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ESTADUAL DE LONDRINA

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**RESPOSTAS FISIOLÓGICAS À REALIZAÇÃO DO
LONDRINA *ADL* *PROTOCOL* EM PACIENTES COM
DOENÇA PULMONAR OBSTRUTIVA CRÔNICA
COMPARADOS A INDIVÍDUOS CONTROLE**

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

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Dedico este trabalho à minha família, amigos e professores que me apoiaram e sempre estiveram ao meu lado nesta caminhada, e aos participantes deste estudo que contribuíram na construção de novos conhecimentos.

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“Tudo o quanto fizerdes, por palavra ou por obra, fazei-o em nome do Senhor Jesus, dando por ele graças a Deus Pai”.

Colossenses 3, 17.

SILVA, Diego Rodrigues da. **Respostas fisiológicas à realização do Londrina ADL Protocol em pacientes com doença pulmonar obstrutiva crônica comparados a indivíduos controle.** 2017. 60 f. Dissertação de Mestrado (Programa de Pós-Graduação em Ciências da Reabilitação – Programa Associado entre UEL - UNOPAR) – Universidade Estadual de Londrina, Londrina, 2017.

RESUMO

INTRODUÇÃO: Para evitar sintomas característicos como dispneia e fadiga, indivíduos com doença pulmonar obstrutiva crônica (DPOC) deixam de realizar atividades físicas. Isso gera o desenvolvimento de um ciclo vicioso de inatividade, descondicionamento e dispneia, que afeta negativamente até mesmo as ocupações simples como as atividades de vida diária (AVDs). Uma avaliação ampla, acurada e aprofundada das atividades cotidianas destes indivíduos pode fornecer informações importantes sobre sua condição. **OBJETIVOS:** Analisar as respostas cardiovasculares, ventilatórias e metabólicas de pacientes com DPOC durante a realização do Londrina ADL Protocol (LAP) e compará-las às respostas de indivíduos controle pareados por idade e gênero (voluntários saudáveis como controle); e determinar qual atividade do LAP demanda maior gasto energético nos pacientes com DPOC. **MÉTODOS:** Estudo transversal no qual 24 indivíduos com DPOC (13H/11M; 67±6 anos) e 20 no grupo controle (10H/10M; 66±7 anos) foram avaliados quanto à função pulmonar, capacidade funcional de exercício e performance no LAP. Adicionalmente, monitores de atividade física verificaram gasto energético e intensidade de movimento durante o LAP. **RESULTADOS:** O grupo DPOC, em relação ao grupo controle, levou mais tempo (410±65 vs 292±43s; P<0,0001), apresentou maior gasto energético (24[18-29]cal vs 18[13-19]cal; P=0,0007), apresentou menor intensidade de movimento ativo (0,1408±0,0409G vs 0,1706±0,0443G; P=0,02) e maior grau de dificuldade no LAP(3[0-5] vs 0[0-0]; P=0,002). O gasto energético nas atividades foi: 8[5-9]cal (organizar objetos na mesa); 12[8-14]cal (caminhar com sacolas); 8[7-9]cal (organizar prateleira); 7[5-8]cal (estender roupas no varal) e 11[8-12]cal (caminhar) (ANOVA P<0,001). **CONCLUSÃO:** Indivíduos com DPOC, em relação ao grupo controle, levam mais tempo para completar o LAP, além de o realizarem sob maior demanda metabólica, com mais sintomas e maior grau de dificuldade. A atividade de maior consumo energético foi caminhar segurando sacolas.

Palavras-chave: Metabolismo energético. Atividades cotidianas. DPOC. Idosos.

SILVA, Diego Rodrigues da. **Physiologic responses to perform the Londrina ADL Protocol in patients with chronic obstructive pulmonary disease compared to age-matched controls**. 2017. 60 p. Dissertação de Mestrado (Programa de Pós-Graduação em Ciências da Reabilitação – Programa Associado entre UEL - UNOPAR) – Universidade Estadual de Londrina, Londrina, 2017.

ABSTRACT

BACKGROUND: In order to avoid symptoms as dyspnea and fatigue, patients with chronic obstructive pulmonary disease (COPD) are hindered in the performance of physical activities. This leads to a vicious cycle of inactivity, deconditioning and dyspnea, which negatively affects even simple tasks such as activities of daily living (ADLs). A comprehensive, accurate and in-depth ADLs assessment may provide useful information about the subject's condition. **OBJECTIVES:** Analyze the cardiovascular, ventilator, and metabolic responses of patients with (COPD) during the accomplishment of the Londrina ADL Protocol (LAP) and compare them to the responses of the controls paired for age and gender (healthy elderly being the control); determining which LAP activity demands higher energy expenditure in patients with COPD. **METHODS:** A transversal study in which 24 individuals with COPD (13M/11F; 67±6 years) and 20 in the control group (10M/10F; 66±7 years) were evaluated regarding pulmonary function, functional capacity for exercise, and LAP performance. Additionally, physical activity monitors checked energy expenditure and intensity of movement during the LAP. **RESULTS:** The COPD group, compared to the control group, took more time to finish the protocol (410±65 vs 292±43s; P<0.0001), presented a higher energy expenditure (24[18-29] cal vs 18[13-19]cal; P=0.0007), a lower intensity of active movement (0.1408±0.0409G vs 0.1706±0.0443G; P=0.02), and a larger degree of difficulty in the LAP(3[0-5] vs 0[0-0]; P=0.002). The energy expenditure in the activities was: 8[5-9]cal (arrange objects in the table); 12[8-14]cal (walk carrying bags); 8[7-9]cal (arrange shelf); 7[5-8]cal (hanging clothes in the clothesline), and 11[8-12]cal (walking) (ANOVA P<0.001). **CONCLUSION:** Individuals with COPD, compared to the control group, take more time to accomplish the LAP, besides accomplishing it under a higher metabolic demand, with more symptoms, and a higher degree of difficulty. The activity with the highest energy expenditure was to walk carrying bags.

Key words: Energy Metabolism. Activities of Daily Living. Chronic Obstructive Pulmonary Disease. Aged.

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LISTA DE ABREVIATURAS E SIGLAS

6MWT	Six Minute Walking Test
AAVD	Atividades avançadas de vida diária
ABVD	Atividades básicas de vida diária
ADLs	Activities of daily living
AFVD	Atividade física na vida diária
AIVD	Atividades Instrumentais de vida diária
ATS	<i>American Thoracic Society</i>
AVDs	Atividades de vida diária
COPD	Chronic Obstructive Pulmonary Disease
CVF	Capacidade Vital Lenta Forçada
DAF	Duração da atividade física
DPOC	Doença Pulmonar Obstrutiva Crônica
DYN	Dynaport
ERS	<i>European Respiratory Society</i>
FC	Frequência Cardíaca
G	Aceleração
GEA	Gasto energético ativo
GET	Gasto energético total
GOLD	Global Initiative for Chronic Lung Disease
IMC	Índice de Massa Corpórea
LAP	Londrina ADL protocol
LFIP	Laboratório de Pesquisa em Fisioterapia Pulmonar
MET	Equivalente metabólico
MRC	<i>Modified Medical Research Council</i>
PA	Pressão Arterial
SAB	SenseWear Armband
SD	Standard Deviation
SpO ₂	Saturação periférica de oxigênio
TC6	Teste de Caminhada de Seis Minutos
VEF ₁	Volume Expiratório Forçado no primeiro segundo

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1 INTRODUÇÃO

A dispneia é um dos sintomas característicos da doença pulmonar obstrutiva crônica (DPOC), além da tosse crônica, hipersecreção pulmonar e fadiga muscular, são consideradas manifestações extra-pulmonares a disfunção muscular, anormalidades nutricionais, ansiedade e depressão ¹. Estas queixas podem ocorrer tanto ao repouso quanto durante a realização de exercícios, mas também durante a realização de atividades de vida diária (AVDs). Uma vez que estes indivíduos referem dispneia e/ou fadiga durante as AVDs, eles deixarão de realizá-las, gerando um ciclo vicioso de inatividade e descondicionamento físico e cardiovascular que pode levar ao aumento de exacerbações e consequentes internações hospitalares, prejuízos financeiros e sociais, sem contar no aumento de mortalidade ².

As AVDs incluem atividades relacionadas à rotina e frequentemente estão ligadas aos afazeres domésticos, cuidados pessoais, lazer e ocupações relacionadas ao trabalho. Devido aos sintomas, pacientes com DPOC apresentam limitações para a realização dessas funções. Por isso, se faz necessária uma avaliação adequada das AVDs a fim de identificar limitações e estabelecer implicações clínicas. No entanto, há divergências nos instrumentos de avaliação existentes.

