GIANNA KELREN WALDRICH BISCA RECHE

AVALIAÇÃO DA CAPACIDADE FUNCIONAL EM PACIENTES COM DPOC:

REVISÃO DA LITERATURA SOBRE TESTES FUNCIONAIS DE MEMBROS INFERIORES, CONFIABILIDADE DO CRONÔMETRO NO REGISTRO DA VELOCIDADE DE MARCHA E UTILIZAÇÃO DO TESTE *4-METRE GAIT SPEED* PARA PRESCRIÇÃO DE EXERCÍCIO FÍSICO

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Tese apresentada ao Programa de Pós-Graduação em Ciências da Reabilitação (Programa Associado entre Universidade Estadual de Londrina [UEL] e Universidade Norte do Paraná [UNOPAR]), apresentada à UEL, como requisito parcial para a obtenção do título de Doutor em Ciências da Reabilitação.

Orientador: Prof. Dr. Fabio de Oliveira Pitta

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Londrina, 30 de setembro de 2016.

Dedico este trabalho à minha familia, que pelo seu apoio e amor, sempre me incentivaram a crescer profissionalmente.

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“Aos outros, dou o direito de ser como são. A mim, dou o dever de ser cada dia melhor.”

(Chico Xavier)

RECHE, Gianna Kelren Waldrich Bisca. **Avaliação da capacidade funcional em pacientes com DPOC:** revisão da literatura sobre testes funcionais de membros inferiores, confiabilidade do cronômetro no registro da velocidade de marcha e utilização do teste *4-metre gait speed* para prescrição de exercício. 2016. 166 f. Tese (Doutorado em Ciências da Reabilitação) – Programa Associado entre UEL e UNOPAR – Universidade Estadual de Londrina, Londrina, 2016.

RESUMO

Introdução: Testes funcionais, tais como velocidade de marcha, *timed Up and Go* (TUG), *sit-to-stand* (STS) e teste do degrau, ganharam popularidade tanto em pesquisa quanto na prática clínica nos últimos anos, visto que avaliam a capacidade funcional de pacientes com doença pulmonar obstrutiva crônica (DPOC) de maneira prática, rápida e com menor custo. Entretanto, as propriedades de medida dos diferentes protocolos de teste, aspectos técnicos e a utilização dos mesmos na prescrição de exercício ainda não foram solidamente estabelecidos. A presente tese de doutorado foi então desenvolvida com o intuito de se aprofundar sobre a utilização de testes funcionais em pacientes com DPOC, e assim contribuir com as evidências científicas relacionadas à avaliação funcional desses pacientes. **Métodos:** Três estudos foram desenvolvidos, sendo um artigo de revisão sistemática da literatura e dois artigos originais. A revisão sistemática (1) avaliou as características e evidências disponíveis sobre as propriedades de medida dos testes de velocidade da marcha, *timed Up and Go* (TUG), *sit-to-stand* (STS) e teste do degrau; investigou a relação entre esses testes e alguns desfechos clínicos importantes na DPOC; e ainda viabilizou recomendações para a prática clínica e para pesquisas futuras. O artigo (2) comparou e avaliou a concordância de dois métodos (cronômetro e vídeo) que registram o tempo de realização do teste velocidade de marcha em 4 metros (ou *4-metre gait speed*, 4MGS) em pacientes com DPOC, e avaliou a concordância entre dois avaliadores que realizaram a mensuração do tempo apenas com cronômetro. No artigo (3) foi avaliada a eficácia do teste 4MGS na prescrição da intensidade de exercício físico e para predizer a distância percorrida no teste da caminhada de seis minutos (TC6min) bem como identificar qual protocolo do teste melhor estima esses resultados em pacientes com DPOC. **Resultados:** O estudo (1) concluiu que testes funcionais simples de membros inferiores revelam informações sobre desfechos clínicos importantes em pacientes com DPOC. Os testes 4MGS; 5 repetições do movimento de levantar e sentar e o teste do degrau de 6 minutos (TD6) apresentam as propriedades psicométricas mais bem estabelecidas quando comparados aos outros testes, enquanto as propriedades do TUG precisam ser melhor estudadas. O estudo (2) mostrou que o cronômetro apresentou resultado semelhante ao método critério (vídeo) e excelente concordância com ele em todos os protocolos do 4MGS testados. Adicionalmente, quando o cronômetro foi utilizado por dois avaliadores independentes, verificou-se excelente concordância entre eles. Como resultado do estudo (3), o 4MGS realizado com velocidade máxima em um corredor de 8 metros predisse melhor a intensidade do exercício, com um coeficiente de determinação R^2 = 0,46. **Conclusão:** Testes funcionais podem ser utilizados na prática clínica para avaliar a capacidade funcional em pacientes com DPOC. Os testes 4MGS, 5STS, TUG e TD6 são bem tolerados pelos pacientes, práticos e viáveis, considerando o

tempo, espaço e recursos disponíveis. Além disso, refletem desfechos clínicos importantes na DPOC de morbimortalidade, hospitalizações, quedas, capacidade de exercício e qualidade de vida. Para a avaliação do tempo gasto no 4MGS, o uso do cronômetro mostrou-se confiável, ampliando a possibilidade de uso do teste na prática profissional. Por fim, a utilidade clínica do 4MGS pode ser maior do que previamente esperado, uma vez que todos os protocolos do teste se correlacionaram com o TC6min e o protocolo do 4MGS realizado com velocidade máxima em um corredor de 8 metros provou ser a melhor opção para a prescrição da intensidade do exercício para pacientes com DPOC moderada a muito grave.

Palavras-chave: Doença pulmonar obstrutiva crônica. Atividade motora. Exercício. Equipamentos e provisões.

RECHE, Gianna Kelren Waldrich Bisca. **Assessment of functional capacity in patients with COPD:** literature review on lower limbs functional tests, stopwatch reliability for gait speed and use of the 4-meter gait speed test for exercise prescription. 2016. 166 p. Thesis (Doctorate degree in Rehabilitation Sciences) – Universidade Estadual de Londrina, Londrina, 2016.

ABSTRACT

Introduction: Functional tests, such as walking speed, timed Up and Go (TUG), sit-to-stand (STS) and step test, have gained popularity in recent years both in research and in clinical practice, as they assess functional capacity of patients with chronic obstructive pulmonary disease (COPD) in a practical, feasible and less costly way. However, the measurement properties of different tests protocols, technical aspects and use of these tests for exercise prescription were not yet solidly established. This thesis was then developed in order to further study the use of functional tests in patients with COPD, and thus contribute to the scientific evidence related to functional assessment of these patients. **Methods:** Three studies were developed: a systematic review of the literature and two original articles. The systematic review (1) evaluated the characteristics and available evidence on the measurement properties of gait speed test, timed Up and Go (TUG), sit-to-stand (STS) and step test; we investigated the relationship between these tests and some important clinical outcomes in COPD; and also some feasible recommendations for clinical practice and future research were pointed. Article (2) compared and evaluated the agreement of two timing methods (stopwatch and video recording) which record the time of completion of the 4-metre gait speed test(4MGS) in patients with COPD; and evaluated the correlation between two observers who simultaneously timed the test using a stopwatch. In article (3), we investigated the efficacy of 4MGS test to prescribe high-intensity exercise and to predict the distance walked in the six-minute walk test (6MWT) and moreover, we identified which test protocol better estimates these results in patients with COPD. **Results:** Study (1) found that simple lower limbs functional tests inform some clinical outcomes in patients with COPD. The 4MGS test; 5 repetitions of sitting and standing movement, and the 6-minute step test (TD6) present the more established psychometric properties compared to other tests, while the TUG properties need to be further studied. Study (2) showed that the stopwatch was similar to the criterion method (video) and showed excellent agreement with it in all 4MGS studied protocols. Additionally, when the stopwatch was used by two independent observers, there was excellent agreement between them. As a result of study (3), the 4MGS performed with maximum speed in a corridor of 8 meters predicts better exercise intensity, with a coefficient of determination of R^2 = 0.46. **Conclusion:** Simple tests can be used in clinical practice to evaluate lower limb functional capacity in patients with COPD. The 4MGS, 5STS tests, TUG and TD6 are well tolerated by patients, as well as practical and feasible, considering time, space and available resources. Furthermore, these tests can inform clinicians about important outcomes in COPD, such as morbidity, mortality, hospitalizations, falls, exercise capacity and quality of life. The stopwatch was reliable as a timing method in the 4MGS, improving the applicability of this test in clinical practice. Finally, the clinical usefulness of the 4MGS may be greater than previously expected, since all the test protocols correlated with the 6MWT and the 4MGS protocol carried out at

maximum speed in a corridor 8 meters proved to be the best option at exercise prescription for patients with moderate to very severe COPD.

Key-words: Pulmonary disease. Chronic obstructive. Motor activity. Exercise. Equipment and supplies.

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LISTA DE ABREVIATURAS E SIGLAS

10MGS	*10-meter gait speed*
30MGS	*30-minute gait speed*
30STS	*30 seconds sit to stand test*
3CRT	*Semipaced 3-minute chair rise test*
4MGS	*4-metre gait speed*
5STS	*Five repetitions of sit to stand test*
6MST	*Six-minute step test*
6MWT	*Six-minute walk test*
ADO	*Age Dyspnea Obstruction index*
AUC	*Area under the curve*
ACSM	*American College of Sports Medicine*
BODE	*Body mass-Index, airflow Obstruction, Dyspnea and Exercise capacity*
CHF	*Chronic heart failure*
COPD	*Chronic obstructive pulmonary disease*
COSMIN	*Consensus-based Standards for the Selection of Health Status Measurement Instruments*
CST	*Chester step test*
CPET	*Cardiopulmonary exercise test*
CPT	Capacidade pulmonar total
CRF	*Chronic renal failure*
CRQ	*Chronic respiratory questionnaire*
CVF	Capacidade vital forçada
DALY	*Disability-adjusted life year*
DLCO	Capacidade de difusão do monóxido de carbono
DPOC	Doença Pulmonar Obstrutiva Crônica
ES	*Effect size*
FC	Frequência Cardíaca
FEV_1	*Forced expiratory volume in 1 second*
FVC	*Forced vital capacity*
GS	*Gait speed*
GOLD	*Global Initiative for Chronic Obstructive Lung Disease*
ICC	*Intraclass correlation coefficient*

IMC	Índice de massa corpórea
IST	*Incremental step test*
ISWT	*Incremental shuttle walk test*
LTOT	*Long-term oxygen therapy*
MID	*Minimal important difference*
MRC	*Medical Research Council*
MRCm	*Medical Research Council* modificada
OMS	Organização Mundial da Saúde
NA	*Not available*
Pab	Pressão Abdominal
PADL	*Physical activity in daily life*
PAL	*Physical activity level*
Palv	Pressão Alveolar
PaO_2	Pressão parcial de oxigênio no sangue arterial
PEEP	Pressão Expiratória Final Positiva
pH	Potencial hidrogeniônico sanguíneo
Ppl	Pressão Pleural
PR	*Pulmonary rehabilitation*
PRISMA	*Parameters of the Preferred Reporting Items for Systematic reviews and Meta-Analyses*
PST	*Paced step test*
QMVC	*Quadriceps maximum voluntary contraction*
r	Coeficiente de correlação linear
r^2	Coeficiente de determinação
ROC	*Receiver operating characteristic*
RP	Reabilitação pulmonar
SEM	*Standard Error of Measurement*
SGRQ	*Saint George Respiratory Questionnaire*
STS	*Sit to Stand*
TC6min	Teste da Caminhada de 6 minutos
TCPE	Teste cardiopulmonar de esforço
TD	Teste do Degrau
TUG	*Timed up and go*
VCO_2	Produção de CO_2

VD	Ventrículo Direito
V_D/V_T	Espaço morto/Volume corrente
VE	Ventilação minuto
VEF_1	Volume Expiratório Forçado em 1 segundo
VO_2	Consumo de oxigênio
VO_2max	Consumo máximo de oxigênio

SUMÁRIO

1. INTRODUÇÃO

Nos dias de hoje, a maioria das pessoas pode esperar viver 60 anos ou mais. No Brasil, a expectativa de vida aumentou significativamente e estima-se que uma criança nascida hoje possa viver 20 anos a mais do que um nascido há 50 anos atrás[1]. Entretanto, a qualidade desses anos adicionais pode ser comprometida pelo fato do envelhecimento estar geralmente associado a um declínio na capacidade de exercício, força muscular, equilíbrio e função pulmonar[2].

Outro importante agravante do aumento na expectativa de vida é o estabelecimento de doenças crônicas, dentre elas a doença pulmonar obstrutiva crônica (DPOC)[3]. Além da obstrução ao fluxo aéreo, pacientes com DPOC apresentam manifestações extra-pulmonares, como a disfunção muscular periférica, a intolerância ao exercício e o descondicionamento físico, as quais contribuem para a gravidade da doença[4, 5].

Tanto o envelhecimento quanto o estabelecimento da DPOC levam também a um comprometimento da capacidade funcional, ou seja, do máximo potencial para a realização de atividades diárias. Como consequência, esses pacientes apresentam limitações para a realização de atividades domésticas, de lazer, profissionais e mesmo as de cuidado pessoal[5]. Evitar ou reduzir a perda funcional em pacientes com DPOC depende, em parte, da habilidade de detectar e tratar qualquer declínio físico que possa estar associado a um pior prognóstico ou vir a ser o precursor de uma perda de função mais pronunciada.

Testes que avaliam a capacidade funcional em pacientes com DPOC, tais como *gait speed* (GS), *sit to stand* (STS), *timed up and go* (TUG) e teste do degrau (TD) ganharam popularidade nos últimos anos, tanto na prática clínica quanto no ambiente de pesquisa. Algumas razões para a crescente aplicação destes testes nesta população são sua semelhança com tarefas diárias e que envolvem movimentos simples; a execução rápida e prática; a dispensabilidade de um lugar especial para a sua execução; e ainda a utilização de apenas equipamentos simples e de baixo custo[6-10]. Entretanto, apesar da crescente popularidade, medidas de validade, reprodutibilidade, responsividade, bem como a relação destes testes com desfechos clínicos importantes em pacientes com DPOC ainda não foram solidamente estabelecidos. Além disso, a confiabilidade da utilização de um cronômetro para avaliar a velocidade de marcha e a utilização do

teste 4MGS para prescrição de exercício físico precisa ser melhor investigada. A presente tese foi então desenvolvida para elucidar essas lacunas vigentes na literatura atual.

2. REVISÃO DE LITERATURA - CONTEXTUALIZAÇÃO

2.1 DOENÇA PULMONAR OBSTRUTIVA CRÔNICA (DPOC)

A DPOC é uma das principais causas crônicas de morbidade e mortalidade em todo o mundo[5]. Segundo a Organização Mundial da Saúde (OMS), o número de pacientes acometidos por essa afecção deverá aumentar nas próximas décadas, devido à contínua exposição a fatores de risco da DPOC e também ao envelhecimento gradual da população (as pessoas vivem mais tempo e, portanto, expressam os efeitos da exposição a longo prazo aos fatores de risco da DPOC)[11]. Em 2020, a DPOC está projetada para ser a terceira principal causa de mortalidade em todo o mundo. Além disso, segundo o critério *Disability-adjusted life year* (DALY), ou seja, a soma de anos perdidos devido a mortes prematuras e de anos vividos com incapacidade, ajustados à gravidade da incapacitação, a DPOC será a sétima causa de DALY no mundo em 2030[5].

Segundo o *Global Initiative for Chronic Obstructive Lung Disease* (GOLD), a DPOC é definida como “uma doença prevenível e tratável, caracterizada por obstrução persistente, geralmente progressiva e associada a uma resposta inflamatória crônica nas vias aéreas e no pulmão, causada por partículas e gases nocivos”[5]. A resposta inflamatória crônica pode resultar em enfisema e fibrose das pequenas vias aéreas, visto que induz a destruição dos tecidos do parênquima e interrompe o reparo normal e os mecanismos de defesa do pulmão. Estas alterações patológicas levam ao aprisionamento de ar e a progressiva limitação ao fluxo aéreo, geralmente medido por meio do volume expiratório forçado em 1 segundo (VEF_1), que é utilizado como um indicador da gravidade da doença[5].

O desconforto respiratório percebido, isto é, a dispneia, aparece como um efeito dessa progressiva limitação ao fluxo aéreo e essa condição é amplificada durante o exercício físico; como consequência, dispneia aos esforços é muitas vezes, a principal queixa dos pacientes com DPOC[5, 12]. Este sintoma leva os indivíduos a reduzirem sua participação nas atividades da vida diária e, consequentemente, a um pior condicionamento físico. Os indivíduos passam a permanecer mais tempo em atividades sedentárias do que em pé ou caminhando ao longo do dia, quando comparados a indivíduos saudáveis com a mesma idade[13]. O descondicionamento, por sua vez, gera mais dispneia e o paciente torna-se cada

vez mais inativo, formando um ciclo vicioso negativo da doença.

Embora o comprometimento pulmonar seja a manifestação mais característica e primária da doença, o acometimento extrapulmonar define essa patologia como sistêmica. A limitação ao fluxo aéreo e particularmente a hiperinsuflação pulmonar comprometem a função cardíaca e a troca gasosa nesses pacientes. Os mediadores inflamatórios na circulação podem contribuir para a perda de massa muscular esquelética e caquexia, e podem ainda iniciar ou agravar comorbidades como doença isquêmica do coração, insuficiência cardíaca, osteoporose, diabetes, síndrome metabólica e depressão[4, 5]. Além disso, a capacidade de exercício é reduzida e está diretamente relacionada a um pior prognóstico da doença[14, 15].

2.2 Intolerância ao Exercício

A intolerância ao exercício é uma condição na qual o paciente é incapaz de realizar exercício físico no nível ou na duração esperada para uma pessoa com a sua idade e a sua condição física geral[16]. As causas da intolerância ao exercício, em indivíduos com DPOC, são complexas e multifatoriais, podendo resultar de alterações ventilatórias, de troca gasosa, disfunção cardíaca, anormalidades na musculatura periférica, ou ainda da combinação de qualquer um dos anteriores. Mesmo pacientes com comprometimento similar na função pulmonar podem apresentar uma ampla variação em sua capacidade de exercício, o que provavelmente reflete a patogênese complexa dessa alteração[12, 16-18].

Por meio da avaliação de capacidade de exercício, é possível informar ao paciente sobre o seu prognóstico, estimar o risco de resultados futuros e os efeitos do tratamento, ajudando-os assim a entender o que o diagnóstico de DPOC realmente significa para eles[19]. A limitação ao exercício está relacionada a uma maior utilização de recursos de saúde, hospitalizações, além de ser um importante preditor de mortalidade em pacientes com DPOC, visto que a capacidade de exercício apresenta associações mais fortes com a mortalidade do que a função pulmonar ou dispneia do indivíduo[14,15,20]. Além disso, o índice BODE (*Body Mass-Index, Airflow Obstruction, Dyspnea and Exercise Capacity*), que é um sistema multigraduado e amplamente utilizado como preditor do risco de mortalidade em

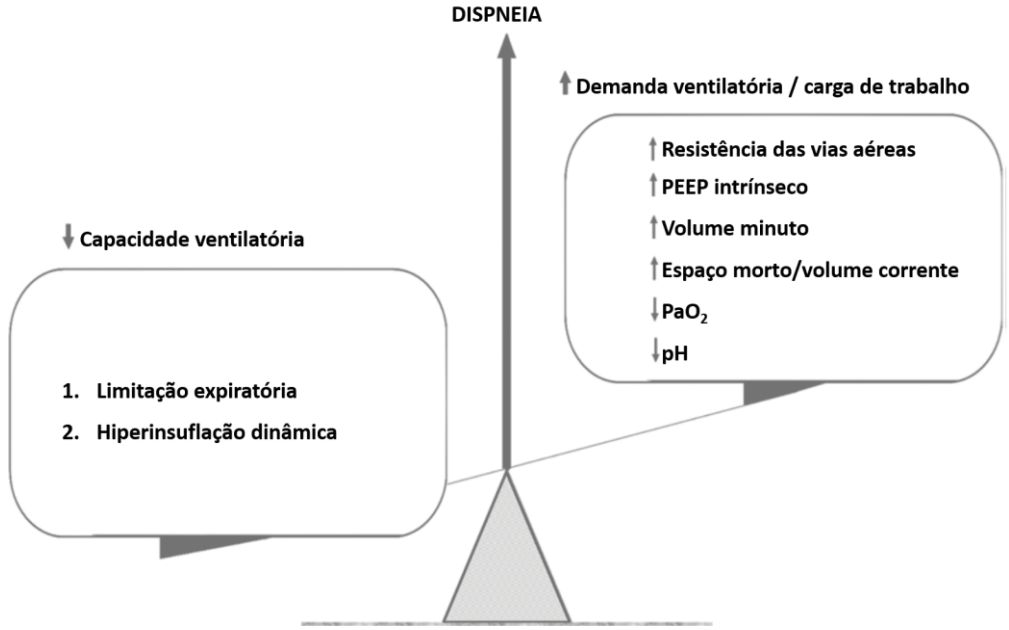
pacientes com DPOC, apresenta a capacidade de exercício como um dos seus preditores[14].

2.2.1 Fatores que Comprometem a Tolerância ao Exercício Em Indivíduos com DPOC

A realização do exercício físico depende de uma série de fatores, em que a ventilação, a troca gasosa, o fluxo de sangue, o sistema muscular e cardiovascular contribuem. Assim, a limitação não é atribuível a uma anormalidade estrutural ou funcional única, tanto em indivíduos saudáveis quanto em indivíduos pneumopatas[12, 16-18]. Identificar os fatores que estão impedindo que um paciente com DPOC realize exercício físico e suas atividades de vida diária contribui para a escolha da terapêutica mais adequada para esse paciente.

