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Alenice Aliane Fonseca

DEMANDA CARDIORRESPIRATÓRIA E METABÓLICA DO TESTE *6-MINUTE PEGBOARD AND RING TEST* (6PBRT) EM INDIVÍDUOS SAUDÁVEIS

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Orientadora: Prof. Dr.ª Vanessa Pereira de Lima
Coorientadora: Prof.ª Dr.ª Ana Cristina Rodrigues Lacerda

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ALENICE ALIANE FONSECA

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Dissertação apresentada ao MESTRADO EM REABILITAÇÃO E DESEMPENHO FUNCIONAL, nível de MESTRADO como parte dos requisitos para obtenção do título de MESTRA EM REABILITAÇÃO E DESEMPENHO FUNCIONAL

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DIAMANTINA

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"*Confie no Senhor de todo o seu coração, e não se apoie em seu próprio entendimento; reconheça o Senhor em todos os seus caminhos, e ele endireitará as suas veredas*".
(Provérbios 3:5-6).

RESUMO

Introdução: Os membros superiores (MMSS) são utilizados extensivamente no cotidiano para a realização das atividades de vida diária (AVD). Sendo assim, avaliar a funcionalidade dos MMSS é uma ferramenta essencial para identificar possíveis limitações em relação aos esforços físicos realizados sem apoio em indivíduos com diferentes condições de saúde. Dentre vários testes, destaca-se o *6-minute Pegboard and Ring Test* (6PBRT), utilizado na avaliação da capacidade funcional de indivíduos com Doença Pulmonar Obstrutiva Crônica (DPOC). Apesar de validado para a população saudável brasileira, o nível de intensidade do teste permanece desconhecido, seu conhecimento irá auxiliar na escolha do teste a ser realizado. **Objetivos:** (1) Caracterizar a demanda cardiorrespiratória e metabólica do 6PBRT em adultos saudáveis. (2) Avaliar a correlação do desempenho no 6PBRT com parâmetros cardiorrespiratórios, antropométricos e nível de atividade física. **Métodos:** Sessenta e seis adultos saudáveis foram randomizados para realizar o teste 6PBRT ou o teste ergométrico progressivo no cicloergômetro isocinético do braço. O segundo teste foi realizado 48 horas após o primeiro. O consumo de oxigênio (VO_2), frequência cardíaca (FC), sintomas de dispneia e fadiga dos MMSS foram avaliados durante os testes. Também foram avaliados os dados demográficos, de composição corporal e nível de atividade física. **Resultados:** Os valores de VO_2 aumentaram de 5,8 para 11,1 $mL.kg\text{-}^{1}.min\text{-}^{1}$ durante o 6PBRT ($p < 0,001$), o que representa 2,39±0,56 METs e 47,2% do VO_{2pico} obtido no CPET. A $FC_{Média}$ e $FC_{máx}$ observada no 6PBRT foi aproximadamente 65% daquelas observadas no teste máximo. A fadiga dos MMSS foi significativamente menor no pós-teste do 6PBRT do que em CPET (escala de Borg = 4,8 vs 7,0; $p < 0,01$). **Conclusões:** O 6PBRT apresenta uma demanda cardiorrespiratória e metabólica moderada em indivíduos saudáveis na comparação do teste ergométrico do braço. Assim, esses dados podem servir de base para a aplicação e interpretação do 6PBRT sob outras condições de comprometimento funcional do MMSS.

Palavras chave: Tolerância ao exercício, Membro superior, Teste ergonometria de braço, consumo de oxigênio, VO2.

ABSTRACT

Introduction: The upper limbs (UL) are used extensively in daily life to perform activities of daily living (ADL). Thus, assessing the functionality of the UL is an essential tool to identify possible limitations in relation to physical efforts performed without support in individuals with different health conditions. Among several tests, we highlight the 6-minute Pegboard and Ring Test (6PBRT), used to assess the functional capacity of individuals with Chronic Obstructive Pulmonary Disease (COPD). **Objectives:** (1) To characterize the cardiorespiratory and metabolic demand of 6PBRT in healthy adults. (2) To evaluate the correlation of 6PBRT performance with body mass index (BMI), lean body mass, fat mass, body fat and physical activity level. **Methods:** Sixty-six healthy adults were randomized to perform the 6PBRT test or the progressive isometric kinetic cycle ergometer (CPET) exercise test on the first day. The second test performed after 48 hours. Oxygen uptake (VO_2), heart rate (HR), dyspnea symptoms and upper limb fatigue were evaluated during the tests. Demographic data, body composition and level of physical activity were also evaluated. **Results:** VO2 values increased from 5.8 to 11.1 mL.kg-^{1}.min-^{1} during 6PBRT ($p < 0.001$), which corresponded to 2.39 + 0.56 METs and 47.2%. VO_{2peak} obtained in the CPET. Mean HR, the HR_{max} observed in the 6PBRT was close to 65% of those observed in the maximal test. Arm fatigue was significantly lower post-test at 6PBRT than at CPET (Borg scale = 4.8 vs 7.0; $p < 0.01$). **Conclusions:** 6PBRT has a moderate cardiorespiratory and metabolic demand in healthy individuals when comparing the arm exercise test. Thus, these data can serve as a basis for the application and interpretation of 6PBRT under other conditions of UL functional impairment.

Keywords: Exercise tolerance, Upper limb, Arm Ergometry Test. oxygen consumption, VO2

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LISTA DE ABREVIATURAS E SIGLAS

6PBRT	*6-minute Pegboard and Ring Test*
AAQ	*Active Australia Questionnaire*
ACSM	*American College of Sports Medicine*
AVD	Atividades de vida diária
BMI	*Body mass index*
CPET	*Isokinetic cycle ergometer maximal progressive test*
COPD	*Chronic obstructive pulmonary disease*
DEXA	*Dual Energy Radiological Absormetry*
DPOC	Doença Pulmonar Obstrutiva Crônica
°C	Graus Celsius
HR	*Heart rate*
MET	*Metabolic rate equivalent*
MMII	Membros Inferiores
MMSS	Membros Superiores
SPSS	*Statistical Package for the Social Sciences*
UFVJM	Universidade Federal dos Vales Jequitinhonha e Mucuri
VO_2	Consumo de oxigênio

SUMÁRIO

CAPÍTULO 1- REFERÊNCIAL TEÓRICO

1 INTRODUÇÃO

Os membros superiores (MMSS) permitem aos indivíduos realizarem inúmeras atividades da vida diária (AVD) (NYBERG; TÖRNBERG; WADELL, 2016; OHARA *et al.,* 2017), e suas funções estabelecem a relação do indivíduo com o ambiente. Atividades simples do cotidiano como vestuário, alimentação, autocuidado, mobilidade, higiene pessoal, até tarefas de maior complexidade, como manejo de ferramentas e instrumentos, estão relacionadas à capacidade funcional do indivíduo em executar tarefas em condições variáveis do cotidiano, ou seja, seu envolvimento em uma situação real da vida diária. No entanto, alguns indivíduos, ao realizarem atividades com MMSS, especialmente sem apoio, utilizam musculatura da cintura escapular. Essa musculatura, ao mesmo tempo que mantem a atividade dos MMSS, também participa das atividades ventilatórias o que leva à limitações quanto a capacidade de tolerância ao esforço (CANCELLIERO-GAIAD *et al*., 2014).

Algumas populações especiais apresentam limitações e intolerância a atividades realizadas com MMSS, seja por disfunções cardiorrespiratórias e pulmonares, como na doença pulmonar obstrutiva crônica (DPOC) (LAREAU; BLACKSTOCK, 2018), na hipertensão arterial pulmonar (ÖZCAN KAHRAMAN *et al.,* 2017) quanto indivíduos com prejuízo funcional de MMSS como nas doenças neuromusculares (ZUPAN,1996), osteoartrite (VANSTEENKISTE *et al*., 2017), amputados (POSTEMA *et al.,* 2018), mulheres com câncer de mama (CEDRAZ; JESUS; MEDRADO *et al.,* 2018), entre outros.

