CENTRO UNIVERSITÁRIO AUGUSTO MOTTA
Vice–Reitoria Acadêmica
Programa de Pós-Graduação Stricto Sensu em Ciências da Reabilitação- PPGCR
Mestrado Acadêmico em Ciências da Reabilitação

MARCELA NICÁCIO MEDEIROS DE OLIVEIRA

AVALIAÇÃO DA ESTABILIDADE ESTÁTICA E DINÂMICA E DO RISCO DE QUEDAS DE INDIVÍDUOS COM DOENÇA PULMONAR OBSTRUTIVA CRÔNICA.

RIO DE JANEIRO
2014

MARCELA NICÁCIO MEDEIROS DE OLIVEIRA

AVALIAÇÃO DA ESTABILIDADE ESTÁTICA E DINÂMICA E DO RISCO DE QUEDAS DE INDIVÍDUOS COM DOENÇA PULMONAR OBSTRUTIVA CRÔNICA.

Dissertação de mestrado apresentada ao Programa de Pós-Graduação Stricto-Sensu em Ciências da Reabilitação do Centro Universitário Augusto Motta, como requisito parcial para obtenção do título de Mestre.

Orientadora: Profa. Dra. Sara Lúcia Silveira de Menezes

Co-Orientador: Prof. Dr. Rodrigo Ribeiro de Oliveira

RIO DE JANEIRO

2014

FICHA CATALOGRÁFICA
Elaborada pelo Sistema de bibliotecas e
Informação – SBI – UNISUAM

616.24 Oliveira, Marcela Nicácio Medeiros de
O48a Avaliação da estabilidade estática e dinâmica e do risco de quedas de indivíduos com doença pulmonar obstrutiva crônica / Marcela Nicácio Medeiros de Oliveira. – Rio de Janeiro, 2014.
52 p.

Dissertação (Mestrado em Ciências da Reabilitação). Centro Universitário Augusto Motta, 2014.

1. Doença pulmonar obstrutiva crônica. 2. Equilíbrio postural. 3. Queda. 4. Revisão sistemática. I. Título.

MARCELA NICÁCIO MEDEIROS DE OLIVEIRA

AVALIAÇÃO DA ESTABILIDADE ESTÁTICA E DINÂMICA E DO RISCO DE QUEDAS DE INDIVÍDUOS COM DOENÇA PULMONAR OBSTRUTIVA CRÔNICA.

Dissertação de mestrado apresentada ao Programa de Pós-Graduação Stricto-Sensu em Ciências da Reabilitação do Centro Universitário Augusto Motta, como requisito parcial para obtenção do título de Mestre.

Aprovada em 16 de dezembro de 2014.

BANCA EXAMINADORA

Profª. Drª. SARA LUCIA OLIVEIRA DE MENEZES – ORIENTADORA
UNISUAM

Prof. Dr. RODRIGO RIBEIRO DE OLIVEIRA – CO- ORIENTADOR
UFC

Prof. Dr. THIAGO LEMOS DE CARVALHO
UNISUAM

Prof. Dr. ARTHUR DE SÁ FERREIRA
UNISUAM

Profª. Drª. MIRIAM RAQUEL MEIRA MAINENTI
EsEFEx

RIO DE JANEIRO
2014

A Deus e a minha Família, pelo incondicional amor e apoio.

AGRADECIMENTOS ESPECIAIS

- **A Deus**, por me mostrar que o amor é infinito, que a força está nele e que o mal nunca vai vencer o bem.

- **Aos meus pais, Antônio Nicácio Sobrinho e Maria Izabel Medeiros Nicácio**, por todo amor, dedicação e ensinamentos, por me mostrarem que a família é tudo, por muitas vezes abrirem mão dos seus sonhos pelos meus, pela força, coragem, determinação, pelos puxões de orelha... Vocês são meu exemplo, minha força, meu tudo. Pai seu presente do dia dos pais tá aí!

- **Aos meus irmãos**, meu segundo exemplo de vida. Eles nem sabem, mas sou a maior fã deles. Sinto falta dos almoços de sábado. (Nadjane se inclua aqui, afinal você sempre foi mais irmã que tia).

- **Aos meus sogros**, por me acolherem sempre, por serem meus segundos pais. Amo vocês.

- **Ao meu cunhado Ronaldo Júnior, Camila, Lêda, D. Júlia, Seu Laurindo** e todos da família Ribeiro Oliveira.

- **A todos os meus familiares**. Sinto muita falta de vocês no meu dia a dia.

- **À querida Família Santos**, pela acolhida e carinho com que sempre fui tratada.

- **À minha orientadora, Sara Lúcia Menezes**, por não me deixar desistir e nem desistir de mim, por ser um exemplo de profissional, dedicada e corajosa. Obrigada professora pela paciência.

- E de todos os agradecimentos o mais importante, **ao meu marido, Rodrigo Ribeiro de Oliveira,** pelo amor, apoio, carinho, paciência, ensinamentos científicos, cobranças (muitas)... Você é um exemplo de profissional, dedicação e amor à fisioterapia e a pesquisa. Você foi meu maior incentivador. Sem você não teria conseguido. TQM

AGRADECIMENTOS

- Ao Curso de Fisioterapia da UFC, especialmente aos profissionais do Laboratório de Análise do Movimento Humano, pela acolhida, apoio e ajuda nas coletas e análises.

- Aos alunos de Iniciação Científica, Pedro Almir, Taynara Teixeira, Fernanda Nair e Elias Brito, vocês foram cruciais na realização das coletas.

- Ao amigo Márcio Almeida pela ajuda nas coletas e caronas aos pacientes.

- Aos profissionais do Serviço de Pneumologia do Hospital de Messejana que de alguma forma me ajudaram na capitação dos indivíduos da pesquisa.

- Aos meus colegas de mestrado que tornaram minha estada longe de casa menos dolorosa. Em especial a Fabiana Azevedo Terra Cunha Belache pelas dúvidas e incertezas em comum e apoio quando eu estava longe de casa.

- A todos os amigos que sempre me apoiaram e torceram por mim. Obrigada pelas orações.

“No mundo haveis de ter aflições, mas coragem; eu venci o mundo.”

Jo 16, 33

RESUMO

Introdução: A doença pulmonar obstrutiva crônica (DPOC) é um problema de saúde que afeta cerca de sete milhões de brasileiros acima de 40 anos. Estudos evidenciam que doenças crônicas, entre elas a DPOC, podem aumentar o risco de quedas através dos efeitos diretos e indiretos da doença. **Objetivo:** Realizar uma revisão sistemática dos estudos transversais que avaliaram o equilíbrio corporal estático e dinâmico e o risco de quedas em indivíduos portadores de DPOC. **Metodologia:** Estratégia de busca: foram pesquisados artigos em bancos de dados eletrônicos da PubMed, BIREME, CINAHL e COCHRANE, incluindo publicações no período de janeiro de 1960 até novembro de 2014. Critérios de seleção: estudos transversais completos e que incluíram um grupo controle de pessoas saudáveis, publicado em qualquer idioma. Os critérios de inclusão para os resultados eram avaliações do equilíbrio postural e risco de quedas em pacientes com doença pulmonar obstrutiva crônica. Extração de dados: a extração de artigos foi realiza de forma independente por dois revisores e foram posteriormente analisados por sua qualidade metodológica utilizando a escala da Agência de Investigação de Saúde e Qualidade para avaliar estudos observacionais. **Resultados:** Oito artigos foram incluídos nesta revisão. Foi utilizada uma variedade de métodos de avaliação, incluindo a escala de Equilíbrio de Berg, teste de Alcance Funcional, questionário sobre a história pessoal e consequências de quedas e testes na plataforma de força. Foi estudado um total de 1.887 indivíduos de ambos os sexos (1417 indivíduos com DPOC e 470 indivíduos saudáveis). **Conclusão:** Os dados sugerem que pacientes com DPOC apresentam equilíbrio corporal prejudicado e aumento do risco de queda. No entanto, devido às limitações metodológicas dos estudos incluídos na revisão, estudos com maior rigor metodologico sobre esta questão são recomendados.

Palavras-Chave: doença pulmonar obstrutiva crônica, equilíbrio postural, queda, revisão sistemática.

ABSTRACT

Introduction: Chronic obstructive pulmonary disease (COPD) is a chronic health problem that has affected about seven million Brazilians over the past 40 years. Studies have shown that chronic diseases, including COPD, may directly or indirectly contribute to an increase in the risk of falls. **Objective:** To carry out a systematic review of the cross-sectional studies that assessed the dynamic and static body balance and the risk of falls in patients with COPD. **Methods:** Search strategy: articles were searched in PubMed, BIREME, CINAHL and COCHRANE electronic databases including publications from January 1960 to November 2014. Selection Criteria: complete cross-sectional studies that included a control group of healthy people, published in any language. The inclusion criteria for the outcomes were assessments of postural balance and risk of falling in patients with chronic obstructive pulmonary disease. Data extraction: Independent extraction of articles by two reviewers which were later analyzed for their methodological quality using the Agency for Healthcare Research and Quality Scale to assess observational studies. **Results**: Eight articles were included in this review. A variety of evaluation methods was used, including the Berg Balance scale, Functional Reach test, a Questionnaire on Personal Histories and Consequences of Falls and tests on the force platform. A total of 1887 subjects of both genders were studied (1417 individuals with COPD and 470 healthy individuals).

Conclusion: The data suggest that patients with COPD present with impaired body balance and increased risk of fall. However, due to the methodological limitations of the studies included in this review, further well designed studies on this issue are recommended.

Keywords: chronic obstructive pulmonary disease; postural balance; fall, systematic review.

SUMÁRIO

1. INTRODUÇÃO

1.1. Doença Pulmonar Obstrutiva Crônica

A Doença Pulmonar Obstrutiva Crônica (DPOC) representa um problema de saúde pública relevante em todo o mundo, com estimativas para ser a terceira principal causa de morte no ano de 2030 (WHO, 2014) e, na atual década, a associação entre DPOC e as altas taxas de morbidade e mortalidade resulta em grave ônus social e econômico (Kim *et al.*, 2014). No Brasil, a DPOC afeta cerca de sete milhões de pessoas acima de 40 anos (Lopez *et al.*, 2006; Menezes *et al.*, 2011), sendo que, na região da Grande São Paulo constatou-se prevalência total de 6 a 15,8% da população nessa faixa etária. Essa taxa de prevalência é considerada alta levando-se em conta o fato de que, em grande parte dos casos, a doença poderia ser prevenida (Menezes *et al.*, 2005). Segundo o DATASUS, os gastos com hospitalizações estão aumentando, enquanto em 2004 se gastava cerca de 72 milhões de reais ao ano com hospitalizações de pacientes com DPOC no sistema público de saúde (Jardim, 2004), em 2010 esses gastos aumentaram para cerca de 92 milhões de reais (Brasil, 2013a).

A DPOC, uma doença comumente prevenível e tratável, é caracterizada por uma limitação persistente ao fluxo de ar que é geralmente progressiva e associada com uma importante resposta inflamatória crônica nas vias aéreas e nos pulmões a partículas e gases nocivos (Fabbri e Hurd, 2003; GOLD, 2014), decorrentes do tabagismo e da poluição do ar (Gómez e Rodriguez-Roisin, 2002; Vestbo *et al.*, 2013; Kim *et al.*, 2014). Essa resposta inflamatória causa remodelamento tecidual das vias aéreas associado à destruição do parênquima e ao desenvolvimento de enfisema pulmonar, aumentando a resistência ao fluxo aéreo e com isso causando aprisionamento de ar e hiperinsuflação dos pulmões (Barnes e Celli, 2009; Vestbo *et al.*, 2013; Wurst *et al.*, 2014).

O termo DPOC inclui pacientes com bronquite crônica e/ou enfisema pulmonar, podendo as duas formas coexistir em um mesmo paciente (Rabe *et al.*, 2007). O processo inflamatório recorrente da bronquite crônica suscita remodelação estrutural da parede brônquica e consequente obstrução do fluxo de ar, enquanto que o enfisema pulmonar apresenta alterações na anatomia da árvore brônquica com destruição do parênquima pulmonar, resultando na dilatação dos espaços aéreos, perda de elasticidade pulmonar e fechamento das pequenas vias aéreas. Embora o mecanismo fisiopatológico

de ambas as doenças seja diferente, a alteração estrutural final resulta em diminuição da luz brônquica e consequente limitação do fluxo aéreo, o que caracteriza a DPOC (Fabbri e Hurd, 2003).