Os questionários, por exemplo, são passíveis de imprecisões por sua subjetividade e necessidade de recorrer à memória as situações funcionais vivenciadas pelos pacientes. Alguns testes de campo também podem refletir o desempenho funcional do paciente, porém não contemplam especificamente o desempenho nas AVDs do paciente de uma maneira global. Pela necessidade do desenvolvimento de um protocolo simples e estruturado, fácil de ser aplicado em laboratório, válido, reproduzível e que avalie um conjunto de AVDs específicas, tanto no caso de pacientes com DPOC, quanto em indivíduos sem disfunção pulmonar, foi desenvolvido o Londrina *ADL Protocol* (LAP) ³.

Levando em consideração o desenvolvimento recente deste instrumento de avaliação de AVDs, torna-se indispensável conhecer os mecanismos fisiológicos de resposta à sua realização, pois já está evidenciado que pacientes

com DPOC tem um consumo metabólico elevado para a realização de atividades consideradas simples e até mesmo quando estão em repouso ^{1,2}.

Assim sendo, o objetivo desta dissertação foi contribuir para o aumento do conhecimento científico sobre a avaliação objetiva das AVDs. A primeira parte da dissertação inclui uma breve revisão da literatura científica, enquanto a segunda parte traz um artigo original desenvolvido sobre o tema.

2 REVISÃO DE LITERATURA – CONTEXTUALIZAÇÃO

2.1 ENVELHECIMENTO E SUAS LIMITAÇÕES FUNCIONAIS

Em quase todos os países em desenvolvimento a proporção de pessoas acima de 60 anos está aumentando mais do que em outros grupos etários. O envelhecimento desafia a população a se adaptar a fim de melhorar a saúde, a independência funcional, assim como a participação social. O envelhecimento saudável depende de vários fatores e comportamentos como alimentação, atividade física e menor exposição a fatores de risco como tabagismo, etilismo ou a outras substâncias tóxicas, tudo isto somado ao declínio natural das atividades biológicas e da capacidade funcional³.

Segundo a Organização Mundial da Saúde (OMS), idoso é todo indivíduo com 60 anos (países em desenvolvimento como o Brasil – Lei nº 10.741/2003) ou 65 anos (países desenvolvidos) ou mais. No entanto, este limite pode variar de acordo com as condições de cada país. É fundamental saber que a idade cronológica não é um marcador preciso para as alterações que acompanham o envelhecimento, permitindo variações quanto às condições de saúde, nível de participação social e principalmente, do nível de independência funcional entre as pessoas idosas em diferentes contextos. O conceito de saúde na população mais velha deve abranger todo o processo que diz respeito desde a diminuição do funcionamento físico, às capacidades cognitivas, ou seja, aspectos que envolvam independência e autonomia⁴.

O envelhecimento bem-sucedido caracteriza-se por baixo risco a doenças e incapacidades funcionais. Isto possibilita às pessoas realizarem seu potencial para o bem-estar físico, social e mental ao longo da vida, participando ativamente da sociedade de forma segura com os cuidados necessários. A velhice bem-sucedida pode ser definida como o equilíbrio entre a compensação das perdas associadas ao envelhecimento e da otimização das potencialidades preservadas^{5,6}. A presença de uma ou mais enfermidades crônicas não significa que o idoso não possa manter sua autonomia e realizar suas atividades de modo independente⁷, a maioria dos idosos brasileiros é capaz de se organizar sem necessidade de ajuda, mesmo com uma ou mais enfermidades crônicas⁸.

O processo de envelhecimento é um fenômeno contínuo acompanhado por alterações nos sistemas fisiológicos que colaboram para o desenvolvimento de síndromes geriátricas e doenças crônicas ⁴. A doença crônica respiratória mais comum é a doença pulmonar obstrutiva crônica (DPOC) ⁹. O típico paciente com DPOC, geralmente, é idoso e apresenta uma ou mais comorbidades associadas com prejuízos consideráveis na capacidade de realizar as atividades diárias necessárias para viver de forma independente conforme a progressão da doença acontece ^{9,10}.

2.2 DOENÇA PULMONAR OBSTRUTIVA CRÔNICA (DPOC)

A doença pulmonar obstrutiva crônica (DPOC) é caracterizada pela limitação progressiva e persistente do fluxo aéreo e está associada à resposta inflamatória crônica aumentada nas vias aéreas e nos pulmões para partículas ou gases nocivos. A exposição a esses fatores, como por exemplo, a fumaça do cigarro que é inalada, provoca inflamação nas estruturas que compõem os pulmões. Esta resposta inflamatória crônica causa destruição do parênquima pulmonar, sendo que os mecanismos normais de reparo e defesa perdem sua função, resultando em fibrose das vias aéreas. Por consequência disso, ocasiona um aprisionamento de ar, resultando em manifestações clínicas como a dispneia, ou seja, a sensação de falta de ar, e outras manifestações como tosse e hipersecreção ¹¹.

Pacientes com DPOC também costumam ter comorbidades associadas e isto contribui para a gravidade da doença. As comorbidades incluem doenças cardiovasculares, disfunção da musculatura esquelética, síndrome metabólica, depressão e câncer de pulmão ¹¹. Além dessas limitações associadas ao comprometimento respiratório, estes indivíduos apresentam manifestações extrapulmonares como disfunção muscular, anormalidades nutricionais, ansiedade e depressão, o que prejudica sua capacidade funcional ¹².

Devido aos sintomas, os pacientes com DPOC evitam a realização de esforços, tanto que, passam menos tempo caminhando e de forma lenta. A inatividade física prejudica e piora sintomas como dispneia e fadiga, repercutindo de forma negativa na realização de simples atividades rotineiras como as atividades de vida diária ^{12,13}.

2.3 FUNCIONALIDADE E ATIVIDADES COTIDIANAS – CONCEITOS E DEFINIÇÕES

Tanto idosos quanto pacientes com DPOC experimentam dificuldades funcionais em decorrência da senilidade ou devido ao desenvolvimento da doença ¹⁴. Diante disso, algumas definições se fazem necessárias para obter um melhor esclarecimento dos aspectos e ações que envolvem as funções relacionadas às atividades do dia-a-dia.

2.3.1 Atividades de vida diária (AVDs)

As atividades de vida diária são consideradas essenciais para se viver de forma independente e incluem situações que envolvem o caminhar, o alcance e o subir escadas, por exemplo. São situações que abrangem todo o cuidado pessoal desde a preparação pela manhã, o deslocar-se de um lugar ao outro durante o dia e o retorno para a cama à noite ¹⁵.

2.3.2 Atividades básicas de vida diária (ABVD)

As atividades básicas de vida diária (ABVD) são as atividades básicas que envolvem rotinas de auto-cuidado e mobilidade, também incluem a capacidade de manter continência e a alimentação independente ¹⁶.

2.3.3 Atividades instrumentais de vida diária (AIVD)

As atividades instrumentais de vida diária incluem as mesmas funções exemplificadas nas AVDs, somadas a outras situações que necessitam da integração do indivíduo com a sociedade. Incluem a habilidade em administrar o ambiente onde vivem e fora de casa. São funções consideradas mais complexas como preparar refeições, usar equipamentos domésticos, lidar com medicamentos e dinheiro, usar o telefone ou utilizar os meios de transporte, por exemplo ¹⁷.

2.3.4 Atividades avançadas de vida diária (AAVD)

As atividades avançadas de vida diária envolvem as atividades voluntárias sociais, ocupacionais, de lazer e recreação. São ações realizadas a partir da motivação pessoal, no tempo livre, independentes do trabalho. Podem indicar boa saúde física e mental, sendo que a sua redução indica declínio funcional, alterações cognitivas e fragilidade ¹⁸.

2.3.5 Atividade física na vida diária (AFVD)

A atividade física na vida diária está relacionada à totalidade de movimentos voluntários produzidos pela musculatura esquelética acima dos níveis de repouso, durante a realização das atividades do dia-a-dia ¹⁹. Incluem desfechos como o número de passos por dia, tempo gasto ativamente e inativamente, intensidade de movimento e gasto energético.

2.3.6 Capacidade funcional

A capacidade funcional pode ser definida como o potencial ou limitação de um indivíduo para realizar determinadas situações usuais, isto é, a habilidade e eficiência em corresponder às tarefas do cotidiano, abrangendo desde atividades básicas para uma vida independente, assim como as atividades mais complexas da rotina diária. A capacidade funcional remete a uma investigação real do desempenho; por isso, pode ser considerada uma avaliação de medida desta aptidão por meio de testes físicos ²⁰⁻²³.

2.3.7 Estado funcional

O estado funcional significa a situação em que o indivíduo se apresenta sem a necessidade de aplicação de testes físicos propriamente ditos. Refere-se ao nível com o qual uma pessoa desempenha funções e AVDs. Pode ser realizado um levantamento das funções essenciais à vida diária, considerando fatores físicos, psicológicos e sociais que afetam a saúde dos indivíduos. O estado

funcional reflete o próprio entendimento de como as pessoas estão vivendo, a percepção pessoal, como se encontram ou respondem a determinadas funções^{22,24-26}.