Neste contexto, destaca-se a importância da avaliação da capacidade funcional dos MMSS para direcionamento dos tratamentos na prática clínica (OHARA *et al.,* 2017), além de proporcionar aos indivíduos com limitações dos MMSS que realizem às necessidades básicas, desempenhem funções habituais, e mantenham a sua saúde e bem-estar (ACSM, 1998).

Com isso, tem sido salientado na literatura a utilização de testes funcionais de MMSS como método de estudo e avaliação dos mecanismos sistêmicos de tolerância ao esforço. Testes máximos são largamente utilizados, e considerados como padrão-ouro para avaliar a condição clínica, hemodinâmica e metabólica, do indivíduo durante o exercício (MENEGHELO *et al.,* 2010). Dentre os testes máximos, destaca-se o cicloergômetro isocinético de MMSS, considerado

o padrão ouro para avaliar as respostas cardiorrespiratórias máximas (LIMA *et al.,* 2016; CHEN *et al.,* 2015; CASTAGNA *et al.,* 2007).

Os testes máximos de exercício predizem o consumo máximo de oxigênio (VO_{2max}). O VO_{2max} depende da capacidade funcional do sistema de transporte de oxigênio em fornecer sangue e da capacidade das células de absorver e utilizar oxigênio na produção de energia durante o exercício (NOONAN; DEAN, 2000). O $VO_{2máx}$ ou VO_{2pico} quando medido em exercícios de MMSS, apresentam cerca de dois terços do obtido com os membros inferiores (MMII) em pessoas saudáveis. A menor massa muscular dos MMSS pode causar fadiga localizada e determinar a interrupção do exercício antes que o débito cardíaco máximo seja atingido, daí a denominação de VO_{2pico} (BELASCO JUNIOR *et al.,* 2010).

No entanto, apesar de apresentar medidas precisas, os testes máximos demandam infraestrutura para serem realizados, tempo e equipamentos de alto custo (SILVA *et al.,* 2011). Diante dessas limitações na utilização destes testes na prática clínica, outros recursos têm sido utilizados para avaliação da capacidade funcional de MMSS, como os testes submáximos, que têm se mostrado benéficos em pacientes quando o teste máximo é contraindicado ou não está disponível (MYERS *et al.,* 2006).

Na prática clínica, os testes funcionais submáximos mimetizam de forma mais simplificada a avaliação das AVD, pois tentam reproduzir movimentos comuns à rotina dos pacientes. Além disso, os resultados obtidos nesses testes muitas vezes são capazes de refletir melhor as limitações do paciente nos seu dia-a-dia do que os testes máximos (SOLWAY *et al.,* 2001; CORRÊA *et al.,* 2011; OHARA *et al*., 2017).

Dentre os testes de MMSS existentes, destaca-se o *6-minute Pegboard and Ring Test* (6PBRT) desenvolvido por Celli, Rassulo e Make (1986) para avaliação da capacidade funcional dos MMSS em indivíduos com DPOC. O teste consiste em anéis deslocáveis a uma distância vertical de 10 cm em um painel, com o paciente sentado e os braços sem suporte mantidos no nível do ombro ou acima dele para recriar as condições sob as quais a dispneia é geralmente relatada pelos pacientes com DPOC. Logo o 6PBRT passou a ser utilizado em diversos estudos como o de Criner e Celli (1988) e Bauldoff *et al.* (1996). No entanto, só em 2006 que sua validade e reprodutividade foi estudada por Zhan *et al*. (2006), mostrando que o 6PBRT é um

método confiável para a avaliação do exercício de extremidade superior não apoiado em pacientes com DPOC. Além disso, o equipamento e as regras do teste foram aprimorados por Zhan *et al*. (2006). Sendo que para a realização do teste o indivíduo deve manter-se sentado em frente a um painel de madeira com quatro pinos (dois superiores e dois inferiores), com 20 argolas (10 em cada pino inferior). Os pinos inferiores são posicionados na altura dos ombros do indivíduo e os pinos superiores 20 cm acima. Os indivíduos são instruídos a mover o maior número de argolas possível dos pinos inferiores para os superiores e vice-versa durante seis minutos, sendo permitido ao indivíduo parar para descansar por motivo de fadiga, dispneia ou outro desconforto e voltar a realizar o teste assim que se sentisse mais confortável, mantendo o cronômetro acionado para medição do tempo (CELLI; RASSULO; MAKE, 1986; ZHAN *et al.,* 2006).

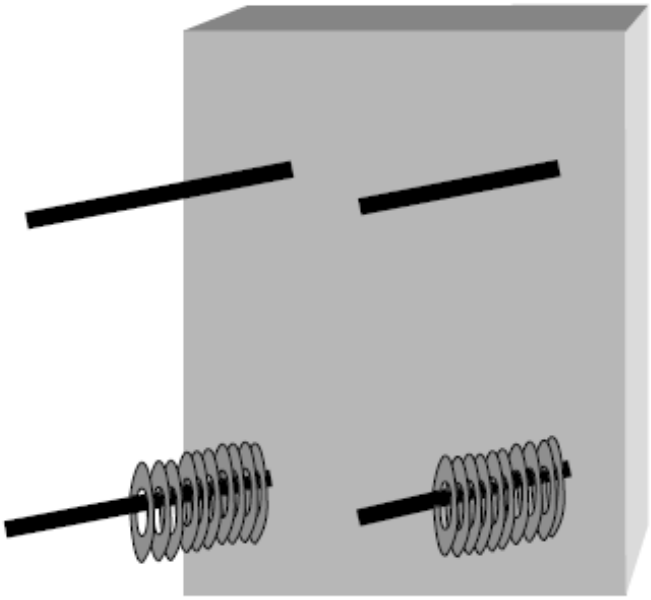

Figura 1: Equipamento utilizado para realização do 6PBRT.

Fonte: Zhan *et al.* (2006)

O 6PBRT então passou a ser utilizado em diversos estudos como parâmetro de avaliação em programas de reabilitação pulmonar (JANAUDIS-FERREIRA *et al*., 2011), como índice de referência ou teste potencial que mimetiza as AVD de MMSS (TAKEDA *et al.,* 2013) e avaliação da capacidade funcional de MMSS em indivíduos com DPOC (NYBERG;

TÖRNBERG; WADELL, 2016).

No entanto, o uso do 6PBRT em outras populações não havia sido explorado, e inclusive sua repercussão em indivíduos saudáveis possibilitaria a utilização do 6PBRT em outras populações clínicas com limitações de MMSS (OHARA *et al.,* 2017; LIMA *et al*., 2018a). Em 2018, Lima *et al.* (2018a) avaliaram a confiabilidade do 6PBRT quanto ao teste-reteste em adultos saudáveis, o que originou valores de referência por faixa etária para o 6PBRT em brasileiros adultos jovens e idosos saudáveis (Tabela 1). Valores de referência do 6PBRT são importantes já que possibilitam a comparação com os valores obtidos em indivíduos com limitações dos MMSS, podendo possibilitar a mensuração de resultados das intervenções terapêuticas em programas de reabilitação (LIMA *et al.,* 2018).

Tabela 1. Valores de referências para desempenho no 6PBRT.

Faixa Etária	**Média**	**DP**	**IC95%**
30-39	430,25	77,11	394,16-466,34
40-49	414,85	61,40	386,11-443,59
50-59	382,70	59,38	359,36-428,44
60-69	373,76	59,41	343,22-404,31
70-79	320,74	65,75	289,05-352,43
>80	265,00	47,38	225,39-304,61

Fonte: Adaptado de Lima *et al.* (2018b). DP: desvio padrão; IC: intervalo de confiança

Atualmente, percebe-se a crescente expansão do 6PBRT e seu grande potencial clínico e científico (IKE *et al*., 2010). Entretanto, a demanda cardiorrespiratória e metabólica, bem como a intensidade do 6PBRT em adultos saudáveis ainda não são conhecidos. Avaliar a intensidade do 6PBRT por meio da frequência cardíaca máxima ($FC_{máx}$) e os valores de VO_{2pico} obtida ao final do teste, comparado a um teste máximo é de extrema relevância para caracterizar a intensidade do 6PBRT em adultos saudáveis. Sabendo-se da repercussão em indivíduos saudáveis, poderemos classificar o resultado de outras populações em porcentagem do previsto em indivíduos saudáveis. Com isso teremos maior precisão do acometimento de MMSS nestas

diferentes populações, promovendo também maior segurança em sua utilização em indivíduos com sintomas cardiorrespiratórios e outras condições de comprometimento funcional dos MMSS.