Os sinais e sintomas presentes no portador de DPOC são tosse, produção de secreção e dispneia, tendo desenvolvimento insidioso e, comumente, em um período de tempo prolongado (Fabbri e Hurd, 2003; GOLD, 2014). O diagnóstico da DPOC é dado pela presença desses sinais e sintomas e/ou pela história de exposição a fatores de risco como cigarro, poluição do ar, entre outros (Gómez e Rodriguez-Roisin, 2002; Vestbo *et al.*, 2013; Kim *et al.*, 2014). A tosse é o primeiro sintoma descrito, porém a dispneia é o principal fator que compromete a capacidade funcional desses indivíduos. Ainda que esses sinais e sintomas se apresentem antes da restrição ao fluxo aéreo, nem todos os indivíduos que os apresentam desenvolvem a DPOC, por este motivo, o diagnóstico da DPOC é confirmado pela espirometria (Fabbri e Hurd, 2003; Gruffydd-Jones, 2012).

A patogenia e as apresentações clínicas da DPOC não estão limitadas somente à inflamação pulmonar e ao remodelamento estrutural, mas se ampliam a uma vasta variedade de alterações sistêmicas (Eisner *et al.*, 2007; Eisner *et al.*, 2008; Beauchamp *et al.*, 2009; Soriano *et al.*, 2013), tais como inflamação sistêmica, disfunção musculo esquelética, anormalidades nutricionais e perda de peso e outros efeitos em órgãos e sistemas (Dourado *et al.*, 2006; Barnes e Celli, 2009). A associação desses fatores pode desencadear outras morbidades, tais como isquemia cardíaca, osteoporose, anemia normocítica, Diabetes Mellitus, síndrome metabólica e depressão (Vestbo *et al.*, 2013; Smith e Wrobel, 2014). As manifestações locais e sistêmicas da DPOC estão resumidas na Figura 1.

O processo inflamatório sistêmico leva ao aumento de citocinas pró-inflamatórias que, por sua vez, incrementam o estresse oxidativo estando relacionadas à perda de peso e caquexia, consequentemente, ocorrerá redução da massa e da força muscular (De Godoy *et al.*, 1996; Dourado *et al.*, 2006). Os danos à função muscular também estão associados aos baixos níveis de vitamina D observados nos indivíduos com DPOC, prejudicando a resistência óssea, força muscular e equilíbrio (Bischoff-Ferrari *et al.*, 2004; Janssens *et al.*, 2013). Danos à função muscular associada à mobilidade funcional reduzida e diminuição da capacidade de realizar exercício em indivíduos com DPOC tem sido documentada por vários estudos (Kim *et al.*, 2008; Beauchamp *et al.*, 2009; Man *et al.*, 2009).

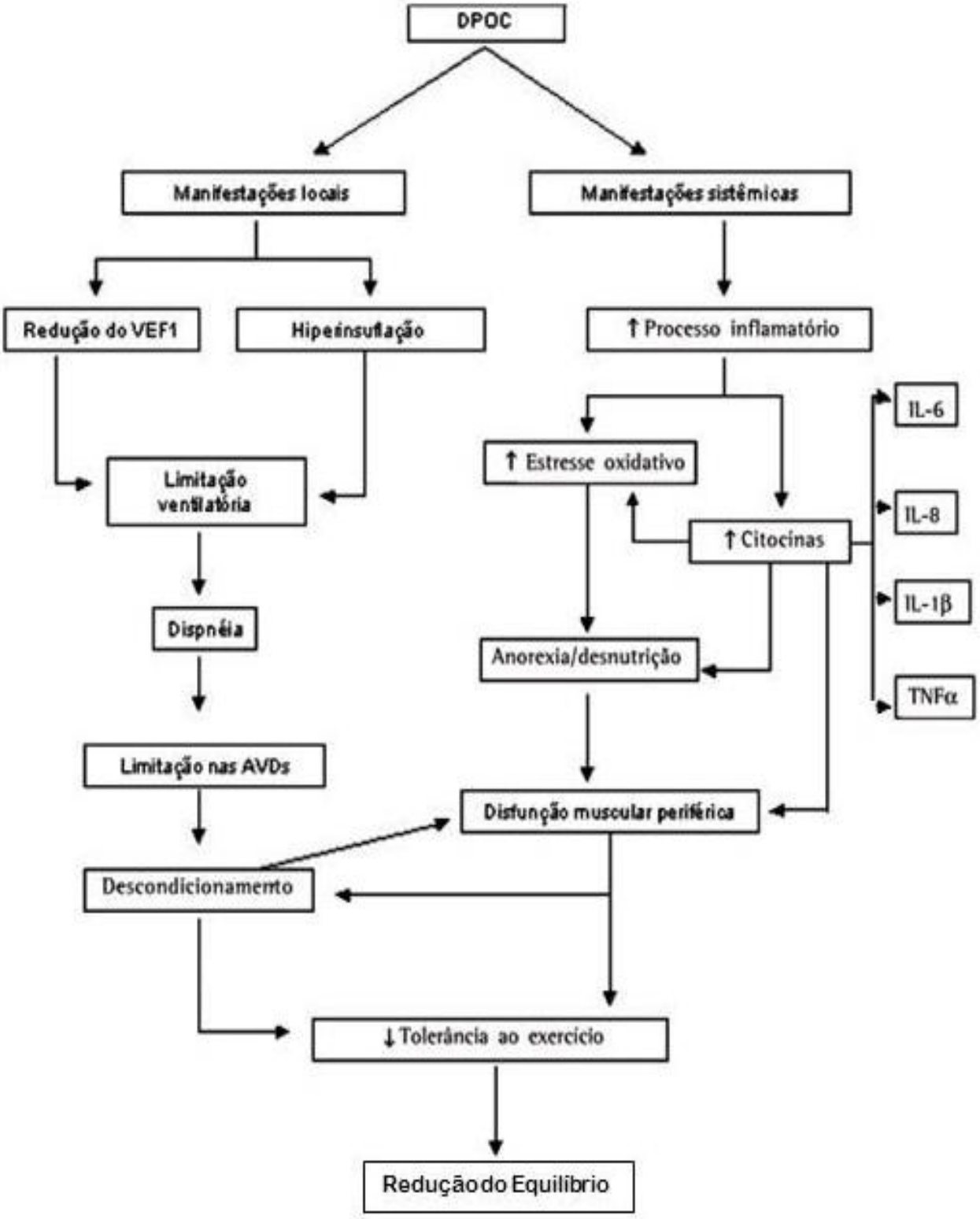

Figura 1 - Fisiopatologia das manifestações sistêmicas e locais da doença pulmonar obstrutiva crônica que podem levar a redução do equilíbrio. Adaptado de Dourado (2006).

1.2. Controle do Equilíbrio e Queda

O controle do equilíbrio é definido como a capacidade de manter o centro de massa corporal dentro dos limites da base de suporte. Quando a projeção desse centro de massa sai dos limites de estabilidade, o indivíduo necessita realizar ajustes para conservar o equilíbrio (Vignola; Cameron e Lord, 2010). O equilíbrio postural permite ao indivíduo resistir às influências de desestabilização e se mover (Bushatsky, 2012). Depende da ponderação das forças internas e externas que atuam no corpo que, quando em postura estática, não está totalmente imóvel, mesmo que o indivíduo esteja o mais parado possível, apresentando deslocamento do seu centro de massa nos eixos ântero-posterior (AP) e médio-lateral (ML) (Barela, 2000; Oliveira *et al.*, 2000).

A manutenção do equilíbrio necessita de uma complexa integração entre os múltiplos processos sensoriomotores envolvendo condições biomecânicas, estratégias de movimento, estratégias sensoriais, orientação espacial, controle dinâmico e processamento cognitivo (Horak, 2006; Beauchamp *et al.*, 2012).

A principal condição biomecânica envolvida na manutenção do equilíbrio é a base de suporte que pode oferecer limitações com relação ao tamanho, força, amplitude, dor ou controle. Essas limitações poderão modificar o centro de massa corporal em relação à base de suporte alterando assim o equilíbrio (Tinetti *et al*., 1988; Horak, 2006).

Já as estratégias de movimento englobam a estratégia de tornozelo, a estratégia de quadril e o passo para recuperar o equilíbrio. A estratégia de tornozelo faz o indivíduo mover-se como um pêndulo invertido e é adequada para manter o equilíbrio em pequenas oscilações. Na estratégia de quadril o corpo exerce torque nos quadris para mover rapidamente o centro de massa corporal e ocorre principalmente quando precisamos ficar em uma superfície estreita e quando o centro de massa corporal precisa ser transferido rapidamente (Horak, 2000). O passo para recuperar o equilíbrio é comum durante a marcha e quando não há a necessidade de manter os pés parados (Horak, 2006).

As estratégias sensoriais dependem das informações fornecidas pelos sistemas visual, somatossensorial e vestibular de forma integrada afim de que o complexo ambiente sensorial seja interpretado. As estratégias sensoriais nos permite uma mudança na dependência de cada sistema, ou seja, é a capacidade que temos de utilizar as informações sensoriais de acordo com o contexto sensorial sendo importante, por

exemplo, quando passamos de um ambiente bem iluminado para uma ambiente pouco iluminado, ou de uma base de apoio sólida para uma base instável (Peterka, 2002).

A orientação espacial refere-se à capacidade de orientar partes do corpo em relação à superfície de suporte, campo visual, gravidade e referências internas e é um importante componente na manutenção do equilíbrio. O sistema nervoso é capaz de alterar automaticamente a orientação corporal no espaço, dependendo da tarefa e do contexto inserido (Horak, 2006).

O controle dinâmico se dá durante a marcha e na mudança postural e requer um controle complexo do movimento do centro de massa corporal, pois, ao contrário de quando estamos em repouso, o centro de massa corporal não se encontra dentro da base de apoio, necessitando tanto de estabilidade anterior quanto lateral (Horak, 2006).

São imprescindíveis diversos recursos cognitivos para manutenção do equilíbrio. Quanto mais difícil e diversificada a tarefa mais processamentos cognitivos são necessário fazendo com que os tempos de reação e o desempenho nas tarefas cognitivas diminuam de acordo com ao aumento da dificuldade postural (Teasdale *et al.*, 2001, Horak, 2006).

Como o equilíbrio depende de associações sensoriais múltiplas, uma falha em qualquer um dos sistemas envolvidos, individualmente ou em conjunto, pode causar desequilíbrio postural e quedas (Aikawa *et al.*, 2012), sendo a queda definida como um deslocamento não intencional para um nível inferior a posição inicial (Brasil, 2013b). As quedas têm consequências negativas, incluindo morbidade, mortalidade e perda de autonomia, além de onerar o sistema de saúde (Findorff *et al.*, 2007).

1.3.Controle do Equilíbrio e Queda na DPOC

As doenças crônicas, entre elas a DPOC, podem alterar o equilíbrio, através dos efeitos diretos e indiretos da doença, tais como redução da atividade física, fraqueza muscular, piora da percepção de dispneia e diminuição do controle do equilíbrio (Lawlor *et al.*, 2003; Roig *et al.*, 2009; Beauchamp *et al.*, 2010; Roig *et al.*, 2011).

O comprometimento musculoesquelético é um dos principais determinantes da alteração do equilíbrio e presença de quedas na população em geral (Moreland *et al.*, 2004) sendo que na DPOC a fraqueza muscular se dá devido, em grande parte, à falta de condicionamento físico provocado pela desnutrição, repouso no leito durante exacerbações, atividades limitadas pela dispneia e uso de corticoides (Smith *et al.*, 2010). Os indivíduos com DPOC apresentam diminuição da força, da funcionalidade e

da resistência dos membros inferiores (Eisner *et al.*, 2008; Miranda *et al.*, 2011) e superiores (Miranda *et al.*, 2011) em função da anormalidade no metabolismo muscular, da dependência do metabolismo glicolítico, do acúmulo rápido de lactato durante o exercício, da disfunção neuromecânica dos músculos respiratórios e da alteração dos volumes pulmonares durante as atividades realizadas com membros superiores (Miranda *et al.*, 2011).

Smith (2010) observou aumento do deslocamento médio-lateral do centro de pressão e do movimento angular de quadril em pessoas com DPOC, em comparação a indivíduos saudáveis, mostrando que esses indivíduos têm reduzido controle de equilíbrio. Sabe-se que o aumento da demanda respiratória, em indivíduos saudáveis, altera a atividade postural dos músculos do tronco (Smith *et al.*, 2010) e a resposta proprioceptiva do tronco e do tornozelo (Janssens *et al.*, 2013) comprometendo o equilíbrio. Com isso, supõe-se que o controle do deslocamento médio-lateral do centro de pressão pode ser prejudicado em pessoas com DPOC, já que a demanda respiratória encontra-se aumentada nesses indivíduos, e poderia contribuir para o aumento do risco de quedas.