2.4 INSTRUMENTOS DE AVALIAÇÃO DAS AVDs

A habilidade para desempenhar as AVDs constitui um fator considerável para avaliar a dependência e, a sua manutenção está relacionada à inserção do indivíduo no meio social em que vive. Utilizar um instrumento padronizado permite estabelecer uma base precisa para fundamentar a tomada de condutas. A identificação de fatores limitantes é fundamental para complementar uma avaliação de forma minuciosa, ajudando a diferenciar situações que poderiam passar despercebidas. Aplicar medidas que avaliam o declínio funcional são necessárias desde que tenham embasamento em um meio formal, válido e confiável. Alguns instrumentos de avaliação podem ter implantação e finalidades distintas^{27,28}.

Dentre os métodos de avaliação funcional existentes, estão os questionários, que podem apresentar algumas variações de aplicação. Outra forma mais objetiva de avaliação de AVDs seria por meio da observação direta ou por filmagens durante a realização de testes de desempenho²⁴. Há uma série de instrumentos disponíveis que propõem avaliar a funcionalidade nas AVDs, cada um com suas características, finalidades e limitações de aplicação. No entanto, deve-se atentar a qualidade desses instrumentos no que diz respeito à validação, confiabilidade, reprodutibilidade ou adaptações nos diferentes contextos e patologias, possibilitando identificar as limitações funcionais e fornecer melhor aplicabilidade.

2.4.1 Questionários para avaliação de AVDs

Uma vez realizadas as diferenciações conceituais na seção de definições, pode-se agora definir melhor alguns exemplos de instrumentos subjetivos disponíveis para a avaliação das atividades de vida diária. Os instrumentos mais comuns são os questionários, considerados menos extenuantes que testes de

exercícios ²⁹. Possibilitam aplicação na forma de entrevista, com questões estruturadas ou até mesmo por auto-aplicação. Podem ser apresentados também em forma de escalas ou índices envolvendo os principais componentes da funcionalidade em AVDs em idosos ou pacientes com DPOC ^{15,17,24,30,31}.

Tratam-se de instrumentos de avaliação que requerem capacidade cognitiva, por isso, deve-se levar em conta a capacidade de entendimento do indivíduo para possibilitar respostas que coincidam com a realidade vivida e assegurem uma interpretação precisa, já que muitas vezes recorre-se à memória para recordar as situações do dia-a-dia. É preciso confiar nas respostas referidas por ser uma avaliação relatada de acordo com a percepção individual. Caso o sujeito avaliado apresente limitações intelectuais o resultado dos testes pode ser comprometedor. São considerados vantajosos para avaliar as AVDs pela praticidade de aplicação e por poder determinar pontos de corte e estabelecer parâmetros de aplicabilidade prática.

Contudo, por permitirem o diálogo, corre-se o risco de prolongar o tempo de aplicação, tornando a avaliação exaustiva ³². Além disso, as limitações desses instrumentos incluem também ser necessário confiar-se na memória e o fato deles por vezes requererem que o paciente seja alfabetizado. Portanto, ao objetivar-se avaliar a performance (e a limitação) de indivíduos na realização de AVDs, muitas vezes é indicado lançar mão de uma avaliação prática com o propósito de obter-se informações mais acuradas e aprofundadas ³².

2.4.2 Testes (ou protocolos) de performance

Dentre os instrumentos existentes mais utilizados para avaliar as AVDs em DPOC, está o teste de AVD-*Glittre*, um protocolo que objetiva avaliar o desempenho dos pacientes com DPOC em uma sequência de atividades que incluem levantar-se de uma cadeira, deslocar-se num percurso de 10 metros utilizando peso extra, subir e descer degraus e organizar objetos em uma estante, repetindo este circuito por 5 vezes o mais rápido possível e considerando o tempo como principal variável ³³. No entanto, este protocolo não inclui uma avaliação objetiva e específica de situações que envolvam os membros superiores, nas quais pacientes com DPOC comumente também apresentam limitações ³⁴. Devido às

características de aplicação (i.e., realização o mais rápido possível), o teste de AVD-*Glittre* associa-se melhor com testes de capacidade de exercício até mesmo no que diz respeito ao consumo de oxigênio, como no teste de caminhada de seis minutos (TC6min), no qual o indivíduo também deve caminhar o mais rápido que conseguir³⁵.

Considerando as limitações enfrentadas pelos pacientes com DPOC durante as AVDs, como a estagnação do ciclo vicioso, por exemplo, gerando consequências negativas nas AVDs, e as desvantagens dos instrumentos disponíveis, como as diferentes maneiras não sistematizadas e não padronizadas de avaliação das atividades cotidianas, julga-se haver espaço para o desenvolvimento de um protocolo de avaliação padronizado, prático, similar às situações do dia-a-dia e de aplicação em laboratório, para refletir o desempenho nas AVDs realizadas em velocidade usual, a fim de contribuir para uma avaliação que reflita melhor a funcionalidade de pacientes com DPOC³⁶.

2.4.3 Londrina *activities of daily living protocol* (LAP)

Para a avaliação objetiva da performance em AVDs, criou-se o Londrina *ADL Protocol* (LAP), um teste composto por 5 cinco atividades realizadas em forma de circuito³⁶, sendo o tempo de execução do protocolo controlado por um cronômetro e descrito como principal desfecho do teste.

A sequência de atividades do LAP acontece da seguinte forma: o participante inicia o circuito de atividades em pé no ponto inicial, caminhando 3 metros (m) até uma mesa com objetos, onde deve sentar-se em uma cadeira sem apoio para os membros superiores e transferir 10 objetos (com variação do peso de 250 g a 2 Kg) de um lado da mesa para o outro, um de cada vez, e depois, retornar os mesmos objetos para o ponto inicial, sempre utilizando as duas mãos (AVD1).

Em seguida, o indivíduo deve andar 1.50 m até o ponto onde encontram-se 2 sacolas que, juntas, contém cerca de 10% do peso corporal do indivíduo divididos igualmente entre ambas as sacolas. O indivíduo deve pegar as sacolas e caminhar sobre uma marcação em linha reta de 6 m por três vezes, deixando as sacolas no chão ao final da caminhada (AVD2).

Após esta atividade desloca-se por 3,5 m até a próxima atividade numa estante onde deve colocar 12 objetos (com variação do peso de 250 g a 2 Kg)

em marcações específicas em uma mesa ao lado desta estante e depois, retornar os mesmos objetos para a mesa, sempre utilizando as duas mãos, um objeto por vez (AVD3).

Para executar a próxima atividade, o indivíduo caminha 4 m até um varal, a fim de estender 10 peças de roupas que se encontravam em um cesto no chão, e depois, as recolher, retornando-as para o cesto (AVD4).

Finalmente, o indivíduo desloca-se a 1.5 m até a mesma marcação de 6 metros em linha reta, e caminha, desta vez livre de pesos, por três vezes (AVD5), encerrando o protocolo de atividades.

O circuito completo está ilustrado na Figura 1. Todas as atividades devem ser previamente explicadas e demonstradas aos participantes pelo avaliador. Adicionalmente, os indivíduos são orientados a executar todas as atividades como se as tivessem realizando em casa, da forma e na velocidade como as fariam no dia-a-dia. São registradas a frequência cardíaca, a saturação periférica de oxigênio, a pressão arterial e sensação de dispneia e fadiga tanto de membros inferiores quanto de membros superiores (escala de Borg modificada para esforço percebido), antes e após a execução do LAP inteiro. Os valores de referência utilizados para o LAP também foram desenvolvidos para a população brasileira ³⁷.

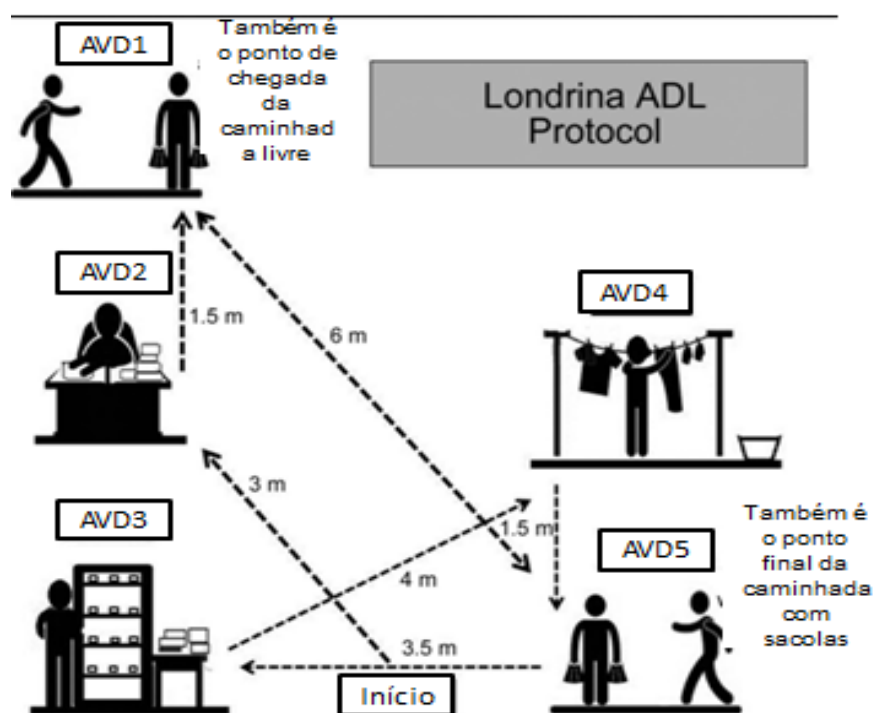


Figura 1. Circuito de atividades do Londrina ADL Protocol

2.5 RESPOSTAS CARDIOVASCULARES, VENTILATÓRIAS E METABÓLICAS

Indivíduos com DPOC adaptam ou reduzem as suas atividades rotineiras devido a alguns fatores que contribuem para as disfunções, como a fraqueza da musculatura esquelética e o desenvolvimento de um padrão respiratório superficial que resulta em respostas cardiorrespiratórias aumentadas com alta demanda metabólica³⁸. Uma simples elevação dos braços, por exemplo, resulta em um aumento significativo da demanda ventilatória e metabólica³⁹.