3 OBJETIVOS

3.1 Objetivo Geral

Avaliar e caracterizar as respostas cardiorrespiratórias e metabólicas durante o 6-*Minute Pegboard and Ring Test* em adultos saudáveis.

3.2 Objetivos Específicos

- Correlacionar as respostas cardiorrespiratórias e metabólicas durante o *6-Minute Pegboard and Ring Test* com o teste do cicloergômetro isocinético para membros superiores.

- Correlacionar os resultados do *6-Minute Pegboard and Ring Test* em adultos saudáveis com parâmetros cardiorrespiratórios, antropométricos e nível de atividade física.

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CAPÍTULO 2- ARTIGO CIENTÍFICO

Cardiorespiratory and metabolic demand of 6-Minute Pegboard and Ring Test in healthy young adults

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ABSTRACT

Objective: To determine the cardiorespiratory and metabolic demand of the 6-Minute Pegboard and Ring Test (6PBRT) in healthy young adults. **Methods:** Sixty-six healthy adults were randomized to performed 6PBRT test or arm isokinetic cycle ergometer maximal progressive test (CPET) in the first day. The second test was performed after 48 hours. Oxygen consumption (VO_2), heart rate (HR), symptoms of dyspnea and upper limb fatigue were assessed during the tests. Demographic data, body composition and level of physical activity were also evaluated. **Results:** VO_2 values increased from 5.8 to 11.1 $mL.kg^{-1}.min^{-1}$ during 6PBRT ($p < 0.001$), which was equivalent to 2.39±0.56 METs in healthy young adults and 47.2% of VO_{2peak} obtained during the CPET. HR_{Mean}, HR_{max} achieved at 6PBRT were close to 65% of those achieved at the maximum test. Arm fatigue was significantly lower posttest in 6PBRT than in CPET (Borg scale = 4.8 vs 7.0; $p < 0.001$). There was a weak positive correlation between the number of rings moved during 6PBRT and VO_{2mean} ($p=0.030$) and VO_{2peak} ($p=0.046$). No correlation was found between the HR_{mean} or HR_{peak} during 6PBRT or level of physical activity and performance in 6PBRT. BMI ($p=0.014$), body fat (0.007) and fat mass ($p=0.001$) were negatively correlated with the number of rings moved. **Conclusions:** This study revealed that 6PBRT test presents a moderate cardiorespiratory and metabolic demand in healthy individuals in comparison of CPET. BMI, body fat and fat mass correlated with the number of rings moved. Thus, these data may assist in the interpretation of 6PBRT under other conditions of upper limb functional impairment, as well as in the choice of exercise test.

Keywords: Exercise tolerance, Upper limb, Arm Ergometry Test. oxygen consumption, VO2.

1. Introduction

The 6-min peg board and ring test (6PBRT) is a simple, inexpensive arm exercise test used in pulmonary rehabilitation programs, especially in subjects with chronic obstructive pulmonary disease (COPD) [1]. The test is valid and reliable for this population and also for healthy adults [2]. The test has potential value in the evaluation of arm function and endurance by asking the subjects to move as many rings as possible from a board with two lower pegs to two upper pegs and vice-versa during 6 minutes [1,3].

Current literature reports that 6PBRT could be an useful tool in the assessment of arm function since it reflects activities of daily living, such as combing hair, shaving, brushing teeth, doing the dishes, or putting groceries on shelves in patients with COPD and also in healthy adults [1,2,4].

Recently, it was determined the normative values of 6PBRT in healthy Brazilian adults [5], in order to compare the normative values in healthy individuals and individuals with upper limb dysfunction. As such we will be able to evaluate the outcome of therapeutic interventions especially in rehabilitation programs. However, to date, it is unknown the cardiorespiratory and metabolic demand for the 6PBRT in healthy adults. Consequently, the primary objective of this study was to characterize the 6PBRT cardiorespiratory demand in healthy adults. Secondary objectives were the comparison of 6PBRT cardiorespiratory demand during the test and arm cycle ergometer and analyze the correlation between cardiorespiratory parameters, anthropometric parameters and physical activity level in healthy young adults.

2. Materials and Methods

2.1. Study design

2.1.1 Volunteers

The sample size was calculated considering a pilot study with 15 volunteers and a correlation coefficient between the peak of VO_2 in the CPET in arm cycle ergometer and the peak of the HR in the 6PBRT (r = 0.34). Considering the alpha of 0.05 and the power of 95%, resulting in a sample size of 54 volunteers [6].

In this cross-sectional study, all volunteers, students and employees, were recruited (April to July 2018) by convenience from Universidade Federal dos Vales Jequitinhonha e Mucuri (UFVJM), Diamantina, Minas Gerais/Brazil, and informed consent was obtained as per the Institutional Review Board and the Declaration of Helsink (Nº. 2.485.479).

The inclusion criteria: age *over 18* years old; without neurological, orthopedic, respiratory, endocrine, heart or musculoskeletal disorders; non-*smokers;* and not having undergone a recent surgical intervention that could affect the performance of the tests. The exclusion criteria the inability to perform any test; changes in the health status during the study or did not attend of data collection.

2.2. Procedures

All volunteer performed both tests (6PBRT and CPET in arm cycle), with 48h interval in between. The test order was randomized before demographic and body composition assessment. The tests were performed with the direct analysis of the gases breath-by-breath in a controlled room temperature at 22 Celsius (°C) and 60% relative humidity.

2.2.1. Body composition

Height was measured using a stadiometer (SECA 206), with a precision of 0.1 mm, in a wall with ninety degrees in relation to the floor and without skirting boards. The weight. expressed in kilograms (kg) was measured using a Digital Scale (Welmy W200A Led) with a capacity of 200 kg. Body mass index (BMI) was determined by total body mass divided by squared height (kg/m^2).

The fat and lean mass was evaluated through Dual Energy Radiological Absormetry (DEXA) (Lunar Radiation Corporation, Madison, Wisconsin, USA, model DPX). The participants were positioned in the equipment scanning area, so that the sagittal line demarcated in the equipment passed under the center of some anatomical points such as skull, spine, pelvis and lower limbs. For both measures, volunteers wore light clothing, standing erect in the center of the equipment and barefoot.

2.2.2. Level of Physical Activity

We used the Active Australia Questionnaire (AAQ) developed by the Australian Institute of Health and Welfare [7] and validated for Brazilians individuals by Rocha et al. [8] AAQ is an instrument consisting of eight questions, correlated, directed and quantified by the time spent on activities, during a week prior to its application. Consequently, the instrument allows measuring the number of sessions of physical activities performed, classifying individuals according to their level of physical activity. Activities such as continuous walking longer than 10 minutes are practical; moderate physical activity; and vigorous activities that require more effort and cause symptoms of increased or increased respiratory rate [7]. To quantify overall activity time, add the

time spent on walking and moderate activity and double the time spent on vigorous activity. Individuals with last week's global activity time of zero are classified as sedentary Those with a time between 150 minutes and are classified as insufficiently active, and those who had above these values classified as active [7].

2.2.3. Strength and endurance of the upper limbs

Upper limb muscle strength and endurance were measured by hand grip with the Dynamometer Jamar (Asimow Engineering Co), expressed in kilograms-force (kgf). The volunteers were instructed to perform a maximum force with the dominant hand for three times with one-minute interval, considering the average of the measurements (for strength). After resting for 10 minutes, it was performed an endurance assessment, where the individual had to pressed the dynamometer to reach a level within the range of 65-75% of their maximum force applied to the strenght test, keeping them to that level as long as possible [9].