Os principais preditores de queda estão presentes nos indivíduos com DPOC, como presença de doenças crônicas, múltiplos medicamentos, mobilidade prejudicada e fraqueza muscular, sendo o histórico de quedas anteriores e o diagnóstico de doenças coronarianas os mais importantes, porém, correlações entre equilíbrio e quedas são muito limitadas (Roig *et al.*, 2009).

O histórico de quedas com a aplicação de questionários relatou que 46% dos indivíduos com DPOC haviam tido pelo menos uma queda durante os últimos 12 meses (Beauchamp *et al.*, 2009). Outro estudo mais recente identificou a presença de pelo menos um evento de queda em ¼ dos portadores de DPOC, no período de seis meses (Ozalevli *et al.*, 2011). Portanto, estudos que explorem o déficit de equilíbrio em DPOC, são de enorme valia, visto que essa população apresenta uma elevada frequência de queda.

1.4. Avaliação do Equilíbrio e do Risco de Queda

Na prática clínica, a avaliação do equilíbrio e do risco de queda deverá ser conduzida através da anamnese e dos testes clínicos específicos do equilíbrio, utilizando instrumentos quantitativos para mensurar e obter resultados confiáveis. Escalas clínicas

para avaliação do equilíbrio são utilizadas para comparar populações, padronizar avaliações e verificar os efeitos terapêuticos das intervenções (Yelnik e Bonan, 2008).

Os instrumentos e escalas observacionais para avaliação do equilíbrio avaliam os sujeitos em tarefas funcionais do cotidiano que podem causar desequilíbrio, sendo que esses métodos geralmente são de fácil aplicação e baixo custo. Alguns exemplos de instrumentos e escalas utilizadas para avaliar equilíbrio e o risco de queda, inclusive em pacientes com DPOC, são a Escala de Equilíbrio Funcional de Berg (EEFB), o *Timed Up and Go*, o teste de Alcance Funcional e o *Short Physical Performance Battery* e a *Activities-specific Balance Confidence* (ABC) (Oliveira *et al.*, 2013).

A EEFB (Berg, 1989) é um método clínico de avaliação, prático e capaz de produzir dados confiáveis e válidos em vários grupos populacionais (Pimentel e Scheicher, 2009) tornando-se com isso uma medida útil na prática clínica, pois reflete com precisão os dados obtidos como indicadores do comportamento ou do fenômeno avaliado (Lima *et al.*, 2012). Entretanto, segundo Schoene (2013), o *Timed Up and Go* (Mathias *et al*., 1986*)*, o teste de Alcance Funcional (Duncan *et al.*, 1990), e o *Short Physical Performance Battery* (Guralnik *et al.*, 1989), apresentam baixa acurácia diagnóstica para determinar alterações do equilíbrio (Schoene *et al.*, 2013).

A EEFB está diretamente relacionada com outros testes de equilíbrio, apresentando uma confiabilidade intra e interobservador de cerca 98%, sendo um instrumento confiável para ser utilizado na avaliação do equilíbrio de pacientes brasileiros idosos (Miyamoto *et al.*, 2004). Artigos de revisão têm evidenciado maior confiabilidade e validade para a utilização da EEFB, em pesquisas científicas, do que outros instrumentos de avaliação assim como destacam sua utilização na prática clínica da reabilitação (Vanswearingen *et al.*, 1998; Whitney *et al.*, 1998; Major *et al.*, 2013; Wong *et al.*, 2014).

Uma recente revisão sistemática sobre instrumentos de medidas para avaliação do equilíbrio e do risco de quedas em portadores de DPOC mostrou não existir um método padronizado estabelecido para avaliar estes desfechos na população-alvo. Contudo, descreve que a EEFB parece ser a melhor recomendação para avaliar o controle postural na prática clínica baseada em seu conteúdo e validade (Oliveira *et al.*, 2013).

Outros instrumentos de mensuração do equilíbrio, além das escalas clínicas, são os equipamentos e métodos de avaliação biomecânica. Contudo, esses são mais empregados com finalidade de pesquisa científica, por possuírem custos mais elevados

e necessitarem de treinamento para manuseio. Os instrumentos mais utilizados são a plataforma de força, a plataforma barapodométria eletrônica para realização do teste de estabilometria e o equipamento *Biodex Balance System* (BBS) (Arnold e Schmitz, 1998).

A estabilometria é um método de avaliação do equilíbrio na postura ortostática, via utilização da plataforma barapodométrica eletrônica e envolve a monitorização dos deslocamentos do centro de pressão (CP) nas direções ML e AP, que corresponde à localização da resultante das forças aplicadas na superfície em contato com os pés, que consiste na base de apoio (Vieira e Oliveira, 2006). A amplitude, a área e a velocidade de oscilação do CP na base de apoio são detectadas por sensores eletromecânicos e parte-se da assertiva que, quanto menor o controle do equilíbrio, maior a área de oscilação do corpo (Stapley *et al.*, 2000). O processamento do sinal é geralmente aplicado nos domínios do tempo e da frequência da oscilação, porém diversos protocolos são utilizados para realização do teste estabilométrico para as diferentes populações, com variações metodológias, tais como o tempo de teste, a base de suporte (pés juntos, afastados, apoio unipodal) e a condição da visão (olhos abertos, olhos fechados). Estas variações conseguem avaliar de forma mais eficaz a capacidade de manter o centro de massa corporal sobre a sua base de apoio, sendo um instrumento com validade e reprodutibilidade reconhecidas (Castagno, 1994; Middleton *et al.*, 1999; Oliveira *et al.*, 1999; Bastos *et al.*, 2005).

Além da plataforma baropodométrica eletrônica outro equipamento usualmente utilizado na avaliação do equilíbrio corporal, em estudos científicos, é o *Biodex Balance System*. Este dispositivo utiliza um sistema com base em microprocessador para ajustar a estabilidade de uma placa de força circular suspensa. A plataforma de força tem um máximo de 20° de inclinação em qualquer direção quando completamente instabilizada e determina a instabilidade de um indivíduo (Pickerill e Harter, 2011). Mede inclinação em graus sobre cada eixo durante os testes (Arnold e Schmitz, 1998; Douglas *et al.*, 2013), sendo um equipamento com vasta variação de protocolos e testes, pois pode realizar a avaliação de forma estática, dinâmica, confiável e repetível, aumentando assim a sensibilidade para diagnóstico do desequilíbrio do balanço postural e do risco de queda (Parraca *et al.*, 2011; Rahimi e Abadi, 2012).

O aumento significativo da prevalência de doenças crônicas, principalmente da DPOC, doença relacionada com o aumento do risco de queda, determina a necessidade

do estudo com métodos de avaliação da estabilidade estática e dinâmica, de forma confiável e reprodutível (Smith *et al.*, 2010).

2. JUSTIFICATIVA

A DPOC apresenta-se subdiagnosticada devido suas estimativas sobre a prevalência estarem baseadas primariamente nas estatísticas de mortalidade (4ª causa de mortalidade no mundo), porém a morbimortalidade é elevada, afetando cerca de 7,5 milhões de pessoas no Brasil. Dados do DATASUS mostram elevados custos ao Sistema Nacional de Saúde Pública gerados por internações.

Além das consequências devastadoras da doença no sistema respiratório, estudos já demostraram aumento de risco para quedas em indivíduos com DPOC. As quedas podem agravar o estado de saúde geral dos pacientes com DPOC, reduzindo sua qualidade de vida e autonomia, e aumentando a mortalidade e os custos do sistema de saúde. Autores anteriores realizaram uma revisão sistemática sobre os instrumentos utilizados para avaliar o controle postural e medo de cair em pessoas com DPOC. No entanto, os dados sobre risco de quedas e diminuição do equilíbrio postural e mobilidade em pacientes com DPOC são escassos.

A elaboração de uma revisão sistemática dos estudos transversais que avaliaram o equilíbrio corporal estático e dinâmico e o risco de quedas em indivíduos portadores de DPOC se faz necessária visto a importância de se prover subsídios para que os profissionais da área de saúde possam elaborar estratégias de avaliação e prevenção de quedas que possibilitem aos pacientes com DPOC envelhecer com qualidade de vida, autonomia, independência e capacidade funcional.

3. OBJETIVOS

3.2. Objetivo Geral

Avaliar se portadores de DPOC tem diminuição do equilíbrio postural e/ou aumento da frequência de quedas em comparação com indivíduos saudáveis.

3.3. Objetivos Específicos

- Observar as ferramentas e procedimentos empregados na avaliação do equilíbrio, frequência e risco de queda em portadores de DPOC;
- Apresentar as características dos estudos selecionados;

- Avaliar a qualidade dos estudos selecionados através dos critérios metodológicos da escala da Agência de Investigação de Saúde e Qualidade.

4. MATERIAIS E MÉTODOS

4.2. Fontes de Dados

A pesquisa foi realizada utilizando as bases de dados eletrônicas PubMed, BIREME, CINAHL e Cochrane no período de janeiro de 1960 a novembro de 2014. Os descritores foram extraídos do Medical Subject Headings (MeSH) e Descritores em Ciências da Saúde (DeCS), no seguinte ordenação:

#1- ("Postural Balance"[Mesh]) OR Functional Balance Assessments) OR Postural Sway ";

#2- (("Accidental Falls"[Mesh]) OR Fear of Fall) OR Fear of Falling

#3- (("Pulmonary Disease, Chronic Obstructive"[Mesh]) OR "Lung Diseases, Obstructive"[Mesh]) OR "Lung Diseases"[Mesh];

#4- #1 OR #2

#5- #4 AND #3

As buscas foram realizadas em bancos de dados eletrônicos por dois investigadores experientes independentes, e incluiu as referências encontradas nos estudos e arquivos pessoais dos autores. Inicialmente foram incluídos todos os artigos que tiveram como desfechos primários ou secundários equilíbrio postural e/ou quedas em indivíduos com doença pulmonar obstrutiva crônica.

4.2. Seleção dos Estudos e Critérios de Elegibilidade

Nos artigos selecionados, foram selecionados os seguintes critérios de inclusão gerais: estudos completos com seres humanos, estudos transversais que incluíram grupo de controle de pessoas saudáveis, publicado em qualquer idioma. Os critérios de inclusão para os resultados eram avaliações do equilíbrio postural, elipse estabilométrica, teste de alcance funcional, teste de alcance lateral, oscilação postural, oscilação do corpo, limites de estabilidade, centro de pressão, teste de equilíbrio estático, teste de equilíbrio dinâmico, teste de equilíbrio funcional, *timed up and go*, posturografia, questionários específicos para análise de equilíbrio (Escala de Equilíbrio de Tinetti, *Community Balance and Mobility Scale*, Escala de Equilíbrio de Berg, outros) e risco de quedas em portadores de doença pulmonar obstrutiva crônica.

Os estudos com as seguintes características foram excluídos desta revisão: estudos de casos, estudos observacionais, estudos sem grupo controle saudável para comparação

com DPOC, cartas, editoriais, resumos estendidos, estudos com animais, bem como os estudos em que os pacientes apresentavam outras condições que podem ter influenciado os resultados (doença vestibular, ferimento ortopédico).

4.3. Avaliação da Qualidade dos Estudos

A qualidade dos estudos foi avaliada pela escala da Agência de Investigação de Saúde e Qualidade, modificada e validada por West et al., 2002. Esses critérios foram utilizados em diversas revisões sistemáticas com ou sem o uso de valores de pontuação.

4.4. Abstração de Dados

Os títulos e resumos identificados através das pesquisas foram revisados independentemente por dois pesquisadores para selecionar estudos potencialmente relevantes. Casos de desentendimentos, quando presentes, foram discutidos com um terceiro pesquisador. Uma vez eleitos, os estudos tiveram seus dados extraídos e compilados, de acordo com os critérios de qualidade. Não foi realizada cegagem dos autores dos estudos.

4.5. Análise dos Dados

Devido à heterogeneidade dos resultados cdos estudos, uma meta-análise não foi realizada e os resultados foram resumidos com ênfase na qualidade do desenho dos estudos selecionados.

5. CONSIDERAÇÕES FINAIS

Os dados atuais sugerem que pacientes com DPOC apresentam equilíbrio corporal prejudicado e aumento do risco de queda. No entanto, devido às limitações metodológicas quanto à seleção dos sujeitos, as amostras não probabilísticas, e viés do entrevistador, esta associação não pode ser sustentada. Outros estudos observacionais, especialmente estudos de coorte e caso-controle, com um projeto mais consistente e incluindo métodos adequados de avaliação do equilíbrio dinâmico, são recomendados.

REFERÊNCIAS

AIKAWA, A. C.; BRACCIALLI, L. M. P.; PADULA, R. S. Efeitos das alterações posturais e de equilíbrio estático nas quedas de idosos institucionalizados. **Revista de Ciências Médicas,** v. 15, n. 3, p.189-196, 2012.