Os pacientes com DPOC apresentam piora nas respostas cardiorrespiratórias comparadas a adultos saudáveis. Um consumo aumentado de oxigênio sugere que esses indivíduos realizam as atividades em alta intensidade e com maior trabalho ventilatório durante as AVDs, tornando-se funções bastante exigentes. A reserva energética inadequada repercute em limitações ventilatórias prejudicando sua rotina devido à dispneia, o que causa a interrupção dessas atividades^{39,40}.

Os desajustes cardíacos, ventilatórios e metabólicos, provavelmente causados pela inflamação sistêmica, tem impacto negativo no desempenho de AVDs para pacientes com DPOC. Por isso, é relevante a monitorização dessas respostas permitindo tomada de decisões mais seguras⁴¹.

3 JUSTIFICATIVA

As AVDs incluem atividades relacionadas à rotina e frequentemente estão ligadas aos afazeres domésticos, cuidados pessoais, lazer e ocupações relacionadas ao trabalho. Devido aos sintomas, pacientes com DPOC apresentam limitações para a realização dessas funções, sendo necessária uma avaliação adequada das AVDs a fim de identificar limitações e estabelecer implicações clínicas. No entanto, os instrumentos de avaliação existentes são passíveis de imprecisões como questionários, considerados instrumentos subjetivos e que exigem recorrer à memória as situações funcionais vivenciadas pelos pacientes, por exemplo. Alguns testes de campo também podem refletir o desempenho funcional do paciente, porém não contemplam especificamente o desempenho nas AVDs do paciente de uma maneira global. É de extrema importância ser evidenciado e mostrado à sociedade de uma forma geral sobre a necessidade do desenvolvimento de um protocolo simples e estruturado, fácil de ser aplicado em laboratório, válido, reprodutível e que avalie um conjunto de AVDs específicas, tanto no caso de pacientes com DPOC, quanto em indivíduos sem disfunção pulmonar, foi desenvolvido o Londrina *ADL Protocol* (LAP)³⁶.

Levando em consideração o desenvolvimento recente deste instrumento de avaliação de AVDs, torna-se indispensável conhecer os mecanismos fisiológicos de resposta à sua realização, pois já está evidenciado que pacientes com DPOC tem um consumo metabólico elevado para a realização de atividades consideradas simples¹. Na tentativa de minimizar este alto consumo metabólico, surgiram as técnicas de conservação de energia que no contexto da Reabilitação Pulmonar, é uma proposta de reeducação funcional visando otimizar a realização das atividades usuais por esses pacientes⁴².

Portanto, adicionalmente à quantificação das AVDs, torna-se essencial caracterizar a realização das mesmas, ou seja, explorar os aspectos fisiológicos da realização de protocolos como o LAP, é necessário elucidar melhor as respostas cardiovasculares, ventilatórias e metabólicas apresentadas pelos pacientes com DPOC durante a realização do novo instrumento de avaliação de AVDs, o Londrina ADL Protocol, e comparar com indivíduos com características semelhantes e sem disfunção pulmonar, tudo isto visando um maior conhecimento

dos mecanismos de limitação da performance nas AVDs com o propósito de fornecer melhores interpretações e intervenções clínicas do LAP.

4 OBJETIVO DO ARTIGO DESENVOLVIDO

O objetivo deste estudo foi analisar as respostas cardiovasculares, ventilatórias e metabólicas de pacientes com DPOC durante a realização do LAP e compará-las a indivíduos controle com características antropométricas e sócio demográficas semelhantes. Objetivou-se também comparar o tempo de realização do LAP entre os grupos, determinando qual atividade do protocolo demanda maior energia e respostas metabólicas mais acentuadas.

5 ARTIGO

Physiologic responses to perform the londrina adl protocol in patients with chronic obstructive pulmonary disease compared to age-matched controls*

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Abstract

Aims: to analyze the cardiovascular, ventilatory, and metabolic responses of patients with chronic obstructive pulmonary disease (COPD) during the performance of the Londrina ADL Protocol (LAP) and to compare them to the responses of age-matched controls; to determine which LAP activity demands higher energy expenditure in patients with COPD. *Methods:* a transversal study in which 24 individuals with COPD (13M/11F; 67±6 years) and 20 controls subjects (10M/10F; 66±7 years) were evaluated regarding pulmonary function, functional exercise capacity, and LAP performance. Additionally, physical activity monitors estimated energy expenditure and intensity of movement during the LAP. *Results:* the COPD group, compared to the control group, took more time to finish the protocol (410±65 vs 292±43s; $P<0.0001$), presented a higher energy expenditure (24[18-29]cal vs 18[13-19]cal; $P=0.0007$), a lower intensity of movement (0.1408±0.0409G vs 0.1706±0.0443G; $P=0.02$), and a larger degree of difficulty in the LAP (3[0-5] vs 0[0-0]; $P=0.002$). The energy expenditure in the activities was: 8[5-9]cal (arrange objects in the table); 12[8-14]cal (walk carrying bags); 8[7-9]cal (arrange shelf); 7[5-8]cal (hanging clothes in the clothesline), and 11[8-12]cal (walking) (ANOVA $P<0.001$). *Conclusion:* individuals

with COPD, compared to the controls, take more time to finish the LAP, besides accomplishing it under a higher metabolic demand, with more symptoms, and a higher degree of difficulty. The activity with the highest energy expenditure was to walk carrying bags.

Keywords: Energy Metabolism; Activities of Daily Living; Chronic Obstructive Pulmonary Disease; Healthy Volunteers.

Introduction

Patients with chronic obstructive pulmonary disease (COPD) no longer perform physical activities due to the pulmonary and systemic changes caused by the disease, in order to avoid the characteristic symptoms like dyspnea and fatigue. This yields the development of a vicious cycle of inactivity, deconditioning, and dyspnea, which affects negatively even simple tasks, such as the activities of daily living (ADLs) (GOLD, 2017). In face of such changes, a broad, accurate, and in-depth assessment of the daily life activities of these individuals might offer important information about their condition.

One of the ways of evaluating ADLs is through surveys. However, since it is a subjective method, it is an instrument susceptible to the influence of psychological and cognitive factors, limiting its reliability (Skumlien et al, 2006). Conversely, there are other instruments described in the scientific literature that might evaluate the ADLs in an objective way (protocols) in this population. Nevertheless, these instruments also present some limitations, possibly because they do not meet certain activities capable of representing the daily routine of the patients with COPD in a comprehensive way.

In this way, a new evaluating protocol of ADLs has been recently elaborated in the laboratory, the *Londrina ADL Protocol* (LAP) (Sant'Anna et al, 2017). It is a simple and low cost instrument that has been shown to be valid and reproducible both with COPD patients and with apparently healthy individuals (Paes et al, 2017).

It is well known that besides being inactive in daily life, patients with COPD perform the ADLs, even the most simples ones, with high energy expenditures (Cavalheri et al, 2011). For this reason, the use of energy conservation techniques, in

the context of Pulmonary Rehabilitation, is a functional re-education proposal that aims to optimize the performance of the usual activities by these patients (Velloso, 2006). Therefore, additionally to the quantification of the ADLs, it becomes essential to characterize the performing of these activities, that is, to explore the physiological aspects of performing protocols such as the LAP, in order to increase the knowledge about the mechanisms that limit the performance of the ADLs, with the proposal of providing better interpretations and interventions.

Therefore, the objective of this study was to analyze the cardiovascular, ventilatory, and metabolic responses of patients with COPD during the performance of the LAP and compare them to apparently healthy individuals with similar anthropometric and sociodemographic characteristics. Also, the time for performing the LAP was compared between the groups and the activity of the protocol which demanded more energy and more marked metabolic responses in COPD identified.