2.2.4. Functional tests

2.2.4.1. 6-minute Pegboard and Ring Test (6PBRT)

For this test, the subjects remained seated in front of a board, containing two pins positioned at the height of their shoulder and two other pins placed 20 cm above this level, as demonstrated in Figure 1. Ten rings were placed on each of the two lower pins. Individuals were instructed to use both hands simultaneously and move one ring at a time, moving it from the lower pin to the upper pin and vice-versa over six minutes [10,11]. Patients were given a standard incentive every minute and allowed to stop due to fatigue, dyspnea or any discomfort, however the timer remained on. The final score was the number of rings moved during six

minutes. Scores for dyspnea and upper limb fatigue (Borg 0-10) were collected before and immediately after the test [10,11]. The 6PBRT was performed twice with a minimum interval of 30 minutes in between [2], the highest score was used for data analysis.

>>>>Figure 1<<<<

2.2.4.2. Cardiopulmonary exercise test (CPET): Arm cycle ergometer

The test was performed in an arm cycle ergometer (CPET) (Angio® Lode BV - Groningen, The Netherlands). All volunteers were carefully positioned in the CPET, sitting in a chair with feet flat on the floor and trunk stabilized, so that the axis of rotation of the glenohumeral joint was at the same level as the axis of the CPET arm crank. The protocol consisted of five minutes of pre-test rest, initiating a two-minute warm-up without resistance, followed by a progressively increased of 10W increment every minute. Subjects were instructed to maintain the 60 RPM [12] cadence, and were encouraged to exercise to exhaustion, and the test was stopped when participants could not reach the requested RPM, or develop any signs or symptoms for exercise intolerance based on the American College of Sports Medicine (ACSM) criteria [13]. After stopping the test, the participants remained for five minutes at rest and under observation.

2.3. Evaluation of cardiorespiratory and metabolic demand of 6PBRT and CPET

All volunteers used a portable gas analyzer system (COSMED, K4b2, Rome, Italy) with face mask. Exhaled gases were collected through a face mask placed over the participant's nose and mouth, the gas analyzer unit and the battery were kept on a pedestal next to the participant. The data collected were transferred in real time through radio transmission of the equipment and plotted in spreadsheets [14]. In addition to the gas analysis system, the heart rate (HR) was

monitored by a heart rate monitor (Polar RS800CX, Electro, Finland). During both arm tests, cardiorespiratory outcome measures were recorded, including oxygen consumption (VO_2 in in $mL.kg^{-1}.min^{-1}$), VO_2 peak, CO_2 production (VCO_2 in mL/min), respiratory rate (RR in $cycles/min^{-1}$),HR (beats/min) and metabolic equivalent (METs) at each breath (breath-by-breath analysis).

In addition, symptoms of dyspnea and upper limb fatigue were assessed by the modified Borg scale (0-10) [15].

2.4. Data analysis

The statistical analysis was performed with the Statistical Package for the Social Sciences version 22.0 (SPSS Inc., Chicago, IL, EUA). The normality of the variables was verified by the Shapiro-Wilk test. The characterization of the metabolic demand of 6PBRT was analyzed in comparison with the maximum effort test by the CPET. The statistical differences of both tests were calculated using the paired t-test samples for peak oxygen uptake (VO_{2peak}), peak CO_2, R, the peak HR and metabolic equivalent (METs) of both tests. To investigate the relationship between two parameters, the Pearson's correlation test was performed. The strength of the correlation coefficients was stratified as low (0-0.25), moderate (> 0.25-0.50), strong (> 0.50-0.75) or very strong (> 0.75) [6]. Friedman's analyzes with Tukey Post hoc were used to express the behavior of VO_2 and HR during 6PBRT and CPET. The level of significance was set at $p < 0.05$.

3. Results

Seventy potential eligible participants attended to the first day of data collection. However, four volunteers were excluded: three volunteers did not attend on the second day and one had flu, totalizing a sample of 66 individuals. Table 1 shows the demographic and anthropometric characteristics of 66 volunteers that completed the study. Most of them were female (57.6%) and thirty-three volunteers (50%) were sufficient active. The total mean score for 6PBRT was 506.74 ± 67.12 and 511.64 ± 69.77; time for CPET were 06:58±1:21 and 11:43±2:13 for females and males respectively.

>>>>Table 1<<<<

3.1. Cardiorespiratory and metabolic demands of 6PBRT and CPET

The cardiorespiratory and metabolic demands for both tests are demonstrated in Table 2. VO_2 values increased from 5.8 to 11.1 $mL.kg^{-1}.min^{-1}$ during 6PBRT ($p < 0.001$), which was equivalent to 2.39±0.56 METs and 47.2% of VO_{2peak} obtained in the CPET. VCO_2peak at 6PBRT was lower than during arm cycle ergometer (146.58±18.04 and 350.19±43.10 mL/min respectively $p = 0.001$). HR_{Mean}, HR_{max} observed at 6PBRT were close to 65% of those observed at the maximum test. Arm fatigue was significantly lower in 6PBRT than in CPET (Borg scale = 4.8 vs 7.0; $p < 0.01$). VCO_2 during 6PBRT was also lower 477.22± 146.58 than during arm cycle ergometer (477.22± 146.58, 931,40 ±350.19; $p = 0.001$.) The value of R during 6PBRT was 0.82±0.12 and 0.93±0.10 during arm cycle ergometer ($p= 0.001$)

>>>>Table 2<<<<

Friedman analyses

At 6PBRT, VO_2 increased from the first to the second minute and reached a plateau, without significantly changes until the end of the test. Regarding the HR, a significant increase was observed in the 3rd minute, and no plateau was observed (Fig. 2).

>>>>Figure 2<<<<

3.2. Correlation between cardiorespiratory parameters, anthropometric, level of physical activity, upper limb strength and endurance with number of rings moved

There was a weak positive correlation between the number of rings moved during 6PBRT and VO_{2mean} (r=0.268; p=0.030) and VO_{2peak} (r=0.247; p=0.046). No correlation was found between the HR_{mean} or HR_{peak} during 6PBRT (Table 3).

BMI (r=-0.301; p=0.014), body fat (r= -0.329; 0.007) and fat mass (r=-0.427; p=0.001) were negatively correlated with the number of rings moved. Regarding the level of physical activity, no correlation was found with performance in 6PBRT. There was no correlation between upper limb strength and number of rings moved, however, a resistance showed low correlation (r= 0.237; p=0,054) (Table 3).

>>>>Table 3<<<<

4. Discussion

Despite the clinical importance of arm tests, such as 6PBRT, for rehabilitation programs, no other study addressed the cardiometabolic demand of this test in healthy individuals. To our knowledge, this is the first study that described the demand for 6PBRT compared with a maximal test. The main findings of the present study were that the 6PBRT [1] promotes moderate

cardiorespiratory and metabolic demands in healthy individuals, demonstrated by the values obtained from VO2, HR, R, METS and arm fatigue during the test when compared to the maximum test [2]. Our findings have great clinical meaning, since they demonstrate, for the first time in the healthy population, that the test is performed at submaximal intensity. Although the maximal test is considered the gold standard in the evaluation of functional capacity, submaximal tests have been proven to be beneficial in patients when the maximal test is contraindicated or not available [16].

Regarding the number of tests created for upper limbs, the number is still small, having been mostly tested and validated in patients with respiratory diseases, especially patients with COPD [1], as they have limitations in performing mainly upper limb tasks without support [4].

The final score of our sample at 6PBRT was 506.74 rings moved, which was higher than the study by Lima et al. [5], who presented a score of 376.19 rings moved. It could be justified by the mean age and physical activity level of the individuals, since the sample of the present study was composed of younger and sufficiently active individuals.

The study of the 6PBRT cardiometabolic demand gives us greater safety regarding its use, even in patients with cardiorespiratory diseases or other limitations. Comparing with the maximal test in healthy individuals, it was observed that the VO_{2peak}, in addition to the mean HR at the end of the test, was 52% and 34% lower respectively than those obtained in the maximal test. Thus we can assume that 6PBRT, despite the stress imposed by physical exercise, does not impose maximal cardiometabolic overload on individuals, which makes it safe, even in patients with some pathology and/or physical limitation [17].