ARNOLD, B. L.; SCHMITZ, R. J. Examination of balance measures produced by the Biodex Stability System. **Journal of athletic training,** v. 33, n. 4, p. 323-327, 1998.

BARELA, J. A. Estratégias de controle em movimentos complexos: ciclo percepção-ação no controle postural. **Rev Paul Educ Fís,** v. 1, Suppl 3, p. 79-88, 2000.

BARNES, P.; CELLI, B. Systemic manifestations and comorbidities of COPD. **European Respiratory Journal,** v. 33, n. 5, p. 1165-1185, 2009.

BASTOS, A. G. D.; LIMA, M. A. D. M. T.; OLIVEIRA, L. F. D. Evaluation of patients with dizziness and normal electronystagmography using stabilometry. **Revista Brasileira de Otorrinolaringologia,** v. 71, n. 3, p. 305-310, 2005.

BEAUCHAMP, M.; HILL, K.; GOLDSTEIN, R.; JANAUDIS-FERREIRA, T.; BROOKS, D. Impairments in balance discriminate fallers from non-fallers in COPD. **Respiratory medicine,** v. 103, n. 12, p. 1885-1891, 2009.

BEAUCHAMP, M. K.; O'HOSKI, S.; GOLDSTEIN, R. S.; BROOKS, D. Effect of pulmonary rehabilitation on balance in persons with chronic obstructive pulmonary disease. **Archives of physical medicine and rehabilitation,** v. 91, n. 9, p. 1460-1465, 2010.

BEAUCHAMP, M. K.; SIBLEY, K. M.; LAKHANI, B.; ROMANO, J.; MATHUR, S.; GOLDSTEIN, R. S.; BROOKS, D. Impairments in Systems Underlying Control of Balance in COPDBalance in COPD. **CHEST,** v. 141, n. 6, p. 1496-1503, 2012.

BERG, K. Measuring balance in the elderly: preliminary development of an instrument. **Physiotherapy Canada,** v. 41, n. 6, p. 304-311, 1989.

BISCHOFF-FERRARI, H.; BORCHERS, M.; GUDAT, F.; DÜRMÜLLER, U.; STÄHELIN, H.; DICK, W. Vitamin D receptor expression in human muscle tissue decreases with age. **Journal of Bone and Mineral Research,** v. 19, n. 2, p. 265-269, 2004.

BRASIL, Ministério da Saúde; Secretaria de Ciências Tecnologia e Insumos Estratégicos; Comissão Nacional de Incorporação de Tecnologias no SUS. Budesonida, beclometasona, fenoterol, salbutamol, formoterol e salmeterol para o tratamento da doença pulmonar obstrutiva crônica (DPOC). **Relatório n° 30,** 2013.

BRASIL, Âgencia Nacional de Vigilância Sanitária; Fundação Oswaldo Cruz. **Programa Nacional de Segurança do Paciente (PNSP). Anexo 01: Protocolo dePrevençãodeQuedas**http://www.anvisa.gov.br/hotsite/segurancadopaciente/documentos/julho/Protocolo%20-%20Preven%C3%A7%C3%A3o%20de%20Quedas.pdf. 2013.

BUSHATSKY, A. **Déficit de equilíbrio corporal: prevalência e fatores associados em idosos residentes no município de São Paulo-Estudo SABE**. 2012. Tese (Programa de pós-graduação em saúde pública) - Faculdade de Saúde Pública, Universidade de São Paulo, 2012.

CAMERON, M. H.; LORD, S. Postural control in multiple sclerosis: implications for fall prevention. **Current neurology and neuroscience reports,** v. 10, n. 5, p. 407-412, 2010.

CASTAGNO, L. A. Abordagem atual do paciente com tontura ou vertigem; Modern aproach in the management of patients with dizziness and vertigo. **Rev. AMRIGS,** v. 38, n. 2, p. 90-100, 1994.

DE GODOY, I.; DONAHOE, M.; CALHOUN, W. J.; MANCINO, J.; ROGERS, R. M. Elevated TNF-alpha production by peripheral blood monocytes of weight-losing COPD patients. **American journal of respiratory and critical care medicine,** v. 153, n. 2, p. 633-637, 1996.

DOUGLAS, M.; BIVENS, S.; PESTERFIELD, J.; CLEMSON, N.; CASTLE, W.; SOLE, G.; WASSINGER, C. A. Immediate effects of cryotherapy on static and dynamic balance. **International journal of sports physical therapy,** v. 8, n. 1, p. 9-14, 2013.

DOURADO, V. Z.; TANNI, S. E.; VALE, S. A.; FAGANELLO, M. M.; SANCHEZ, F. F.; GODOY, I. Systemic manifestations in chronic obstructive pulmonary disease. **Jornal brasileiro de pneumologia,** v. 32, n. 2, p. 161-171, 2006.

DUNCAN, P. W.; WEINER, D. K.; CHANDLER, J.; STUDENSKI, S. Functional reach: a new clinical measure of balance. **Journal of gerontology,** v. 45, n. 6, p. M192-M197, 1990.

EISNER, M. D.; BLANC, P. D.; SIDNEY, S.; YELIN, E. H.; LATHON, P. V.; KATZ, P. P.; TOLSTYKH, I.; ACKERSON, L.; IRIBARREN, C. Body composition and functional limitation in COPD. **Respir Res,** v. 8, n. 7, p. 1- 10, 2007.

EISNER, M. D.; BLANC, P. D.; YELIN, E. H.; SIDNEY, S.; KATZ, P. P.; ACKERSON, L.; LATHON, P.; TOLSTYKH, I.; OMACHI, T.; BYL, N. COPD as a

systemic disease: impact on physical functional limitations. **The American journal of medicine,** v. 121, n. 9, p. 789-796, 2008.

FABBRI, L.; HURD, S. Global strategy for the diagnosis, management and prevention of COPD: 2003 update. **European Respiratory Journal,** v. 22, n. 1, p. 1-2, 2003.

FINDORFF, M. J.; WYMAN, J. F.; NYMAN, J. A.; CROGHAN, C. F. Measuring the direct healthcare costs of a fall injury event. **Nursing research,** v. 56, n. 4, p. 283-287, 2007.

GOLD, Global Iniciative for Chronic Obstructive Lung Desease, **Global strategy for the diagnosis, management and prevention of chronic pulmonary disease**. http://www.goldcopd.org/. 2014.

GÓMEZ, F. P.; RODRIGUEZ-ROISIN, R. Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines for chronic obstructive pulmonary disease. **Current opinion in pulmonary medicine,** v. 8, n. 2, p. 81-86, 2002.

GRUFFYDD-JONES, K. GOLD guidelines 2011: what are the implications for primary care. **Prim Care Respir J,** v. 21, n. 4, p. 437-41, 2012.

GURALNIK, J. M.; BRANCH, L. G.; CUMMINGS, S. R.; CURB, J. D. Physical performance measures in aging research. **Journal of Gerontology,** v. 44, n. 5, p. M141-M146, 1989.

HORAK FB, KUO A. Postural adaptation for altered environments, tasks and intentions. **Biomechanics and Neuronal Control of Posture and Movement.** p.267–281, 2000.

HORAK, F. B. Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? **Age and ageing,** v. 35, n. suppl 2, p. ii7-ii11, 2006.

JANSSENS, L.; BRUMAGNE, S.; MCCONNELL, A. K.; CLAEYS, K.; PIJNENBURG, M.; BURTIN, C.; JANSSENS, W.; DECRAMER, M.; TROOSTERS, T. Proprioceptive changes impair balance control in individuals with chronic obstructive pulmonary disease. **PloS one,** v. 8, n. 3, p. e57949, 2013.

JARDIM, J. R. B. II Consenso Brasileiro de Doença Pulmonar Obstrutiva Crônica (DPOC). **J Pneumol,** v. 30, n. Supl 1, p. 42, 2004.

KIM, H. C.; MOFARRAHI, M.; HUSSAIN, S. N. Skeletal muscle dysfunction in patients with chronic obstructive pulmonary disease. **International journal of chronic obstructive pulmonary disease,** v. 3, n. 4, p. 637-658, 2008.

KIM, W. J.; SONG, J. S.; PARK, D. W.; KWAK, H. J.; MOON, J.-Y.; KIM, S.-H.; SOHN, J. W.; YOON, H. J.; SHIN, D. H.; PARK, S. S. The effects of secondhand smoke on chronic obstructive pulmonary disease in nonsmoking Korean adults. **The Korean journal of internal medicine,** v. 29, n. 5, p. 613-619, 2014.

LAWLOR, D. A.; PATEL, R.; EBRAHIM, S. Association between falls in elderly women and chronic diseases and drug use: cross sectional study. **BMJ,** v. 327, n. 7417, p. 712-717, 2003.

LIMA, P. O.; OLIVEIRA, R. R.; MOURA FILHO, A. G.; RAPOSO, M. C.; COSTA, L. O.; LAURENTINO, G. E. Concurrent validity of the pressure biofeedback unit and surface electromyography in measuring transversus abdominis muscle activity in patients with chronic nonspecific low back pain. **Brazilian Journal of Physical Therapy,** v. 16, n. 5, p. 389-395, 2012.

LOPEZ, A.; SHIBUYA, K.; RAO, C.; MATHERS, C.; HANSELL, A.; HELD, L.; SCHMID, V.; BUIST, S. Chronic obstructive pulmonary disease: current burden and future projections. **European Respiratory Journal,** v. 27, n. 2, p. 397-412, 2006.

MAJOR, M. J.; FATONE, S.; ROTH, E. J. Validity and Reliability of the Berg Balance Scale for Community-Dwelling Persons With Lower-Limb Amputation. **Archives of physical medicine and rehabilitation,** v. 94, n. 11, p. 2194-2202, 2013.

MAN, W.; KEMP, P.; MOXHAM, J.; POLKEY, M. Skeletal muscle dysfunction in COPD: clinical and laboratory observations. **Clinical Science,** v. 117, p. 251-264, 2009.

MATHIAS, S.; NAYAK, U.; ISAACS, B. Balance in elderly patients: the" get-up and go" test. **Archives of physical medicine and rehabilitation,** v. 67, n. 6, p. 387-389, 1986.

MENEZES, A. M. B.; JARDIM, J. R.; PÉREZ-PADILLA, R.; CAMELIER, A.; ROSA, F.; NASCIMENTO, O.; HALLAL, P. C. Prevalence of chronic obstructive pulmonary disease and associated factors: the PLATINO Study in São Paulo, Brazil. **Cadernos de Saúde Pública,** v. 21, n. 5, p. 1565-1573, 2005.

MENEZES, A. M. B.; MACEDO, S. E. C.; NOAL, R. B.; FITERMAN, J.; CUKIER, A.; CHATKIN, J. M.; FERNANDES, F. L. A. Tratamento farmacológico da DPOC. **J Bras Pneumol,** v. 37, n. 4, p. 527-543, 2011.

MIDDLETON, J.; SINCLAIR, P.; PATTON, R. Accuracy of centre of pressure measurement using a piezoelectric force platform. **Clinical Biomechanics,** v. 14, n. 5, p. 357-360, 1999.

MIRANDA, E. F.; MALAGUTI, C.; DAL CORSO, S. Disfunção muscular periférica em DPOC: membros inferiores versus membros superiores. **J Bras Pneumol,** v. 37, n. 3, p. 380-388, 2011.

MIYAMOTO, S.; LOMBARDI JUNIOR, I.; BERG, K.; RAMOS, L.; NATOUR, J. Brazilian version of the Berg balance scale. **Brazilian journal of medical and biological research,** v. 37, n. 9, p. 1411-1421, 2004.

MORELAND, J. D.; RICHARDSON, J. A.; GOLDSMITH, C. H.; CLASE, C. M. Muscle weakness and falls in older adults: a systematic review and meta-analysis. **Journal of the American Geriatrics Society,** v. 52, n. 7, p. 1121-1129, 2004.

OLIVEIRA, C. C.; LEE, A.; GRANGER, C. L.; MILLER, K. J.; IRVING, L. B.; DENEHY, L. Postural Control and Fear of Falling Assessment in People With Chronic Obstructive Pulmonary Disease: A Systematic Review of Instruments,< i> International Classification of Functioning, Disability and Health Linkage, and Measurement Properties. **Archives of physical medicine and rehabilitation,** v. 94, n. 9, p. 1784-1799. e7, 2013.

OLIVEIRA, L.; SIMPSON, D.; NADAL, J. Calculation of area of stabilometric signals using principal component analysis. **Physiological Measurement,** v. 17, n. 4, p. 305, 1999.