Methods

Design and sample

This transversal study was conducted in the Laboratory of Research in Respiratory Physiotherapy (LFIP), at the University Hospital of the State University of Londrina (UEL), Londrina, Brazil. The data were collected from September 2016 to March 2017. The convenience sample was composed of volunteers that took part in the study, divided into two groups: in the first group patients with COPD, recruited from the initial evaluation of a physical training program conducted in the LFIP-UEL; and in the second group, individuals paired for age and gender that comprised the control group. The healthy volunteers were recruited among the relatives of the students and employees of the Healthy Science Centre at UEL, individuals that answered to the advertising posters fixed at UEL and in the public transport system of the city of Londrina, and among the participants of physical exercise groups available in the community.

The COPD group included individuals with a confirmed diagnose according to the *Global Initiative for Chronic Obstructive Lung Disease* (GOLD) with clinical stability, that is, without infections and exacerbations in the last three months; that did not use home oxygen therapy without the need of supplementation during the tests; without serious and/or limiting diseases; and ready to participate in the study. The

criteria for inclusion in the control group were the same, except for the COPD diagnostic. The participants were excluded if they were not able to perform activities the proposed in the study and, in the case of the COPD group, if they presented peripheral oxygen saturation (SpO₂) below 80%, sustained during the evaluations (Vaes et al, 2011). However, there were no exclusions.

The study was approved by the Ethics and Research Committee from the UEL (report n°151/2013). Before being included in the study, all the participants signed an informed consent form containing all the necessary information about the procedures of evaluation.

Assessments

Daily life activities - Londrina ADL Protocol (LAP)

In order to objectively evaluate the performance in the ADLs, the LAP was applied, consisting of test that comprises five activities performed as a circuit (Sant'Anna et al, 2017), with the time of completion of the protocol being controlled by a chronometer and described as the main outcome of the test. The sequence of activities of the LAP occurred in the following way: the participant started the circuit of activities standing at the initial point, walking for 3 meters (m) to a table with objects, where he should sit down on a chair without support for the upper limbs and transfer 10 objects (with weights varying from 250 g to 2 kg) from one side of the table to the other, one at a time, and after that, returning the same objects to the initial point, always using the two hands (ADL1). Next, the individual walked 1.50 m to the point where 2 bags were placed, that together contain around 10% of the body weight of the individual, divided equally between both bags. The individual took the bags and walked on a 6 m straight line marking for three times, leaving the bags on the floor at the end of the walk (ADL2). After this activity he should move for 3.5 m to the next activity in front of a bookcase, where he should put 12 objects (with weights varying from 250 g to 2 kg) in specific markings in a table at the side of the bookcase and after that, return the same objects to the table, always using both hands, one object at a time (ADL3). In order to execute the next activity, the individual walked 4 m to a clothesline to hang 10 clothes that were placed in a basket on the floor, and later, gathered them and returned them to the basket (ADL4). Finally, the individual moved for 1.5 m until the same 6 meters straight line, and walked three times on it, this time

free from loads (ADL5), finishing the protocol of activities. The complete circuit is illustrated in Figure 1. All the activities were previously explained and demonstrated to the participants by the evaluator. Additionally, the individuals were instructed to execute all the activities as if they were performing them at home, in the way and speed they would perform them in the daily life. The heart rate, peripheral oxygen saturation, blood pressure, and the sensation of dyspnea and fatigue were recorded, both in the lower limbs and in the upper limbs (Borg modified scale for perceived exertion, 1982), before and after the execution of the whole LAP. The values of reference used for the LAP were developed for the Brazilian population (Paes et al, 2017).

Both groups performed each activity separately during a pre-determined period of 3 minutes (established by the authors according to the monitoring device) to allow the evaluation of the cardiovascular, ventilatory, and metabolic variables. The sequence of the activities was randomly determined by a previous for each individual. The time interval between the activities was determined as the time required for the resting conditions to return to their initial values. Only after that, the next would start, until all of them have been performed. The same guidance was explained and demonstrated for both groups, and the same variables evaluated during the execution of the whole LAP were collected for each activity.

Monitoring the LAP activities

The participants used simultaneously two physical activity monitors: the SenseWear Armband (SAB) and the DynaPort (DYN). The SAB is a multisensor composed of a biaxial accelerometer and other physiologic sensors, valid to estimate the energy expenditure of patients with COPD (Hill et al, 2010) and healthy adults (Santos-Lozano et al, 2017). The participants used the device on their left arm, approximately at the level of the brachial triceps. For this study the SAB was configured to detect the following variables during the activities proposed in the evaluation protocol: total energy expenditure (TEE), energy expenditure in physical activity (EEPA), the average metabolic equivalents (MET), and the duration of the physical activity with an intensity above 3 METs (DPA>3METs). The DynaPort is a device that was also used to monitor the physical activity in both populations (Rabinovich et al, 2013; van Hees, van Lummel and Westerterp, 2009). The device was used in the lower lumbar region

attached by an elastic strap. This monitor provides various data, although, in this study, only the intensity of active movement was used, estimated by acceleration, during the whole LAP execution.

Functional exercise capacity – Six-minute walk test (6MWT)

The 6MWT was executed twice according to the international standards (Holland et al, 2014), being considered for analysis the greatest walked distance. The reference values used were described for the Brazilian population (Britto et al, 2013).

Anthropometric and demographic data

Data such as gender, age, weight, and height were collected, and the body mass index (BMI) was calculated (kg/m^2).

Comorbidities

A survey elaborated by the researchers to investigate the presence of previously diagnosed comorbidities was applied, according to a previous article (Paes et al, 2017).

Pulmonary function

The pulmonary function was assessed by a pletismography (Vmax, Carefusion, USA) for the COPD group. For the control group, the spirometry was performed (Spiropalm®, COSMED, Italy) to confirm the normal lung function. The evaluations were made according to the international recommendations (Miller et al, 2005). The predicted values used were specifically calculated for the Brazilian population (Pereira, Sato and Rodrigues, 2007).

Calculation of the sample size

The sample size was calculated (G*Power Version 3.1.9.2, Franz Faul, Universität Kiel, Germany) based on the difference of the total energy expenditure found in the COPD group and the control group (COPD group [n=25]: 1972 ± 594 cal/day vs control group [n=25]: 2438 ± 407 cal/day) (Tufanin et al, 2014). Considering $\alpha=0.05$

and a power of 0.80, the calculated number of required participants for this study was 22 for the COPD group and 18 for the control group.

Statistical analysis

The software GraphPad Prism 6 (*Version* 6.01 La Jolla, CA, USA) was used for the statistical analyses. The normality of the data distribution was checked by the Shapiro-Wilk test. The data were expressed as means and standard deviation or as median and interquartile range (25-75%). The categorical variables were presented in absolute and relative frequencies.

The Student t non-paired test or the Mann-Whitney test was used for the intergroup comparisons, depending on the normality of the data distribution. The Chi-squared test was used to compare the gender distribution between the groups. The intragroup comparisons were made by the *one-way* ANOVA or Friedman test, with post-hoc tests Tukey or Dunn, respectively. The level of statistical significance adopted for all the tests was $P<0.05$.

Results

Twenty four patients were evaluated in the COPD group and the control group was composed of 20 individuals, with no exclusions. The groups were similar regarding gender, age, BMI, and a number of comorbidities (Table 1). Besides that, the differences found between the groups in pulmonary function and functional exercise capacity were already expected.

When the two groups were compared based on their time of LAP completion, the individuals with COPD took more time (410 ± 65 vs 292 ± 43 s; $P<0.0001$) and had a worse (i.e., higher) percentage of the predicted ($120\pm 19\%$ vs $87\pm 15\%$; $P<0.0001$). When the metabolic values of the LAP were analyzed and compared, the COPD group had a higher TEE than the control group ($24[18-29]$ cal vs $18[13-19]$ cal; $P=0.0007$, respectively). There was no significant statistical difference between the groups regarding the other metabolic variables EEPA, the average METs, and DAF >3 METs).

The COPD group presented active movements with lower intensity ($0,1408\pm 0,0409$ G vs $0,1706\pm 0,0443$ G; $P=0.02$) and a higher degree of difficulty reported at the end of the LAP in a scale of 0 to 10 ($3[0-5]$ vs $0[0-0]$; $P=0,002$). The

cardiovascular, ventilatory, and metabolic variables during the LAP are presented in Table 3.