The 6PBRT presented a demand for VO_{2peak}, HR_{max} and METS that reached a moderate intensity level in healthy individuals based on ACSM guidelines for exercise testing and prescription. The 6PBRT requires the individual to remain with their shoulders flexed at 90 ° throughout the test, performing movements with small amplitude [1,5], resulting in increases in metabolic demands, similar to mild and moderate exercise [17]. In healthy individuals, unsupported arm activities cause an increase in transdiaphragmatic pressure, VO_2 and HR, disrupting mechanics and the pectoral and abdominal compartments [8,18]. In individuals with cardiorespiratory dysfunction, these changes are even greater [17,19].

When comparing the behavior of VO_2 and HR during the tests (Figure 2), it was observed that in CPET the variables increased continuously, while in 6PBRT the increase is observed from the first minute and remains constant until the end of the test. This behavior shows that although 6PBRT has lower cardiorespiratory demand, it is a test that possibly requires greater demand for motor coordination and endurance [4,5], since this is a task that involves upper limbs alone [20], further studies are needed to confirm our hypothesis.

There was a significant increase in upper limb fatigue and dyspnea after both tests. Studies have shown that localized fatigue in a specific muscle group causes major changes in muscle coordination [21], range and speed of movement [22] and changes the sense of upper limb position in healthy adult individuals [23]. According to Richardson et al. [24] during physical exercise blood flow is directed to the task-specific muscles, and 16% of the total value to the respiratory muscles, being a limiting factor of VO_{2peak}, which may affect performance.

HR did not correlate with the number of rings moved during the test. It has been shown that even the volunteer maintaining upper limbs without support and in isometric contraction lead to

cardiac repercussions [25]. However, when correlating the average VO_2 and VO_{2peak} presented moderate and significant correlations with 6PBRT.Though the 6PBRT didn't promote a significant increase in HR or VO_2. The behavior of VO_2 presented great variation between the two tests, demonstrating the specific characteristic of them.

According to ACSM [7], in classifying exercise intensity individual factors, such as body weight, and individual's fitness level, should be taken into account. Therefore, when assessing the correlation of physical activity level with performance in the 6PBRT, a weak correlation was observed ($r = 0.232$; $p = 0.014$), which corroborates the findings obtained by Lima et al. [5] and Ohara et al. [26]. It can be partially explained by the fact that volunteers are sufficiently active, and consequently have a gain of endurance and motor coordination through the physical activity practiced [27].

In a previous study the 6PBRT [5] showed no correlation with arm and forearm circumference and arm length measurements with the final score of the test which could be related to increased fat and / or weight of the limb. In the present study, BMI, body fat percentage and fat mass were negatively correlated with the number of rings moved, The most likely explanation is that individuals with a higher percentage of body fat as well as fat mass have a heavier limb being in mechanical disadvantage for 6PBRT performance, as the test requires keeping the arms almost static in isometric contraction unsupported. It may result in early muscle fatigue and poor functional performance [28]. It is also known that accumulation of subcutaneous fat may lead to decreased oxidative capacity and consequently worsen exercise performance in healthy individuals, which could justify the worse test score with increased BMI, body fat percentage and fat mass [29].

Upper limb endurance but no strength correlate with 6PBRT performance, showing that in healthy individuals the best test performance does not depend on the individual's strength, but the upper limb endurance. This relationship between 6-PBRT, upper limb strength and endurance has been studied in studies with patients with respiratory disorders such as COPD [3,30], and the results of this study allow us to infer that, 6PBRT is an upper limb muscle endurance test even in healthy individuals.

In summary, 6PBRT has been shown to be a submaximal/moderate intensity test in healthy individuals. It is a simple, fast, low-cost methods that represents daily activities and evaluates the functional capacity of upper limbs. BMI, body fat, fat mass and upper limb endurance, correlated with the number of rings moved, but not with the level of physical activity and strength. Thus, the 6PBRT can be a test with potential value in the functional assessment of individuals with cardiorespiratory symptoms and/or who have limitations of upper limbs [17].

Limitations

Our study has some limitations. Firstly, we have difficulties in recruiting older adults, the majority of our sample were students. Our results may not be generalizable to all ages category. However, despite the limitation, our study showed, a scientific *novelty*: the association between the scores on 6PBRT and BMI, fat mass and body fat percentage. Showing that the higher percentage of body fat as well as fat mass (a heavier limb) could promote a mechanical disadvantage for 6PBRT.

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Disclosure of interest

The authors declare that they have no competing interest.

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Figure 1. (A) volunteer performing the 6PBRT. (B) volunteer performing the CPET.

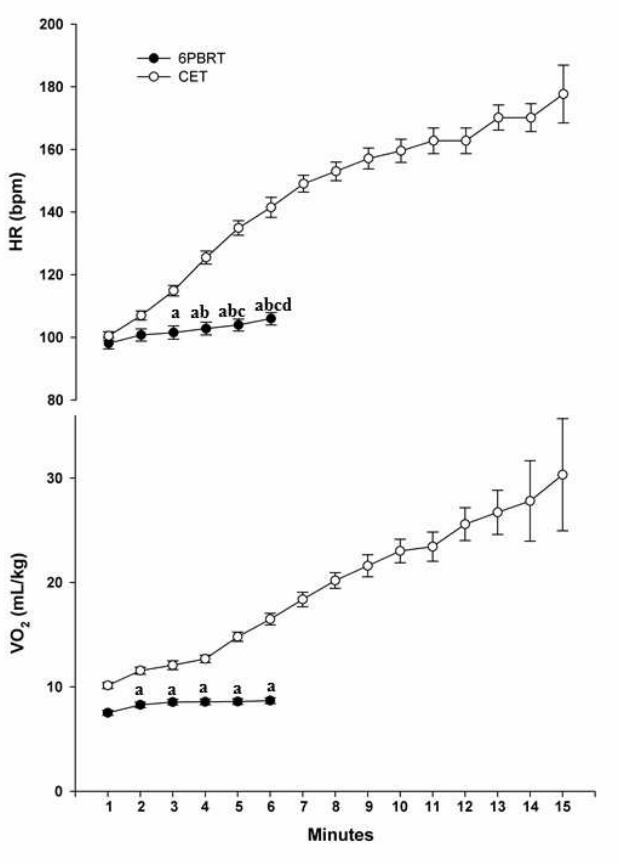

Figure 2. HR and VO_2 behavior during 6PBRT and CPET.

a: p<0.05 when compared to minute 1; b: p<0,05 when compared to minute 2; c: p<0.05 when compared to minute 3; d: p<0.05 when compared to minute 4.

Table 1 Demographic and anthropometric characteristics of the participants.

Characteristics	**All participants (n=66)**
Sex, n (%)	
Female	38 (57.6)
Male	28 (42.4)
Age, mean (SD)	25.27 (4.78)
Weight (kg), mean (SD)	68.07 (15.57)
Heigth (m), mean (SD)	1.68 (0.08)
BMI (kg/m^2), n (%)	
Underweight	03 (4.5)
Normal weight	38 (57.6)
Overweight	25 (37.9)
Lean mass (kg/m^2), mean (SD)	45.48 (11.83)
Fat mass (kg/m^2), mean (SD)	19.24 (8.42)
Level of physical activity, n (%)	
Sedentary	07 (10.6)
Insufficiently active	26 (39.4)
Active enough	33 (50.0)
Score 6PBRT, mean (SD)	508.82 (67.77)
Time CPET, mean (SD)	08:59 (2:57)

SD: Standard Deviation; BMI: body mass index; 6PBRT: 6-minute pegboard and ring test; CPET: arm isokinetic cycle ergometer maximal progressive test;

Table 2 Cardiorespiratory and metabolic outcomes measured before and after the 6-minute pegboard and cardiopulmonary exercise test arm cycle ergometer.