OLIVEIRA, L. F. D.; IMBIRIBA, L. A.; GARCIA, M. A. C. Índice de estabilidade para avaliação do equilíbrio postural. **Rev. bras. biomec,** v. 1, n. 1, p. 33-38, 2000.

OZALEVLI, S.; ILGIN, D.; NARIN, S.; AKKOCLU, A. Association between disease-related factors and balance and falls among the elderly with COPD: a cross-sectional study. **Aging clinical and experimental research,** v. 23, n. 5-6, p. 372-377, 2011.

PARRACA, J. A.; OLIVARES SÁNCHEZ-TOLEDO, P. R.; CARBONELL BAEZA, A.; APARICIO GARCÍA-MOLINA, V. A.; ADSUAR SALA, J. C.; GUSI FUERTES, N. Test-Retest reliability of Biodex Balance SD on physically active old people. **Journal of human sport & exercise, v. 6, n. 2, p. 444-451,** 2011.

PETERKA, R. J.; Sensorimotor integration in human postural control. **Journal of Neurophysiology**, v. 88, n. 3, p. 1097–1118, 2002.

PICKERILL, M. L.; HARTER, R. A. Validity and reliability of limits-of-stability testing: a comparison of 2 postural stability evaluation devices. **Journal of athletic training,** v. 46, n. 6, p. 600-606, 2011.

PIMENTEL, R. M.; SCHEICHER, M. E. Comparação do risco de queda em idosos sedentários e ativos por meio da escala de equilíbrio de Berg. **Fisioterapia e Pesquisa,** v. 16, n. 1, p. 6-10, 2009.

RABE, K. F.; HURD, S.; ANZUETO, A.; BARNES, P. J.; BUIST, S. A.; CALVERLEY, P.; FUKUCHI, Y.; JENKINS, C.; RODRIGUEZ-ROISIN, R.; VAN WEEL, C. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. **American journal of respiratory and critical care medicine,** v. 176, n. 6, p. 532-555, 2007.

RAHIMI, A.; ABADI, Z. E. The Effects of Anxiety on Balance Parameters in Young Female University Students. **Iranian journal of psychiatry,** v. 7, n. 4, p. 176-179, 2012.

ROIG, M.; ENG, J. J.; MACINTYRE, D. Falls in patients with chronic obstructive pulmonary disease: a call for further research. **Respiratory medicine,** v. 103, n. 9, p. 1257-1269, 2009.

ROIG, M.; ENG, J. J.; MACINTYRE, D. L.; FITZGERALD, J.; BURNS, J.; REID, W. Falls in people with chronic obstructive pulmonary disease: an observational cohort study. **Respiratory medicine,** v. 105, n. 3, p. 461-469, 2011.

SCHOENE, D.; WU, S. M. S.; MIKOLAIZAK, A. S.; MENANT, J. C.; SMITH, S. T.; DELBAERE, K.; LORD, S. R. Discriminative Ability and Predictive Validity of the Timed Up and Go Test in Identifying Older People Who Fall: Systematic Review and Meta-Analysis. **Journal of the American Geriatrics Society**, v. 61, n. 2, p. 202-208, 2013.

SMITH, M. C.; WROBEL, J. P. Epidemiology and clinical impact of major comorbidities in patients with COPD. **International journal of chronic obstructive pulmonary disease,** v. 9, p. 871-888, 2014.

SMITH, M. D.; CHANG, A. T.; SEALE, H. E.; WALSH, J. R.; HODGES, P. W. Balance is impaired in people with chronic obstructive pulmonary disease. **Gait & posture,** v. 31, n. 4, p. 456-460, 2010.

SORIANO, J. B.; ALFAGEME, I.; ALMAGRO, P.; CASANOVA, C.; ESTEBAN, C.; SOLER-CATALUÑA, J. J.; DE TORRES, J. P.; MARTINEZ-CAMBLOR, P.; MIRAVITLLES, M.; CELLI, B. R. Distribution and Prognostic Validity of the New

Global Initiative for Chronic Obstructive Lung Disease Grading ClassificationNew GOLD COPD Grading. **CHEST** v. 143, n. 3, p. 694-702, 2013.

STAPLEY, P.; POZZO, T.; GRISHIN, A.; PAPAXANTHIS, C. Investigating centre of mass stabilisation as the goal of posture and movement coordination during human whole body reaching. **Biological cybernetics,** v. 82, n. 2, p. 161-172, 2000.

TEASDALE, N.; SIMONEAU, M. Attentional demands for postural control: the effects of aging and sensory reintegration. **Gait & Posture**, v. 14, n. 3, p. 203-210, 2001.

TINETTI, M.E.; SPEECHLEY, M.; GINTER, S.F. Risk Factors for Falls among Elderly Persons Living in the Community. **The new england journal of medicine,** 319, p. 1701-1707, 1988.

VANSWEARINGEN, J. M.; PASCHAL, K. A.; BONINO, P.; CHEN, T.-W. Assessing recurrent fall risk of community-dwelling, frail older veterans using specific tests of mobility and the physical performance test of function. **The Journals of Gerontology Series A: Biological Sciences and Medical Sciences,** v. 53, n. 6, p. M457-M464, 1998.

VESTBO, J.; HURD, S. S.; AGUSTI, A. G.; JONES, P. W.; VOGELMEIER, C.; ANZUETO, A.; BARNES, P. J.; FABBRI, L. M.; MARTINEZ, F. J.; NISHIMURA, M. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. **American journal of respiratory and critical care medicine,** v. 187, n. 4, p. 347-365, 2013.

VIEIRA, T. D. M. M.; OLIVEIRA, L. F. D. Equilíbrio postural de atletas remadores. **Rev Bras Med Esporte,** v. 12, n. 3, p. 135-8, 2006.

VIGNOLA, B. A. P. **Avaliação do equilíbrio em pacientes com esclerose múltipla**. 2014. Dissertação (Programa de neurologia_ - Faculdade de Medicina, Universidade de São Paulo, 2014.

WEST, S.; KING, V.; CAREY, T. S.; LOHR, K.N.; MCKOY, N.; SUTTON, S. F.; et al. Systems to rate the strength of scientific evidence. Evidence Report Technology Assessment (Summ), n. 47, p. 1-11, 2002.

WHITNEY, S. L.; POOLE, J. L.; CASS, S. P. A review of balance instruments for older adults. **American Journal of Occupational Therapy,** v. 52, n. 8, p. 666-671, 1998.

WONG, C. K.; CHEN, C. C.; BLACKWELL, W. M.; RAHAL, R. T.; BENOY, S. A. Balance ability measured with the Berg Balance Scale: a determinant of fall history in community-dwelling adults with leg amputation. **Journal of rehabilitation medicine**, 2014.

WORLD HEALTH ORGANIZATION (WHO). **World health statistics 2014**. http://www.who.int/mediacentre/news/releases/2014/world-health-statistics-2014/en/

WURST, K. E.; ST LAURENT, S.; MULLEROVA, H.; DAVIS, K. J. Characteristics of patients with COPD newly prescribed a long-acting bronchodilator: a retrospective cohort study. **International journal of chronic obstructive pulmonary disease,** v. 9, p. 1021-1031, 2014.

YELNIK, A.; BONAN, I. Clinical tools for assessing balance disorders. **Neurophysiologie Clinique/Clinical Neurophysiology,** v. 38, n. 6, p. 439-445, 2008.

ANEXO IV – Artigo de Revisão Sistemática

Review Article

Postural balance and falls in patients with chronic obstructive pulmonary disease – a systematic review

Marcela Nicácio Medeiros de Oliveira

Rehabilitation Sciences Post Graduation Program – Augusto Motta University Center – UNISUAM – Rio de Janeiro/RJ – Brazil.

Guilherme Pinheiro Ferreira da Silva

Medical Science Post Graduation Program – Federal University of Ceará - UFC - Fortaleza/CE– Brazil.

Rodrigo Ribeiro de Oliveira

Physical Therapy Department, Faculty of Medicine, Federal University of Ceará - UFC - Fortaleza/CE– Brazil.

Fernando Silva Guimarães

Rehabilitation Sciences Post Graduation Program - Augusto Motta University Center – UNISUAM – Rio de Janeiro/RJ – Brazil.

Physical Therapy Department, Faculty of Medicine, Federal University of Rio de Janeiro/RJ - Brazil

Sara Lucia Silveira de Menezes*

Rehabilitation Sciences Master's Program - Augusto Motta University Center – UNISUAM – Rio de Janeiro/RJ – Brazil.

*** Corresponding Author**

Sara Lúcia Silveira de Menezes
Centro Universitário Augusto Motta
Programa de Pós-graduação em Ciências da Reabilitação
Praça das Nações 34, 3º andar, Bonsucesso, RJ, CEP 21041-010
Tel.: +55 (21) 3882-9797 (extensão 1015)
E-mail: saraposgraduacao@yahoo.com.br

ABSTRACT

BACKGROUND: Skeletal muscle dysfunction and reduced exercise tolerance are well described conditions in chronic obstructive pulmonary disease (COPD). It is believed that these patients can also have impaired static and dynamic body balance.

OBJECTIVE: To carry out a systematic review of the cross-sectional studies that assessed the dynamic and static body balance and the risk of falls in patients with COPD.

METHODS: Search strategy: articles were searched in PubMed, BIREME, CINAHL and COCHRANE electronic databases including publications from January 1960 to November 2014. Selection Criteria: complete cross-sectional studies that included a control group of healthy people, published in any language. The inclusion criteria for the outcomes were assessments of postural balance and risk of falling in patients with chronic obstructive pulmonary disease. Data extraction: Independent extraction of articles by two reviewers which were later analyzed for their methodological quality using the Agency for Healthcare Research and Quality Scale to assess observational studies.

RESULTS: Eight articles were included in this review. A variety of evaluation methods was used, including the Berg Balance scale, Functional Reach test, a Questionnaire on Personal Histories and Consequences of Falls and tests on the force platform. A total of 1887 subjects of both genders were studied (1417 individuals with COPD and 470 healthy individuals).

CONCLUSION: The current data suggest that patients with COPD present with impaired body balance and increased risk of fall. However, due to the methodological limitations of the studies included in this review, further well designed studies on this issue are recommended.

Key-words: chronic obstructive pulmonary disease; postural balance; fall, systematic review.

Introduction

Chronic obstructive pulmonary disease (COPD) is a prevalent respiratory disorder that has a strong association with the use of tobacco and is characterized by progressive, partially reversible obstruction of the airways and by pulmonary hyperinflation[1]. Although the physiopathology is primarily pulmonary, COPD is often associated with systemic complications[2,3].

The principal characteristic of COPD is the presence of airflow limitation, resulting from inflammation and remodeling of the airways, parenchyma destruction and the development of emphysema. However, in many patients the disease is associated with various systemic manifestations, which can result in impairment of functional capacity and quality of life[4,5]. Skeletal muscle dysfunction associated with reduced functional mobility and ability to perform exercise in individuals with COPD has been documented in several studies[6-9]. Nevertheless, the impact of COPD on other aspects of functional capacity, as for example, static and dynamic body balance has not been well described[3].

Some predictors of falling are widely known, such as age, chronic diseases, use of multiple medications, impaired mobility and muscle weakness. In this respect, it is believed that COPD patients may have an increased risk of falls due to the reduced physical activity level, muscle weakness, reduced perception of dyspnea and decreased balance control[10-13]. Falls may worsen the general health status of COPD patients, reducing their quality of life and autonomy, and increasing the mortality and the health system costs[14]. Previous authors performed a systematic review on the instruments used to assess postural control and fear of falling in people with COPD[14]. Nevertheless, data

on risk of falls and decreased postural balance and mobility in COPD patients are scarce[13,14].

Therefore, the aim of this systematic review was to evaluate if patients with COPD have decreased postural balance and/or increased frequency of falls in comparison with health people.

Methods

This systematic review followed the PRISMA statement recommendations[15].

Data sources and research

A search was performed using the PubMed, BIREME, CINAHL and COCHRANE electronic databases for the period from January 1960 to November 2014. The descriptors were extracted from the *Medical Subject Headings* (MeSH) and the *Descritores em Ciências da Saúde* (DeCS), in the following ordering:

#1- *("Postural Balance"[Mesh]) OR Functional Balance Assessments) OR Postural Sway "*;

#2- *(("Accidental Falls"[Mesh]) OR Fear of Fall) OR Fear of Falling*

#3- *(("Pulmonary Disease, Chronic Obstructive"[Mesh]) OR "Lung Diseases, Obstructive"[Mesh]) OR "Lung Diseases"[Mesh];*

#4- #1 OR #2

#5- #4 AND #3

The searches were carried out in electronic databases by two independent experienced researchers, and included the references found in the studies and the

authors' personal files. Were initially included all articles which had postural balance and/or falls in individuals with chronic obstructive pulmonary disease as primary or secondary outcomes.