A limitação ventilatória é muitas vezes o principal contribuinte para a intolerância ao exercício, visto que a capacidade é insuficiente para corresponder à exigência ventilatória[12, 16, 18, 21] (Figura 1). Em pacientes com DPOC, tal desequilíbrio leva à sensação de dispneia intensa. Quando a exigência ventilatória aumenta, a combinação do volume de reserva expiratório aumentado e o aumento do volume corrente traz o volume pulmonar no final da inspiração mais para perto do volume máximo que pode ser inalado: a capacidade pulmonar total (CPT). Em volumes próximos a CPT, o trabalho respiratório aumenta e a sobrecarga nos receptores da parede torácica enviam sinais para o cérebro, contribuindo assim, para a sensação de dispneia[12]. Pacientes com DPOC atingem sua capacidade ventilatória máxima, enquanto a função cardíaca e outras funções fisiológicas estão operando abaixo do seu limiar[16]. Assim, a expansão excessiva resultante dos pulmões, denominada de "hiperinflação dinâmica", é uma característica regular durante o exercício nesses indivíduos e é um dos principais fatores desencadeantes da dispneia[12]. Além disso, há uma forte correlação entre índices de hiperinflação pulmonar dinâmica e medidas de dispneia e capacidade de exercício[21]. Somando-se a estas alterações, o aumento do espaço morto e a maior relação V_D/V_T (espaço morto/volume corrente), resultam em troca gasosa prejudicada, hipoxemia e hipercapnia, o que compromete ainda mais a realização de exercício físico[16, 18].

Figura 1 – Esquema que representa os mecanismos de desequilíbrio entre capacidade e demanda ventilatória. PEEP: pressão expiratória final positiva; PaO2: pressão parcial de oxigênio no sangue arterial; pH: potencial hidrogeniônico sanguíneo. Adaptado de: Vogiatzis & Zakynthinos[16].

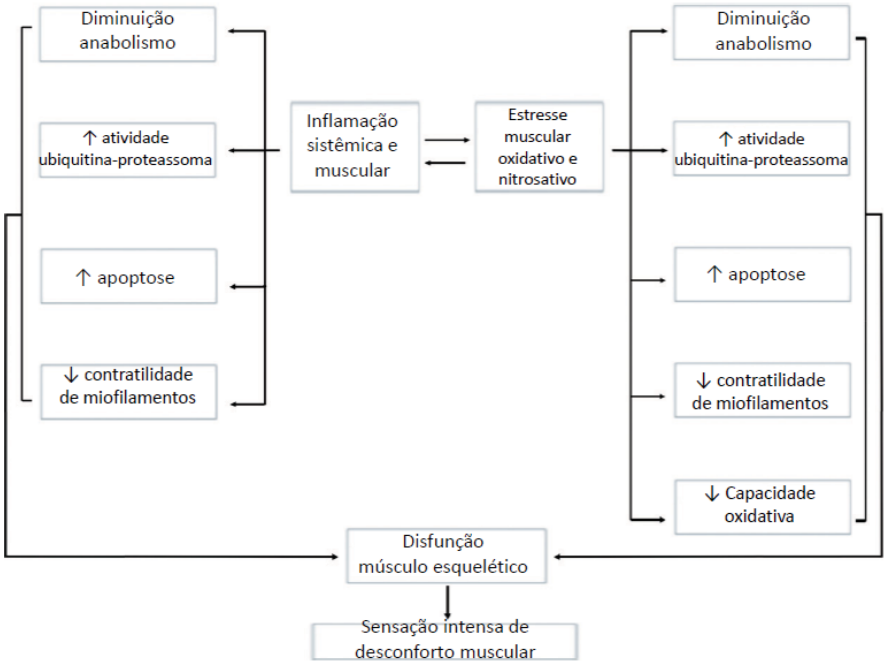


Todavia, mais de 40% dos pacientes com DPOC referem a fadiga muscular periférica como principal sintoma limitante ao esforço[17]. As anormalidades da musculatura periférica na DPOC que foram descritas incluem reduções em massa e força muscular, alterações na distribuição do tipo de fibra, disfunção mitocondrial, diminuição da capacidade oxidativa e resistência muscular reduzida. Como causas dessa alteração muscular periférica foram descritos o descondicionamento físico, estresse oxidativo, inflamação sistêmica, comprometimento nutricional, uso de corticoesteróides e envelhecimento[22, 23]. A inflamação sistêmica e/ou muscular e o estresse oxidativo podem desencadear disfunção muscular agindo sobre a mitocôndria e as propriedades dos miofilamentos (Figura 2)[16]. Consequentemente, os músculos dos membros inferiores em pacientes com doenças pulmonares crônicas estão atrofiados, fracos, fadigados e metabolicamente ineficientes. Estas características musculares desfavoráveis concorrem para limitar a capacidade de exercício nestes pacientes[16].

Os músculos respiratórios também sofrem uma sobrecarga e apresentam tanto a força quanto a resistência muscular inspiratória comprometidas, e assim, consequentemente, contribuem com a intolerância ao exercício[22]. Para um mesmo volume pulmonar, os músculos inspiratórios, em pacientes com DPOC, são

capazes de gerar mais pressão do que em um grupo controle saudável[18, 24], visto que o diafragma nesses pacientes está adaptado à sobrecarga crônica. No entanto, a hiperinflação estática e dinâmica coloca seus músculos respiratórios em desvantagem mecânica[16], o que compromete a força e a resistência muscular.

Figura 2 – Ilustração dos mecanismos relacionados à disfunção muscular periférica. Adaptado de: Vogiatzis & Zakynthinos[16].



A doença pulmonar crônica também acomete a função cardiovascular, tendo como impacto mais importante uma elevada pós-carga ventricular direita. Grande parte deste efeito é explicada pela vasoconstrição pulmonar hipóxica, que aumenta a resistência vascular pulmonar, e consequentemente sobrecarrega o ventrículo direito (VD). A hiperinsuflação dinâmica é outro agravante que atua no aumento da pós-carga de VD[18]. A hipertrofia do VD pode ainda comprometer o enchimento ventricular esquerdo, o que pode contribuir para uma diminuição ainda maior da capacidade do coração de satisfazer exigências do exercício[25]. Os pacientes com DPOC interrompem o exercício a um nível mais baixo de débito cardíaco e consumo máximo de O_2 quando comparado a indivíduos saudáveis. No entanto, a relação entre o consumo de oxigênio e o débito cardíaco é normal. Assim, a limitação ao exercício em pacientes com DPOC não é exatamente cardiovascular, mas resulta de alterações na mecânica pulmonar que afetam a ventilação[16, 25].

2.3 Avaliação da Capacidade de Exercício

A capacidade de exercício sofre reduções ao longo do tempo em pacientes com DPOC. Este declínio parece ser maior do que o observado em outras variáveis funcionais, tais como o VEF_1, o que sugere que medidas repetidas de capacidade de exercício podem ser um marcador mais sensível de mudanças do estado clínico nestes pacientes do que as medidas de função pulmonar propriamente ditas[20, 26]. Além disso, a limitação da capacidade de exercício não pode ser predita a partir de variáveis respiratórias ou demográficas[27], logo a realização de testes que mensurem a capacidade de exercício se faz necessária, tanto em pesquisa quanto na prática clínica.

2.3.1 Teste Cardiopulmonar de Esforço

O teste cardiopulmonar de esforço (TCPE) é considerado o método padrão ouro para avaliar a redução na capacidade de exercício, bem como as causas fisiológicas dessa redução. Esse teste baseia-se no princípio de que a falha do sistema (por exemplo, músculo-energético, cardiovascular ou pulmonar) ocorre enquanto o mesmo encontra-se sob estresse. Durante o TCPE, há a imposição de um exercício incremental máximo e paralelamente há o monitoramento de variáveis hemodinâmicas (frequência cardíaca – FC, pressão arterial – PA), ventilatórias (volume corrente – VC, frequência respiratória - FR, ventilação minuto – VE), metabólicas (consumo de oxigênio - VO_2, produção de CO2 pulmonar - VCO_2,) e respostas sintomatológicas (dispneia, fadiga). Além disso, conforme necessário, medidas de dessaturação de oxigênio relacionada ao exercício, hiperinflação dinâmica e força muscular periférica podem ser realizadas[28, 29].

Embora o TCPE represente uma aproximação bem menor que a ideal com a realidade das atividades de vida diária, ele fornece, de forma precisa e controlada, uma avaliação global das respostas integradas dos sistemas pulmonar, cardiovascular, hematopoiético, neuropsicológico e músculo esquelético ao exercício, que não se encontram adequadamente refletidas por meio da medição individual de cada sistema. Apesar de sua importância, o TCPE nem sempre está

disponível na rotina clínica e científica devido ao seu elevado custo e à necessidade de profissionais devidamente treinados para a sua realização[28, 29].

2.3.2 *Incremental Shuttle Walk Test*

O *incremental shuttle walk test* (ISWT) avalia a capacidade máxima de exercício e o paciente é orientado a caminhar (ou correr) em um corredor de 10 metros de acordo com uma velocidade controlada externamente, por meio de um sinal de áudio[19, 30]. A velocidade de caminhada inicial é de 0,5 m/s e a cada minuto essa velocidade aumenta 0,17 m/s. O teste é finalizado quando o participante referir que não consegue mais continuar ou ainda quando não puder acompanhar o ritmo necessário do teste. A duração máxima do ISWT é de 20 minutos[19, 30].

O teste ISWT é uma medida válida da capacidade máxima de exercício em pacientes com DPOC, visto que uma forte relação entre a distância percorrida no ISWT e o VO_2max ou a carga de trabalho em um teste cardiopulmonar de esforço foi observada[19, 31, 32]. Apesar de ser um teste reprodutível, com coeficientes de correlação intraclasse que variam de 0,80 a 0,93, sabe-se que a realização de dois ISWT é necessária, visto que existe um efeito aprendizado de aproximadamente 20 m (IC 95%: 9-31 m) entre o primeiro e o segundo teste[32-34].

Além disso, poucas revisões sistemáticas relataram mudanças no ISWT após intervenções de eficácia comprovada; no entanto, estudos concebidos especificamente para avaliar a resposta ao tratamento sugerem o ISWT como um teste responsivo[35, 36]. Sabe-se também que um aumento de aproximadamente 48 metros no ISWT é o mínimo necessário para se comprovar os benefícios de um programa de reabilitação, ou seja, esse valor corresponde à mínima diferença clinicamente importante[37].

Algumas equações de referência foram desenvolvidas, e permitem que a distância percorrida no ISWT seja relatada como uma percentagem do valor normal (ou previsto, ou esperado). A distância pode então ser estimada com base em variáveis antropométricas simples. No total, foram desenvolvidas três fórmulas, sendo dois dos estudos realizados no Brasil e estes contribuem com a maior parte dos dados[38-41].

2.3.3 Teste da Caminhada de Seis Minutos

O teste de caminhada de seis minutos (TC6min) é um teste de campo frequentemente utilizado para avaliar a capacidade funcional de exercício, o prognóstico e a resposta ao tratamento em uma ampla gama de doenças respiratórias crônicas[19]. Neste teste auto-ritmado, o paciente é orientado a caminhar a maior distância possível em seis minutos ao longo de um corredor plano. A distância percorrida, dada em metros, é a principal variável avaliada e as instruções e incentivos são padronizados durante o teste. A realização do TC6min é muito sensível a variações na metodologia, incluindo o uso de encorajamento, a suplementação de oxigênio, o uso de dispositivos de marcha, o comprimento e o formato do corredor (oval, triangular, reto); assim, sua execução deve seguir os parâmetros previamente estabelecidos pelas diretrizes[19].

O TC6min é válido visto que apresenta correlações com outros desfechos clínicos importantes. A distância percorrida no TC6min correlaciona-se mais fortemente com medidas máximas de carga de trabalho e com a atividade física da vida diária do que com a função respiratória ou a qualidade de vida, o que apoia a sua conceitualização como um teste de capacidade funcional de exercício[19, 31, 42-45]. Por ser um teste com a velocidade ritmada pelo próprio paciente, o TC6min também é considerado um teste que avalia um nível submáximo e que melhor reflete a capacidade funcional de exercício para a realização de atividades de vida diária[46]. Apesar de ser considerado um teste submáximo, alguns estudos já demonstraram que variáveis cardiovasculares e ventilatórias se elevam a valores próximos de um teste máximo em pacientes com DPOC[47].

A reprodutibilidade do TC6min em pacientes com DPOC, ou seja, a extensão na qual o teste fornece o mesmo resultado em repetidas ocasiões, foi foco de atenção em diferentes estudos[42, 48-50]. O teste mostrou-se reprodutível visto que os valores de coeficiente de correlação intraclasse variaram de 0,88 a 0,99[42, 48-50]. Entretanto, mesmo com a comprovada reprodutibilidade desse instrumento de medida, é notável um efeito aprendizado no TC6min quando dois ou mais testes são conduzidos[48]. Em pacientes com DPOC, há uma melhoria média de 26 metros no segundo teste e a proporção de indivíduos que caminham uma distância mais longa no segundo TC6min varia de 50% a 87% dos indivíduos[48, 49, 51, 52]. No intuito de

controlar o efeito aprendizado, recomenda-se a realização de duas repetições do TC6min.

O TC6min é um teste responsivo, ou seja, sensível a mudanças ao longo do tempo, particularmente após um programa de reabilitação pulmonar[42, 53, 54]. O avaliador deverá ser capaz de identificar se o efeito do tratamento, ou seja, a mudança na distância percorrida foi clinicamente importante para o paciente. A mínima diferença clinicamente importante no TC6min, para indivíduos com DPOC, é de aproximadamente 25 a 35 metros[55-58].

Diferentes equações de referência foram publicadas na literatura específica, permitindo que a distância do TC6min seja relatada como uma percentagem do previsto[42, 59-62]. A idade, estatura e massa corporal são as variáveis incluídas na maioria das equações; no entanto, a aplicação de diferentes equações de referência dá origem a ampla variação na distância prevista. Devido a essa variabilidade, recomenda-se que uma equação de referência gerada e verificada em uma população local deve ser aplicada quando possível. Além disso, deve-se levar em consideração o valor do coeficiente de determinação (r^2) do modelo de regressão construído[19].

2.3.4 Relação Entre Desfechos Clínicos e os Testes de Campo TC6min e ISWT em Pacientes com DPOC

A distância percorrida no TC6min e no ISWT pode ter importância para identificar a capacidade de exercício do paciente, os fatores limitantes ao exercício (dispneia, fadiga, limitações musculoesqueléticas) e a sua resposta a uma intervenção, assim como para avaliar índices prognósticos[19]. Em DPOC, uma distância < 350 metros no TC6min está associada à maior risco de morte[14]; além disso, esse ponto de corte é utilizado para o cálculo do índice BODE[14]. Um pior desempenho no ISWT, mais especificamente, uma distância menor que 170 metros, também é capaz de predizer uma mortalidade mais elevada em indivíduos com DPOC[63].

Ambos os testes também apresentam associação com risco de exacerbações agudas da doença e readmissão hospitalar[64, 65], conseguem detectar dessaturação de oxigênio durante o esforço[66, 67] e podem ser utilizados para a

prescrição da intensidade de exercício físico em programas de reabilitação pulmonar[68-70].

2.4 Avaliação da Capacidade Funcional

A melhora do estado funcional é vista como um dos principais objetivos de tratamento em pacientes com DPOC[71]. O estado funcional é um conceito multidimensional, que caracteriza a capacidade que uma pessoa tem de prover as necessidades da vida, e envolve quatro constructos: capacidade funcional, desempenho funcional, reserva funcional e utilização da capacidade funcional[72]. Estes constructos, embora distintos, estão relacionados e devem ser considerados ao escolher as ferramentas de avaliação funcional. A capacidade funcional é o máximo potencial para realizar as atividades, enquanto o desempenho funcional refere-se à maneira como as pessoas realizam essas atividades do dia-a-dia em sua rotina normal, de acordo com os limites impostos pela sua capacidade funcional[73].

O declínio na capacidade funcional com o aumento da idade é um fenômeno conhecido e normal e embora o desempenho diário seja limitado pela capacidade funcional, as pessoas geralmente executam menos atividade física de vida diária do que realmente poderiam executar e a intensidade das atividades que elas realizam é abaixo de sua capacidade funcional[74]. Na DPOC, os pacientes caminham a uma velocidade mais baixa e passam a permanecer mais tempo em atividades sedentárias quando comparados a indivíduos saudáveis com a mesma idade[13]. Esse fato compromete ainda a realização de atividades de auto-cuidado (comer, tomar banho, vestir-se), trabalho, tarefas domésticas e de lazer.

Os testes de velocidade de marcha, *sit-to-stand*, *timed up and go* e teste do degrau avaliam a capacidade funcional de pacientes com DPOC e envolvem atividades comuns, essenciais à vida cotidiana e conhecidas por serem problemáticas para esses pacientes[6, 8, 75, 76].

O TC6min, frequentemente considerado um teste funcional, avalia a capacidade funcional de exercício, é comumente utilizado em pacientes com DPOC, apresenta um alto valor prognóstico e tem suas propriedades psicométricas bem estabelecidas na literatura[19, 42]. No entanto, a necessidade de corredores mais longos (30 metros), avaliadores treinados e o maior tempo de intervalo (30 minutos) ao executar dois testes são algumas das características que podem limitar a sua

aplicabilidade[19, 77]. Por outro lado, testes funcionais mais simples podem ser menos rigorosos metodologicamente, mas são ferramentas confiáveis, válidas e estão disponíveis para auxiliar na quantificação da capacidade funcional em pacientes com DPOC. Além disso, há um custo mínimo na implementação destes testes, os mesmos podem ser realizados dentro do ambiente clínico, hospitalar, no domicílio e em unidades básicas de saúde visto que não exigem um local específico para a sua realização e simulam atividades da vida diária que envolvem movimentos básicos[6, 8, 78, 79]. A simplicidade/praticidade e baixo custo destes testes faz com que eles se tornem atraentes para a avaliação de rotina da gravidade da doença e das limitações físicas impostas pela DPOC.

Nesta sessão serão discutidos os testes funcionais de membros inferiores comumente utilizados na avaliação de pacientes com DPOC.

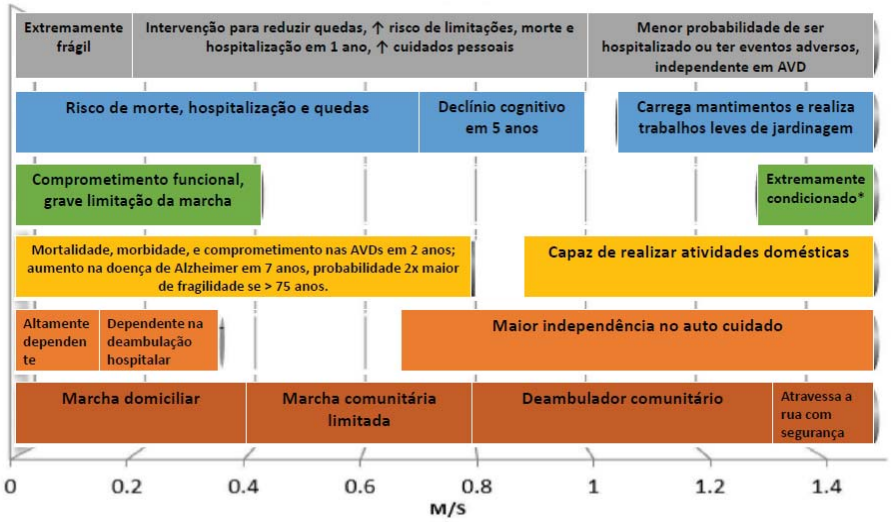
2.4.1 Teste de Velocidade de Marcha

O teste tem por finalidade avaliar quanto tempo um paciente leva para percorrer uma distância curta, ou seja, a velocidade de marcha. Esta é uma medida prática, amplamente utilizada em idosos fisicamente independentes e foi promovida como o sexto sinal vital, podendo servir como uma medida de função física em pacientes com diferentes condições e doenças crônicas[80, 81]. Por ser uma medida válida e confiável, testes que avaliam a velocidade de marcha foram incorporados tanto na prática clínica como em ambientes de pesquisa. Idosos fisicamente independentes que caminham em uma velocidade ≥ 0,80m/s apresentam velocidade de marcha preservada; enquanto velocidades abaixo desse valor são consideradas velocidades lentas[82]. Além disso, valores de normalidade e determinantes da velocidade de marcha foram propostos para indivíduos adultos[83, 84].

A velocidade de marcha é modificável por meio de treinamento de força e reabilitação, tornando-se um potencial marcador de melhora funcional, bem como declínio dessa função[85-87]. Um incremento na velocidade de pelo menos 0,1 m/s é um preditor útil para o bem-estar enquanto que um decréscimo desse mesmo valor está relacionado a um pior estado de saúde, maior debilidade e permanência hospitalar[88, 89]. Sabe-se também que em idosos a velocidade da marcha pode prever uma série de desfechos clínicos importantes e está associada à incapacidade; piora cognitiva; quedas; um maior número de admissões em instituições e mortalidade

(Figura 3)[80, 81]. Muito parecido com outros sinais vitais, uma medida única de velocidade da marcha pode fornecer uma medida objetiva de funcionamento do organismo com um todo e pode sinalizar alterações da função física que requerem intervenção[85].