Even with the two groups having the same amount of time to perform each LAP activity separately, patients with COPD had a lower number of repetitions in the five ADLs of the protocol (ADL1: 3[3-4] vs 4[3-5]; $P=0.04$; ADL2: 22[21-25] vs 27[25-30]; $P=0.0001$; ADL3: 2[1-2] vs 2[2-3]; $P=0.001$; ADL4: 1[1-1] vs 2[2-3]; $P<0.0001$; ADL5: 24[22-25] vs 28[25-31]; $P=0.0002$). Regarding the metabolic behavior of the TEE (Figure 2), the COPD group presented statistically the lowest energy expenditure just in the ADL4 (put clothes in the clothesline) (Figure 2E). From the activities that required the use of the upper limbs, the variation of fatigue reported by the patients with COPD at the end of the protocol, compared to the pre-test, was statistically higher in the ADL2 (walking holding bags) when compared to the control group ($P=0.0008$). With exception of the ADL1 (objects in the table), in all the other activities executed separately, the patients with COPD presented significant reduction of the SpO₂ and some degree of dyspnea related to the rest. The other results related to the performance in isolated activities are shown in Table 3. The intragroup variation means (final – rest) of the cardiovascular and ventilatory variables and of the metabolic behavior between the five activities executed separately were compared. The metabolic expenditures (TEE and average of MET) between the isolated activities were statistically different in the two studied groups, as shown in Figure 3, panels A and B, respectively.

Discussion

The present study has revealed that patients with COPD exhibit different answers when compared to paired individuals without pulmonary dysfunction in the evaluation of ADL performance. Besides taking more time to execute the same protocol of ADLs, they perform it with higher energy expenditure, more slowly, and report a greater difficulty. When the activities of the protocol were evaluated separately, the mentioned symptoms were also more pronounced in patients with COPD.

The present results confirm the previous literature, which shows that, even when resting, the energy expenditure for the individuals with COPD is high (Ramires et al, 2012). The higher metabolic demand observed in this study can be explained, at least in part, due to the inflammatory process characteristic of the COPD. At the

cellular level, it is well known that the mitochondrial respiration is impaired due to the persistent inflammatory process, suppressing the enzymatic back-up responsible for the balance of this process. The mitochondria face a bioenergetics fail through the inhibition of the respiratory complexes in the lungs of the patients COPD, liberating free radicals, that once in high numbers, act as pro-inflammatory markers. That is, these inflammatory mediators remodel the mitochondrial structure altering, consequently, the cellular function, producing a dysfunctional cycle that causes a disproportional increase in oxygen consumption (Prakash, Pabelick and Sieck, 2017). Other factors that contribute to a higher metabolic uptake are the high overload placed on the respiratory muscles and the low ventilatory back-up, which causes a higher burden of the pulmonary mechanics, in which patients with COPD show a higher dynamic hyperinflation during the execution of the ADL tests (Santos et al, 2016).

In a study about the physiologic responses of individuals with COPD during the ADL-Glittre test published previously, it was demonstrated that when patients with COPD performed a test of ADL they had a slightly higher consumption of oxygen, probably due to the characteristics of the activities executed during the ADL-Glittre test and to the increase of muscular overload. The peak of oxygen increased gradually until reaching a plateau of consumption, evident in the third turn of the test, generating ventilatory responses similar to what happens in TC6min (Karloh et al, 2016). This shows that the ADL-Glittre test has characteristics more similar to a submaximum test. This same test was used in the study of Cavalheri et al (2011) that had as its main result the higher energy expenditure in patients with COPD during the activity of going up and down the stairs.

In the study of Vaes et al (2011), the authors have shown that patients with COPD had a higher consumption of oxygen compared to a control group when five routine activities were proposed, with four-minutes intervals for rest between each one of them. The activities involved situations like putting socks and shoes (sited in a chair), put on a coat, fold eight towels, arrange supplies in a closet, wash dishes, glasses, and saucers (all activities performed standing) and sweep the floor during four minutes. In this last activity, that apparently demands a higher involvement of several different muscular groups and a wider range of movements, from the upper limbs as well as the lower limbs, the proportion of the peak of the aerobic capacity

was higher than in the most static activities. Another study revealed that activities apparently considered simple represent an oxygen consumption of approximately 50 to 60% of the maximal consumption and require a ventilatory increase of 60 to 70% (Lima et al, 2016). In the present study, the activity which showed a higher energy expenditure was walking carrying the bags at the usual speed, which might be explained by the complexity of the muscular synergism in the different phases of the gait, added to an overload of the upper limbs, that is, there is a higher mechanical work, possibly generating as consequence the increase of the metabolic uptake.

When the activities performed separately for the same period of time (3 minutes) are compared, the ADL4 (put clothes in the clothesline) was the activity in which patients with COPD spent less energy than the control group. This fact is explained by the smaller number of repetitions that the COPD completed in isolated activities compared to the control group.

Together with the lower intensity of active movement found in the individuals with COPD in this study, it is suggested that these patients develop a mechanism of “saving” energy due to their difficulty in the execution of these activities, performing them slower with the expectation of yielding fewer symptoms. This concept is based on the techniques of energy conservation, which are strategies employed to reduce the energy expenditure of the patients with COPD during the execution of ADLs (Velloso, 2006).

The lower intensity of the active movements during accomplishment of the whole LAP compared to the control of this study, complement the previous findings that point in the same direction, showing that patients with COPD present a lower intensity of movements in activities performed at home (Vorrink et al, 2011; Cavalheri et al, 2011). Different studies reveal that the level of physical activity of patients with COPD is markedly lower than that observed in healthy individuals (Bossenbroek et al, 2011; Pitta et al, 2005). In the study where it was created, the LAP was correlated to the intensity of movement in the PADL (Sant’anna et al, 2017). This result also highlights one of the advantages of the LAP as an instrument that seems to reflect what happens in the routine of the patients with COPD, since they are instructed to perform the activities in the same way and speed they would they would do at home.

Regarding the referred symptoms after performing each LAP activity, the patients with COPD reported a higher sensation of dyspnea in most of them. In

contrast, the sensation of muscular fatigue reported by the patients with COPD was higher just in the ADL2, that is, the activity that involved carrying the bags with a load. It is already known that dyspnea is a limiting factor for the performance of routine activities by patients with COPD (Velloso et al, 2003; Lahaije et al, 2010). In a systematic review of the physiological mechanisms during the ADLs, patients with COPD had the worst cardiorespiratory responses and the higher sensation of dyspnea during the use of the upper limbs (Lima et al, 2016). Another study has recently shown that, when performing an ADL test, the parameter that differentiated the patients with COPD when they were sorted according to their severity was the low ventilatory back-up. This showed once more that ventilation is the main limitation during the performance of ADLs by patients with COPD, being the factor responsible for the increase of the dyspnea reported by these individuals (Souza et al, 2017). These ventilatory variations appeared in the present study as responses to the execution of the ADLs and, further, there was a great SpO₂ fall at the end of almost all the LAP activities. This worsening of the ventilatory function might result in a higher limitation of the ADLs, worsening of the quality of life, and possibly increases in the number of exacerbations and hospitalizations due to the stagnation of a vicious cycle (Gea et al, 2016).

Besides the higher sensation of dyspnea when carrying the bags, the COPD patients of this study also reported a higher fatigue of the upper limbs during the same activity. In general, the increase in muscular fatigue for patients with COPD is apparently due to the increase in muscular strength for the execution of an activity that requires moving and an overload of the upper limbs, that is, working more with the respiratory muscles. The symptoms of fatigue and dyspnea are characteristic of patients with COPD and were reported in this study even before performing the LAP. However, it should be mentioned that all the participants from both groups were instructed in the same way and under the same conditions when they started the tests.

It is already known that patients with COPD have more chance of desaturating during exercises than healthy individuals (Hadeli et al, 2001). Two previously published studies have shown that patients with COPD presented SpO₂ reduction at the end of the ADL-Glittre test, although not statistically significant (Karloh et al, 2014; Corrêa et al, 2011). In the present study, the variation of SpO₂ after the LAP

was also not different between the groups; differences were observed only when the activities were evaluated separately. This marked fall might be explained by the already known characteristics that involve the pulmonary mechanics of the patients with COPD, that are low tolerance for performing great efforts, dysfunction of the skeletal muscles, and aerial imprisonment.

The variation of the heart rate, double product, and blood pressure has shown no significant difference between the two analyzed groups. These results contrast with the findings related the ADL-Glittre test, since patients with COPD presented a higher variation of heart rate than control individuals at the end of the test, according to Santos et al (2016). Such differences in the cardiovascular responses are possibly related to the fact that the ADL-Glittre test was performed as fast as possible, while in the LAP the individuals were instructed to perform the activities of the protocol in the usual speed, that is, in the way they usually do in their daily lives. Our initial hypothesis was that the activities of the LAP would have a higher energy demand for patients with COPD due to the pulmonary and muscular dysfunctions and, because of that, there would be a higher overload of the cardiovascular system, revealed by a higher heart rate frequency and double product. However, our only finding was a higher initial and final heart frequency in the patients with COPD, revealing a higher physical deconditioning.

This was the first study to compare the performances and the physiologic behaviors in the LAP between individuals with or without pulmonary functional change. Despite the efforts of the authors, this study was limited due to the lack of a gas analyzer to evaluate the maximum consumption of oxygen and ventilatory variables in parallel with the energy expenditure estimated by the monitor of the physical activity. Such approach is encouraged in future researches to complement the present findings.