Selection of studies and eligibility criteria

Articles were selected taking into account the following general inclusion criteria: complete studies with humans, cross-sectional studies that included a control group of healthy people, published in any language. The inclusion criteria for the outcomes were assessments of postural balance, stabilometric ellipse, functional reach test, lateral reach test, postural sway, body sway, limits of stability, center of pressure, static balance test, dynamic balance test, functional balance test, timed up and go, posturography, specific questionnaires for analysis of balance (Tinetti Balance Scale, Community Balance and Mobility Scale, Berg Balance Scale, other) and risk of falling in patients with chronic obstructive pulmonary disease.

Studies with the following characteristics were excluded from this review: case studies, observational studies without a healthy control group for comparison with COPD, letters, editorials, extended abstracts, animal studies, as well as studies where the patients presented with other conditions that may have influenced the results (vestibular disease, orthopedic injury).

Quality assessment

The quality of the studies was assessed by the *Agency for Healthcare Research and Quality* (AHRQ) scale, as modified and validated by West et al. (2002)[16]. These criteria have been used in several systematic reviews with or without the use of *score* values[17-21].

Data abstraction

Titles and abstracts identified through the searches were reviewed independently by two researchers to select potentially relevant studies. Cases of disagreements, when present, were discussed with a third party assessor. Once elected, the studies had their data extracted and compiled in a form, in accordance with the quality criteria. No blinding of the authors of studies was made.

Data analysis

Due to the heterogeneity of the studies outcomes, a meta-analysis was not performed and the results were summarized with emphasis on the quality of the design of the selected studies.

Results

Of the 192 articles found, 161 (83.85%) were excluded by the title, 14 (7.29%) after reading the abstract, 09 (4.68%) after reading the full-text articles and 08 (4.16%) were selected according to predefined criteria (Figure 1)[15]. All studies included in this review were designed as cross-sectional studies.

Assessment tools and procedures

A wide variety of outcomes were found in the studies, as that related to physical, psychological, and quality of life assessments. However, this review focuses on the procedures and instruments which aimed to evaluate balance, and the frequency and risk of falling in patients with COPD. These data are shown in Table 1.

The biomechanical analysis was the most common way to measure the body balance, using methods as posturography performed on the force platform[22-24] and stabilometry performed on the pressure platform[25,26]. Conversely, other studies applied different functional tests, such as timed stand and walk test - *Timed Up and Go* (TUG)[22], Sit-to-Stand test[25], the Functional Reach test and the Short Physical

Performance Battery (SPPB)[3]. Furthermore, a tool called Community Balance and Mobility Scale was applied to evaluate balance[22].

Additionally, tests and scales were used in assessing the frequency and risk of falls, as in the study of Rocco *et al*. (2011) where the authors applied the Tinetti Scale[25], and in the study of Beauchamp *et al*. (2012), in which the Berg Balance Scale (BBS), the Balance Evaluation Systems Test (BESTest) and the Activity-specific Balance Confidence (ABC)[27] were used. Questionnaires on history of fall, consequences of falls or tripping were used in the study of Ozalevli *et al.* (2011)[28].

Aiming at identify possible associations between the main outcomes and some specific conditions/variables, other variables were measured in six studies[3,22,23,25,27,28], such as quality of life, the QOL measured using a visual analog scale, self-reported functional limitation, use of medications, comorbidities, use of oxygen supplementation, frequency of acute exacerbations, and the 6MWT outcome.

Measurements of outcomes

The characteristics of the selected studies are presented in chronological order of publication (Table 1). In the eight selected manuscripts, a total population of 1887 subjects of both genders was studied, 1417 individuals with COPD and 470 healthy individuals. Although most of the studies divided their sample into two groups (healthy and COPD), Butcher *et al*. 2004[22] made comparisons between three groups: healthy individuals, individuals with COPD and individuals with COPD under oxygen supplementation.

Eight studies were excluded because the lack of a control group of healthy individuals. As for example, in the study of Roing *et al*. (2011) they compared the results between COPD patients with and without history of falls. The other seven studies included only subjects with COPD[6,10,29-33].

There was great variation in the sample size among the studies, as well as in the average age of individuals surveyed (Table 1). As for the eligibility of subjects, the authors used different exclusion criteria in order to avoid individuals who suffered other conditions which might affect the main outcomes (Table 1).

Balance

All studies included in this review assessed balance in individuals with COPD[3,22-28]. The study of Butcher *et al* (2004), which used the TUG, posturography and the Community Balance and Mobility Scale, found a difference between COPD patients requiring oxygen supplementation and healthy subjects. Another study found that the group of subjects with COPD showed decreases in the average score of the SPPB and performance in the Functional Reach test when compared to the group of healthy subjects [3]. In addition, Smith *et al*. (2010) demonstrated that individuals with COPD had a deficit in balance, as they had greater displacement of pressure on the medio-lateral axis and in the angular movement of the hip in relation to healthy subjects[23]. Also, the study of Janssens *et al,* (2013) showed an increased body sway in anterior-posterior direction in individuals with COPD[24].

The study of Beauchamp *et al.* (2012) demonstrated reduced balance scores in each component of the BESTest, with marked deficits (30% reduction) in biomechanics, transitions, and gait in subjects with COPD compared with control subjects[27]. However, the study of Horie *et al*. (2011) did not show difference in the measured one-leg standing time and total trace length between COPD and control groups[26].

Falls

Only one study examined the presence of falls among COPD patients. The results of Ozalevli *et al*. (2011) showed that the frequency of falls in the last year before the assessment was the following: one fall in 9 COPD patients (25%), two falls in 1

COPD patient (2.8%), and one fall in 3 healthy individuals (15%). Moreover, the frequency of falls in the COPD patients were correlated with dyspnea and leg fatigue severity, the SpO_2 value measured after the 6MWT, and PaO_2 and SaO_2 values[28].

Result of quantitative assessment

No studies met all methodological criteria of the Agency for Healthcare Research and Quality (AHRQ). The study of Eisner *et al*. (2008) had the best score, achieving 74 points. The quantitative analysis is presented in Table 3 and is discussed in the next section.

Discussion

In the present review we aimed to analyze the existing studies on postural balance and falls in patients with chronic obstructive pulmonary disease. Although COPD has a major impact on physical health, the postural balance and the risk of fall has not been clarified in these group of patients. Most of the articles included in this review indicate the reduction of balance and/or increased frequency of falls in patients with COPD.

Despite the fact that individuals with COPD have many risk factors predisposing them to falls, there are few data in the literature about balance in this population[13]. Additionally, these patients have a high prevalence of osteoporosis, stressing the need for identification of possible factors that might lead to falls in order to subsidize the development of prevention and treatment programs[34].

Patients with COPD who use supplemental oxygen are six times more likely to fall than those who do not[6,22]. The underlining mechanisms behind this association have not yet been clearly elucidated in the literature, but it is believed that is related to the worse functional capacity of patients who make use of this therapy. Another possible

explanation, and that should be investigated, is the chronic effects of hypoxemia in the motor control of these individuals[6,35].

A possible factor that influences the increased risk of falls and imbalance in patients with COPD originates from biomechanics. The increased respiratory rate and, consequently, the increased movement of the thorax and abdomen have been shown to shift the center of mass, favoring the anterior displacement of the body and the occurrence of fall[36]. Whereas, the subjects with COPD exhibited deficits in each of the six subsystems but, the deficits were most pronounced in the subsystems of biomechanics, when compared with control subjects[27]. These deficits are of similar magnitude to those reported in populations with neuromuscular disease[37].

Currently, the literature is scarce with regard to the topic of balance in patients with COPD, but there is a growing concern about the balance impairment deficit in this population. Recent studies have shown a reduction of balance and coordination in this population when compared to control individuals. However, the methods and procedures of the studies have limitations and biases that can diminish the power of its conclusions. This fact can be better observed by the scores obtained for the studies through the application of the AHRQ qualitative scale for analysis of observational studies (Table 3).

To compare the selected studies was necessary to analyze the methodological aspects of each one, in particular those related to the sample characteristics, as well as how the subjects were selected.

The probabilistic selection of subjects was not described by the authors of the studies included in this review. The absence of sample size calculation and the use of samples of convenience, factors that occurred in most of the studies assessed in this review, may imply the involvement of a number of people who don’t represent the

interest population, which is extremely important to ensure the ability of any study to address the proposed objectives[38]. These components of the methodology are essential to support the results obtained in the research, therefore the selected studies present factors that can systematically alter the estimate between expression (COPD) and the outcomes listed, such as falling, lack of balance and the biomechanical analysis[39].

In consideration of the gender proportion, the proportion of women was higher[3,22]. This predominance in the samples was already expected, considering the question of the longevity of female subjects compared to males[38].

The clinimetric property of the tools used for assessment of the groups studied in the articles included in this review is an important point, as the results of the studies depend on the accuracy of these instruments.

Balance was examined in the studies through various evaluation methods. For example, the Timed Up and Go[22], despite being considered a test with good intra- and inter-examiner confidentiality[40], has low diagnostic accuracy to determine changes in balance, having more diagnostic precision in determining changes in function and gait[41]. Therefore, the internal validity of the studies that used this method might have been compromised, because few aspects of balance are observed through this method[6,22,42]. The computerized static posturography scan, used in the study of Butcher *et al*. (2004)[22] and force platform[23,24], pressure platform[25] and stabilometer[26], are tools with recognized validity and reproducibility[14,43], however, they provide superficial information on postural imbalance. Furthermore, since these assessments are recorded statically, they do not correlate with the frequency of falls[44], demonstrating a low sensitivity for diagnosis of postural imbalance. In this way, the analyses and associations of these studies may have been compromised.

Considering the functional tests and scales used in the studies to evaluate the postural balance and the risk of falls, one can highlight that there are practical and low-cost means of evaluation. The functional scales used in the studies included in this review obtained good validity and reliability as attested by experiments with other populations, such as the Community Balance and Mobility Scale used in a study with patients with cerebral lesions[45] and those that have suffered strokes[46], the Activities-Specific Balance Confidence (ABC) in subjects who have suffered strokes[47] and the Short Physical Performance Battery (SPPB) in elderly patients[48,49]. Because its practicality and validity, The Berg Balance Scale and the BESTest appear to be the recommended instruments to assess postural control in clinical practice[14]. However, these instruments have not been validated for patients with respiratory disorders, particularly COPD. In addition, the Functional Reach Test is a poor measure for evaluating postural balance due the influence of the trunk during the test and compensatory mechanisms[50], compromising the conclusions of this analysis, as reported in the study of Smith et al., (2010)[23].

To assess the frequency of falls, Ozalevli *et al*., (2011)[28] conducted interviews asking about the occurrence of falls over the year before the assessment, but survey estimations based on self-reporting tend to underestimate the use of health care in the older population, as they are greatly impacted by recall and non-response biases[51].

In none of the studies included in this review the assessor were blinded, which can have compromised its internal validity. Another item that deserves special attention is that all studies included in this review had a cross sectional design, which does not allow for a causal analysis of the frequency of falls and balance changes in subjects with COPD. These facts reduce the power of analysis of the association between COPD and the outcome variables.

This review demonstrates the difficulty of performing a systematic review with observational studies, due to the variety of characteristics of people with COPD, as well as the various tools and methods used to analyze the fall and balance outcomes. Furthermore, it would be valuable to include in design planning a multivariate analysis to observe the influence of one or more variables as predictive of outcome variables, however, the small sample size of the studies included in this systematic review makes impossible to perform a proper correlation analyses between physiological variables of the respiratory system and gender with the outcome variables.

The current data suggest that patients with COPD present with impaired body balance and increased risk of fall. However, due to methodological limitations as to the selection of subjects, non-probabilistic samples, and interviewer bias, this association cannot be sustained. Other observational studies, especially cohort studies and case-control, with more consistent design and including proper methods of dynamic balance assessment are recommended.

Acknowledgements

Mrs. Marcela Nicácio Medeiros received the support of CAPES (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*) of the Brazilian government to carry out this study.

The Authors declare that there are no conflicts of interest.

References

1. Marciniuk DD, Brooks D, Butcher S, Debigare R, Dechman G, Ford G, et al. Optimizing pulmonary rehabilitation in chronic obstructive pulmonary disease–practical issues: A Canadian Thoracic Society Clinical Practice Guideline. Canadian respiratory journal: journal of the Canadian Thoracic Society. 2010;17(4):159.

2. Bishop MD, Robinson ME, Light KE. Tobacco use and recovery of gait and balance function in older adults. Archives of physical medicine and rehabilitation. 2009;90(9):1613-8.