Figura 3 – Representação da velocidade de marcha e desfechos clínicos associados.



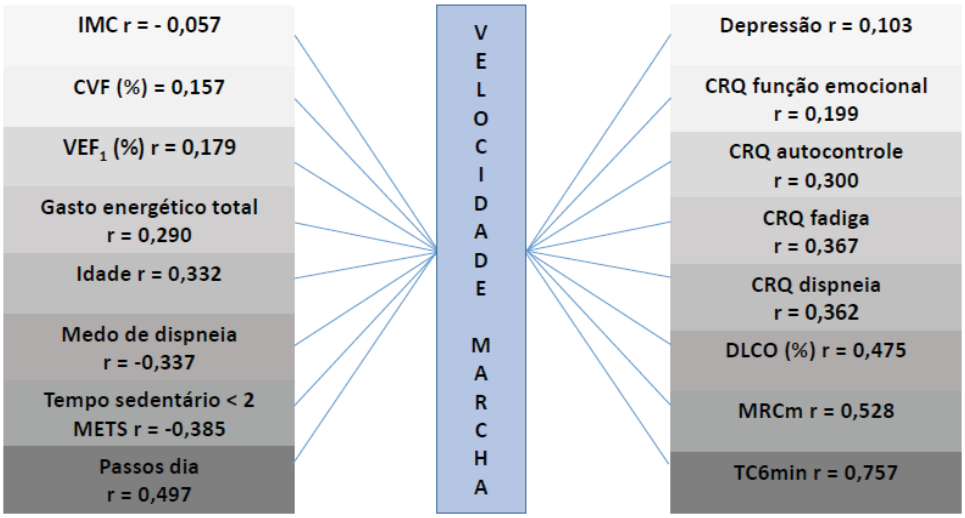
m/s: metros por segundo; ↑: aumento; ADL: atividades da vida diária; 2x: duas vezes; * Capaz de subir vários lances de escada. Adaptado de: Middleton, Fritz, Lusardi[80].

Uma variedade de protocolos está disponível para avaliar a velocidade da marcha; no entanto, esses protocolos diferem em relação à distância (dois metros a 40 metros), início do teste (estático versus dinâmico), velocidade (habitual versus velocidade máxima), instrução ("andar em um ritmo confortável" versus "caminhar como se você está tomando um passeio pelo parque") e instrumento de mensuração do tempo (cronômetro, temporizador automático, monitores de atividade física)[80, 90-92]. Apesar de nenhum protocolo padronizado ter sido estabelecido, algumas evidências disponíveis podem ajudar na seleção do teste em idosos fisicamente independentes: aplicação de testes com distâncias de até 10 metros, considerar testes com início dinâmico (fases de aceleração e desaceleração), usar corredores retos e para a temporização do teste os cronômetros podem ser utilizados[80]. Para diferentes populações a serem estudadas, as propriedades psicométricas dos vários testes devem ser levadas em consideração.

Em pacientes com DPOC, a velocidade de marcha é altamente confiável e reprodutível, independentemente da distância a ser percorrida, ritmo instruído, ou mecanismo utilizado na mensuração do tempo[6, 7, 85, 93]. Essa medida é determinada

principalmente pela capacidade de exercício, mas reflete bem-estar global e capta os efeitos multissistêmicos de gravidade da doença, ao invés do comprometimento pulmonar isoladamente (Figura 4)[85].

Figura 4 – Constructo da velocidade de marcha: correlação (r) entre variáveis psicológicas e funcionais.



IMC: índice de massa corpórea; CVF: capacidade vital forçada; VEF_1: volume expiratório forçado no 1º segundo; METS: equivalente metabólico; CRQ: *chronic respiratory questionnaire*; DLCO: capacidade de difusão do monóxido de carbono; MRCm: escala Medical Research Council modificada; TC6min: teste da caminhada de seis minutos. Adaptado de: Karpman & Benzo[85].

O teste *4-metre gait speed* (4MGS), velocidade de marcha avaliada em um corredor de 4 metros, é o protocolo mais amplamente utilizado em pacientes com DPOC. O 4MGS equilibra uma distância curta o suficiente para ser viável na maioria das situações clínicas, mas assegura uma medição acurada da velocidade de marcha[6, 7, 85, 93].

2.4.2 Teste *Sit-to-stand*

O teste *sit-to-stand* (STS) avalia diferentes aspectos da capacidade funcional (controle postural, risco de quedas, força de membros inferiores e propriocepção) por meio de uma atividade comum no cotidiano: movimentos de levantar e sentar de uma cadeira[94, 95]. O teste foi primariamente desenvolvido como um método alternativo para avaliar a força muscular de membros inferiores em idosos saudáveis e o protocolo consistia na avaliação do tempo necessário para a realização de 10 movimentos de levantar e sentar[94]. Algumas variações subsequentes do teste foram desenvolvidas, podendo ser facilmente aplicadas: levantar e sentar da cadeira utilizando cinco repetições, ou durante, 30 segundos, um e dois minutos[9, 96-99].

Esse instrumento de medida mostrou-se válido e reprodutível em indivíduos idosos e também em diferentes doenças incapacitantes[94, 96, 100-102]. No que se refere a valores de referência, indivíduos podem ser classificados com um desempenho ruim caso excedam o limite de tempo estabelecido no teste STS de cinco repetições: 60 a 69 anos (11,4 segundos), de 70 a 79 anos (12,6 segundos) e de 80 a 89 anos (14,8 segundos)[103]. Para uma melhor interpretação dos resultados do STS, outros valores de referência também foram propostos de acordo com diferentes protocolos estabelecidos na literatura[97, 103, 104].

Aspectos técnicos, como a altura da cadeira, o apoio para os braços e o posicionamento de membros inferiores têm grande influência sobre a capacidade de fazer o movimento do STS. Usar o assento da cadeira mais elevado resulta em menor trabalho ao nível do joelho e quadril, enquanto o abaixamento do assento da cadeira aumenta a necessidade de geração de impulso ou reposicionamento dos pés; usar o apoio para os braços diminui o trabalho realizado pelos membros inferiores; e o posicionamento dos pés (anteriormente, posteriormente, de acordo com a preferência do avaliado) influencia a estratégia de movimento do STS. A não consideração dessas variáveis pode levar a interpretações equivocadas de mudanças no desempenho do STS[95].

Alterações na capacidade de executar o movimento de levantar e sentar são encontradas em pessoas idosas e/ou com doenças incapacitantes. Os indivíduos idosos que executam menos de 45 repetições ao dia do movimento de levantar e sentar podem estar enfrentando um déficit funcional, o que pode contribuir

para a fraqueza muscular e limitação na realização de atividades de vida diária[105]. Além disso, a incapacidade de realização desse movimento básico na vida diária por indivíduos idosos está relacionada com institucionalizações, limitações de mobilidade e funcionalidade[95, 106, 107].

2.4.3 Teste *Timed Up and Go*

O teste *Timed Up & Go* (TUG) foi desenvolvido em 1991, para avaliar mobilidade funcional em idosos, como uma versão modificada do *Get Up and Go test*. É um teste válido, reprodutível, simples e de baixo custo no qual o indivíduo é orientado a levantar-se de uma cadeira (altura aproximada de 46 cm), caminhar uma distância reta de três metros, em um ritmo confortável e seguro, virar, caminhar de volta e sentar-se novamente na cadeira. O tempo gasto para a realização do teste é considerado para as análises, e o avaliado deverá realizar o teste uma vez antes de o mesmo ser cronometrado, para que possa se familiarizar com o percurso. É permitido que o indivíduo a ser avaliado use apoio para a marcha (bengala ou andador), se necessário[108].

O TUG mostra-se atrativo no sentido de mesclar avaliações de mobilidade diferentes, tais como transições de postura na cadeira (mudança de sentado para em ortostatismo e vice-versa), rotações, marcha em linha reta, controle do equilíbrio e realização de atividades em sequência[108-110]. Além disso, em idosos frágeis, o TUG correlaciona-se com outros desfechos clínicos funcionais como equilíbrio, velocidade de marcha e o índice de Barthel[111, 112]. Valores de referência para o TUG foram desenvolvidos[113, 114] e, segundo Bohannon, o avaliado apresenta desempenho no teste abaixo da média quando realiza o teste em um tempo > 9 segundos para 60 a 69 anos de idade, > 10,2 segundos para 70 a 79 anos de idade, e > 12,7 segundos para indivíduos de 80 a 99 anos de idade[114].

Segundo a *American Geriatrics Society* e a *British Geriatrics Society* o TUG pode ser utilizado também como uma ferramenta de triagem de rotina que identifica indivíduos idosos que podem se beneficiar de uma avaliação detalhada para risco de quedas por meio da simples avaliação da marcha e do equilíbrio[115]. Um tempo mais rápido de execução indica um melhor desempenho funcional e uma pontuação ≥ 13.5 segundos é utilizado como um ponto de corte para identificar

indivíduos com aumento do risco de quedas em ambiente comunitário[116]. No entanto, os valores de limiar relatados variam de 10 a 33 segundos na literatura[116, 117].

Em função de sua praticidade, o TUG passou a ser utilizado como ferramenta de avaliação em diferentes condições e doenças crônicas, tais como, pacientes com déficits respiratórios, neurológicos, ortopédicos, câncer, crianças e adolescentes que apresentam algum tipo de limitação motora e/ou déficit de equilíbrio[75, 118-120]. O TUG também é capaz de predizer a morbidade e mortalidade em diferentes doenças[121-123].

2.4.4 Teste do Degrau

O teste do degrau (TD) (ou *step test*) é utilizado na avaliação da capacidade funcional de indivíduos saudáveis e vem sendo mais empregado no meio clínico, principalmente em doenças respiratórias crônicas[76]. O TD envolve uma atividade cotidiana comum e tem como vantagem a utilização de um ergômetro (degrau) de fácil obtenção e baixo custo. Inicialmente, o TD foi descrito por Master e Oppenheimer em 1929, e tornou-se conhecido como o teste de dois degraus de Master. Neste teste, o avaliado era orientado a subir e descer de uma plataforma de dois degraus, durante um tempo pré-estabelecido de 90 segundos[124]. Posteriormente, diferentes protocolos do TD foram desenvolvidos, embora poucos deles tenham sido validados em populações clínicas. Em indivíduos saudáveis, os protocolos diferem quanto à altura do degrau (10 a 50,8 cm), cadência, duração do teste e ritmo (auto cadenciado *versus* cadenciado externamente) [76].

Equações de referência foram propostas para o TD de seis minutos, por meio de variáveis demográficas e antropométricas. Além disso, equações baseadas no TD são capazes de predizer o consumo máximo de oxigênio (VO_2max) em idosos fisicamente independentes[125-127]. Modelos de predição baseados no tempo do TD, idade, frequência cardíaca, índice de massa corpórea e pulso de O_2 explicam 72-86% da variação do VO_2max. Quando os pacientes foram reavaliados após um programa de treinamento físico, a equação baseada no TD foi sensível a mudanças pós-treinamento[125].

O TD pode ser considerado um teste de capacidade máxima ou submáxima, quando a altura do degrau e/ou o número de repetições realizado durante o teste são aumentados ou mantidos, respectivamente[128-131]. Além disso, as

respostas fisiológicas durante um TD são distintas das respostas a um teste de caminhada[132]. O trabalho contra a gravidade e o uso de grupamentos musculares que não são utilizados com tanta frequência na vida diária tornam as demandas metabólicas e ventilatórias mais intensas durante um TD, o que explica a correlação desse teste com a tolerância máxima ao exercício[78, 130].

Outro aspecto metodológico desse teste é que o uso de degraus com diferentes alturas pode ser necessário em indivíduos com extremos de altura e com limitações ortopédicas.

2.5 Reabilitação Pulmonar e Prescrição de Exercício em Pacientes com DPOC

A promoção da atividade física regular é de importância fundamental na redução da morbimortalidade, na melhora da qualidade de vida, da tolerância ao exercício e dos sintomas, em pacientes com DPOC[18, 53, 133]. O desafio atual para a reabilitação pulmonar (RP) é a necessidade de desenvolver estratégias que induzam ou facilitem a melhoria dos níveis diários de atividade física, porque só o treinamento físico, apesar de melhorar a capacidade de exercício, pode não gerar melhorias semelhantes na atividade física da vida diária[18].

O exercício físico é o principal componente da RP e tem como objetivos garantir o condicionamento da musculatura periférica e melhorar a aptidão cardiorrespiratória, reduzindo assim a dispneia, a fadiga e visando o aumento a atividade física de vida diária. O treinamento físico de alta intensidade é comumente utilizado em programas de reabilitação pulmonar; porém antes de iniciar o treinamento físico, uma avaliação é necessária para garantir a individualização na prescrição do exercício, avaliar a eventual necessidade de oxigênio suplementar, e ajudar a garantir a segurança da intervenção[18].

A prescrição deve ainda, seguir alguns princípios da fisiologia do treinamento físico: frequência, intensidade, duração e modalidade. A frequência em pacientes com DPOC segue a mesma recomendada pelo *American College of Sports Medicine* (ACSM), de três a cinco vezes por semana. O treinamento físico de alta intensidade, feito geralmente em esteira ou bicicleta, é considerado como todo exercício realizado acima de 60% da capacidade máxima de exercício individual e recomenda-se uma duração de 20 a 60 minutos por sessão[18].

A intensidade do exercício físico é considerada como um importante determinante da resposta ao tratamento e é geralmente prescrita como uma porcentagem da capacidade máxima de exercício, idealmente mensurada a partir de um teste cardiopulmonar de esforço (TCPE). No entanto, um TCPE pode não ser acessível na prática clínica e científica devido ao seu elevado custo e à necessidade de profissionais devidamente treinados para a sua realização[28].

Testes de campo, como o ISWT e o TC6min, parecem ser alternativas mais práticas para a prescrição de exercícios de caminhada, visto que durante sua execução, apresentam respostas similares ao TCPE em termos de VO_2max[31, 42, 68, 69]. Apesar do perfil submáximo do TC6min, Zainuldin e cols. demonstraram que ele pode ser usado para prescrever intensidade de exercício de caminhada, visto que fornece estresse fisiológico suficiente mesmo em indivíduos com DPOC leve. O exercício pode ainda ser prescrito com base na sensação de esforço percebida pelo paciente. Nesse caso a mensuração pode ser realizada por meio da escala de Borg modificada (0-10), objetivando uma sensação de esforço entre 4-6, ou entre 14-17 para a escala de Borg original (6-20).

No entanto, a utilização de testes funcionais mais simples para a prescrição da intensidade de exercícios de caminhada ainda não foi investigada nessa população, e envolve um dos trabalhos realizados nessa tese.

3. OBJETIVOS

Na presente tese de doutorado três estudos foram desenvolvidos, sendo dois artigos originais e um artigo de revisão sistemática da literatura.

O propósito da revisão sistemática foi descrever as características e avaliar as propriedades psicométricas de quatro testes funcionais em pacientes com DPOC (GS, STS, TUG e TD); avaliar a relação entre esses testes e desfechos clínicos importantes na DPOC e, ainda, viabilizar recomendações para a prática clínica e pesquisas futuras.

Os objetivos do segundo estudo foram comparar e avaliar a concordância de dois métodos que registram o tempo de realização do teste *4-meter gait speed* - 4MGS (cronômetro e vídeo) em pacientes com DPOC, bem como avaliar a concordância interavaliadores que realizaram a mensuração do tempo apenas com o cronômetro.

O terceiro artigo busca avaliar a eficácia do 4MGS para a prescrição da intensidade de exercício físico e para predizer a distância percorrida no teste da caminhada de 6 minutos, além de identificar qual protocolo do teste melhor estima esses resultados em pacientes com DPOC.

Por fim, a tese foi desenvolvida com o intuito de investigar, de forma mais minuciosa, a utilização de testes funcionais em pacientes com DPOC, e assim contribuir com a aproximação entre a prática clínica e a evidência científica concernente à avaliação da capacidade funcional dessa população. A avaliação do paciente é a chave principal na condução de um tratamento e o profissional da saúde poderá se beneficiar de técnicas mais simples de avaliação, capazes de identificar outras vertentes que levam à queixa do paciente, considerando as atividades exercidas durante o seu dia a dia.

4 ARTIGO 1

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SIMPLE LOWER LIMB FUNCTIONAL TESTS IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE: A SYSTEMATIC REVIEW

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Abstract

Objectives: The objectives of this review were to describe the characteristics and available evidence on the measurement properties of the gait speed (GS) test, timed up and go (TUG), sit to stand (STS) and step test; to investigate their relationship with clinical outcomes in Chronic Obstructive Pulmonary Disease (COPD); and to provide recommendations for clinical practice and future research.

Data Sources: Studies were systematically identified from a literature search using PubMed, PEDro, CINAHL and Cochrane Library databases and the reference lists of included papers.

Study Selection: Studies including one or more of these four lower limb functional tests (GS, TUG, STS and step test) in patients with COPD were selected. No limits were applied for language and study design.

Data Extraction: Two researchers independently performed data extraction and, by using COSMIN, assessed the quality of those studies which described measurement properties.

Data Synthesis: Forty two articles were analyzed. GS, STS and step test are valid, reproducible and responsive tests, especially the 4-meter GS, 5-repetition STS and 6-minute step test. The TUG test is reliable; however studies concerning other measurement properties are missing. Outcomes of these tests are correlated with mortality, physical activity in daily life, exercise capacity, dyspnea and quality of life.

Conclusions: Simple and functional lower limb tests provide information about important clinical outcomes in patients with COPD. The 4-meter GS, 5-repetition STS and 6-min step test had their psychometric properties better described whereas the properties for the TUG need to be further studied.

Keywords: pulmonary disease, chronic obstructive; review; activity of daily living; exercise test

Introduction

Exercise intolerance in patients with Chronic Obstructive Pulmonary Disease (COPD) is a common finding and its explanation goes beyond ventilatory constraints, including features such as impaired body composition, psychological status, cardiovascular and muscle dysfunction[1-3]. As consequence of the disease, patients can be limited in their daily living tasks such as washing dishes, clothing and bathing[4].

Functional exercise capacity assessment is often used in patients with COPD as a way to quantify the reflection of disease severity on the physical ability to perform daily activities[4]. The most common field test which objectively evaluates functional exercise capacity in this population is the six-minute walk test (6MWT)[4, 5]. The 6MWT has a number of merits such as its prognostic value and its well-established psychometric properties. However, there are some features involved in the 6MWT standardization which can limit its applicability (e.g. need for a 30-m course and 30 minutes of interval when performing two tests)[5, 6].

While the 6MWT assesses functional exercise capacity, other functional tests aim mainly at assessing the functionality of the patient, and not his/her exercise capacity. A few of these tests are increasingly used in healthcare settings in order to assess lower limb functional limitations in patients with COPD. They are more simple and practical in terms of required space and time and easier to be performed in home care settings[7-10] in comparison to the 6MWT. However, some features of these tests have not yet been summarized, such as their measurement properties and their relationship with other relevant outcomes. For this reason the aims of this study were (1) to describe the characteristics and available evidence on the measurement properties of four simple lower limb functional capacity tests (gait speed [GS] test, timed up and go [TUG], sit to stand [STS] and step test) in individuals with COPD, when available; (2) to investigate the correlation between the performance in these tests and clinical outcomes such as mortality, physical activity in daily life, exercise capacity, dyspnea, quality of life, desaturation, exacerbations, hospitalizations and readmissions of patients with COPD; and (3) to provide recommendations for clinical practice and to indicate future research in the field of lower extremity assessment and training.

Materials and Methods

Data sources and searches

The search was independently conducted by two investigators (G.W.B. and A.A.M.) and the strategies were developed in the following databases: PubMed, PEDro, CINAHL and Cochrane Library, from the inception of these databases until November 2014. Search terms used were: “COPD” or “pulmonary disease, chronic obstructive” and “gait speed”, “walking speed”, “4-meter gait speed”, “4-metre gait speed”, “timed up and go”, “TUG”, “sit to stand”, “chair stand” and “step test”. Furthermore, the search was conducted throughout the articles and hand searching was performed on the reference lists of papers included in the systematic review.

Study selection

Studies of any design which included one or more of the four tests as an outcome in individuals with COPD were considered. These four tests were characterized by the authors as simple measures of lower limb functional capacity according to the following criteria: (1) practical in terms of time, space and required resources; (2) considers the number of repetitions or time to perform a lower limb activity as an outcome; and (3) includes movements that are commonly performed in daily living. The general characteristics of the tests were described in Table 1. The choice to focus on leg exercise tests was made because the majority of pulmonary rehabilitation programs has as the main outcome the lower limb assessment. Furthermore, a previously published systematic review[11] had already answered important questions on measures of arm exercise in individuals with COPD.

In order to determine study eligibility, two investigators (G.W.B and A.A.M.) reviewed the study title and abstract independently and, thereafter, the full articles. The report was excluded if the study was presented only in abstract format and if it presented methodological differences that could compromise the feasibility of the test. In cases of uncertainty, a third reviewer (F.P.) was consulted. No limits were applied for language since abstracts and papers in non-English language were translated.

Data extraction and quality assessment

Two reviewers (G.W.B. and A.A.M.) extracted study details and data. The extraction of data included the names of the tests, sample characteristics (including number of participants and disease severity), tests' protocols, psychometric properties, results, advantages, disadvantages and results, and correlations with other outcomes commonly assessed in patients with COPD. The Consensus-based Standards for the Selection of Health Status Measurement Instruments (COSMIN) checklist assesses methodological quality per study on a measurement property[12]. In this systematic review, the studies which involved measurement properties (validity, reliability and responsiveness) were evaluated by this checklist[12].