Parameters	VO_2 Peak (ml.kg.min)	$\%VO_{2max}$	HR Mean (bpm)	$\%HR_{max}$	R	METS	Borg Scale (Fatigue)	Borg Scale (Dyspnea)	Intensity
Baseline CPET	5.72±1.02	---------	83.45±11.10	---------	---------	--------	0.5±1.2	0.5+0.9	--------
Baseline 6PBRT	5.83±1.11	---------	80.97±11.14	---------	---------	--------	0.9±1.4	0.5±0.9	--------
Post CPET	23.5±6.1*#	100*#	162.9±16.3*#	100*#	0.93 (0.10) *#	3.95±1.17*#	7.0±2.0*#	2.3±2.2*	Maximal
Post 6PBRT	11.1±2.7*	47.2*	106.6+16.3*	65.9*	0.82 (0.12) *	2.39±0.56*	4.8±2.6*	2.3±2.2*	Moderate

Data were described as mean±standard deviation.*significantly different from baseline and # significantly different from CPET and 6PBRT ($p<0.05$).
SD: Standard Deviation; 6PBRT: 6-minute pegboard and ring test; CPET: cardiopulmonary exercise test arm cycle ergometer; HR: heart rate; VO_2max - maximum oxygen uptake.

Table 3 Pearson correlation coefficient between variables number of rings moved.

Variables	Number of rings moved in 6PBRT	
	r	**p-value**
VO_2 mean	0.268	0.030*
VO_2 peak	0.247	0.046*
HR mean	0.173	0.165
HR peak	0.183	0.141
BMI (kg/m^2)	-0.301	0.014*
Body fat (%)	-0.329	0.007*
Fat mass (kg/m^2)	-0.427	0.001*
Lean mass (kg/m^2)	-0.127	0.311
Level of physical activity	0.232	0.060
Handgrip strength	-0.047	0.711
Handgrip endurance	0.237	0.054*

*p-value <0.05

r: Correlation coefficient; 6PBRT: 6-minute Pegboard and Ring Test; VO_2: oxygen uptake; HR: heart rate; BMI: body mass index.

ANEXOS

ANEXO A- NORMAS DA REVISTA ANNALS OF PHYSICAL AND REHABILITATION MEDICINE

ANNALS OF PHYSICAL AND REHABILITATION MEDICINE

AUTHOR INFORMATION PACK

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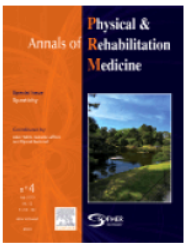

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Annals of Physical and Rehabilitation Medicine (APRM) is a scientific journal created in 2009 from the existing Annales de Réadaptation et de Médecine Physique. It is published in English and covers all fields and aspects of Physical Medicine and Rehabilitation, from basic, to medical and social sciences related to rehabilitation.

Annals of Physical and Rehabilitation Medicine is published in association with the International Society of Physical and Rehabilitation Medicine (ISPRM). In addition, it is one of the Official journals of the Physical and Rehabilitation Medicine section of the European Union of Medical Specialists (UEMS) and is the official organ of the **S**ociété **F**rançaise de **M**édecine **P**hysique et de **R**édaptation (SOFMER). The Journal is indexed in **MEDLINE**. SCImago Journal Rank (SJR) covers the journal, **which is ranked in the second quartile of the 'Rehabilitation' category as well as the 'Orthopaedics and Sports Medicine' category.** SJR indicators for APRM are improving regularly. Also increasing is the number of citations per document recently published in the journal.

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[1] Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. J Sci Commun 2010;163:51–9. https://doi.org/10.1016/j.Sc.2010.00372.
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[2] Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. Heliyon. 2018;19:e00205. https://doi.org/10.1016/j.heliyon.2018.e00205
Reference to a book:
[3] Strunk Jr W, White EB. The elements of style. 4th ed. New York: Longman; 2000.
Reference to a chapter in an edited book:

[4] Mettam GR, Adams LB. How to prepare an electronic version of your article. In: Jones BS, Smith RZ, editors. Introduction to the electronic age, New York: E-Publishing Inc; 2009, p. 281–304.
Reference to a website:
[5] Cancer Research UK. Cancer statistics reports for the UK, http://www.cancerresearchuk.org/aboutcancer/statistics/cancerstatsreport/; 2003 [accessed 13 March 2003].
Reference to a dataset:
[dataset] [6] Oguro M, Imahiro S, Saito S, Nakashizuka T. Mortality data for Japanese oak wilt disease and surrounding forest compositions, Mendeley Data, v1; 2015. https://doi.org/10.17632/xwj98nb39r.1.
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ANEXO B- COMPROVANTE DE APROVAÇÃO DO COMITÊ DE ÉTICA EM PESQUISA

cep comitê de ética em pesquisa

UNIVERSIDADE FEDERAL DOS VALES DO JEQUITINHONHA E MUCURI

Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: CARACTERIZAÇÃO DA DEMANDA METABÓLICA DO TESTE 6-MINUTE PEGBOARD AND RING TEST (6PBRT) EM INDIVÍDUOS SAUDÁVEIS

Pesquisador: Vanessa Pereira de Lima

Área Temática:

Versão: 2

CAAE: 82035317.9.0000.5108

Instituição Proponente: Universidade Federal dos Vales do Jequitinhonha e Mucuri

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 2.485.473

Apresentação do Projeto:

Trata-se de um projeto da pesquisadora Vanessa Lima, que propõe caracterizar a demanda metabólica de indivíduos saudáveis através do teste 6-minute Pegboard and Ring Test (6PBR). Será realizado um estudo transversal com 52 indivíduos recrutados por conveniência. O estudo terá duração de vinte e quatro meses. Serão avaliadas inicialmente os dados demográficos, nível de atividade e composição corporal dos voluntários. Em seguida será realizado um teste de força manual e então será avaliada a demanda metabólica exigida pelos testes, 6PBRT e cicloergômetro isocinético de com análise direta de gases respiratórios e monitoração dos sinais vitais.

Objetivo da Pesquisa:

Objetivo Primário:

Caracterizar a demanda metabólica do teste 6PBRT em indivíduos saudáveis.

Objetivo Secundário:

• Correlacionar as respostas metabólicas durante o 6PBRT e o teste de rampa no cicloergômetro isocinético para MMSS, a fim de classificar a intensidade do referido teste de campo.

• Analisar a associação entre força e os resultados dos testes de MMSS.

Endereço: Rodovia MGT 367 - Km 583, nº 5000
Bairro: Alto da Jacuba **CEP:** 39.100-000
UF: MG **Município:** DIAMANTINA
Telefone: (38)3532-1240 **Fax:** (38)3532-1200 **E-mail:** cep@ufvjm.edu.br

• Avaliar a associação entre endurance muscular e os resultados dos testes de MMSS.
• Desenvolver uma equação de regressão para a predição do consumo de VO2pico para MMSS pelo 6PBRT em sujeitos saudáveis.

Avaliação dos Riscos e Benefícios:

Riscos:

Os procedimentos e testes realizados envolvem riscos inerentes à prática, uma vez que os voluntários realizarão um teste máximo para MMSS, e após a realização do mesmo, poderá sentir tonturas, dispneia, cansaço intenso e fadiga muscular dos membros superiores. Entretanto, tais sintomas são minimizados com o repouso após a realização do teste. Para recuperação os mesmos serão orientados a permanecerem sentados, mantendo-se a frequência respiratória em padrão fisiológico. Ao início e final dos testes medidas de monitoramento da PA, SpO2, FC serão avaliadas afim de controlar e amenizar qualquer risco, e ainda estará disponível com os avaliadores o número do serviço de urgência para eventuais ocorrências. A pesquisa será imediatamente interrompida caso o participante deseje e manifeste sua intenção, sem qualquer prejuízo para o mesmo. Além disso, os testes serão aplicados por profissionais de Educação Física e Fisioterapeutas devidamente treinados, e os voluntários devem estar enquadrados em baixo risco segundo as Diretrizes do American College of Sports Medicine (ACSM, 2003).

Benefícios:

Os benefícios decorrentes da realização deste projeto para os voluntários incluem: avaliação detalhada da composição corporal bem como de sua capacidade de realizar os testes propostos. O presente projeto terá maiores benefícios para a população, e comunidade científica, uma vez que as análises encontradas, o teste poderá ser utilizado como forma de tratamento e/ou avaliação em diferentes populações.

