, l'activité physique et l'éducation physique, pour déterminer la performance et la puissance aérobie validé dans différentes populations, en tenant compte des variables différentes. Certaines méthodes, comme des cours de test Navette et Cooper, fournir des informations fiables, sont acceptés par la communauté scientifique et sont largement utilisés, d'autres méthodes sont en cours de validation l'avantage de tenir compte des variables spécifiques tels que l'âge, l'IMC, indice lipidique, l'activité physique, le sport et les différences ethniques marquées par des différences génétiques.

REVISIÓN DE ALGUNOS MÉTODOS DIRECTOS E INDIRECTOS UTILIZADOS PARA MEDIR EL VO2 MÁX EN ACTIVIDAD FÍSICA Y DEPORTE

RESUMEN

Se realizó una revisión bibliográfica, con el fin de analizar algunos de los métodos directos e indirectos que se utilizan como pruebas o test, para la obtención del VO2 máx., siendo ésta una variable fundamental en el ámbito de la medicina clínica y deportiva. Dentro del análisis de los métodos directos, se encuentra la Ergoespirometría, que proporciona información a cerca de la capacidad funcional del individuo y del VO2 máx., esta prueba de esfuerzo se puede medir a partir del trabajo realizado en un Cicloergómetro o en Cinta Rodante. En los métodos indirectos convencionales, aparecen el de Course Navette, un test máximo y progresivo que determina la aptitud cardiorespiratoria (Álvarez, J. et al. 2001; Corral J. et al. 2010), también, se describe el test de Cooper que mide la capacidad máxima aeróbica de media duración en 12 minutos comúnmente utilizada en la educación física. En los métodos no convencionales analizados aparecen: el TIVREBasket, determinación de VO2 máx., a partir de la grasa corporal, prueba escalonada y determinación de VO2 en niños. Es importante conocer, aplicar y desarrollar nuevos métodos para la obtención del VO2 máx., en el área del deporte, la actividad física y la educación física, para la determinación validada del rendimiento y potencia aeróbica en diferentes poblaciones, teniendo en cuenta diferentes variables. Algunos métodos como el de Course Navette y test de Cooper, proporcionan información confiable, están aceptados por la comunidad científica y son ampliamente utilizados, otros métodos en proceso de validación tienen la ventaja de ser específicos teniendo en cuenta variables como la edad, el IMC, el índice lipídico, tipo de actividad física, deporte y las diferencias étnicas marcadas por diferencias genéticas.

PALABRAS CLAVE: Vo2 máx., Métodos y Actividad física.

A REVISÃO DE ALGUNS MÉTODOS DIRETOS E INDIRETOS USOU-SE MEDIR O MÁX VO2 NA ATIVIDADE E NO ESPORTE FÍSICOS

SUMÁRIO

À revisão bibliographical foi feito, com a finalidade de analisar alguns dos métodos diretos e indiretos de que os arados usados como testes ou teste, para obter do VO2 máx., sendo a esta variável clínica um fundamental no espaço e na medicina do esporte. Dentro da análise dos métodos diretos, um é o Ergoespirometría, a que informação dos prograpevines perto da capacidade funcional do indivíduo e do VO2 máx., este teste possível do esforço é vê medido do trabalho feito em uma fita adesiva de Cicloergómetro ou de Rolling. Nos métodos, nos eles indiretos convencionais a parecer o um naturalmente Navette, ao teste máximo e progressivo que você determina o cardiorespiratoria da aptidão (Alvarez, J. ET a. 2001; Cerca J. ET a. 2010), também, o teste do Cooper máximo é descrito quem mede a capacidade do aeróbica da duração média em 12 que você faz um esboço usado geralmente na instrução física. Nos métodos nonconventional analisados eles a aparecer: o TIVREBasket, determinação do VO2 máx., da gordura corporal, prova pisado e determinação de VO2 nas crianças. É importante saber, aplicar-se e tornar-se aos métodos novos para obter do VO2 máx., na área do esporte, a atividade física e a instrução física, aeróbica para a determinação validada do rendimento e poder em populações diferentes, considerando a variável diferente. Alguns métodos gostam do um naturalmente Navette e o teste do Cooper, da informação de confiança do probidet, dos arados aceitados pela comunidade científica e extensamente dos arados usados, a outros métodos no processo do validation específico tem a vantagem de considerar a variável como a idade, o IMC, o índice do lipídico, tipo de atividade física, deports e as diferenças étnicas marcadas por diferenças genetic.

PALAVRAS CHAVES: VO2 máx., métodos. Atividade física.