The punctuation of each property was classified as excellent, good, fair, or poor and obtained by taking the lowest rating of that measurement property. The same two investigators independently appraised the quality of each article and agreement was reached by consensus.

Measurement properties

The measurement properties of an instrument determine its quality. Validity is the ability of an instrument to measure what it is intended to measure[13]. Reliability was defined as the degree to which a measurement is considered consistent and free from error. In this review the test-retest reproducibility and the interrater reliability were considered[13]. Responsiveness is defined as the degree to which an instrument is able to detect minimal change over time[13].

Data synthesis and analysis

The protocols, measurement properties and methodological quality assessment of each test were analyzed and synthesized by two co-authors (G.W.B. and A.A.M.). Meta-analysis was not performed because the purpose of this review was not to combine data from two or more studies but critically evaluate all the available scientific evidence on a research question. The recommendations of the PRISMA (Parameters of the Preferred Reporting Items for Systematic reviews and Meta-Analyses) statement for systematic reviews were followed[14].

Results

Study selection

The search in electronic bibliographic sources as well as hand searching provided a total of 607 citations. After adjusting for duplicates, 142 remained. Out of these, 97 studies were removed because after reviewing the title and abstracts these papers clearly did not meet the inclusion criteria. Three studies were excluded after the full-text analysis because of methodological differences, as follows: in two studies, the GS was assessed by the 6MWT[15, 16]; and in one study, in the step test the authors did not use a step but a staircase, which is not commonly available anywhere[17]. Finally, a total of 42 studies involving the four tests were included in this review. Six articles[18-23] which evaluate two or more tests simultaneously were counted just once in the included studies. The process of literature search is presented in Figure 1.

Study quality appraisal and evidence for measurement properties

Eighteen included studies evaluated the measurement properties of the tests (Table 2). The quality assessments performed by the COSMIN are shown in Table 2. Most studies were classified as “fair” in the quality appraisal. The TUG was the only test which did not have its responsiveness assessed in the currently available

literature. So far, measurement properties were more frequently evaluated in the 4-meter GS (4MGS), five repetitions of STS test (5STS) and 6-minute step test (6MST).

Lower limb functional tests

Gait speed: It was assessed in 10 studies[8, 19-21, 24-29]. Protocols were not standardized concerning corridor length, instructed pace (maximal or usual), start of the test (static or rolling) and timing system (stopwatch or automated timer).

The most widely used protocol in patients with COPD was the 4MGS, that is, the required speed to walk four meters[8, 26-29]. Five studies described this protocol with some specificities: usual walking speed in a 4-meter course[8, 26, 29] or usual and maximal speed in an 8-meter course (two-meter acceleration zone, a four-meter timing area and a two-meter deceleration zone)[27, 28]. The 4MGS is a valid, reliable and responsive test in patients with COPD[8, 26, 27, 29] and presents the value of 0.11m/s as minimal important difference (MID)[29] (Table 3). It correlates with measures of exercise capacity (Incremental Shuttle Walk Test [ISWT] r=0.78 and 6MWT r=0.70)[8, 28], dyspnea (Medical Research Council scale [MRC] r=-0.55)[8] and health status (Saint George Respiratory Questionnaire [SGRQ] r=-0.44)[8]. Furthermore, a modest correlation was found between the 4MGS and physical activity in daily life (PADL) (r=0.35)[26, 28] (Table 3).

Another protocol to evaluate GS was described by Andersson *et al*.[24]. Patients were instructed to walk in a 30-meter corridor (30MGS). At first, they walked in the course at a self-selected pace and after a 3-minute resting period, walked at a maximum walking speed. The mean walking speed at both, the self-selected and the maximal speeds, was used as an outcome. The cutoff for normal walking speed was set at 1.0 m/s[24]. The 30MGS is a reliable test (Table 2); it is strongly correlated to the 6MWT but more poorly correlated with PADL[24, 25] (Table 3).

Four studies further reported some variations of the GS assessment: GS of the central 6-meter in a 10-meter corridor, walking fast[20]; 5-meter of self-selected GS in an 8-m course[19]; 5-meter in a corridor of 10 meters at maximal speed[21] and to walk 10 meters at usual and maximal speed in a 14-meter corridor (10MGS)[27]. The reliability was only evaluated in the 10MGS with an ICC of 0.97 for test-retest[27] (Table 3).

Timed up and go: Nine studies verified functional balance status in patients with COPD using the TUG test[18, 20, 21, 23, 30-34]. It was performed in a corridor where patients needed to stand up from a chair, walk 3 meters, then walk back and sit down again. Although the outcome (time) was the same for all studies, there were differences in protocols regarding the course length and the speed of execution. In five studies[20, 21, 30, 32, 33] the subject was instructed to perform the test at an usual speed whereas in four[18, 23, 31, 34] the subject was instructed to perform it as fast as possible. The study by Benton *et al.*[23] was the only one in which the protocol was performed in a 2.50 m length course[23].

Mesquita *et al*.[32] investigated the reliability of the test, confirming the test-retest reproducibility (Table 3). There are no studies about its responsiveness and the only validity article did not find correlation with lower limb strength[23].

The TUG test is able to detect functional disabilities[33] and risk of falling[30]. Beauchamp *et al*. demonstrated that the test could discriminate fallers from non-fallers; the test duration was 3.1 seconds longer in fallers compared with non-fallers[30]. Moreover, longer time to complete the TUG test at baseline and after 1-year follow-up period were predictors of deterioration in disease related health status[33].

Sit-to-stand test: Fifteen studies which used the STS test to evaluate lower limb functionality were found[7, 18, 19, 21-23, 35-43]. The protocols vary greatly (Table 1), including differences in chair height, which ranged from 40 to 48 cm[7, 22, 35-42] or was adjusted to establish 90-degree angle of hips and knees in the sitting position[43]. Another difference is how the outcomes were presented: number of repetitions performed in a period of time, or time spent to perform an established number of repetitions.

Three studies[7, 19, 43] described the time spent to perform 5 STS repetitions (5STS). The 5STS has its psychometric properties well described: it is a valid and reproducible test, and showed to be responsive after an 8-week pulmonary rehabilitation with a MID value of 1.7 seconds[7].

The majority of articles depicted the number of repetitions performed in a certain period of time as outcome. Six studies[36-39, 41, 42] assessed the number of repetitions within 1 minute, three[18, 21, 23] within 30 seconds and two[22, 40] within 2 minutes. Validity was only evaluated in the 30 seconds STS test (30STS), which proved to be valid[44] (Table 3).

Aguilaniu *et al*.[35] used a slightly different protocol, the "semipaced 3-minute chair rise test (3CRT)," which consisted of standing up and sitting down during 3 minutes. The first minute was performed in a dictated rhythm of 12, 15 or 20 repetitions and in the last 2 minutes patients were instructed to repeat the movement as many times as possible. The test is reliable (Table 3) and the physiological responses at the end of this test were similar to those of the 6MWT.

Puhan *et al.* described the 1-minute STS test as a stronger predictor of 2-year death; a higher number of movements was observed at baseline in those patients who would survive in comparison to non-survivors (19.5 *versus* 11.8 repetitions; AUC=0.78 of ROC curve)[38]. On the other hand, van Gestel *et al.*, concluded that although the 1-minute STS was associated with objectively measured physical activity, it cannot be used to identify patients with an inactive lifestyle (AUC=0.31)[42].

Step test: A wide variety of protocols concerning the step test have been described in fifteen studies[9, 10, 22, 44-55]. There is no standardization regarding cadence (self-paced or externally paced), step height, test duration and how the results should be presented (Table 1). A step test can be performed with constant or incremental work rates.

In seven studies[22, 45, 48, 50-53] the step test was performed in a self-paced speed, with constant work rate, and patients were instructed to step up and down as many times as possible within 6 minutes (6MST). This protocol can be done without a familiarization test since it does not present a learning effect[45]. Regarding its psychometric properties, the number of steps was valid to verify exercise capacity in patients with COPD and a cutoff of 78 steps identified patients with an impaired exercise tolerance[50]. Furthermore, the 6MST is reproducible[45] when performed by the same examiner, and showed to be responsive after a physical training program[48].

The paced step test (PST) could also be considered a constant workload test because the stepping rate was kept constant throughout the test (15 steps/minute) until exhaustion. The difference is that the speed is externally paced and patients were instructed to perform the test until exhaustion. No psychometric properties were described in patients with COPD[9].

The Chester step test (CST)[10, 44, 47], incremental step test (IST)[44, 46] and step test[49] combine the characteristics of presenting an externally paced speed and an incremental pattern. The CST was performed with an initial load of 15 steps/min and

a load increment of 5 steps in every 1 – 2 minutes. Ten minutes is the total time of this protocol[10, 44, 47]. The IST is an adaptation of the CST, with a reduction in the initial cadence to 10 steps/ min and an increment of 1 step every 30 seconds, until exhaustion[44, 46]. The IST can be a complementary evaluation of exercise-induced hypoxemia since patients presented a greater desaturation during IST compared to cardiopulmonary exercise testing (CPET)[46], whereas the CST showed a strong correlation with the ISWT and the 6MWT[10, 47]. The CST and the IST also presented high reliability[10, 46]. The step test, described by Perrault *et al.*, was performed by stepping up and down at constant rates of 18, 22, 26 and 32 steps/min in four bouts (3-minute each), with a 10-minute rest between each step bout. The test is reproducible, with an ICC ≥ 0.91[49] (Table 3).

Another protocol is the 15 steps exercise oximetry test. The patient is instructed to climb up and down the step 15 times as fast as possible and the time was recorded according to the desaturation and recovery time. Measurement properties of this test have not been verified yet[55].

Discussion

This systematic review identified 42 articles which used as an outcome in individuals with COPD one or more of the following four simple functional tests for the lower limbs: GS, TUG, STS and step test. The findings indicate that the GS, STS and step test are valid, reliable and responsive tests in this population. A MID was reported only for the 4MGS and 5STS and may be used to help interpreting treatment effects in these two tests[7, 29]. The TUG test is reproducible[32] but further studies concerning other measurement properties of this test are lacking. Furthermore, these functional tests are related to some important clinical outcomes such as mortality[38], physical activity in daily life[25, 26, 28, 42], exercise capacity[7, 8, 24, 28, 47, 50, 55], dyspnea[7, 8] and quality of life[7, 8, 33].

There are some general reasons to apply a simple functional tests in clinical practice: they do not require a special place to be performed; they are easy to perform and require simple and low cost equipment[7-10]; they simulate everyday tasks and involve basic movements. At the same time, a number of different protocols have

been described in the literature with no clear evidence to which one stands out as the best one in the COPD population.

The GS test can be used as a screening tool for exercise intolerance and as an outcome measure for frail patients[8, 56]. A 4MGS lower than 0.90 m/s can predict a poor exercise capacity (six minute walk distance [6MWD] < 350 meters), whereas a 4MGS lower than 0.80 m/s is a predictor of an even worse 6MWD (< 200 meters)[28]. Regardless of corridor length, instructed speed and timing system, the test proved to be valid and reproducible[27]. However, Karpman *et al*. suggested that adhering to one protocol of GS measurement is the best option because a significant difference in gait speeds was found between longer (10 meter) and shorter (4 meter) corridors[27].

Some disadvantages of the GS test can be noticed, such as a "ceiling" effect in short corridor protocols, and the difficulty to accurately measure changes, as the test has a very short duration (changes are in seconds or in milliseconds). These barriers though, are more pronounced in patients with mild COPD[29] in comparison to more severe stages of the disease. Furthermore, despite a significant association with exercise capacity measured by both the 6MWT[24, 28] and the ISWT[8], the characteristics and nature of the GS do not allow its use for exercise prescription and to identify the need and titration of oxygen supplementation.

The TUG test may have a wide range of indications since in addition to evaluating lower limbs function, it also estimates balance and mobility. It is a screening test for fall risk and a predictor of deterioration in health status[30, 33]. Beauchamp *et al*. demonstrated that the test could discriminate fallers from non-fallers; the test duration was 3.1 seconds longer in fallers compared with non-fallers[30]. Moreover, longer time to complete the TUG test at baseline and after 1-year follow-up period were predictors of deterioration in disease related health status[33]. Despite these advantages, only scarce literature concerning the measurement properties in the COPD population is available, hindering the current evidence-based knowledge of the test.

The STS test can be used as a stratification tool: patients who are unable to perform the 5STS test had a significant impairment in their exercise capacity and quadriceps force[7]. One advantage of this test is that it does not present a learning effect, and can therefore be performed just once[7]. The 1-min STS causes less hemodynamic stress when compared to the 6MWT[37] and is a potential predictor of survival[38]. Regarding the 3CRT, patients who are able to perform more than 50 rises

during 3 minutes have no significant disability[35]. The disadvantages of the STS are the presence of a “floor” effect with some patients unable to perform the test[7], as well as the potential hindrance by orthopedic problems that can influence its execution and results.

The step test can be considered a maximal or submaximal test when the height of the step and the number of repetitions performed during the course of the test is increased or maintained, respectively[9, 10, 22, 44-55, 57]. Differently from the others, this test (both incremental and externally-paced protocols) can be used to determine the intensity (number of steps) of step training[44, 46]. The step test (15 steps oximetry) may assess arterial hypoxemia during exercise and determine whether oxygen supplementation is required in patients with severe COPD[54]. On the other hand, orthopedic problems can also influence its execution and results. Other limitations of the test are that large load increments in the Chester step test result in a short test duration, which is not efficient for assessing cardiopulmonary responses[10, 44, 57]; and self-paced protocols are limited by time and can vary according to the degree of patient motivation[22, 45, 48, 50-53].

It is important to highlight that, during the performance of the STS and step test, the height of the chairs and steps, respectively, were not standardized in all rehabilitation centers. This may influence the external validity of these tests since different heights of chairs and steps result in different work rates for taller or shorter individuals[46]. However, in daily ("real") life it is not possible to standardize these equipments' features in order to take into account individual patients' characteristics (e.g. markedly tall or short individuals), and therefore the non-standardization seen in the literature may not lead to negative clinical impact since those tests are in fact aimed at simulating daily "real life" activities.

The 4MGS, 5STS and 6MST were the tests with more in-depth description of psychometric properties in the literature[7, 8, 26, 27, 29, 45, 48, 50, 56]; however, this is not the only determinant that should be considered when choosing a test in clinical setting. Individual characteristics of patients, target constructs being measured and clinical applicability should also be considered. It seems reasonable to indicate the applicability of these tests in more weakened, hospitalized patients and/or who are under long-term oxygen therapy (LTOT) use. However, just one study assessed one of these tests during an acute exacerbation of the disease[51], and therefore the vast majority of data published so far involves stable patients only. Patients under LTOT

are allowed to perform the tests; however, in this case it may be difficult to perform gas analysis throughout the test. Another important issue is related to the exercise prescription. All functional tests, except for the incremental step test[46], may be performed to evaluate functional capacity but they cannot be used to prescribe the intensity, velocity or work load in an exercise training program. Clinicians should also look carefully to what they intend to measure (e.g., general health, balance, mobility, prognostic or intervention response) and then judge which test is the most appropriate. A brief summary of recommendations is listed in Table 4.

Study Limitations and Future Implications

Most studies of this review were classified as having a “fair” quality appraisal since the COSMIN checklist uses a conservative criterion. Even if a study has received the highest score in all other items, a single item that was scored lower is what should be reported; therefore, this fact can explain the high prevalence of "fair" score[12].

Further studies will be necessary to compare different tests and protocols, and to elucidate the most suitable test choice in patients with COPD. Moreover, the psychometric properties are not totally described and responsiveness of these tests in longitudinal studies are still lacking. Although functional tests can be used as indicators of overall well-being in the clinical setting, the scientific literature still lacks more studies to reach evidence-based conclusions on the strength of these tests to predict desaturation, exacerbations, hospitalizations and readmissions of patients with COPD.

Conclusions

Simple tests such as gait speed, timed up-and-go, sit-to-stand and step test can be used in clinical practice to evaluate lower limbs' functional capacity. They are well tolerated by patients, practical and feasible considering time, space and available resources.

These tests can inform clinicians about important outcomes in COPD such as mortality, physical activity in daily life, exercise capacity and quality of life.

The 4MGS, 5STS and 6MST are those with better described psychometric properties in patients with COPD, while the properties for the TUG need to be further studied.

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Table 1. General data of the included studies.

Test	Study	COPD sample (FEV1%pred)	Protocol	Outcome
GS	Karpman *et al.*[28]	n=130 (50±20%)	Usual and maximal 4MGS in an 8-meter course (2-m acceleration zone, 4-m timing area, 2-m deceleration zone).	Time
	Kon *et al.*[29] DePew *et al.*[26] Kon *et al.*[8]	n=301 (49 [32–63]%) n=70 (31.5±13.9%) n=586 (46 [29–61]%)	Usual walking speed in a 4-meter course.	Time
	Karpman *et al.*[27]	n=70 (53±18%)	4-meter and 10-meter with usual and maximal GS in an 8-meter and 14-meter corridor, respectively (2-m acceleration zone, 4-m or 10-m timing area, 2-m deceleration zone).	Time
	Butcher *et al.*[20]	n=30 (29.8±3.73% – 45.7±3.73%)	To walk the central 6-meter as quickly as possible in a 10-meter corridor.	Time
	Roig *et al.*[19]	n=21 (47.2 ± 12.9%)	To complete 5-meter of self-selected GS in an 8-m course.	Time
	Andersson *et al.*[24] Andersson *et al.*[25]	n=47 (46±17%) n=72 (43±16%)	To walk in a 30-meter corridor, at a self-selected pace and after rest at a maximum walking speed.	Time
	Horie *et al.* [21]	n=31 (51.0±19.4%)	Maximal walking speed of 5-meter in a corridor of 10 meters.	Time
TUG	Wilke *et al.*[33] Mesquita *et al.*[32]	n= 85 (34.3±13.6%) n=95 (33[26-42]%)	To stand up from a chair and walk 3 meters at usual speed, turn and walk back to the chair and sit down again.	Time
	Horie *et al.*[21] Beauchamp *et al.*[30] Butcher *et al.*[20]	n=31 (51.0±19.4%) n=39 (41.5±17.0%) n=30 (29.8±3.73% – 45.7±3.73%)		
	Cruz *et al.*[31] Jacome *et al.*[34] Butcher *et al.*[18]	n=134 (58 ±24.6% - 68.40±22.41%) n=160 (63.1±23.0%) n=13 (47.9 ± 13.9%)	To stand up from a chair, walk 3 meters, turn around, walk back to the chair and sit down as fast as possible.	Time
	Benton *et al.*[23]	n=40 (36.7±2.6%)	To stand up from a chair and walk 250cm, thereafter, turn and walk back to the chair and sit down as fast as possible.	Time

STS	Aguilaniu *et al.*[35]	n=40 (53.7±16.4%)	To stand up and sit down in a 48 cm chair during 3 minutes with a rhythm in the first minute (12, 15 or 20 repetitions) and in the last 2 minutes to rise and sit down as many times as possible.	Number of repetitions
	Rausch-Osthoff *et al*.[39]	n=27 (37.6±17.6%)	To stand up and sit down on the 46 to 48 cm chair as many times as possible within 1 minute..	Number of repetitions
		n=14 (39%)		
	Canuto *et al*.[36]	n=53 (46±9%)		
	Ozalevli *et al.*[37]	n=409 (59[25-78] %)		
	Puhan *et al.*[38]	n=22 (39.88±8.69%)		
	Rocco *et al.*[41]	n=70 (43±22%)		
	Van Gestel *et al.*[42]			
	Janssens *et al*.[43]	n=18 (51±19%)	To perform 5 STS movements as fast as possible in a chair of 48 cm or adjusted to create a 90 degree angle of hips and knees.	Time
	Jones *et al.*[7]	n=475 (47.6±20.6%)		
	Roig *et al.*[19]	n=21 (47.2 ± 12.9%)		
	Benton *et al.*[23]	n=40 (36.7±2.6%)	To stand up and sit down as fast as possible and complete as many repetitions as possible within 30 seconds. The chair height was enough to allow both feet to be flat on the floor or with 40 cm.	Number of repetitions
	Butcher *et al.*[18]	n=13 (47.9 ± 13.9%)		
	Horie *et al.*[21]	n=31 (51.0±19.4%)		
	Pessoa *et al.*[22]	n=11 (46.1 ± 15.2%)	To stand up and sit down on a 46 cm chair as fast as possible within 2 minutes.	Number of repetitions
	Regueiro *et al.*[40]	n=10 (45.83±14.25%)		
Step test	Andrade *et al.*[44]	n=32 (50±15%)	Chester step test: performed on a 20 cm step incrementally (5 steps per minute every 2 minutes), with a pace of 15 steps per minute until 35 steps per minute, in a total time of 10 minutes.	Number of repetitions
	Camargo *et al*.[10]	n=32 (46±15%)		
	Karloh *et al.*[47]	n=10 (38.1±11.8%)	Chester step test II: performed on a 17 cm step incrementally (5 steps per minute every 1 minute), starting with a pace of 15 steps per minute, in a total time of 10 minutes.	Number of repetitions

Andrade *et al.*[44] Dal Corso *et al.*[46]	n=32 (50±15%) n=34 (46±14%)	Incremental Step Test: to begin with 10 steps per minute and the increment of 1 step every 30 seconds until exhaustion. The step height was 20 cm.	Number of repetitions
Costa *et al.*[45] Marrara *et al.*[48] Pessoa *et al.*[50] Pessoa *et al.*[22] Marino *et al.*[52]	n= 32 (45.8±17.7%) n=36 (48.5 ± 15.4%) n=32 (45.8±17.7%) n=11(46.1 ± 15.2%) n=17 (45.5±11%)	6-minute step test: to step up and down a 14 – 20 cm step at self-paced speed as many times as possible within 6 minutes.	Number of repetitions
Machado *et al.*[53] Schnaider and Karsten[51]	n=20 (NA) n=8 (NA)		
Perrault *et al.*[49]	n=43 (49 ± 16%)	Step test: to step up and down in four bouts (3-minute each), at constant stepping rates of 18, 22, 26 and 32 steps.min^{-1} with a 10-minute of rest between each step bout.	Number of repetitions
Swinburn *et al.*[9]	n=17 (0.77±0.30 in liters) (NA in %)	Paced step test: to step up the 25-cm platform with both feet immediately on hearing the timer and step down in the next signal given every four seconds until exhaustion.	Number of repetitions
Starobin *et al.*[55] Kramer *et al.*[54]	n=50 (46.3 ± 19.9%) n=96 (30±10-83±15%)	15 steps exercise oximetry test: performed in a 20-cm step; to climb up and down the step 15 times as fast as possible and the time of the exercise was recorded according to the desaturation and recovery time.	Time

FEV_1=forced expiratory volume in 1 second; GS = gait speed; TUG = timed up and go; STS =sit-to-stand test; COPD = chronic obstructive pulmonary disease; CHF = chronic heart failure; CRF = chronic renal failure; 4MGS = 4-metre gait speed; NA = not available.