Comentários e Considerações sobre a Pesquisa:

A população alvo deste estudo será composta voluntários saudáveis, de ambos os sexos, recrutados por conveniência, por meio de convite verbal, virtual (e-mail; chamada pública) e por meios de comunicação (folhetos). Aqueles que atenderem aos pré-requisitos de participação, considerando-se os critérios de inclusão, serão convidados a assinarem o Termo de Consentimento Livre e Esclarecido- TCLE (APÊNDICE B). Após a concordância dos voluntários em participar do estudo, será atribuído aos participantes um número de identificação que será utilizado durante todo o período do estudo. Documentos que contêm informações de identificação

serão mantidos em um armário trancado na UFVJM, em uma sala diferente daquela em que se encontram todas as outras folhas de dados. Após serem coletados os dados o número de identificação será incluído e serão inseridos eletronicamente em uma planilha de Excel. Inicialmente serão coletados dados demográficos (Idade; sexo; escolaridade; raça; estado civil) , análise da composição corporal, avaliação da força muscular de preensão manual e o nível de atividade física dos voluntários. Em seguida serão feitos dois testes funcionais: 6PBRT e cicloergômetro isocinético de MMSS, com análise direta de gases respiratórios. Antes e após a realização dos testes funcionais serão feitas medidas de monitoração dos sinais vitais. Para isso cada voluntário deverá comparecer ao LAFIEX para realização dos testes em dois dias distintos com intervalo de 24 horas entre eles, onde os testes e procedimentos serão realizados.
Inicialmente será testada a normalidade dos dados através do teste de Kolmogorov–Smirnov e as diferenças entre as variáveis medidas serão determinadas pelo teste t pareado para variáveis com distribuição normal ou o teste de Wilcoxon para variáveis com distribuição não normal. Em seguida será feita análise de correlação entre os escores obtidos no 6PBRT com os dados demográficos, composição corporal, força de preensão palmar, endurance (avaliado pelo preensão palmar), nível de atividade física, idade e VO2pico de MMSS para avaliar associações bivariadas. A partir da análise de correlação selecionaremos as variáveis que serão incluídas no modelo de regressão. O critério para inclusão será baseado no valor de $p < 0,05$ e para exclusão, $p > 0,10$. Construiremos a partir desta análise pelo método stepwise o modelo de regressão. Os modelos finais serão determinados a partir do coeficiente de determinação ajustado (R2) e significância estatística. Os resultados são apresentados como média e desvio padrão, salvo indicação em contrário. Para a análise dos dados será utilizado o programa Statistical Package for the Social Sciences (SPSS) for Windows versão 22.0.

Considerações sobre os Termos de apresentação obrigatória:

- Foram apresentados todos os termos de apresentação obrigatória.

A carta da Instituição Co-partícipe foi apresentada conforme Resolução 466/12.

Recomendações:

- Segundo a Carta Circular nº. 003/2011/CONEP/CNS, de 21/03/11, há obrigatoriedade de rubrica em todas as páginas do TCLE pelo sujeito de pesquisa ou seu responsável e pelo pesquisador, que deverá também apor sua assinatura na última página do referido termo.

ANEXO C- QUESTIONÁRIO DE ATIVIDADE FÍSICA- ACTIVE AUSTRÁLIA

1) NA **ÚLTIMA SEMANA**, quantas vezes você caminhou sem parar, por pelo menos 10 minutos, como diversão, exercício ou para ir ou voltar de algum lugar?

☐ Dias por semana

2) Qual o tempo total estimado que você passou andando dessa maneira no **ÚLTIMA SEMANA**?

☐ Horas ☐ Minutos

3) NA **ÚLTIMA SEMANA**, quantas vezes você fez alguma atividade vigorosa como jardinagem ou algum outro trabalho pesado no seu quintal que tenha feito você respirar mais forte ou ficar ofegante?

☐ Dias por semana

4) Qual o tempo total estimado que você gastou fazendo jardinagem vigorosa ou trabalho pesado ao redor do quintal na **ÚLTIMA SEMANA**?

☐ Horas ☐ Minutos

5) NA **ÚLTIMA SEMANA**, quantas vezes você fez atividades físicas vigorosas que tenham feito você respirar mais forte ou ofegante? (exe.: corrida, ginástica, futebol, subir ou descer escadas ou ladeiras)

☐ Dias por semana

6) Qual o tempo total estimado que você gastou fazendo atividade vigoroso na **ÚLTIMA SEMANA**?

☐ Horas ☐ Minutos

7) NA **ÚLTIMA SEMANA**, quantas vezes você fez atividades físicas moderadas que você ainda não falou? (exe.: dança de salão, hidroginástica, limpeza de garagem ou calçada, cuidar de crianças ou idosos e atividades religiosas de pé).

☐ Dias por semana

8) Qual o tempo total estimado que você gastou fazendo essas atividades na **ÚLTIMA SEMANA**?

☐ Horas ☐ Minutos

APENDICES

APENDICE A – CONVITE PARA PARTICIPAÇÃO NO ESTUDO

APENDICE B- TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO (TCLE)

Você está sendo convidado (a) a participar de uma pesquisa intitulada: "**Caracterização da demanda metabólica do teste *6-minute pegboard and ring test* (6PBRT) em indivíduos saudáveis**", coordenada pela Professora Dr. Vanessa Pereira de Lima e pela mestranda Alenice Aliane Fonseca.

Você foi selecionado (a) para participar deste estudo pelo fato de ter mais de 18 anos de idade, e não ter nenhum histórico de doença cardíaca sintomática, neurológica, ortopédica, respiratória, e endócrina, problemas musculoesqueléticos ou dificuldade de visão.

A sua participação não é obrigatória sendo que, a qualquer momento da pesquisa, você poderá desistir e retirar seu consentimento. Sua recusa não trará nenhum prejuízo para sua relação com o pesquisador ou com a UFVJM, ou com a Clínica Escola de Fisioterapia.

Os objetivos desta pesquisa são: Caracterizar a demanda metabólica do teste do teste *6-minute pegboard and ring test* (6PBRT) em indivíduos saudáveis; correlacionar as respostas metabólicas durante o 6PBRT e o teste de rampa no cicloergômetro isocinético para MMSS. Além disso avaliar a relação entre os resultados dos testes de MMSS com a idade, nível de atividade física e força de preensão manual.

Caso você decida aceitar o convite, você deverá comparecer em dois dias no Laboratório de Fisiologia do Exercício da UFVJM onde será submetido (a) aos seguintes procedimentos:

Inicialmente serão feitas perguntas a respeito dos seus dados pessoais, em seguida será aplicado um questionário de atividade física, que tem como objetivo avaliar o seu nível de atividade física. Feito isso, faremos uma avaliação da composição corporal, onde através de aparelho chamado DEXA, serão avaliados a massa corporal total, massa gorda (gordura), massa magra e a densidade mineral óssea, e a sua estatura será medida através de um estadiômetro. Você será avaliado (a) trajando roupas leves, sem o uso de qualquer objeto de metal que possa interferir nas medidas e será orientado (a) a se manter em silêncio e realizar o mínimo de movimentos possíveis enquanto o aparelho realiza o escaneamento corporal e determina a composição corporal, esse aparelho não gera nenhuma dor ou desconforto.

Em seguida será feito um teste de força de pressão manual, onde você deverá permanecer sentado (a) com os pés apoiados no chão, ombro aduzido e em rotação neutra e o cotovelo a 90º. O antebraço e punho em posição neutra, sendo permitida leve extensão de punho (até 30º), segurando um dinamômetro. Você pressionará o aparelho numa sequência de

três vezes com intervalo de um minuto entre as medidas, em seguida manter pressionado o aparelho o maior tempo possível.