In conclusion, individuals with COPD, compared to control group, take more time to complete a laboratory protocol of ADLs, the LAP, besides executing it under a higher metabolic demand, with more symptoms, and a higher degree of difficulty. Walking carrying bags was the activity in the protocol that generated the highest energy expenditure.

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Conflicts of interest

There were no conflicts of interest.

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LEGENDS OF THE FIGURES

Figure 1. Circuit of activities of the *Londrina ADL Protocol*.

Figure 2. Comparisons of total energy expenditure in the LAP isolated activities between the COPD and control groups.

Figure 3. Comparisons of total energy expenditure (A) and average metabolic equivalents (METs) (B) between the LAP isolated activities in the COPD and the control groups. * $P < 0.05$.

TABLES AND FIGURES

Table 1. Characteristics of the participants

Variables	COPD group (n=24)	Control group (n=20)	<i>P</i>
Gender (m/f)	13/11	10/10	0.78
Age (years)	67±6	66±7	0.63
Weight (Kg)	76.3±15.5	76.7±17.0	0.92
Hight (cm)	162.8±8.8	160±9.9	0.40
BMI (Kg/cm ²)	28.7±5.0	29.6±4.6	0.54
GOLD I/II/III/IV	1/12/10/11	NA	-
Pulmonary function			
FEV ₁ (L)	1.5±0.4	2.5±0.6	<0.0001
FEV ₁ (%)	55.4±17.2	94.9±11.6	<0.0001
FVC (L)	2.8±0.5	3.0±0.9	0.34
FVC (%pred)	83[70.5-98.0]	93.2[83,3-101.4]	0.1
FEV ₁ /FVC (L)	53[44.2-60.5]	103.2[99.8-109.5]	<0.0001
Comorbidities (n)	2[1-2]	1[0-3]	0.53
6MWT (m)	458±46	550±62	<0.0001
6MWT (%pred)	88±10	106±10	<0.0001

Data presented as mean ± standard deviation or median and interquartile range [25-75%]. M: male; F: female BMI: body mass index; GOLD: Global Initiative for Chronic Obstructive Lung Disease; FEV₁: final expiratory volume in the first second; FVC: forced vital capacity; 6MWT: 6-minute walk test; NA: not applicable; n: number; pred: predicted.

Table 2. Comparison of variables at the beginning and the end of the LAP

	Initial			Final			Δ		
	COPD group	Control group	<i>P</i>	COPD group	Control group	<i>P</i>	COPD group	Control group	<i>P</i>
SpO₂(%)	93[91-94]	97[95-98]	<0.000 1	93[90-94]	96[94-98]	<0.000 1	0[-2-1]	0[-2-1]	0.85

Borg D (pts)	0[0-2]	0[0-0]	0.0008	3[1-4]	0[0-1]	0.0006	1[0-3]	0[0-1]	0.02
Borg F LL (pts)	0[0-2]	0[0-0]	0.09	1[0-3]	0[0-1]	0.03	0[0-1]	0[0-0]	0.07
Borg F UL (pts)	0[0-2]	0[0-0]	0.03	1[0-3]	0[0-1]	0.01	0,5[0-1]	0[0-0]	0.04
HR (bpm)	83[73-92]	70[63-85]	0.02	95[82-106]	82[73-95]	0.02	12[9-17]	9[6-16]	0.27
SBP (mmHg)	120[110-130]	120[112-140]	0.2	125[110-140]	130[120-155]	0.4	10[0-17]	8[0-18]	0.9
DBP (mmHg)	80[62-80]	80[70-80]	0.3	75[62-80]	80[70-80]	0.2	0[-0]	0[0-0]	0.4
Double product (bpm/m mHg)	9355[849-11425]	8640[7890-10455]	0.2	11825[10110-13913]	11075[9436-12873]	0.3	2015[1253-3350]	1780[958-2770]	0.4

Data presented in median and interquartile range [25-75%]. LAP = Londrina ADL Proccol. Δ = variation (final-initial); COPD: chronic obstructive pulmonary disease; SpO₂: peripheral oxygen saturation; %: Percentage; Borg D: dyspnoea; Pts: points; Borg F: fatigue; LL: lower limb; MS: upper limb; HR: heart rate; bpm: beats per minute; SBP systolic blood pressure; mmHg: millimeters of mercury; DBP: diastolic blood pressure; *P*: level of significance between groups.

Table 3. Comparison of cardiovascular and ventilatory variables in isolated LAP activities

	ADL1 (objects on the table)		ADL2 (walk with bags)				ADL3 (shelf)				ADL4 (clothesline)				ADL5 (walking)					
	COPD		Control		COPD		Control		COPD		Control		COPD		Control		COPD		Control	
	Initial	Δ	Initial	Δ	Initial	Δ	Initial	Δ	Initial	Δ	Initial	Δ	Initial	Δ	Initial	Δ	Initial	Δ	Initial	Δ
HR(bpm)	80[72-93]	4[0.2-9]	69[65-83]	7[1-13]	81±12	13±1	68[64-86]	15±8	80[71-90]	13[10-16]	69[65-88]	10[6-14]	84[72-93]	9[5-14]	69[65-88]	10[6-14]	81.5±1	11±1	69[65-89]	12±6
SpO₂(%)	95[93-96]	-0.5[-2-0]	96[95-98]	0[-1-1]	95[92-96]	-1.8±2*	97±2	-0.1±1.2*	94[93-95]	-3[-3-0.5]*	96[95-97]	0[0-1]*	95[93-96]	-1[-3-0]*	96[95-97]	0[0-1]*	94.2±2	-2.2±2.2*	96.1±2*	-0.9±1.7*
BorgD	0.2[0-2]	1[0-2]	0[0-0]	0[0-2]	0[0-2]	1[0-3]*	0[0-0]	0[0-0.5]*	0.2[0-2]	1[0-2]	0[0-0]	0[0-2]	0[0-2]	1[0-2]	0[0-0]	0[0-2]	0[0-2]	0.5[0-3]	0±0	0[0-1]
Borg F MI	0[0-1]	0[0-1]	0[0-0]	0[0-0]	0[0-2]	1[0-2]	0[0-0]	0[0-2]	0[0-1]	0[0-2]	0[0-0]	0[0-0]	0[0-1]	0.5[0-1]*	0[0-0]	0[0-0]*	0[0-1]	0.7[0-2]*	0[0-0]	0[0-0.7]*
Borg F MS	0[0-1]	2.5[1-3]	1[0-3]	1[0-3]	0[0-2]	1[0-2]*	0[0-0]	0[0-0]*	0[0-1]	1[0-2]	0.2[0-1]	0.3[0-1]	0[0-1]	1[0-2]	0[0-0]	0.3[0-1]	0[0-1]	0[0-0.5]	0[0-0]	0[0-0]

Data presented in mean ± standard deviation or median and interquartile range [25-75%]. LAP = Londrina ADL Prococol. AVDs: daily life activity; Δ = variation (final-initial); COPD: chronic obstructive pulmonary disease; SpO₂: peripheral oxygen saturation; %: Percentage; HR: heart rate; Bpm: beats per minute; Borg D: dyspnoea; Borg F: fatigue; MI: lower limb; MS: upper limb; P: level of significance between groups; * Comparisons between the values of variation (Δ) between the COPD and control groups with P≤0.03.