Table 2. Methodological quality of measurement properties in the included studies.

Functional Test	Studies	Protocols	Measurement Properties		
			Validity	Reliability	Responsiveness
GS	Kon *et al.*[29]	4MGS	-	-	Fair
	Kon *et al.*[8]	4MGS	Fair	Fair	-
	Karpman *et al.*[27]	4MGS and 10MGS	-	Poor	-
	De Pew *et al.*[26]	4MGS,	Fair	-	-
	Andersson *et al.*[24]	30MGS	Fair	Fair	-
Step Test	Marrara *et al.*[48]	6MST	-	-	Poor
	Camargo *et al.*[10]	CST	-	Fair	-
	Costa *et al.*[45]	6MST	-	Fair	-
	Pessoa *et al.*[50]	6MST	Fair	-	-
	Dal Corso *et al.*[46]	IST	-	Fair	-
	Karloh *et al.*[47]	CST II	Poor	-	-
	Perrault *et al.*[49]	Step test	-	Fair	-
	Starobin *et al.*[55]	15 steps exercise oximetry test	Fair	-	-
TUG	Mesquita *et al.*[32]	Usual speed; 3m	-	Poor	-
	Benton *et al.*[23]	Fast speed; 2,5m	Fair	-	-
STS	Aguilaniu *et al.*[35]	3CRT	-	Fair	-
	Benton *et al.*[23]	30STS	Fair	-	-
	Jones *et al.*[7]	5STS	Fair	Good	Fair

GS = gait speed; 4MGS = 4-metre gait speed; 10MGS = 10-meter gait speed; 30MGS = 30-meter gait speed; 6MST = six-minute step test; CST = chester step test; IST = incremental step test; TUG = timed up and go; STS =sit-to-stand test; 3CRT = 3-minute chair rise test.

Table 3. Psychometric properties of the simple lower limb functional tests.

Test	Validity	Reliability	Responsiveness
GS	Correlation between 4MGS and ISWT, 6MWD, MRC, SGRQ and PAL (r=0.78[8], ≥0.70[26, 28], -0.55[8], -0.44[8], 0.35[26] respectively; all p≤0.007). Correlation between 30MGS and 6MWD and PAL (r=0.78[24]; r=0.43[25] respectively; p<0.001).	Test-Retest 4MGS (ICC≥0.95)[8, 27]. Interobserver 4MGS (ICC=0.99)[8]. Test-Retest 10MGS (ICC=0.97)[27]. Test-Retest 30MGS (ICC=0.87 – 0.93)[24].	Significant increase in mean 4MGS with PR (0.08 $m.s^{-1}$); ES=0.4; MID=0.11 $m.s^{-1}$ [29].
TUG	-	Test-Retest TUG (ICC=0.85 – 0.98)[32]	-
STS	Correlation between 5STS and ISWT, QMVC, SGRQ, MRC, ADO and iBODE (r=-0.59, -0.38, 0.35, 0.43, 0.42, 0.46, respectively; all p<0.001)[7]. Correlation between 30sec STS and 1RM (r>0.38; p<0.05)[23].	Test-Retest 5STS (ICC =0.97)[7]. Interobserver 5STS (ICC=0.99)[7]. Test-Retest 3 CRT (ICC >0.80)[35].	Significant reduction in median 5STS with PR (-1.4s); ES=0.32; MID=1.7[7].
Step Test	Correlation between 6MST and 6MWT (r=0.76; p<0.05)[50]. Correlation between Chester step test and ISWT and 6MWT (r=0.67[47], 0.83[47], respectively; all p<0.05).	Test-Retest 6MST (ICC≥0.79)[45]. Test-Retest Chester step test (ICC=0.99)[10]. Test-Retest IST (ICC=0.98)[46]. Test-Retest Step Test (ICC≥0.91)[49].	Significant increase in mean 6MST with physical training (11 steps)[48].

GS = gait speed; TUG = timed up and go; STS = sit-to-stand test; 4MGS = 4-metre gait speed; ISWT = incremental shuttle walking test; 6MWT = six-minute walk test; MRC = medical research council; SGRQ = St. George's Respiratory Questionnaire; PAL = physical activity level; 10MGS = 10-meter gait speed 30MGS = 30-meter gait speed; 6MWD = six-minute walk distance; 5STS = 5-repetition sit-to-stand test; QMVC = quadriceps maximum voluntary contraction; ADO = Age Dyspnea Obstruction index; iBODE = BODE index; 6MST = six-minute step test; ICC = intraclass correlation coefficient; 3CRT = 3-minute chair rise test; IST = incremental step test; PR = pulmonary rehabilitation; ES = effect size; MID = minimal important difference.

Table 4. Recommendations for clinical practice of four types of simple lower limb functional tests.

Test	Recommendations
Gait Speed	Easy to perform and requires simple and inexpensive equipment. Shorter courses (e.g., 4 m) are more suitable when assessing patients with severe disability.
Timed up and go	The most appropriate of these four tests in order to assess functional mobility and to objectively detect balance impairment and risk of falling in patients with COPD.
Sit to stand	Evaluates a common activity in daily life and should be considered in situations where space is restricted. It is used for screening patients with poor physical functioning and is a strong predictor of 2-year death in COPD.
Step Test	Easy to standardize. It is able to detect when oxygen supplementation is required and evaluates a type of daily activity other than the ability to walk in patients with COPD. Incremental protocols may help the prescription of intensity, speed or work load in an exercise training program.

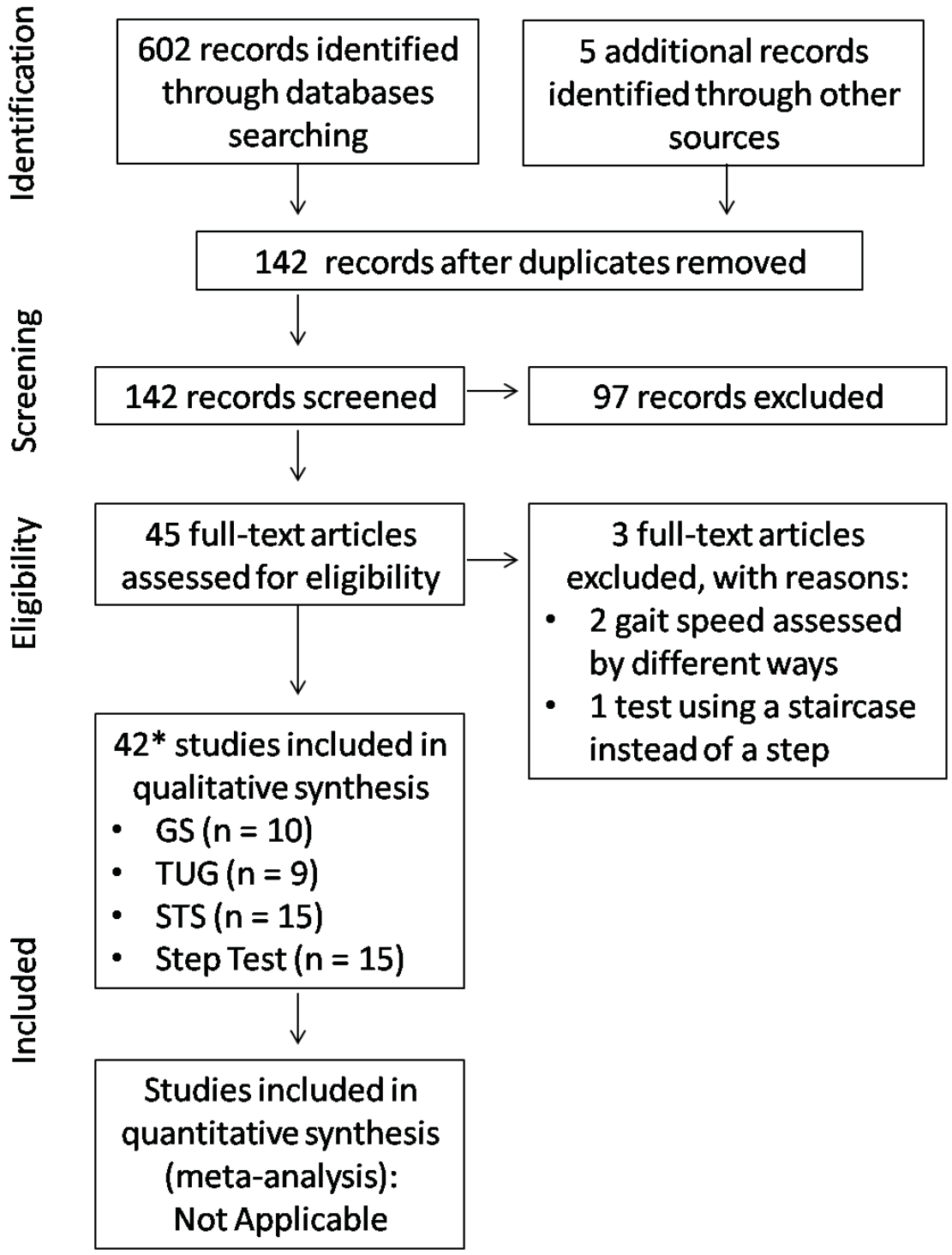

Figure 1. Flowchart of literature search

5 ARTIGO 2

Artigo original formatado de acordo com as normas do periódico Journal of Cardiopulmonary Rehabilitation and Prevention; Fator de Impacto: 1,58; Qualis A1.

4-METRE GAIT SPEED TEST IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE: INTERRATER RELIABILITY OF THE ASSESSMENT USING A STOPWATCH

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ABSTRACT

PURPOSE: The 4-metre gait speed (4MGS) is increasingly used to assess functional performance in patients with chronic obstructive pulmonary disease (COPD). However, the current literature lacks information regarding some technical standards of this test. Therefore, the purpose of this study was to compare and to evaluate the interrater reliability between the stopwatch and video recording used as timing systems in the 4MGS in patients with COPD, as well as to verify the interrater reliability, in which two observers measured the 4MGS time by a manual stopwatch.

METHODS: Fifty-one patients performed the 4MGS through four different protocols (random order): walking at the usual and maximum speed in a 4-meter course; and walking at the same two speeds in an 8-meter course, considering a 2-meter acceleration zone, a 4-meter timing area, and a 2-meter deceleration zone. Gait speed was measured simultaneously using a stopwatch and a video recording. Moreover, in a sub analysis (n=24) two independent observers timed the 4MGS using the stopwatch.

RESULTS: There was no significant differences in comparison between the two timing methods ($P>0.05$ for all) and the reliability between video recording and stopwatch was excellent in all 4MGS studied protocols (ICC≥0.91). Moreover, when comparing gait speed measured by two observers using a stopwatch, no difference was found among all proposed protocols ($P>0.05$ for all). There was also excellent reliability between the two independent observers (ICC≥0.94).

CONCLUSION: The stopwatch, a low-cost and feasible tool, is reliable as a timing system for the 4MGS in patients with COPD.

Keywords: pulmonary disease, chronic obstructive; activity of daily living; exercise test.

CONDENSED ABSTRACT

The stopwatch, a low-cost and feasible tool, is reliable as a timing system for different protocols of the 4-metre gait speed test in patients with chronic obstructive pulmonary disease. There were no differences in comparison to video recording and when comparing gait speed measured by two observers using a stopwatch.

INTRODUCTION

Gait speed has been studied in non-disabled older community-dwellers and has been showed to be associated with increased hospitalization, falls and mortality rate[1]. Additionally, in subjects with chronic diseases, gait speed is inversely related to the severity of the illness[2]. As an example, there has been growing interest in studying the walking speed of patients with chronic obstructive pulmonary disease (COPD). Studies have shown association of these patients' gait speed with exercise capacity (Incremental Shuttle Walking Test [ISWT] and the Six-minute Walk Test [6MWT]), dyspnea (Medical Research Council [MRC] scale), health-related quality of life (Saint George's Respiratory Questionnaire) and with variables of physical activity in daily life (e.g. number of steps/day and sedentary time)[3-6].

The 4-metre gait speed (4MGS) can be an useful tool to evaluate walking speed in COPD since it is simple, practical, requires only limited space[3, 5-7] and therefore can be performed in research as well as in clinical settings.

However, the current literature lacks information regarding some technical standards and execution, such as the length of the corridor (4 or 8 meters), the selected speed (usual or maximum) and the possible timing methods in order to determine the gait speed. Concerning the latter, the measurement of time in the 4MGS test may be performed basically by two methods: video recordings, in which the exact moment that the patient starts and ends the test is carefully analyzed by videotape; or by manual stopwatch, which is a simple and cheap device[7, 8]. Hence, it is yet unknown whether the stopwatch presents good measurement properties in comparison to video recordings. Therefore, the aims of this study were to compare and to evaluate the interrater reliability of two timing methods used in the 4MGS

(stopwatch and video recording) in patients with COPD, as well as to verify the interrater reliability in which two observers (previously trained physical therapy students) measured the time in the 4MGS by a manual stopwatch.

METHODS

Study design and sample

This is a cross-sectional study, carried out from January 2014 to May 2015 at the Laboratory of Research in Respiratory Physiotherapy of State University of Londrina, Brazil. The study was approved by the ethics committee of the institution (080/2014) and all the patients have signed the informed consent. The recommendations of GRRAS (Guidelines for Reporting Reliability and Agreement Studies) were followed[9].

A convenience sample was composed by patients with diagnosis of COPD[10], which was recruited during the initial assessment of a pulmonary rehabilitation program. Besides the diagnosis of COPD, other inclusion criteria were: clinical stability (i.e. absence of exacerbation within previous three months) and not having attended any pulmonary rehabilitation program or physical exercise training in the previous 12 months. Participants were excluded from the study if they had severe comorbidities such as cardiovascular, orthopedic or neuromuscular conditions that could compromise the performance in the tests, or if they did not complete all the proposed assessments.

Assessments

Participants had their clinical data, lung function and gait speed assessed. Lung function was evaluated by spirometry, according to international standard guidelines and the reference values adopted were those proposed for the Brazilian population[11].

In order to measure the gait speed, patients underwent four different protocols of the 4MGS test, which included a corridor of 4 or 8 meters, and usual or maximum speed (see details below). Each protocol was performed twice, without rest between them, and in a randomized sequence. Moreover, time spent to perform the tests was simultaneously recorded by a stopwatch (Herweg®, Brazil) and by video recording (digital Cyber-shot camera, Sony®, Japan). The time obtained by the stopwatch was simultaneously assessed by two independent observers, in order to verify the inter-rater reproducibility. The raters were not blinded to the protocol that was being undertaken. The video recording was set up alongside the corridor of the test to record a full image. Then, the exact time of the test recorded by video was analyzed using a specific software (Windows Movie Maker, Microsoft®, USA). Based on the recorded time and covered distance in the 4MGS, the gait speed was calculated in meters per second (m/s). The following protocols of the 4MGS were performed:

4MGS-4[6] (static start)*:* Two cones were placed 4 meters apart and the participant was positioned immediately before the starting point (first cone) at the beginning of the test. Timing started with the patient's first movement and stopped when the first foot completely crossed the second cone. Participants were instructed to walk in this corridor on their usual (4MGS-4U protocol) and maximum (4MGS-4M protocol) pace.

4MGS-8[7] (rolling start)*:* A corridor of 8 meters was used, in which the initial 2 meters were provided as an acceleration zone, followed by the 4-meter timing area and 2 more meters at the end, representing the deceleration zone. Firstly, the subject was positioned immediately before the starting line of acceleration zone. The time spent to move along the 4-meter central course began when the first foot crossed the first cone and finished when the first foot completely crossed the second cone. In this protocol, participants were also instructed to walk at their usual (4MGS-8U) and maximum (4MGS-8M) pace.

Statistical analysis

All the analyses were performed using the softwares SPSS 20.0 (Statistical Package for Social Sciences Inc., USA) and GraphPad Prism 6.0 (GraphPad Software Inc., USA). The normality of continuous variables was verified by the Shapiro-Wilk test and described as mean±standard deviation (SD) or median [interquartile range 25%-75%]. Moreover, the comparison between different timing methods (video or stopwatch) was performed by the paired t-test. The interrater reliability analysis was performed in a subgroup of patients (n=24), in which the 4MGS time was recorded by the stopwatch. Subsequently, to compare time measured by two independent observers (previously trained physical therapy students), the Wilcoxon test was used. To analyze the interrater reliability measures between the 4MGS protocols and between the two observers, the intraclass correlation coefficient (ICC) was performed. Furthermore, the graphical method proposed by Bland and Altman was used to analize interrater agreement.

The Standard Error of Measurement (SEM), which measures the amount of error in the sample (variability around the mean), was calculated according to the

equation (SEM=SD*√1-ICC)[12]. It was used to verify the agreement between the timing methods (stopwatch and video) and between the two observers and it was expressed in percentage and absolute values. For all analyses, a $P \leq 0.05$ was set as statistically significant.

The sample size calculation was performed with the Power and Sample Size Program (version 3.0) considering the study of Karpman et al[7]. Taken into account a difference of 0.06±0.14 m/s in the 4MGS protocols, alpha value of 0.05, power of 80%, the number of subjects for this study was 45 patients.

RESULTS

Fifty-one patients were included in the study: 29 men, 68±8 years, body mass index (BMI) of 27±5 kg/m^2 and forced expiratory volume in the first second (FEV_1) of 52[33-61]% of predicted. Considering the severity of the disease, patients were classified as follows: 28 had moderate disease (GOLD II), 16 had severe disease (GOLD III) and 7 had very severe disease (GOLD IV).

When comparing the gait speeds obtained by the stopwatch and the video recording, no differences were found for any of the studied protocols ($P>0.05$ for all). Gait speeds and ICC values are described in Table 1. In addition, the reliability of time measured by video recording and stopwatch proved to be excellent in all protocols (Table 1) and are illustrated in the Bland & Altman plot (Figure 1).

The subgroup analysis (15 men, 69±8 years; BMI 27±6 kg/m²; FEV_1 48±18%pred), which had the 4MGS walking time measured by the stopwatch by two independent observers, did not reveal any difference in gait speed for the studied

protocols. Furthermore, the interrater reliability proved to be excellent. Gait speeds and ICC values are shown in Table 1.

Comparing the timing methods (stopwatch and video recording), the SEM values ranged from 0.08 to 0.10 m/s and 5.3 to 9.1% for all studied protocols. Moreover, the SEM values in interrater analysis ranged from 0.05 to 0.10 m/s and 3.8 to 6.8%.

DISCUSSION

The present study elucidates some technical questions regarding the 4MGS test performed in patients with COPD. The use of a stopwatch, a practical and low cost tool, proved to be trustworthy as a timing mechanism of this test when compared to the criterion method. Furthermore, the stopwatch has proven to be reproducible when two independent observers assessed the walking speed during the 4MGS test.

A variety of 4MGS testing protocols are available for assessing gait speed; however, procedures differ among themselves and there is no standardization in regard to the corridor length, selected speed (usual or maximum) or timing procedure and instrument[3, 6, 7]. In the present study, four different assessment protocols of gait speed and two different methods were selected for time recording. Although a standardized protocol has not been adopted, it is recommended to adhere to one specific protocol, that is, to perform the test in the same distance and with the same speed instruction for all patients[7].

Maggio *et al.*[13] showed that the stopwatch might lead to misclassification of gait speed in non-disabled older community-dwellers and the reliability of this manual

instrument with a tri-axial accelerometer is not optimal. The conflicting results with the present study can be explained by some methodological differences between them, such as the studied population and the timing mechanisms used for comparison with the stopwatch. It is already known that patients with COPD walk less slowly when compared with healthy elderly[14]. Moreover, the ability of a tri-axial accelerometer to measure functional outcomes in elderly patients is still poorly investigated[13].