3. Eisner MD, Blanc PD, Yelin EH, Sidney S, Katz PP, Ackerson L, et al. COPD as a systemic disease: impact on physical functional limitations. The American journal of medicine. 2008;121(9):789-96.

4. Barnes P, Celli B. Systemic manifestations and comorbidities of COPD. European Respiratory Journal. 2009;33(5):1165-85.

5. Dourado VZ, Tanni SE, Vale SA, Faganello MM, Sanchez FF, Godoy I. Systemic manifestations in chronic obstructive pulmonary disease. Jornal brasileiro de pneumologia. 2006;32(2):161-71.

6. Beauchamp M, Hill K, Goldstein R, Janaudis-Ferreira T, Brooks D. Impairments in balance discriminate fallers from non-fallers in COPD. Respiratory medicine. 2009;103(12):1885-91.

7. Kim HC, Lee GD, Hwang YS. Skeletal Muscle Dysfunction in Patients with Chronic Obstructive Pulmonary Disease. Tuberculosis and Respiratory Diseases. 2010;68(3):125-39.

8. Kim HC, Mofarrahi M, Hussain SN. Skeletal muscle dysfunction in patients with chronic obstructive pulmonary disease. International journal of chronic obstructive pulmonary disease. 2008;3(4):637.

9. Man W, Kemp P, Moxham J, Polkey M. Skeletal muscle dysfunction in COPD: clinical and laboratory observations. Clinical Science. 2009;117:251-64.

10. Beauchamp MK, O'Hoski S, Goldstein RS, Brooks D. Effect of pulmonary rehabilitation on balance in persons with chronic obstructive pulmonary disease. Archives of physical medicine and rehabilitation. 2010;91(9):1460-5.

11. Lawlor DA, Patel R, Ebrahim S. Association between falls in elderly women and chronic diseases and drug use: cross sectional study. Bmj. 2003;327(7417):712-7.

12. Roig M, Eng J, MacIntyre D, FitzGerald J, Burns J, Reid W. Falls in people with chronic obstructive pulmonary disease: An observational cohort study. Respiratory medicine. 2011;105(3):461-9.

13. Roig M, Eng JJ, Reid WD. Falls in patients with chronic obstructive pulmonary disease: A call for further research. Respiratory medicine. 2009;103(9):1257-69.

14. Oliveira CC, Lee A, Granger CL, Miller KJ, Irving LB, Denehy L. Postural Control and Fear of Falling Assessment in People With Chronic Obstructive Pulmonary Disease: A Systematic Review of Instruments,< i> International Classification of Functioning, Disability</i> and Health Linkage, and Measurement Properties. Archives of physical medicine and rehabilitation. 2013;94(9):1784-99. e7.

15. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Medicine. 2009;6(7).

16. West S, King V, Carey TS, Lohr KN, McKoy N, Sutton SF, et al. Systems to rate the strength of scientific evidence. Evid Rep Technol Assess (Summ). 2002(47):1-11.

17. Atluri S, Datta S, Falco FJ, Lee M. Systematic review of diagnostic utility and therapeutic effectiveness of thoracic facet joint interventions. Pain Physician. 2008;11(5):611-29.

18. Conn A, Buenaventura RM, Datta S, Abdi S, Diwan S. Systematic review of caudal epidural injections in the management of chronic low back pain. Pain Physician. 2009;12(1):109-35.

19. Manchikanti L, Singh V, Smith HS, Hirsch JA. Evidence-based medicine, systematic reviews, and guidelines in interventional pain management: part 4: observational studies. Pain Physician. 2009;12(1):73-108.

20. Parr AT, Diwan S, Abdi S. Lumbar interlaminar epidural injections in managing chronic low back and lower extremity pain: a systematic review. Pain Physician. 2009;12(1):163-88.

21. De Oliveira R, Lemos A, de Castro Silveira P, Da Silva R, De Moraes S. Alterations of tendons in patients with diabetes mellitus: a systematic review. Diabetic Medicine. 2011;28(8):886-95.

22. Butcher SJ, Meshke JM, Sheppard MS. Reductions in functional balance, coordination, and mobility measures among patients with stable chronic obstructive pulmonary disease. Journal of Cardiopulmonary Rehabilitation and Prevention. 2004;24(4):274-80.

23. Smith MD, Chang AT, Seale HE, Walsh JR, Hodges PW. Balance is impaired in people with chronic obstructive pulmonary disease. Gait & posture. 2010;31(4):456-60.

24. Janssens L, Brumagne S, McConnell AK, Claeys K, Pijnenburg M, Burtin C, et al. Proprioceptive changes impair balance control in individuals with chronic obstructive pulmonary disease. PloS one. 2013;8(3):e57949.

25. Rocco CCdM, Sampaio LMM, Stirbulov R, Corrêa JCF. Neurophysiological aspects and their relationship to clinical and functional impairment in patients with chronic obstructive pulmonary disease. Clinics. 2011;66(1):125-9.

26. Horie J, Murata S, Hayashi S, Murata J, Miyazaki J, Mizota K, et al. Factors that delay COPD detection in the general elderly population. Respiratory care. 2011;56(8):1143-50.

27. Beauchamp MK, Sibley KM, Lakhani B, Romano J, Mathur S, Goldstein RS, et al. Impairments in Systems Underlying Control of Balance in COPDBalance in COPD. CHEST Journal. 2012;141(6):1496-503.

28. Ozalevli S, Ilgin D, Narin S, Akkoclu A. Association between disease-related factors and balance and falls among the elderly with COPD: a cross-sectional study. Aging clinical and experimental research. 2011;23(5-6):372-7.

29. Hellström K, Vahlberg B, Urell C, Emtner M. Fear of falling, fall-related self-efficacy, anxiety and depression in individuals with chronic obstructive pulmonary disease. Clinical Rehabilitation. 2009;23(12):1136-44.

30. Beauchamp MK, Janaudis-Ferreira T, Parreira V, Romano JM, Woon L, Goldstein RS, et al. A randomized controlled trial of balance training during pulmonary rehabilitation for individuals with COPD. Chest. 2013;144(6):1803-10.

31. Chang AT, Seale H, Walsh J, Brauer SG. Static balance is affected following an exercise task in chronic obstructive pulmonary disease. J Cardiopulm Rehabil Prev. 2008;28(2):142-5.

32. Eisner MD, Blanc PD, Sidney S, Yelin EH, Lathon PV, Katz PP, et al. Body composition and functional limitation in COPD. Respir Res. 2007;8(7).

33. Jacome C, Cruz J, Gabriel R, Figueiredo D, Marques A. Functional balance in older adults with chronic obstructive pulmonary disease. Journal of aging and physical activity. 2014;22(3):357-63.

34. Biskobing DM. COPD and osteoporosis. CHEST Journal. 2002;121(2):609-20.

35. Grant I, Heaton RK, McSweeny AJ, Adams KM, Timms RM. Neuropsychologic findings in hypoxemic chronic obstructive pulmonary disease. Archives of Internal Medicine. 1982;142(8):1470.

36. Gurfinkel V, Kots YM, Paltsev E, Feldman A. The compensation of respiratory disturbances of the erect posture of man as an example of the organization of interarticular interaction. Models of the structural functional organization of certain biological systems MIT Press, Cambridge. 1971:382-95.

37. Leddy AL, Crowner BE, Earhart GM. Functional gait assessment and balance evaluation system test: reliability, validity, sensitivity, and specificity for identifying individuals with Parkinson disease who fall. Phys Ther. 2011;91(1):102-13.

38. Valim-Rogatto PC, Rogatto GP, Corrêa A, Brêtas ACP. Nível de atividade física e quedas acidentais em idosos: uma revisão sistemática. Rev Bra Cineantropom Desempenho Hum. 2009;11(2):235-42.

39. Tian G-L, Tang M-L, Liu Z, Tan M, Tang N-S. Sample size determination for the non-randomised triangular model for sensitive questions in a survey. Statistical Methods in Medical Research. 2011;20(3):159-73.

40. de Figueiredo KMOB, Lima KC, Guerra RO. Instrumentos de avaliação do equilíbrio corporal em idosos. Rev Bras Cineantropom Desempenho Hum. 2007;9(4):408-13.

41. Schoene D, Wu SMS, Mikolaizak AS, Menant JC, Smith ST, Delbaere K, et al. Discriminative Ability and Predictive Validity of the Timed Up and Go Test in Identifying Older People Who Fall: Systematic Review and Meta-Analysis. Journal of the American Geriatrics Society. 2013.

42. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Physical Therapy. 2000;80(9):896-903.

43. Middleton J, Sinclair P, Patton R. Accuracy of centre of pressure measurement using a piezoelectric force platform. Clinical Biomechanics. 1999;14(5):357-60.

44. Baloh RW, Spain S, Socotch TM, Jacobson KM, Bell T. Posturography and balance problems in older people. Journal of the American Geriatrics Society. 1995;43(6):638.

45. Howe J, Inness E, Venturini A, Williams J, Verrier M. The Community Balance and Mobility Scale-a balance measure for individuals with traumatic brain injury. Clinical rehabilitation. 2006;20(10):885-95.

46. Knorr S, Brouwer B, Garland SJ. Validity of the Community Balance and Mobility Scale in community-dwelling persons after stroke. Archives of physical medicine and rehabilitation. 2010;91(6):890-6.

47. Salbach NM, Mayo NE, Robichaud-Ekstrand S, Hanley JA, Richards CL, Wood-Dauphinee S. Balance self-efficacy and its relevance to physical function and perceived health status after stroke. Archives of physical medicine and rehabilitation. 2006;87(3):364-70.

48. da Câmara SMA, Alvarado BE, Guralnik JM, Guerra RO, Maciel ÁCC. Using the Short Physical Performance Battery to screen for frailty in young-old adults with distinct socioeconomic conditions. Geriatrics & Gerontology International. 2012.

49. Freire AN, Guerra RO, Alvarado B, Guralnik JM, Zunzunegui MV. Validity and Reliability of the Short Physical Performance Battery in Two Diverse Older Adult Populations in Quebec and Brazil. Journal of aging and health. 2012;24(5):863-78.

50. Jonsson E, Henriksson M, Hirschfeld H. Does the functional reach test reflect stability limits in elderly people? Journal of rehabilitation medicine. 2003;35(1):26-30.

51. Hunger M, Schwarzkopf L, Heier M, Peters A, Holle R. Official statistics and claims data records indicate non-response and recall bias within survey-based estimates of health care utilization in the older population. BMC Health Services Research. 2013;13(1):1.

52. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009;6(7):e1000097.

Table 1. Modified AHRQ scale, appropriate for observational studies.

CRITERION	Weighted Score (points)
1. Study Question	***2***
• Clearly focused and appropriate question	
2. Study Population	***8***
• Description of study population	**5**
• Sample size justification	**3**
3. Comparability of Subjects for All Observational Studies	**22**
• Specific inclusion/exclusion criteria for all groups	**5**
• Criteria applied equally to all groups	**3**
• Comparability of groups at baseline with regard to disease status and prognostic factors	**3**
• Study groups comparable to non-participants with regard to confounding factors	**3**
• Use of concurrent controls	**5**
• Comparability of follow-up among groups at each assessment	**3**
4. Exposure or Intervention	***11***
• Clear definition of exposure	**5**
• Measurement method standard, valid and reliable	**3**
• Exposure measured equally in all study groups	**3**
5. Outcome measures	***20***
• Primary/secondary outcomes clearly defined	**5**
• Outcomes assessed blind to exposure or intervention	**5**
• Method of outcome assessment standard, valid and reliable	**5**
• Length of follow-up adequate for question	**5**
6. Statistical Analysis	**19**
• Statistical tests appropriate	**5**
• Multiple comparisons taken into Consideration	**3**
• Modeling and multivariate techniques appropriate	**2**
• Power calculation provided	**2**
• Assessment of confounding	**5**
• Dose-response assessment if appropriate	**2**
7. Results	***8***
• Measure of effect for outcomes and appropriate measure of precision	**5**
• Adequacy of follow-up for each study group	**3**
8. Discussion	***5***
• Conclusions supported by results with possible biases and limitations taken into consideration	
9. Funding or Sponsorship	***5***
• Type and sources of support for study	
TOTAL SCORE	***100***

Modified and adapted by West S et al. Systems to Rate the Strength of Scientific Evidence, Evidence Report, Technology Assessment.