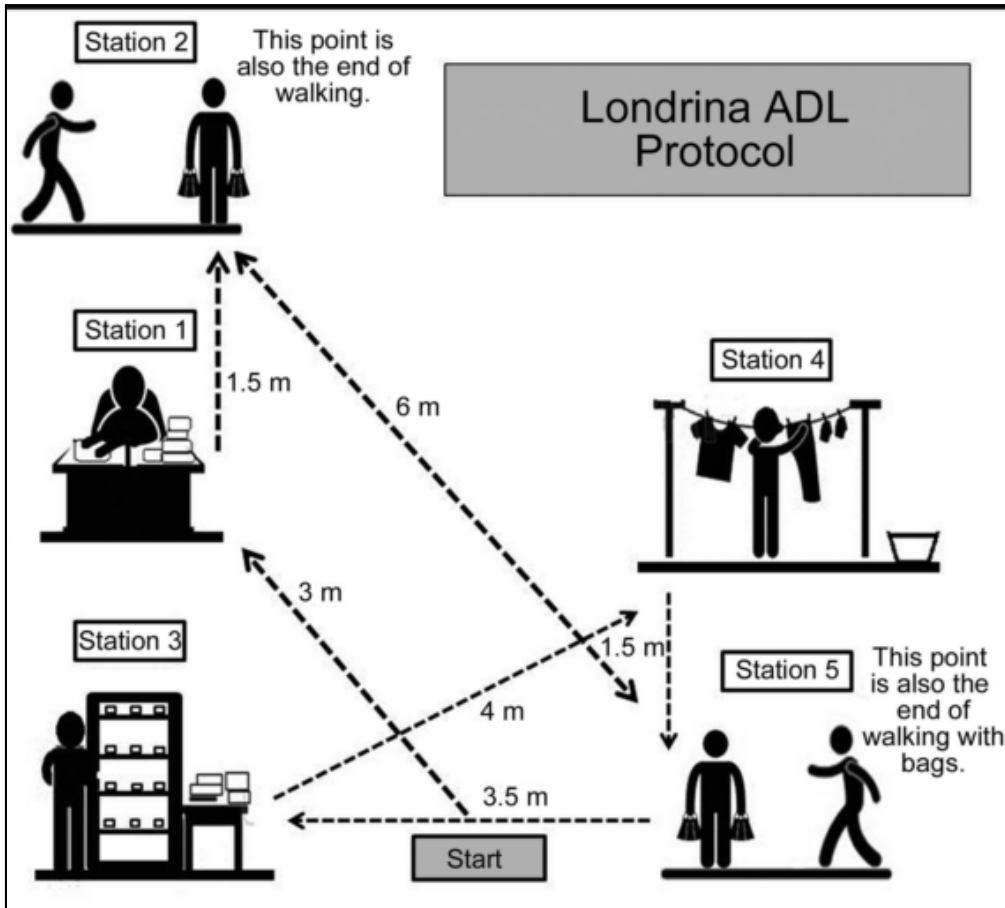


Figure 1. Circuit of activities of the Londrina ADL Protocol.

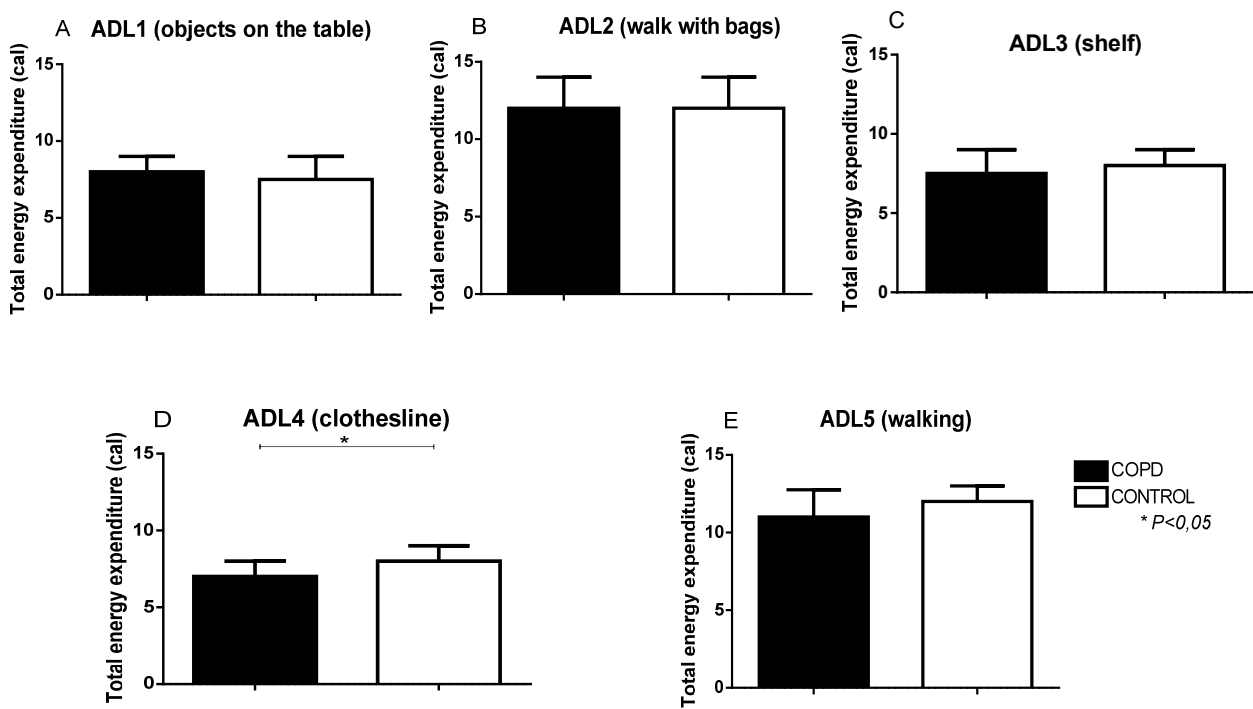


Figure 2. Comparisons of total energy expenditure in the LAP isolated activities between the COPD and control groups.

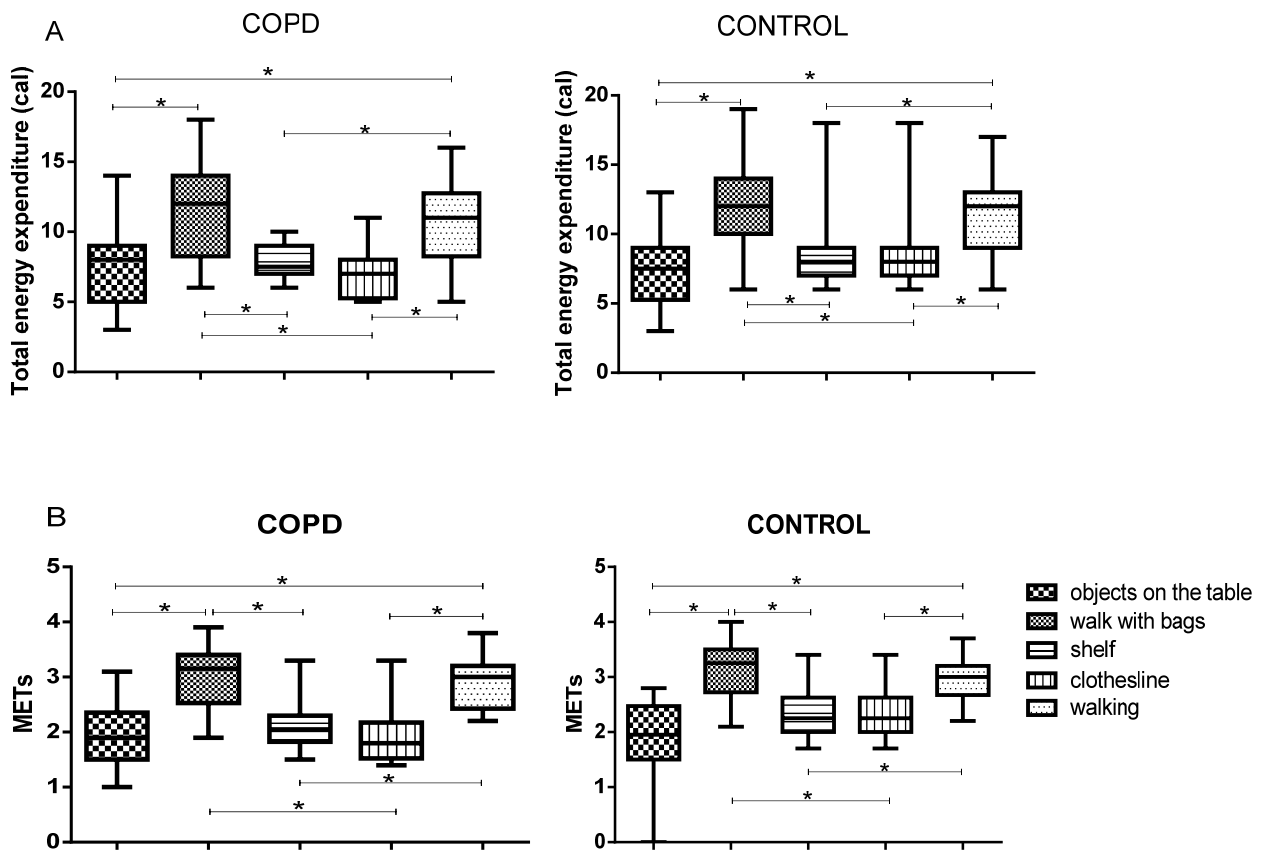


Figure 3. Comparisons of total energy expenditure (A) and average metabolic equivalents (METs) (B) between the LAP isolated activities in the COPD and the control groups. * $P < 0.05$.

CONCLUSÃO GERAL

O presente estudo demonstrou que pacientes com DPOC apresentam respostas diferentes em relação a idosos aparentemente saudáveis no que diz respeito à comparação do comportamento cardiovascular, ventilatório e metabólico na avaliação da performance em atividades de vida diária. Essas diferenças foram evidenciadas principalmente no maior consumo metabólico para realizar tarefas da vida diária, com um gasto energético mais alto nessas atividades. Pacientes com DPOC também apresentaram maior sensação de dispneia, demoraram mais tempo na realização do Londrina *ADL Protocol* e com maior grau de dificuldade, porém sem grande diferença em variáveis cardiovasculares. A atividade de maior consumo energético para os pacientes com DPOC foi caminhar segurando sacolas.

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ANEXO

ANEXO A

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