On the other hand, Karpman *et al.*[7], demonstrated that, in patients with COPD, there is a good reliability between a stopwatch and an automatic timing system when evaluating the 4MGS protocols in both maximum and usual speed, corroborating the present study findings. Furthermore, the use of the video recording as a criterion method in this study adds some solid information to the literature regarding the reliability of the stopwatch as a timing method, since the video could be analysed as many times as necessary to ensure accurate detection of the start and end times of the test[14].

There were no differences in gait speed, timed by the stopwatch, when it was evaluated by two different observers. This finding corroborate with previous studies that performed simple and practical functional tests using a manual stopwatch to measure time[3]. Furthermore, the SEM was lower than 10% for all measurements, which is considered an acceptable error for assessment instruments[15].

Gait speed, measured by the 4MGS test, is feasible and reliable in patients with COPD[3, 6, 7]. However, an investigation of accurate, standardized and reproducible techniques of measurement, considering this variable, are in fact, necessary. Moreover, the use of a simple and low-cost tool, such as the stopwatch, further enables the application of this test in clinical practice.

Probably the most important limitation of the present study was the lack of individuals with mild COPD (GOLD I) in the sample, which may limit the external validity of the results. The authors are aware that gait speed slows down with increasing COPD severity[2] and gait speed values are higher for patients with mild COPD. This fact may compromise the ability to generalize the results, since the stopwatch may be less accurate in short-distance walks with faster speed[7]. Nevertheless, this study included patients with a wide range of moderate to very severe disease, which is the typical population involved in pulmonary rehabilitation programs.

CONCLUSION

When assessing two timing methods to evaluate gait speed, there were similarity and excellent reliability between the stopwatch and video recording in all 4MGS tested protocols. In addition, when the stopwatch was used for timing the 4MGS test by two independent observers, an excellent reliability was found between them. Thus, it was concluded that the stopwatch, a practical and low-cost tool, provided a reliable measure of time spent in the 4MGS test by patients with COPD, expanding the possibility of using this test in clinical and research settings.

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Table 1. Comparison and reliability of gait speed in different protocols of 4MGS measured by video, stopwatch and inter-rater assessment.

Protocol	Video (m/s)	Stopwatch (m/s)	ICC	CI 95%	*P*	Observer 1 (m/s)	Observer 2 (m/s)	ICC	CI 95%	*P*
4MGS-4M	1.36±0.24	1.38±0.24	0.91	0.85-0.95	0.25	1.32 [1.2-1.5]	1.33 [1.2-1.5]	0.97	0.93-0.99	0.88
4MGS-4U	1.05±0.21	1.07±0.24	0.91	0.84-0.95	0.17	1.02±0.24	1.03±0.20	0.95	0.89-0.98	0.63
4MGS-8M	1.71±0.26	1.70±0.31	0.95	0.92-0.97	0.69	1.69±0.26	1.72±0.32	0.94	0.87-0.98	0.23
4MGS-8U	1.31 [1.2-1.5]	1.32 [1.1-1.4]	0.95	0.92-0.97	0.12	1.34±0.23	1.33±0.25	0.97	0.93-0.99	0.72

ICC: Intraclass correlation coefficient, 4MGS-4M: 4-metre gait speed protocol in 4-meter course at maximum pace; 4MGS-4U: 4-metre gait speed protocol in 4-meter course at usual pace 4MGS-8M: 4-metre gait speed protocol in 8-meter at maximum pace; 4MGS-8U: 4-metre gait speed protocol in 8-meter at usual pace. $P \leq 0.05$.

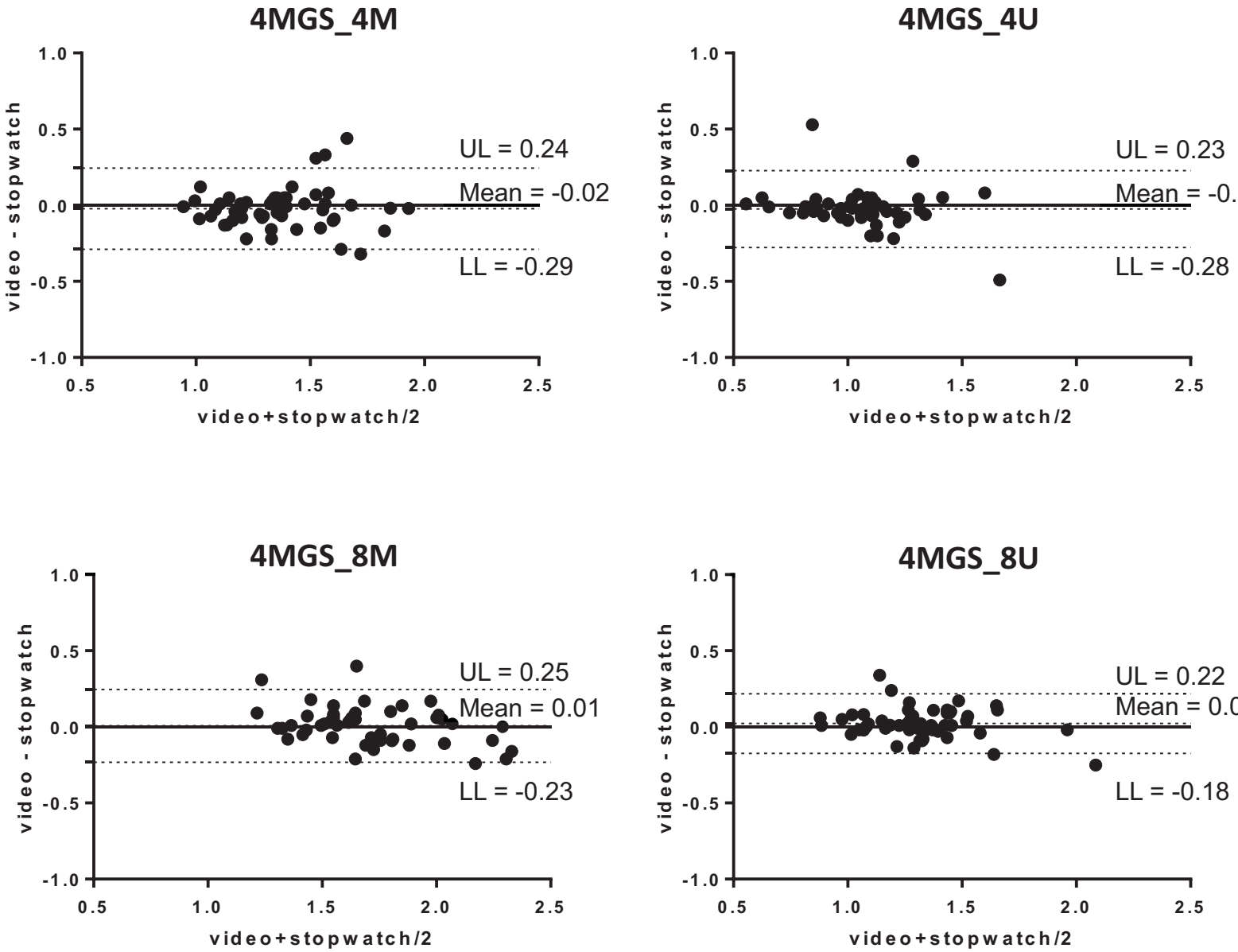

Figure 1. *Bland & Altman* plots of the difference *versus* mean of two timing assessment methods (video and stopwatch) in the protocols of the 4-metre gait speed: 4 meters at maximum pace (4MGS_4M) and usual pace (4MGS_4U); and 8 meters at maximum (4MGS_8M) and usual (4MGS_8U) pace.

6 ARTIGO 3

Artigo original formatado de acordo com as normas do periódico Clinical Rehabilitation; Fator de Impacto: 2,403; Qualis A1.

4-metre gait speed test as an exercise prescription tool in patients with COPD

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Abstract

Objectives: To analyze the efficacy of the 4-metre gait speed test (4MGS) to prescribe high-intensity exercise and predict distance covered in the 6-minute walk test (6MWT) in patients with chronic obstructive pulmonary disease (COPD). In addition, a second aim was to identify which 4MGS protocol better estimates these outcomes.

Methods: Patients with moderate-to-very severe COPD (N=44) performed four different 4MGS protocols: walking 4 meters in a 4-meter course at the usual and maximum speed, (4MGS_4U and 4MGS_4M, respectively) (i.e., static start); and walking at these same two speeds in an 8-meter course (4MGS_8U and 4MGS_8M respectively), considering only the mid-4m section of the course (rolling start). Intensity for exercise prescription was determined as 75% of the 6MWT average speed.

Results: Average walking speeds for the 4MGS_4U, 4MGS_4M, 4MGS_8U and 4MGS_8M were 1±0.2 m/s; 1.4±0.2 m/s; 1.3±0.2 m/s and 1.7±0.3 m/s, respectively. Patients walked 453±73 meters in the 6MWT, generating a prescribed speed of 0.96±15 m/s. The four protocols correlated with 75% of the average 6MWT speed (0.47≤r≤0.69) and three protocols (4MGS_4M, 4MGS_8U and 4MGS_8M) correlated significantly with the walked distance in the 6MWT (0,40≤r ≤0.49). The 4MGS_8M was the protocol which better predicted exercise intensity, with a coefficient of determination of R^2=0.46. None of the protocols could explain more than 23% of the distance covered in the 6MWT.

Conclusion: Compared to different 4MGS protocols, the 4MGS at the maximum speed in a corridor of 8 meters is a promising tool to prescribe high-intensity exercise for patients with moderate-to-very severe COPD.

Keywords: Pulmonary Disease, Chronic Obstructive; Exercise; Exercise Test; Validation Studies.

Introduction

Exercise training remains the essential component of rehabilitation programs and an appropriate prescription of exercise intensity is necessary in order to guarantee the training benefits[1]. The target intensity for training is generally prescribed as a percentage of maximum exercise capacity; however, a cardiopulmonary exercise test (CPET) may not be accessible in many settings due to limited resources.

The 6-minute walking test (6MWT) was also shown to be useful in high-intensity exercise prescription for walking and a percentage of the 6MWT average speed was set as training speed[2, 3]. In patients with COPD the test presents similar VO2max responses in comparison to CPET. Despite the undeniable importance of the 6MWT to evaluate exercise capacity[4], the test requires space and time, which may hinder its use in some clinical settings.

In order to carry out the exercise prescription in a simpler way, the 4-metre gait speed (4MGS) may be another option. The test evaluates the gait speed in a distance of 4 metres. It is a reliable and low cost test which requires short time and space[5-7].Although the 4MGS has potential as an assessment tool[5-8], no prior study confirmed its utility for exercise prescription.

Therefore, the aims of this study were to verify whether it is possible to prescribe the high-intensity of exercise training and to predict the distance covered in the 6MWT through the 4MGS in patients with moderate-to-very severe COPD. In addition, since there are different available protocols for the 4MGS, another aim was to identify which protocol better estimates these outcomes.

Methods

Forty-four patients were cross-sectionally assessed concerning their lung function (spirometry)[9] and functional exercise capacity (4MGS and 6MWT). The study was approved by the Research Ethics Committee of the University Hospital, State University of Londrina, Brazil (080/2014) and all patients signed a written informed consent.

Inclusion criteria were the diagnosis of COPD according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria, absence of exacerbations within the previous 3 months and not having attended a pulmonary rehabilitation program in the last year. Subjects were excluded if presenting any comorbidity that might influence the execution of the tests or if unable to perform the proposed activities for any reason.

Six-minute walk test: The 6MWT was performed in accordance with international standards[4] and Brazilian normal values were used[10]. Each subject performed two tests and the test with longer walked distance ($6MWT_{distance}$) was considered for analysis. The exercise training intensity for walking was set at 75% of the average 6MWT speed ($6MWT_{75\%speed)}$[3].

Gait speed[5, 6]**:** Patients were instructed to walk in a 4-m course hallway and a stopwatch was used to record the time taken to complete the course. Individuals were submitted to four different protocols of the 4MGS (4MGS_4U; 4MGS_4M; 4MGS_8U; 4MGS_8M, as described below) in a randomized sequence. Each protocol was repeated twice without rest and the faster of the two tests was used to calculate the speed (m/s).

4MGS_4 (static start): Two cones were placed 4 meters apart and the participant was positioned slightly behind the first cone. Timing with the stopwatch started when the participant began to move and was stopped when the participant's first foot completely crossed the second cone. Patients were instructed to walk at the usual (4MGS_4U) and maximum (4MGS_4M) speed.

4MGS_8 (rolling start): It was performed in an 8-m course (a 2-m acceleration zone, a 4-m timing area and a 2-m deceleration zone) and the gait speed in the central 4-m of the corridor was evaluated. The timing started when the participant's first foot completely crossed the start of the 4-m timing area and stopped when the participant's first foot completely crossed out of this area. The instructed pace was also usual (4MGS_8U) and maximum (4MGS_8M) speed.

Statistical analysis was performed using the statistical software packages SPSS 21.0 (SPSS Inc., USA) and GraphPad Prism 6.0 (GraphPad Software Inc., USA). Normality of data distribution was checked by the Shapiro-Wilk test and

described as mean±SD. Paired t test was used to compare 4MGS and $6MWT_{75\%speed}$. Pearson correlation coefficients were calculated and a model of multivariate linear regression was tested (anthropometric data and 4MGS protocols as independent variables tested with $6MWT_{distance}$ and $6MWT_{75\%speed}$ as dependent variables). No multivariate model was statiscally successful, and therefore an univariate linear regression was applied (4MGS protocols as independent variables only).

In order to verify the reliability of the regression equation, it was applied *a posteriori* in a different group of patients with COPD (n=12) selected according to the same inclusion criteria of the present sample. The Intraclass Correlation Coefficient (ICC) was used to evaluate agreement between the actual 6MWT distance and the $6MWT_{75\%speed}$ with the predicted values. $P<0.05$ was set as significant.

Results

The characteristics of 44 patients with COPD are described in Table 1. The gait speed varied among the 4MGS protocols (Table 1). The speed achieved in all 4MGS protocols was higher than $6MWT_{75\%speed}$ ($P<0.01$ for all).

Considering the 4MGS protocols and anthropometric variables, significant correlations were found between $6MWT_{75\%speed}$ with age (r=-0.40), forced vital capacity (FVC)(r=0.35) and all 4MGS protocols ($0,47 \leq r \leq 0.69$, see table 2). There were also significant correlations between $6MWT_{distance}$ with age (r=0.33), 4MGS_4M, 4MGS_8U and 4MGS_8M, ($0,40 \leq r \leq 0.49$, see table 2). Regression analysis was performed, however only the 4MGS protocols remained in the model. The coefficient of determination values were described in Table 2. $6MWT_{distance}$ could not be estimated in a satisfactory way by the 4MGS protocols. On the other hand, a model of univariate linear regression showed that the 4MGS-8M better predicts exercise intensity, explaining 46% of the variability in the $6MWT_{75\%speed}$ ($P<0.0001$) (Figure 1). According to 4MGS-8M, the reference equation for the $6MWT_{75\%speed}$ was:

$$6MWT_{75\%speed}\,(m/s) = [0.407 + (0.329 * 4MGS\_8M)]$$

The characteristics of the matched group composed by 12 patients (6 male) included *a posteriori* were: age 68±7 years, BMI 27±4 kg/m^2, FEV_1 57±17%pred and

FVC 77±22%pred (*P*>0.05 for all). When the reference equation derived from the 4MGS-8M was applied in this group, there was good agreement between the actual $6MWT_{75\%speed}$ and the predicted value obtained from the reference equation (ICC=0.80). No difference between the actual and predicted $6MWT_{75\%speed}$ was found (*P*=0.81) and there was moderate correlation between the actual and predicted $6MWT_{75\%speed}$ (r=0.63).

Discussion

Although the 4MGS can be used as an assessment tool of physical function in patients with COPD[5-7], to the authors' best knowledge this is the first study to assess its capacity to prescribe exercise. In addition, the findings were extended to different 4MGS measurement protocols. Among the 4 studied protocols, the 4MGS performed at maximum speed in an 8-meter corridor seems to be a suitable option to prescribe exercise intensity for patients with COPD. The present results also demonstrated that these 4 studied protocols were not able to properly predict the distance achieved in the 6MWT.

Although the 6MWT has a submaximal profile, it can be used to prescribe walking exercise intensity since it provides sufficient physiological stress in patients with COPD[2]. Responses concerning maximal oxygen consumption (VO_2max) are similar during the execution of the 6MWT and during the cardiopulmonary exercise test (CPET)[11]. Although the 4MGS provides less physiological information and was not able to identify the need for oxygen supplementation when compared to the 6MWT[12], it was applicable to prescribe exercise training intensity in an easy-to-perform way. Furthermore, as shown in previous studies[5, 8, 13], the present study also found a significant association between the gait speed and exercise capacity.

Simple functional tests which simulate everyday tasks and involve basic movements are increasingly used in clinical practice[12]. The 4MGS offers some advantages in daily practice since it does not require a special place to be performed (e.g., 30-m corridor), has a short administration time and requires simple and low cost equipment[5, 6, 12].

Gait speed measurements are reliable in patients with COPD regardless of the instructed pace and distance[6]; however, according to the present results, exercise

intensity can be better explained by the 4MGS_8M protocol. This discrepancy happens because a greater number of steps and a rolling start in the test might be more accurate for estimating gait speed[15]. A static start in short distances can result in slower speed[15]. None of the protocols could explain more than 23% of $6MWT_{distance}$, and this is likely because speed and distance have different constructs. Therefore, the 4MGS does not predict well the $6MWT_{distance}$ and cannot replace it, although it seems to provide a feasible way to prescribe exercise.

Despite all efforts, the present study has limitations. The use of a convenience sample, with no patient classified as GOLD I, restricts the results to patients with moderate-to-very severe degree of airflow obstruction. Moreover, larger studies could provide more robust prediction models.

In conclusion, the clinical usefulness of the 4MGS may be larger than previously expected since all 4MGS protocols are significantly associated with 6MWT. Among the studied 4MGS protocols, the 4MGS at the maximum speed in a corridor of 8 meters proved to be the best option in the prescription of exercise intensity for patients with moderate-to-very severe COPD.

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Table 1. Characteristics of the study subjects.

	n=44
Gender (M/F)	24/20
Age (years)	69±8
BMI ($kg.m^{-2}$)	25[22-30]
FEV_1 (L)	1.25±0.45
FEV_1 (%predicted)	49±18
FEV_1/FVC (%)	53±12
GOLD (II/III/IV)	23/15/6
$6MWT_{distance}$ (m)	453±73
6MWT (%predicted)	85±15
$6MWT_{speed}$ (m/s)	1.28±0.20
$6MWT_{75\%speed}$ (m/s)	0.96±0.15
4MGS_4U(m/s)	1.05±0.23
4MGS_4M (m/s)	1.38±0.24
4MGS_8U (m/s)	1.29±0.23
4MGS_8M (m/s)	1.68±0.31

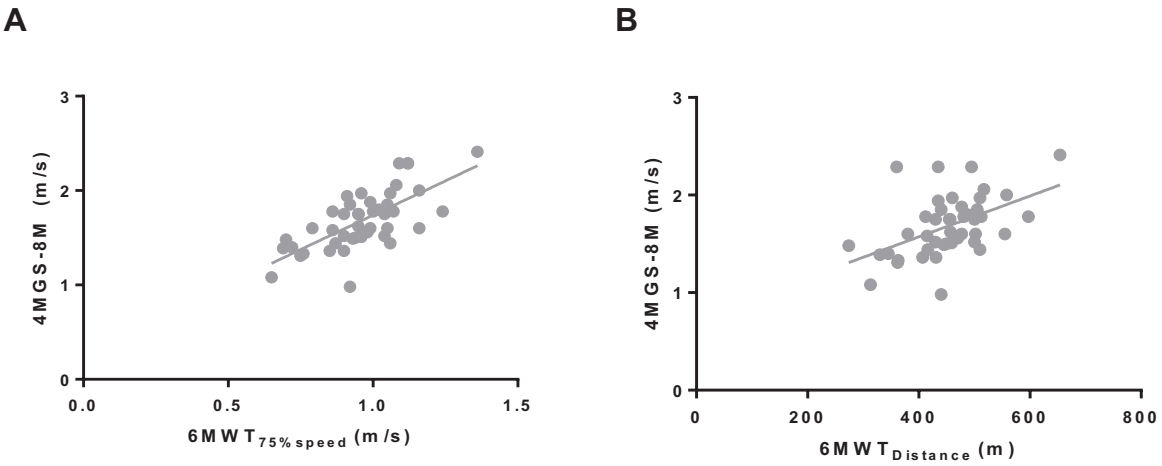
Data expressed as absolute frequency, mean±SD or median [IQR]. M:male; F:female; BMI:body mass index; FEV_1:forced expiratory volume in the first second; FVC: forced vital capacity; GOLD: Global Initiative for Chronic Lung Disease; $6MWT_{75\%speed}$: 75% of the six-minute walk test average speed; $6MWT_{distance}$: distance walked in the six-minute walk test; 4MGS_4U: four-metre gait speed at the usual speed in an 4-meter course; 4MGS_4M: four-metre gait speed at the maximal speed in an 4-meter course; 4MGS_8U: four-metre gait speed at the maximal usual speed in an 8-meter course; 4MGS_8M: four-metre gait speed at the maximal speed in an 8-meter course.

Table 2. Pearson correlation coefficients and univariate linear regression of the four 4MGS protocols with exercise intensity and the distance covered in the 6MWT as dependent variables.