Posteriormente você será instruído a sentar-se em uma cadeira, permanecendo em repouso durante 10 minutos, em seguida serão avaliados a sua pressão arterial, frequência cardíaca e saturação periférica de oxigênio. Em seguida você será conduzido até uma câmara ambiental, onde realizará dois testes de avaliação pulmonar (6PBRT e teste máximo em um cicloergômetro isocinético de MMSS), sendo a ordem da realização feita através de uma randomização (sorteio), com um intervalo de 30 minutos entre cada teste. Para o 6PBRT', você deverá permanecer sentado (a) em frente a um quadro de madeira, contendo dois pinos posicionados na altura de seu ombro e outros dois pinos colocados 20 cm acima do nível do ombro. Dez argolas estarão postas em cada um dos dois pinos inferiores. Usando ambas as mãos simultaneamente você deverá mover uma argola de cada vez, deslocando-as do pino inferior para o superior e vice-versa durante 6 minutos. Durante o teste você poderá parar para descansar por motivo de fadiga, dispneia ou outro desconforto e voltar a realizar o teste assim que se sentir mais confortável. No teste do cicloergômetro você será posicionado em uma cadeira, com as costas apoiadas, pés apoiados no chão e tronco estabilizado de modo que o eixo de rotação da articulação gleno-umeral esteja no mesmo nível que o eixo do braço da manivela do cicloergômetro. Em seguida você será instruído a realizar pedalamentos no aparelho para um aquecimento de dois minutos sem carga, em seguida a cada minuto será acrescentado uma carga adicional e você deverá manter uma frequência de 60 pedalamentos por minuto, até a interrupção do exercício por exaustão ou pela incapacidade de manter o mínimo de pedalamentos.

Ao final de cada teste as medidas de pressão arterial, frequência cardíaca e saturação de oxigênio serão novamente medidas. Para ambas as avaliações você deverá utilizar roupas leves (short, tênis e camiseta) e será orientado (a) a evitar prática de atividade extenuante e de longa duração, além de não ingerir bebidas alcoólicas e cafeína nas 24 horas antecedentes ao teste, dormir no mínimo oito horas na noite anterior, realizar uma refeição leve e ingerir 500 ml de água duas horas antes do teste.

O tempo previsto para a sua participação é de aproximadamente duas horas.

Os riscos relacionados com sua participação são: Os procedimentos e testes realizados envolvem riscos inerentes à prática, uma vez que você realizará um teste máximo para

MMSS, e após a realização do mesmo, poderá sentir tonturas, dispneia, cansaço intenso e fadiga muscular dos membros superiores. Entretanto, tais sintomas são minimizados com o repouso após a realização do teste. Para recuperação você será orientado a permanecer sentado, mantendo-se a frequência respiratória em padrão fisiológico. Ao início e final dos testes medidas de monitoramento da PA, SpO2, FC serão avaliadas afim de controlar e amenizar qualquer risco, e ainda estará disponível com os avaliadores o número do serviço de urgência para eventuais ocorrências. A pesquisa será imediatamente interrompida caso você deseje e manifeste sua intenção, sem qualquer prejuízo para o mesmo. Além disso, os testes serão aplicados por profissionais de Educação Física e Fisioterapeutas devidamente treinados, e você só poderá realizar os testes se estiver baixo risco cardiovascular segundo as Diretrizes do American College of Sports Medicine.

Os benefícios decorrentes da realização desta pesquisa estão relacionados ao conhecimento de sua saúde física, através de uma avaliação detalhada de sua composição corporal, bem como de sua capacidade funcional de membros superiores.

Os resultados desta pesquisa poderão ser apresentados em seminários, congressos e similares, entretanto, os dados/informações pessoais obtidos por meio da sua participação serão confidenciais e sigilosos, não possibilitando sua identificação. Não há remuneração com sua participação, bem como a de todas as partes envolvidas. Não está previsto indenização por sua participação, mas em qualquer momento se você sofrer algum dano, comprovadamente decorrente desta pesquisa, terá direito à indenização.

Você receberá uma cópia deste termo onde constam o telefone e o endereço do pesquisador principal, podendo tirar suas dúvidas sobre o projeto e sobre sua participação agora ou em qualquer momento.

Coordenadora do Projeto: Vanessa Pereira de Lima
Endereço: Clínica Escola de Fisioterapia. Rodovia MGT 367 - Km 583 - nº 5000 -
Alto da Jacuba – Diamantina/MG CEP39100000
Telefone: (38) 3532-1239 (38) 99103-4886

Declaro que entendi os objetivos, a forma de minha participação, riscos e benefícios dos mesmos e aceito o convite para participar. Autorizo a publicação dos resultados da pesquisa, a qual garante o anonimato e o sigilo referente à minha participação.

Nome do sujeito da pesquisa: _____

Assinatura do sujeito da pesquisa: _____

Assinatura do pesquisador: _____

Impressão do Polegar

Informações – Comitê de Ética em Pesquisa da UFVJM
Rodovia MGT 367 - Km 583 - nº 5000 - Alto da Jacuba –
Diamantina/MG CEP39100000
Tel.: (38)3532-1240 –
Coordenador: Prof. Disney Oliver Sivieri Junior
Secretária: Ana Flávia De Abreu
Email: cep.secretaria@ufvjm.edu.br e/ou cep@ufvjm.edu.br.

APÊNDICE C- FICHA DE AVALIAÇÃO/IDENTIFICAÇÃO

FICHA DE IDENTIFICAÇÃO	
Nome do voluntário: _____ Identificação (Analisador de Gases): _____	
Ordem da randomização: _____/_____	Data do teste: ___/____/_____
Telefone: ( ) _____._____	
Data de nascimento: ____/____/_____ Idade: _____	Sexo: ( ) Masculino ( ) Feminino

Estado Civil:	( ) Solteiro ( ) Casado ( ) Viúvo ( ) Divorciado ( ) Outro
Escolaridade:	( ) Ensino Fundamental ( ) Ensino Médio ( ) Ensino técnico ( ) Ensino Superior
Raça:	( ) Branco ( ) Pardo ( ) Preto ( ) Amarelo ( ) Outra

Peso	
Altura	
Dexa	

TESTE 1

6-MINUTE PEGBOARD AND RING TEST -6PBRT					
PRÉ-TESTE Sinais Vitais	**FC (Bpm)**	**PA**		**ESCALA DE BORG**	
		Sistólica	**Diastólica**	**Dispneia**	**Cansaço**

TESTE	**Nº de anéis movidos**					
	Nº descanso					
Frequência Cardíaca	**1 min**	**2 min**	**3 min**	**4 min**	**5 min**	**6 min**

PÓS-TESTE Sinais Vitais	**FC (Bpm)**	**PA**		**ESCALA DE BORG**	
		Sistólica	**Diastólica**	**Dispneia**	**Cansaço**

ANÁLISADOR DE GASES- K4B2	
Início do teste	
Término do teste	

TESTE 2

6-MINUTE PEGBOARD AND RING TEST -6PBRT					
PRÉ-TESTE Sinais Vitais	**FC (Bpm)**	**PA**		**ESCALA DE BORG**	
		Sistólica	**Diastólica**	**Dispneia**	**Cansaço**

TESTE	**Nº de anéis movidos**					
	Nº descanso					
Frequência Cardíaca	**1 min**	**2 min**	**3 min**	**4 min**	**5 min**	**6 min**

PÓS-TESTE Sinais Vitais	**FC (Bpm)**	**PA**		**ESCALA DE BORG**	
		Sistólica	**Diastólica**	**Dispneia**	**Cansaço**

ANÁLISADOR DE GASES- K4B2	
Início do teste	
Término do teste	

CICLOERGÔMETRO ISOCINÉTICO DE MMSS					
PRÉ-TESTE Sinais Vitais	**FC (Bpm)**	**PA**		**ESCALA DE BORG**	
		Sistólica	**Diastólica**	**Dispneia**	**Cansaço**

Cargas adicionadas (w)	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**	**105**		
Tempo de teste	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**		
Duração total do teste													
Frequência Cardíaca													

CICLOERGÔMETRO ISOCINÉTICO DE MMSS					
PÓS-TESTE Sinais Vitais	**FC (Bpm)**	**PA**		**ESCALA DE BORG**	
		Sistólica	**Diastólica**	**Dispneia**	**Cansaço**

ANÁLISADOR DE GASES- K4	
Início do teste	
Término do teste	