Protocol	r $6MWT_{75\%speed}$	r $6MWT_{distance}$	R^2 $6MWT_{75\%speed}$	R^2 $6MWT_{distance}$
4MGS_4U	0.47	0.28#	0.20	0.06#
4MGS_4M	0.63	0.46	0.38	0.19
4MGS_8U	0.59	0.40	0.33	0.14
4MGS_8M	0.69	0.49	0.46	0.23

$6MWT_{75\%speed}$: 75% of the six-minute walk test average speed; $6MWT_{distance}$: distance walked in the six-minute walk test; 4MGS_4U: four-metre gait speed at the usual speed in an 4-meter course; 4MGS_4M: four-metre gait speed at the maximal speed in an 4-meter course; 4MGS_8U: four-metre gait speed at the maximal usual speed in an 8-meter course; 4MGS_8M: four-metre gait speed at the maximal speed in an 8-meter course; #*P*=0.06. All other correlations were statistically significant.

Figure 1. Correlation between 4MGS-8M and 6MWT (A - 75% of the average speed: r= 0.69; and B - distance walked: r= 0.49; *P*≤0.001 for both).



6MWT: six-minute walk test; 4MGS-8M: four-metre gait speed at the maximal speed in an 8-meter course.

7 CONCLUSÃO GERAL DA TESE E PERSPECTIVAS FUTURAS

A gravidade da doença, idade avançada, múltiplas comorbidades e questões ambientais são alguns dos fatores que podem vir a restringir a capacidade funcional de indivíduos com doença pulmonar obstrutiva crônica (DPOC). Consequentemente esses indivíduos reduzem sua participação nas atividades de vida diária, tornando-se mais inativos e com pior condicionamento físico. A presente tese tem o potencial de contribuir para a literatura visto que há uma crescente necessidade de encontrar maneiras mais simples para identificar esse declínio funcional na prática clínica, e assim, orientar os recursos necessários para prevenir e/ou reduzir essas perdas. É válido ressaltar que a implementação destes testes requer um custo mínimo, logo, os mesmos podem ser realizados dentro do ambiente clínico, hospitalar, no domicílio e em unidades básicas de saúde visto que não exigem um local específico para a sua realização.

O primeiro artigo traz uma síntese da literatura sobre testes funcionais simples, que avaliam a capacidade funcional de MMII em pacientes com DPOC. Os testes mais comumente encontrados foram a velocidade de marcha (GS), o sit-to-stand (STS), o timed up and go (TUG) e o teste do degrau (TD). O GS é um teste fácil de executar, exige equipamento simples e de baixo custo, e ainda, os corredores mais curtos são mais adequados para pacientes com grave incapacidade. O TUG é o teste mais adequado para avaliar a mobilidade funcional e detectar comprometimento no equilíbrio e risco de quedas. O STS pode ser utilizado na triagem de pacientes com capacidade física reduzida e é um forte preditor de mortalidade na DPOC. O TD possui protocolo incremental e pode ser usado para prescrever a intensidade, velocidade ou carga de trabalho em um programa de treinamento físico. Alguns protocolos destes testes apresentam as propriedades de medida melhor estabelecidas em pacientes com DPOC, tais como, o teste de velocidade de marcha realizado em quatro metros, cinco repetições do teste STS e o TD de seis minutos. Além disso, os testes funcionais estão relacionados com a mortalidade, capacidade de exercício e qualidade de vida, que são importantes desfechos clínicos da DPOC.

A velocidade de marcha tem sido apontada como um sinal vital funcional e sua medida por meio do teste 4MGS demonstra ser prática e válida em

pacientes com DPOC. O 2º artigo comparou técnicas de medição dessa variável e concluiu que a utilização do cronômetro, instrumento simples e de baixo custo, pode ser realizada. Tal informação viabiliza ainda mais a aplicação desse teste na prática clínica.

O terceiro artigo aborda a utilização do teste 4MGS na prescrição de exercício de caminhada de alta intensidade, o que até então não havia sido investigado nessa população. O resultado encontrado no estudo possibilitará a correta avaliação da intensidade de treino em centros onde testes mais sofisticados e que requerem mais espaço não são disponíveis. É válido ressaltar que os resultados obtidos nesse estudo ainda não foram testados, sendo necessários mais estudos para investigar a utilização dessa prescrição e as respostas a esse treinamento.

Quanto às perspectivas futuras, mais estudos serão necessários para comparar diferentes testes e protocolos, e para elucidar a escolha do teste mais adequado ao avaliar indivíduos com DPOC de diferentes faixas etárias ou diferentes graus de comprometimento da capacidade de exercício. Além disso, as propriedades de medida ainda não estão totalmente esclarecidas e a capacidade de resposta destes testes em estudos longitudinais precisa ser melhor explorada. Embora os testes funcionais possam ser utilizados como indicadores de bem-estar geral no ambiente clínico, a literatura científica ainda carece de mais estudos para chegar a conclusões baseadas em evidências sobre a força destes testes para predizer dessaturação, exacerbações, internações e reinternações de pacientes com DPOC, bem como a utilização destes testes em pacientes exacerbados.

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APÊNDICE

APÊNDICE A

Termo de Consentimento Livre e Esclarecido

Título da pesquisa:

"Qual teste funcional de exercício reflete melhor as mudanças na atividade física de vida diária após programa de treinamento físico em pacientes com doença pulmonar obstrutiva crônica?"

Prezado(a) Senhor(a):

Gostaríamos de convidá-lo (a) a participar da pesquisa "Qual teste funcional de exercício reflete melhor as mudanças na atividade física de vida diária após programa de treinamento físico em pacientes com doença pulmonar obstrutiva crônica?" realizada no Laboratório de Pesquisa em Fisioterapia Pulmonar da Universidade Estadual de Londrina (Londrina, Brasil). O objetivo da pesquisa é: identificar o teste funcional de exercício que reflete melhor a atividade física de vida diária (AFVD) após programa de treinamento físico em pacientes com DPOC. A sua participação é muito importante e ela se daria da seguinte forma: os pacientes incluídos serão submetidos a algumas avaliações em dois momentos: no início do protocolo e ao término (após 12 semanas de tratamento). Serão realizadas as seguintes avaliações: função pulmonar por meio do teste de espirometria, capacidade funcional de exercício por meio do teste da caminhada de 6 minutos, *4-meter-gait-speed* e do *Sit-to-stand test*, capacidade máxima de exercício por meio do *Incremental Shuttle Walk Test*, força muscular de pernas e braços por meio do teste de uma repetição máxima, e a atividade física de vida diária que será realizada durante 7 dias consecutivos pelos aparelhos Dynaport (DynaPort Activity Monitor, McRoberts, Holanda) e Armband (SenseWear Armband, BodyMedia, Estados Unidos). Esses aparelhos são pequenos e leves, utilizados um na cintura e o outro no braço acima do cotovelo, de manuseio extremamente simples que monitoram todas as atividades físicas realizadas pelo paciente, permitindo saber o quanto ativo ele é. Nos 7 dias de avaliação, o paciente permanecerá durante 24 horas com os aparelhos, havendo a necessidade de retirá-los apenas durante o banho e atividades realizadas em piscina (por exemplo: natação, hidroginástica). O paciente não deverá fazer nenhuma atividade extra, ou seja, será orientado a não mudar suas atividades de rotina. Após a avaliação inicial, os pacientes realizarão um programa de treinamento baseado em exercícios aeróbicos e de força para braços e pernas realizado 3 vezes por semana, 1 hora por sessão, durante 12 semanas. Todas as avaliações e as sessões de treinamento físico serão realizadas no Laboratório de Pesquisa em Fisioterapia Pulmonar da Universidade Estadual de Londrina (Londrina, Brasil)**.** Gostaríamos de esclarecer que sua participação é totalmente voluntária, podendo você: recusar-se a participar, ou mesmo desistir a qualquer momento sem que isto acarrete qualquer ônus ou prejuízo à sua pessoa.

Informamos ainda que as informações serão utilizadas somente para os fins desta pesquisa e serão tratadas com o mais absoluto sigilo e confidencialidade, de modo a preservar a sua identidade.

Os benefícios esperados são: os participantes do estudo receberão tratamento baseado em exercício físico o qual resultará em redução dos sintomas (falta de ar e cansaço), melhora da capacidade física e redução do risco de crises respiratórias. Também esperamos contribuir com a prática clínica visto que alguns testes funcionais de exercício talvez possam refletir o nível de AFVD e assim tornar possível a sua utilização como alternativa às técnicas complexas e de alto custo. Neste estudo, nenhum dos procedimentos utilizados constitui risco direto para a integridade física ou moral dos participantes. Informamos que o(a) senhor(a) não pagará nem será remunerado por sua participação. Garantimos, no entanto, que todas as despesas decorrentes da pesquisa serão ressarcidas, quando devidas e decorrentes especificamente de sua participação na pesquisa.

Caso você tenha dúvidas ou necessite de maiores esclarecimentos pode nos contactar nos telefones (43) 3371-2477 ou 3371-2252 ou pessoalmente no Ambulatório de Fisioterapia Respiratória do Hospital Universitário Regional Norte do Paraná: Av. Robert Koch, 60 – Vila Operária – Londrina – PR (perguntar pelo Professor Fábio de Oliveira Pitta – fabiopitta@uol.com.br)**,** ou no telefone (43) 9647 4010 (falar com Gianna Bisca)**,** ou ainda procurar o Comitê de Ética em Pesquisa Envolvendo Seres Humanos da Universidade Estadual de Londrina, na Avenida Robert Kock, nº 60, ou no telefone 3371-2490. Este termo deverá ser preenchido em duas vias de igual teor, sendo uma delas, devidamente preenchida e assinada entregue a você.

Londrina, ___ de _____de 2014.

Prof. Fábio de Oliveira Pitta
RG: 3626743-7
Pesquisador Responsável e Coordenador do Projeto

_____ (**nome por extenso do sujeito de pesquisa**), tendo sido devidamente esclarecido sobre os procedimentos da pesquisa, concordo em participar **voluntariamente** da pesquisa descrita acima.

Assinatura (ou impressão dactiloscópica):_____

Data:_____

Obs: Caso o participante da pesquisa seja menor de idade, deve ser incluído o campo para assinatura do menor e do responsável.

ANEXOS

ANEXO A

Normas de formatação do periódico *Archives of Physical Medicine and Rehabilitation*

Introduction

Archives of Physical Medicine and Rehabilitation publishes original articles that report on important trends and developments in physical medicine and rehabilitation and in the wider interdisciplinary field of rehabilitation. *Archives of Physical Medicine and Rehabilitation* brings readers authoritative information on the therapeutic utilization of physical and pharmaceutical agents in providing comprehensive care for persons with disabilities and for chronically ill individuals. *Archives* began publication in 1920, publishes monthly, and is the official journal of the ACRM | American Congress of Rehabilitation Medicine. Its content is cited more often than any other rehabilitation journal.

Types of papers

Original Research: Present new and important basic and clinical information, extend existing studies, or provide a new approach to a traditional subject. Manuscripts should be limited to 3000 words of text (Introduction through Conclusions). Figures, tables, and references should be limited to the number needed to clarify, amplify, or document the text.

Brief Reports: Provide preliminary communications of new data, research methods, new ideas, and techniques. Manuscripts should be limited to 1500 words of text (or 1200 words plus 1-2 figures or tables, Introduction through Conclusions), and no more than 10 references. Brief reports should be accompanied by the appropriate reporting guideline and checklist.

The *Archives* will **not** consider case reports or animal studies for publication. Please do not submit them.

Commentaries (by Invitation): Focus on issues in physical medicine and rehabilitation. Manuscripts should be limited to 2000 words of text (Introduction through Conclusions). The Editorial Board reserves the right to ensure that the author

is qualified, through education and professional experience, to write knowledgeably and appropriately about a particular subject before accepting a Commentary for publication. The Editorial Board will choose the author(s) for Invited Commentaries and the author(s)' identity will be anonymous until publication. Authors of the subject article may submit a response for a subsequent issue.

Editorials: Editorials published in *Archives* may only be written by the elected officers of ACRM, or by members of the Editorial Board. Prior to publication, all editorials are approved by the Editorial Board's Executive Committee. Editorials do not represent the opinions or positions of ACRM or the Editorial Board. Editorials should be limited to 1000 words of text.

Information/Education: The ACRM Communications Committee has developed a new feature, Information/Education Pages, which appear in the Organization News section of *Archives*.
These fact sheets are printed as tear-out pages. They are designed to provide consumer-friendly information on topics relevant to rehabilitation medicine, including basic background or overview, similar to a Wikipedia entry, or brief how-to suggestions. They are targeted toward people with disabilities, their caregivers, or clinicians; and are designed so that a practitioner can tear out and copy, or download the pages, to make them available to patients and caregivers.

Authors are invited to submit Information/Education Page manuscripts or proposals to the *Archives*' Editorial Office (ArchivesMail@archives.acrm.org). The ACRM Communications Committee will assess subject matter, content, and target reading level then provide feedback on suitability and instructions on how to proceed directly to the author. Note that this should not be considered an official peer review of the content.

Letters to The Editor: Letters are published at the discretion of the Editorial Board and should be directly related to the published article on which it comments. Letters may not reference unpublished studies or reference "in press" studies that are not publicly available. The Editorial Board reserves the right to solicit a response from the

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Measurement Tools: These instrument summaries, which appear in the Organization News section of *Archives*, are designed to facilitate the selection of outcome measures by trained clinicians. The information contained in this summary represents a sample of the peer-reviewed research available at the time of the summary's publication. The information contained in these summaries does not constitute an endorsement of the instrument for clinical practice. The views expressed are those of the summary authors and do not represent those of authors' employers, instrument owner(s), the *Archives*, the Rehabilitation Measures Database or the United States Department of Education. The Rehabilitation Measures Database and Instrument Summary tear-sheets are funded by the National Institute on Disability and Rehabilitation Research, United States Department of Education through the Rehabilitation Research and Training Center on Improving Measurement of Medical Rehabilitation Outcomes (H133B090024) and Improving Measurement of Medical Rehabilitation Outcomes (H133B090024). Authors are invited to submit Measurement Tools through the*Archives*' submission platform.

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Special Communications: Provide information or an objective analysis of issues in physical medicine and rehabilitation that does not qualify as a research or clinical paper or commentary. Manuscripts are peer reviewed and should be limited to 5000 words of text, exclusive of references.

Before You Begin

Ethics in Publishing

Authorship

Manuscripts should have no more than 8 authors; a greater number requires written justification. The order of authorship is a joint decision of the coauthors. *Archives* follows the *Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals* guidelines [1], which state authorship credit should be based only on substantial contributions to (1) conception and design, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, and (3) final approval of the version to be published. Conditions 1, 2, and 3 must all be met. Participation solely in the acquisition of data does not justify authorship, nor does general supervision of the research group. *Archives*may require authors to justify the assignment of authorship. Increasingly, multicenter trials are attributed to a corporate author. All members of the group who are named as authors, either in the authorship position below the title or in a footnote, must fully meet the criteria for authorship as defined above. Group members not meeting these criteria should be listed, with their permission, in the Acknowledgments. Acknowledgments to other investigators for advice or data must be documented by written authorization specifically granting permissions to the authors.

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Authors have read the submitted manuscript and vouch for its accuracy. All authors have participated sufficiently in the conception and design of this work and the analysis of the data (where applicable), as well as the writing of the manuscript to take public responsibility for its content. If any author (or group of authors) listed cannot verify substantial contribution, the author's name should be moved to the acknowledgment section. If requested, authors shall produce the data on which the manuscript is based for examination by *Archives* or its assignees.

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Clinical trial

While there may be occasional exceptions, the *Archives* is committed to the need for clinical trial reports to be accompanied by adequate periods of follow-up. A lack of sufficient follow-up may be detrimental to a paper's acceptance.

Beginning January 1, 2016 all manuscripts reporting clinical trials must be registered before submission. For trials that are underway and are already enrolling patients, registration will be ***retrospective***. This is an interim step that will end January 1, 2017. At that time, the *Archives* will only consider clinical trials that have been registered before the first patient is enrolled.

For our purposes, a clinical trial is defined as "any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes"

(http://www.who.int/ictrp/en). Thus, cohort and retrospective studies without an intervention do not require registration, and neither do observational studies of clinical care. However, studies of human subjects with prospective assignment of an intervention by the investigators, regardless of the size of the trial or method of assignment, must be registered.

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All submissions will be screened by editors to determine their suitability for further review. Manuscripts that are approved for review will be evaluated by at least one recognized expert in the particular subject matter. Biostatistical review may be obtained. Peer reviewers' assessments are referred to a member of the Editorial Board, who may also critique the manuscript. The assigned Editorial Board Member will then make a final decision and communicate with the corresponding author via e-mail. Decisions are typically communicated within 60 days after the manuscript has been approved for peer review. All reviews are conducted in a double-blind fashion.

Letters to the Editors and Editorials are generally evaluated by an editorial committee, however, external reviews may also be sought.

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When submitting your revised manuscript, at the request of the Editorial Board, please include a document, separate from your cover letter, itemizing your response to each of the suggested revisions and any other changes you have made. Use consecutive line numbering in the text and cite line numbers for each change. In addition, highlight each change in the revised manuscript. You will upload this document in the file upload step as the "Detailed Response to Reviewers." Please note that this file should be blinded and should not include author names or institutional letterhead.

If revisions are not received within the time specified in the decision e-mail, the manuscript file will be closed. A revision received after a file has been closed will be handled as a new submission. An extension beyond the deadline may be granted at the Editorial Board's discretion, but only in extenuating circumstances, given the editors' commitment to prompt publication.

Submission of a revised manuscript includes submission of separate documents in the following order: (1) cover letter; (2) title page, including acknowledgments and explanation of any conflicts of interest; (3) main text file with highlighted changes, including an appropriate (structured or standard) abstract, keywords, list of abbreviations, body of the text, suppliers' list, references, figure legends; (4) a clean copy of the main text file with no highlighted changes, including an appropriate abstract, keywords, list of abbreviations, body of the text, suppliers' list, references, figure legends; (5) figures; (6) tables; (7) appendices; (8) supplementary files; (9) checklist; and (10) ICMJE Form for Disclosure of Potential Conflicts of Interest for each author.

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Main Manuscript

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State the purpose of the article. Summarize the rationale for the study or observation. Give only pertinent references, and do not review the subject extensively. Do not include data or conclusions from the work being reported. Do not include a heading for this section.

Methods

Describe the selection of the observational or experimental subjects (patients or experimental animals, including controls) clearly. Discuss eligibility of experimental subjects. Give details about randomization. Describe the methods for any blinding of observations. Identify the methods, equipment and materials, and procedures in sufficient detail to allow others to reproduce the results. Reference established methods, including statistical methods (see below); provide very brief descriptions for methods that have been published but are not well known; describe new or substantially modified methods, give reasons for using them, and evaluate their limitations. Identify precisely all drugs and chemicals used, including generic name(s), dose(s), and route(s) of administration.

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When submitting manuscripts on randomized controlled trials (RCTs), authors must include the CONSORT (Consolidated Standards for Reporting Trials) flow diagram. See the Reporting Guidelines.

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When data are summarized in the Results section, specify the statistical methods used to analyze them. Describe the success of any blinding of observations. Report treatment complications. Give numbers of observations. Report losses to observation (ie, dropouts from a clinical trial). Present results in logical sequence in the text, tables, and illustrations. *Archives* aims to publish no more than 5 figures per manuscript so restrict tables and figures to those needed to explain arguments and to assess their support. Use graphs as an alternative to tables with many entries; do not duplicate data in graphs and tables. Do not repeat in the text all the data in the tables, illustrations, or both; emphasize or summarize only important observations.

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300 dpi is minimum resolution to achieve high quality images. Typical desired resolutions are 300 dpi for black and white and color figures; 500 dpi for combination art (combined photo with line art); and 1000 dpi for line art.
Figures should be numbered consecutively in the order they are first cited in the text. If a figure has been published, acknowledge the original source in the reference list and the figure legend, and submit written permission from the copyright holder to reproduce the material. Permission is required, irrespective of authorship or publisher, except for documents in the public domain.
Letters, numbers, and symbols should be clear and even throughout, and of sufficient size that when reduced for publication each item will still be legible. Titles and detailed explanations belong in the legends for figures, not on the figures themselves. For multi-part figures, please label each component separately with A, B, C, etc. both in the figure itself and in the legend.

Consistency in size within the article is strongly preferred. Any special instructions regarding sizing should be clearly noted.

Photomicrographs must have internal scale markers. Symbols, arrows, or letters used in the photomicrographs should contrast with the background.
If photographs of persons are used, either the subjects must not be identifiable or the author must obtain and archive permission to publish the pictures and attest that

permission has been granted in the cover letter that accompanies the manuscript submission.

The Editorial Board reserves the right to determine which figures are appropriate for publication. There is no charge for publication of black and white illustrations.

Electronic artwork

General points

• Make sure you use uniform lettering and sizing of your original artwork.Preferred fonts: Arial (or Helvetica), Times New Roman (or Times), Symbol, Courier. Number the illustrations according to their sequence in the text. Use a logical naming convention for your artwork files.

• Indicate per figure if it is a single, 1.5 or 2-column fitting image.

• For Word submissions only, you may still provide figures and their captions, and tables within a single file at the revision stage.

• Please note that individual figure files larger than 10 MB must be provided in separate source files.

A detailed guide on electronic artwork is available.

You are urged to visit this site; some excerpts from the detailed information are given here.

Formats

Regardless of the application used, when your electronic artwork is finalized, please 'save as' or convert the images to one of the following formats (note the resolution requirements for line drawings, halftones, and line/halftone combinations given below):

EPS (or PDF): Vector drawings. Embed the font or save the text as 'graphics'.

TIFF (or JPG): Color or grayscale photographs (halftones): always use a minimum of 300 dpi.

TIFF (or JPG): Bitmapped line drawings: use a minimum of 1000 dpi.

TIFF (or JPG): Combinations bitmapped line/half-tone (color or grayscale): a minimum of 500 dpi is required.

Please do not:

• Supply files that are optimized for screen use (e.g., GIF, BMP, PICT, WPG); the resolution is too low.
• Supply files that are too low in resolution.
• Submit graphics that are disproportionately large for the content.

Color artwork

Color figures (minimum 300dpi) will be published without charge when color reproduction is essential to understanding of the material presented.

Figure legends

A list of figure legends should be provided after the reference list, listing each figure in order by number. Legends/captions should not be embedded in the figure files themselves.

Figure captions

Ensure that each illustration has a caption. A caption should comprise a brief title (**not** on the figure itself) and a description of the illustration. Keep text in the illustrations themselves to a minimum but explain all symbols and abbreviations used.

Tables

Submit each table as a separate file. Accepted file formats are PDF and Word (Please do not upload Excel files). If needed, Excel files will be requested from the authors upon a final editorial decision of accept. Number tables consecutively in the order of their first citation in the text. Include a brief title for each table, include a short or abbreviated heading for each column. Place explanatory matter in footnotes, not in the title or column headings. Explain in footnotes all nonstandard abbreviations that are used in each table. For footnotes, use the following symbols, in this sequence: *,

†, ‡, §, ||, ¶, #, **, ††, ‡‡ Identify statistical measures of variations such as standard deviation and standard error of the mean. Do not use internal horizontal and vertical rules. Be sure that each table is cited in the text in order. Using too many tables in relation to the length of the text may produce typesetting difficulties.

Data from another published or unpublished source may only be used with permission and must be acknowledged fully. It is the author's responsibility to obtain such permission.

Supplementary data

Archives accepts electronic supplementary material to support and enhance your scientific research. Supplementary files offer the author additional possibilities to publish supporting applications, high-resolution images, background datasets, sound clips, and more. Supplementary files supplied will be published online alongside the electronic version of your article in Elsevier Web products, including ScienceDirect: http://www.sciencedirect.com.

Suppliers

Before the References section, provide a Suppliers list with contact information (names and complete mailing addresses) for manufacturers of devices and other non-drug products used directly in a study (ie, do not provide such information for products not directly used in your research but mentioned in studies you cite). Identify equipment and/or materials in text, tables, and legends by superscript lower case letters. List suppliers consecutively in the order they are mentioned in the text.

Manufacturer names and locations should **not** be listed in the text where the product is introduced. Do not list Suppliers in the References list. Do not list drug manufacturers in the Suppliers list.

References

References in manuscripts accepted by *Archives* shall include only material that is retrievable through standard literature searches. Number references consecutively in the order in which they first appear in the text. Identify references in text, tables, and legends by superscript Arabic numerals. References cited only in tables or in legends to figures should be numbered in accordance with a sequence established by the first identification in the text of the particular table or figure.

Try to avoid using abstracts as references; "unpublished observations" and "personal communications" may not be used as references, although references to written, not oral, communications may be inserted (in parentheses) in the text. Avoid "personal communication" unless it provides essential information not available from a public source. In this case, cite the name of the person and date of communication in parentheses in the text. For scientific articles, authors should obtain written permission and confirmation of accuracy from the source of personal communication.

Include among the references those papers **accepted** but not yet published; designate the journal and add "In press." Authors must obtain written permission to cite such papers as well as verification that they have been accepted for publication. Editors will request from the author(s) a copy of the letter from the journal accepting the "in press" article if the manuscript in which it is cited is accepted by *Archives*. Information from manuscripts **submitted** but not yet accepted should be cited in the text as "(unpublished observations)" with written permission from the source.

The references must be verified by the author(s) against the original documents. List all authors and/or editors for each reference. Do not insert "et al." Click here for examples of correct reference formats.

Citations in the running text

Number references consecutively in the order in which they first appear in the text. Identify references in text, tables, and legends by superscript Arabic numerals. References cited only in tables or in legends to figures should be numbered in

accordance with a sequence established by the first identification in the text of the particular table or figure.

Reference management software

Most Elsevier journals have a standard template available in key reference management packages. This covers packages using the Citation Style Language, such as Mendeley (http://www.mendeley.com/features/reference-manager) and also others like EndNote (http://www.endnote.com/support/enstyles.asp) and Reference Manager (http://refman.com/downloads/styles). Using plug-ins to word processing packages which are available from the above sites, authors only need to select the appropriate journal template when preparing their article and the list of references and citations to these will be formatted according to the journal style as described in this Guide. The process of including templates in these packages is constantly ongoing. If the journal you are looking for does not have a template available yet, please see the list of sample references and citations provided in this Guide to help you format these according to the journal style.

If you manage your research with Mendeley Desktop, you can easily install the reference style for this journal by clicking the link below: http://open.mendeley.com/use-citation-style/archives-of-physical-medicine-and-rehabilitation
When preparing your manuscript, you will then be able to select this style using the Mendeley plug-ins for Microsoft Word or LibreOffice. For more information about the Citation Style Language, visit http://citationstyles.org.

Reference formatting

There are no strict requirements on reference formatting at submission. References can be in any style or format as long as the style is consistent. Where applicable, author(s) name(s), journal title/book title, chapter title/article title, year of publication, volume number/book chapter and the pagination must be present. Use of DOI is highly encouraged. The reference style used by the journal will be applied to the accepted article by Elsevier at the proof stage. Note that missing data will be

highlighted at proof stage for the author to correct. If you do wish to format the references yourself they should be arranged according to the following examples:

Reference style

Text: Indicate references by (consecutive) superscript Arabic numerals in the order in which they appear in the text. The numerals are to be used *outside* periods and commas, *inside* colons and semicolons. For further detail and examples you are referred to the AMA Manual of Style, A Guide for Authors and Editors, Tenth Edition, ISBN 0-978-0-19-517633-9 (see http://www.amanualofstyle.com).
List: Number the references in the list in the order in which they appear in the text. Click here for examples of correct reference formats.

Journal abbreviations in references

The titles of journals should be abbreviated according to the style used in *MEDLINE*. Consult *List of Serials Indexed for Online Users*, which is available from the NLM at http://www.nlm.nih.gov/tsd/serials/lsiou.html.

AudioSlides

The journal encourages authors to create an AudioSlides presentation with their published article. AudioSlides are brief, webinar-style presentations that are shown next to the online article on ScienceDirect. This gives authors the opportunity to summarize their research in their own words and to help readers understand what the paper is about. More information and examples are available. Authors of this journal will automatically receive an invitation e-mail to create an AudioSlides presentation after acceptance of their paper.

Submission checklist

Archives requires the completion and upload of a checklist with each manuscript. Please follow the instructions on the checklist, which can be downloaded here, to ensure all required manuscript elements are included with your submission. Please note that this submission checklist is NOT the same as a reporting guideline checklist or form noted above. This is a separate item specific to the*Archives*.

For any further information please visit our customer support site at http://support.elsevier.com.

After Acceptance

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Author Inquiries

Track your submitted article

Track your accepted article

You are also welcome to contact the Elsevier Support Center.

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2. Committee on Publication Ethics. Flowcharts: Changes in Authorship. nd. Available at: http://www.publicationethics.org/resources/flowcharts. Accessed June 16, 2014.

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Updated November 5, 2015

ANEXO B

Parecer do Comitê de Ética em Pesquisa

UNIVERSIDADE ESTADUAL DE LONDRINA

COMITÊ DE ÉTICA EM PESQUISA ENVOLVENDO SERES HUMANOS
Universidade Estadual de Londrina
Registro CONEP 5231

Parecer CEP/UEL:	080/2014
CAAE:	31112714.3.0000.5231
Data da Relatoria:	26/05/2014
Pesquisador(a):	Fábio de Oliveira Pitta
Unidade/Órgão:	CCS - Progr. de Pós-Grad. em Ciências da Reabilitação

Prezado(a) Senhor(a):

O "**Comitê de Ética em Pesquisa Envolvendo Seres Humanos da Universidade Estadual de Londrina**" (Registro CONEP 5231) – de acordo com as orientações da Resolução 466/12 do Conselho Nacional de Saúde/MS e Resoluções Complementares, avaliou o projeto:

"QUAL TESTE FUNCIONAL DE EXERCÍCIO REFLETE MELHOR AS MUDANÇAS NA ATIVIDADE FÍSICA DE VIDA DIÁRIA APÓS PROGRAMA DE TREINAMENTO FÍSICO EM PACIENTES COM DOENÇA PULMONAR OBSTRUTIVA CRÔNICA?"

Situação do Projeto: **Aprovado**

Informamos que deverá ser comunicada, por escrito, qualquer modificação que ocorra no desenvolvimento da pesquisa, bem como deverá apresentar ao CEP/UEL, via Plataforma Brasil, relatório final da pesquisa.

Londrina, 03 de junho de 2014.

Profa. Dra. Paula Mariza Zedu Alliprandini
Vice-coordenadora do Comitê de Ética em Pesquisa Envolvendo Seres Humanos
Universidade Estadual de Londrina

ANEXO C

Normas de formatação do periódico *Journal of Cardiopulmonary Rehabilitation and Prevention*

Instructions for Authors

Ethical/Legal Considerations

A submitted manuscript must be an original contribution not previously published (except as an abstract or a preliminary report), must not be under consideration for publication elsewhere, and, if accepted, must not be published elsewhere in similar form, in any language, without the consent of Lippincott Williams & Wilkins. Each person listed as an author is expected to have participated in the study to a significant extent. Although the editors and referees make every effort to ensure the validity of published manuscripts, the final responsibility rests with the authors, not with the Journal, its editors, or the publisher.

All manuscripts must be submitted online through the journal's Web site at http://jcrp.edmgr.com/. See submission instructions, under "manuscript submission."

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For Special Projects **and Reprints** (non-U.S./Canada), contact Silvia Serra, Translations Rights, Licensing & Permissions Manager, Wolters Kluwer Health (Medical Research) Ltd, 250 Waterloo Road, London SE1 8RD, UK. Phone: +44 (0) 207 981 0600. E-mail: silvia.serra@wolterskluwer.com

Preparation of Manuscript

Manuscripts that do not adhere to the following instructions will be returned to the corresponding author for technical revision before undergoing peer review.

Manuscript Submission

Authors are invited to submit original investigations, scientific reviews, brief reports, and case reports in all areas relating to the prevention and management of cardiopulmonary disease. These areas include but are not limited to cardiac and/or pulmonary rehabilitation, primary and secondary prevention, epidemiology, and exercise testing and training.

All manuscripts must be submitted on-line through the Journal Web site at http://jcrp.edmgr.com/. **First-time users:** Please click the Register button from the menu above and enter the requested information. On successful registration, you will be sent an E - mail indicating your user name and password. Print a copy of this

information for future reference. Note: If you have received an E - mail from us with an assigned user ID and password, or if you are a repeat user, do not register again. Just log in. Once you have an assigned ID and password, you do not have to re-register, even if your status changes (that is, author, reviewer, or editor). **Authors:** Please click the log-in button from the menu at the top of the page and log in to the system as an Author. Submit your manuscript according to the author instructions. You will be able to track the progress of your manuscript through the system. If you experience any problems, please contact **Abigail Lynn, Editorial Coordinator at jcrp@smithbucklin.com**. Requests for help and other questions will be addressed in the order received.

As of January 1, 2013, JCRP no longer requires that manuscripts be submitted in a blinded format. Author names, institutions, funding information, etc, are permissible within manuscript text.

If possible, all tables and figures should be included at the end of the text. The word count for the **text-only** portion for original investigations should be limited to 3000 words. A shortened form of the title should be included at the top of each manuscript page after the title page. A structured abstract and condensed abstract should be included for all manuscripts. Manuscripts are received with the understanding that they have not been previously published and are not currently under consideration for publication in any other journal. Manuscripts will be acknowledged upon receipt; those accepted for publication are subject to copy editing. The name, address, home and work telephone numbers, fax number, and e-mail address of the author responsible for correspondence regarding the manuscript should be included in an accompanying cover letter.

Acknowledgments must be given when material from other publications is included. Copies of the authors' and publishers' permission letters should be included with the manuscript. Provide names of author(s), title of article, title of journal or book, volume number, page(s), month, and year.

Figures:

A) Creating Digital Artwork

Learn about the publication requirements for Digital Artwork: http://links.lww.com/ES/A42

1. Create, Scan and Save your artwork and compare your final figure to the Digital Artwork Guideline Checklist (below).
2. Upload each figure to Editorial Manager in conjunction with your manuscript text and tables.

B) Digital Artwork Guideline Checklist

Here are the basics to have in place before submitting your digital artwork:

- Artwork should be saved as TIFF, EPS, or MS Office (DOC, PPT, XLS) files. High resolution PDF files are also acceptable.
- Crop out any white or black space surrounding the image.
- Diagrams, drawings, graphs, and other line art must be vector or saved at a resolution of at least 1200 dpi. If created in an MS Office program, send the native (DOC, PPT, XLS) file.
- Photographs, radiographs and other halftone images must be saved at a resolution of at least 300 dpi.
- Photographs and radiographs with text must be saved as postscript or at a resolution of at least 600 dpi.
- Each figure must be saved and submitted as a separate file. Figures should not be embedded in the manuscript text file.

Remember:

- Cite figures consecutively in your manuscript.
- Number figures in the figure legend in the order in which they are discussed.
- Upload figures consecutively to the Editorial Manager web site and enter figure numbers consecutively in the Description field when uploading the files.

Color Figures

The journal accepts for publication color figures that will enhance an article. Authors who submit color figures will receive an estimate of the cost for color reproduction. If they decide not to pay for color reproduction, they can request that the figures be converted to black and white at no charge.

Tables: Create tables using the table creating and editing feature of the word processing software (ie, Microsoft Word). Do not use Excel or comparable spreadsheet programs. Group all tables at the end of the manuscript, or supply them together in a separate file. Cite tables consecutively in the text, and number them in that order. Key each on a separate sheet, and include the table title, appropriate column heads, and explanatory legends (including definitions of any abbreviations used). Do not embed tables within the body of the manuscript. They should be self-explanatory and should supplement, rather than duplicate, the material in the text.

ABBREVIATIONS

Abbreviations should be limited to five commonly used terms or phrases per manuscript. Abbreviations should be spelled out at the first mention in the abstract and then again in the body of the text. The abbreviation should follow in parentheses. A term or phrase should be used more than five times to merit abbreviation.

TITLE PAGE

Information on the title page should include the full name, academic degree, hospital or university affiliation of each author and a word count for text only (excluding references). If an author's present affiliation is different from that under which the work was done, both should be given. The name, address, phone, fax, and e-mail of the corresponding author should be provided.

The title page must also include disclosure of funding received for this work from any of the following organizations: National Institutes of Health (NIH); Wellcome Trust; Howard Hughes Medical Institute (HHMI); and other(s).

FORMAT AND ABSTRACTS

Original investigations should follow this outline: 1) title page; 2) structured abstract and condensed abstract; 3) introduction and statement of purpose; 4) patients (or subjects) and methods; 5) results; 6) discussion; 7) references; 8) tables; and 9) figure legends.

All submissions should be accompanied by two abstracts: a structured abstract of 250 words or less and a condensed abstract of no more than 50 words for use in the Table of Contents. The structured abstract should consist of four paragraphs, labeled Purpose, Methods, Results, and Conclusions. They should briefly describe, respectively, the rationale for the study, how the study was conducted, the salient results, and what the authors conclude from the findings.

REFERENCES

References should be listed in the order in which they appear in the article and should be typed double-spaced. Authors are responsible for the completeness and accuracy of all references. Journal references should include authors' surnames followed by initials (without punctuation), title of article, name of journal as abbreviated in *Index Medicus*(if not included in *Index Medicus*, the journal name should be spelled out), year of publication, volume number, and inclusive page numbers. If there are six or fewer authors, all authors should be listed. If there are seven or more authors, the first three authors and et al is adequate. Personal communications and unpublished data should be included within the text of the manuscript or as footnotes, not as references. References should be formatted as shown in the American Medical Association Manual of Style 10th edition.

SUBMISSION REQUIREMENTS FOR ALL CATEGORIES

- Manuscripts must conform to "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" (*N Engl J Med*. 1997;336:309-315).
- Manuscripts may not contain previously published material or be under consideration for publication elsewhere.

- If an author has work that is in preparation, has been previously submitted or published, or is in press and potentially overlaps the submitted manuscript, the work must be submitted as an attachment with the current submission.
- All sources of support must be cited on the title page. Sources of support and potential conflicts of interest must be stated in the submission letter.
- A statement of submission must accompany the manuscript. It should state the following: "All authors have read and approved submission of the manuscript and the manuscript has not been published and is not being considered for publication elsewhere in whole or part in any language except as an abstract."
- Word count for the text-only portion of the manuscript should be stated in the title page.

AFTER ACCEPTANCE

Page Proofs and Corrections

Corresponding authors will receive electronic page proofs to check the copyedited and typeset article before publication. Portable document format (PDF) files of the typeset pages and support documents (e.g., reprint order form) will be sent to the corresponding author by E - mail. Complete instructions will be provided with the E - mail for downloading and printing the files and for faxing the corrected page proofs to the publisher. It is the author's responsibility to ensure that there are no errors in the proofs. Changes that have been made to conform to journal style will stand if they do not alter the authors' meaning. Only the most critical changes to the accuracy of the content will be made. Changes that are stylistic or are a reworking of previously accepted material will be disallowed. The publisher reserves the right to deny any changes that do not affect the accuracy of the content. Authors may be charged for alterations to the proofs beyond those required to correct errors or to answer queries. Proofs must be checked carefully and corrections faxed within 24 to 48 hours of receipt, as requested in the cover letter accompanying the page proofs.

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A number of research funding agencies now require or request authors to submit the post-print (the article after peer review and acceptance but not the final published article) to a repository that is accessible online by all without charge. As a service to our authors, LWW will identify to the National Library of Medicine (NLM) articles that require deposit and will transmit the post-print of an article based on research funded in whole or in part by the National Institutes of Health, Wellcome Trust, Howard Hughes Medical Institute, or other funding agencies to PubMed Central. The revised Copyright Transfer Agreement provides the mechanism.

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Authors must state all possible conflicts of interest in the manuscript, including financial, consultant, institutional, and other relationships that might lead to bias or a conflict of interest. If there is no conflict of interest, this should also be explicitly

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A copy of the form is made available to the submitting author within the Editorial Manager submission process. Co-authors will automatically receive an Email with instructions on completing the form upon submission.

ANEXO D

Normas de formatação do periódico *Clinical Rehabilitation*

Clinical Rehabilitation is a highly ranked, peer reviewed scholarly journal. It is a multi-professional journal covering the whole field of disability and rehabilitation, publishing research and discussion articles which are scientifically sound, clinically relevant and sometimes provocative.

The journal acts as a forum for the international dissemination and exchange of information amongst the large number of professionals involved in rehabilitation.

The leading journal in its field, *Clinical Rehabilitation* combines clinical application of scientific results and theoretical aspects in an ideal form. It gives high priority to articles describing effectiveness of therapeutic interventions and the evaluation of new techniques and methods.

1. Peer review policy

The journal's policy is to obtain at least two independent reviews of each article. It operates a double-blind reviewing policy in which the reviewer’s name is always concealed from the submitting author; authors may choose to reveal their name but the journal otherwise leaves the article anonymous. Referees will be encouraged to provide substantive, constructive reviews that provide suggestions for improving the work and distinguish between mandatory and non-mandatory recommendations.

All manuscripts accepted for publication are subject to editing for presentation, style and grammar. Any major redrafting is agreed with the author but the Editor's decision on the text is final.

2. Article types

The journal publishes original papers, systematic reviews, Rehabilitation in Practice articles correspondence relating to published papers and short reports. Other article types should be discussed with the editor before submission.

2.1 Summary of manuscript structure:

- A title page with names and contact details for all authors
- A **structured** abstract of **no more than 250 words** (the website checks this)
- The text (usually Introduction, Methods, Results, Discussion)
- Clinical Messages (2-4 bullet points, 50 words or less)
- Acknowledgements, author contributions, competing interests and funding support
- References (Vancouver style)
- Tables, each starting on a new page
- Figures, each starting on a new page
- Appendix (if any)

Please note that short reports follow a different format:

- The main text of a short report will usually be between **1000 and 1500 words** in length.
- A short report should have sufficient key references to cover all important points, but no more and usually there will be a**maximum of 15 references**.
- Tables and figures can be very efficient and effective ways of presenting data. A short report will usually have **no more than three tables and figures** (in total) and most will be restricted to two.

Further information on short reports can be found here.

3. How to submit your manuscript

Before submitting your manuscript, please ensure you carefully read and adhere to all the guidelines and instructions to authors provided below. Manuscripts not conforming to these guidelines may be returned. If you would like to discuss your paper prior to submission, please contact the Editor (Derick Wade) at: clinical.rehabilitation@sagepub.co.uk

Clinical Rehabilitation has a fully web-based system for the submission and review of manuscripts. All submissions should be made online at the *Clinical Rehabilitation* SAGETRACK website:

http://mc.manuscriptcentral.com/clinrehab

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