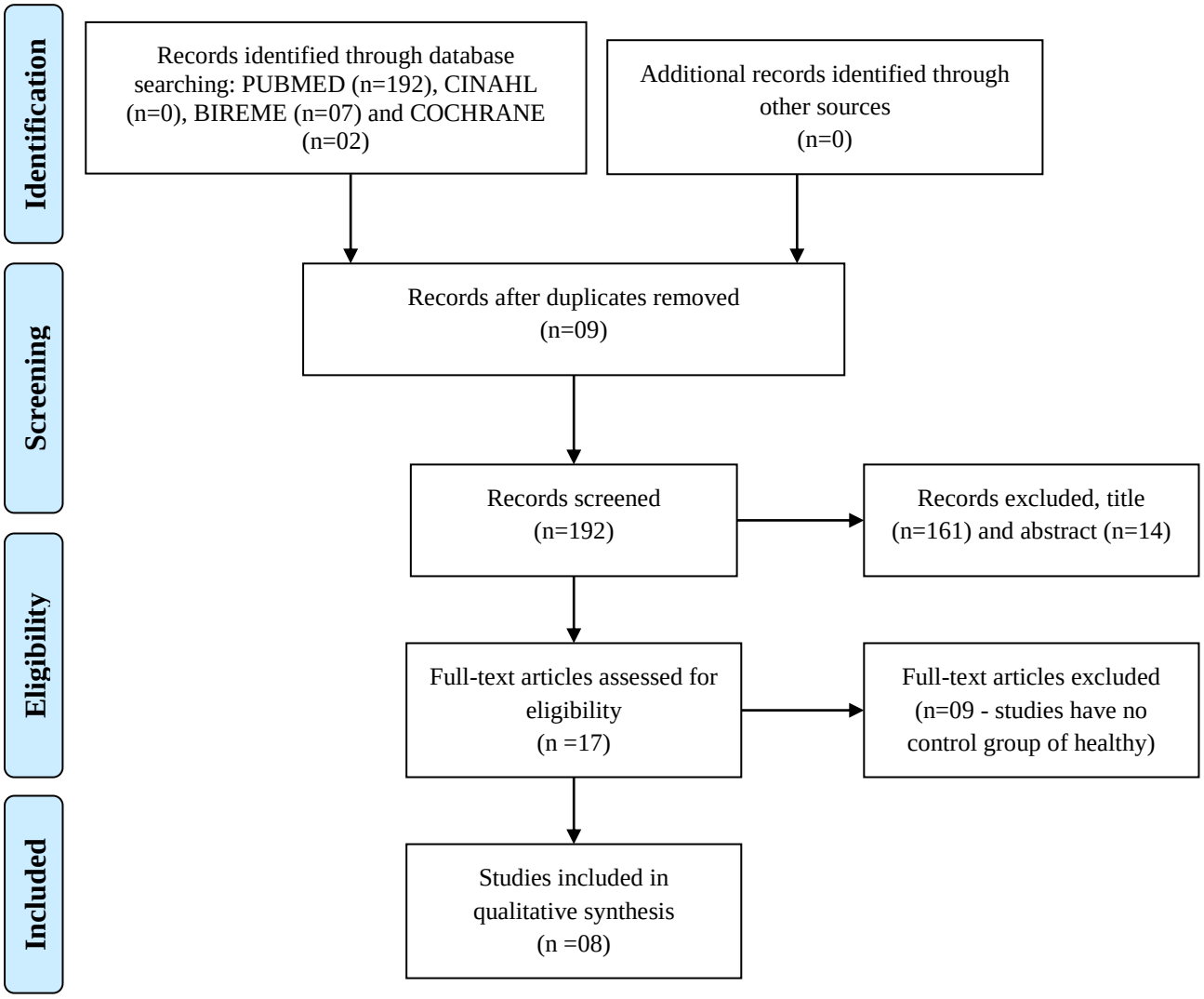

Figure 2: PRISMA (Preferred Reporting of Systematic Reviews and Meta-Analyses) flow diagram of the literature search [55].

Table 2. Characteristics of studies elegible for this review.

Author/year	Subjects	Age of Sample	Exclusion Criteria	Evaluation
Butcher S.J. et al, 2004	51 subjects: 21 healthy (3M/18F), 15 (7M/8F) with COPD and 15 (5M/10F) subjects with COPD + oxygen supplement therapy	Healthy (68.1 ± 1.86 years) COPD without O_2 (72.1 ± 2.23 years) COPD with O_2 (69 ± 8.53 years)	Neuromuscular disease, disorder of the inner ear, pain or limitation of joint mobility, known cognitive impairment, other lung disease, significant pathological process	Timed Up and Go Test; Posturography, Community Balance and Mobility Scale.
Eisner M.D. et al., 2008	1505 subjects: 302 healthy (117M/185F); 1202 subjects with COPD (511M/691F)	Healthy (58.5 ± 6.2 years) COPD (58.2 ± 6.2 years)	Individuals under the age of 40 or over 65 years; failure to attend the clinical visit and peform spirometric test;	Short Physical Performance Battery (SPPB); Functional Reach Test
Smith M.D. et al., 2010	24 subjects: 12 healthy subjects (7M/5F) and 12 subjects with COPD (7M/5F)	Healthy (63.5 ± 5.4 years) COPD (64.6 ± 7.2 years)	Asthma; cardiovascular changes, lower limb lesions; vestibular system disorder; neurological disease; urinary incontinence; difficulty in understanding English; use of walking aid or use of oxygen supplement therapy	Force Platform
Rocco C.C.M. et al., 2011	38 subjects: 16 healthy (9M/7F); 22 subjects with COPD (19M/3F)	Healthy (68 ± 6.5 years) COPD (70 ± 6.6 years)	All participants should be currently non-smokers and not have other associated comorbidities such as asthma and neurological diseases.	Pressure platform; Tinetti Scale; Sit-to-Stand test.
Ozalevli S. et al., 2011	56 subjects: 20 healthy (13M/7F); 36 subjects with COPD (25M/11F)	Healthy (68.5 ± 7.3 years) COPD (70.3 ± 3.0 years)	Clinically unstable within the last 6 weeks, Individuals under the age of 55 orthopedic disease and unable to ambulate without assistance.	Assessment of Falls and Tripping, Berg Balance Scale (BBS);
Horie J. et al., 2011	120 subjects: 60 healthy (39M/21F); 60 subjects with COPD (39M/21F)	Healthy (76.3 ± 1.8 years) COPD (76.8 ± 6.8 years)	With diagnosis of a respiratory disease (including respiratory tract infection); joint disorders that impair gait; residents; decreased physical performance; and residents who were incapable of fully understanding the objective and methods of the study.	Stabilometer
Beauchamp M.K. et al., 2012	57 subjects: 20 healthy subjects and 37 subjects with COPD	Healthy (67 ± 9 years) COPD (71 ± 7 years)	Inability to communicate, use of medications that may have increased the risk of falls, and neurologic or musculoskeletal conditions that limited mobility.	Berg Balance Scale (BBS); Activity-specific Balance Confidence (ABC); Balance Evaluation Systems Test (BESTest)
Janssens L. et al., 2013	36 subjects: 18 healthy; 18 subjects with COPD (14M/6F)	Healthy (64 ± 6 years) COPD (64 ± 7 years)	Not maintain their balance without manual assistance.	Force platform

M= Male; F= Female gender

Table 3. Results and limitations of studies eligible for revision

Author/Year	Results	Limitations of the Study	Correlations with other variables
Butcher S.J. et al, 2004	COPD had increased Timed Up and Go test (F=4.78; *P*=0.004; η^2=0.209; Power=0.873); Posturography balance peak in test 3 (F=3.71, *P*=0.032, η^2=0.136; Power= 0.653), balance index in test 3 (F=5.00, *P*=0.011, η^2=0.175; Power=0.788) and Community Balance and Mobility Scale (F=12.6; *P*=0.001; η^2=0.348; Power=0.995)	▪ There was no calculation of sample size; ▪ The sample was of convenience and without randomization	Comparisons between coordination, FEV_1, forced vital capacity, peak expiratory flow among subjects with COPD who use supplementary oxygen, subjects with COPD who do not use supplementary oxygen and healthy subjects
Eisner M.D. et al., 2008	Statistically significant differences in lower extremity function [1.0 (1.25 to 0.73) *P*<0.0001], performance in the lower submaximum exercise [334 (384 to 282) *P*.0001] and standing balance [3.0 (4.2 to 1.8) *P*.0001] between subjects with COPD and without COPD	▪ There was no calculation of sample size; ▪ The sample was of convenience and without randomization	Comparisons of muscular strength of the upper and lower extremities, self-reported functional limitation (OR 6.4; 95% CI, 3.7-10.9), moderate limitation of activity (OR 7.6, 95% CI, 4.0-14.4), and limitation in climbing stairs (OR 11.7; 95% CI, 7.3-18.6) between subjects with COPD and subjects without COPD
Smith M.D. et al., 2010	The individuals with COPD had increased displacement mediolateral pressure (p=0,013) and angular motion of the hip (0,001) compared with the Control Group (CG).	▪ No calculation of sample size was described	Correlation between balance and increased respiratory demand from exercise with upper limbs
Rocco C.C.M. et al., 2011	The individuals with COPD had a lower number repetitions on the SST 19.27±3.88 (p<0.05), and exhibited deficits in functional balance and gait on the Tinetti scale, 26.86±1.69 (p<0.05), compared with the CG.	▪ There was no calculation of sample size; ▪ The sample was of convenience and without randomization	The BODE Index demonstrated correlations with balance assessment (determined by the Tinetti scale), r = 0.59 (p<0.05) and the sit-to-stand test, r = 0.78 (p<0.05)
Ozalevli S. et al., 2011	The frequency of falls in the past year were as follows: one fall in 9 COPD patients (25%), two falls in 1 COPD patient (2.8%), and one fall in 3 healthy individuals (15%). The BBS scores decrease in COPD patients compared with the healthy individuals (p=0.001)	▪ There was no calculation of sample size; ▪ The sample was of convenience and without randomization	BBS scores, frequency of falls and trips were correlated with each other in COPD patients (r=-0.63, r=-0.46, r=0.89, p<0.05). In the COPD patients, BBS scores and frequency of falls were correlated with dyspnea and leg fatigue severity, the SpO2 value measured after the 6MWT, and PaO2 and SaO2 values
Horie J. et al., 2011	The COPD group there was no significant difference in the measured One-leg standing time and total trace length, compared with the CG.	▪ Study questions in not cleary ▪ There was no calculation of sample size; ▪ The sample was of convenience and without randomization ▪ There was not use of concurrent controls ▪ Method of outcome was not assessment standard, valid and reliable	There was no correlations with other variables
Beauchamp M.K. et al., 2012	Subjects with COPD demonstrated reduced balance scores on each component of the BESTest, with marked déficits(30% reduction) in biomechanics, transitions, and gait. Lower BBS, balance confidence scores, and physical activity levels were also evident in subjects with COPD compared with control subjects (all P< .001).	▪ The sample was of convenience and without randomization	Self-reported physical activity was positively associated with BBS scores, total BESTest scores, BESTest biomechanics, transitions, and reactive subscores (P=.003). Measures of lower extremity muscle strength were associated with BBS and BESTest total scores, and with five of the six BESTest subscores
Janssens L. et al., 2013	Individuals with COPD showed an increased body sway in anterior-posterior direction (RMS: 6.5±3.0 cm) when compared to controls (RMS: 4.5±1.5 cm) (p = 0.037).	▪ There was no calculation of sample size; ▪ The sample was of convenience and without randomization	There was no correlations with other variables

Table 4. Quantitative evaluation of the studies eligible for systematic review

CRITERION	Weighted Score (points)	Butcher, 2004	Eisner, 2008	Smith, 2010	Rocco, 2011	Ozalevli, 2011	Horie, 2011	Beaucamp 2012	Janssens, 2013
1. Study Question	***2***								
• Clearly focused and appropriate question		**2**	**2**	**2**	**2**	**2**	**0**	**2**	**2**
2. Study Population	***8***								
• Description of study population	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
• Sample size justification	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**
3. Comparability of Subjects for All Observational Studies	***22***								
• Specific inclusion/exclusion criteria for all groups	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
• Criteria applied equally to all groups	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**0**
• Comparability of groups at baseline with regard to disease status and prognostic factors	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
• Study groups comparable to non-participants with regard to confounding factors	**3**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**
• Use of concurrent controls	**5**	**5**	**5**	**5**	**5**	**5**	**0**	**5**	**0**
• Comparability of follow-up among groups at each assessment	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4. Exposure or Intervention	***11***								
• Clear definition of exposure	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
• Measurement method standard, valid and reliable	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
• Exposure measured equally in all study groups	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
5. Outcome measures	***20***								
• Primary/secondary outcomes clearly defined	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
• Outcomes assessed blind to exposure or intervention	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
• Method of outcome assessment standard, valid and reliable	**5**	**5**	**5**	**5**	**5**	**5**	**0**	**5**	**5**
• Length of follow-up adequate for question	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
6. Statistical Analysis	**19**								
• Statistical tests appropriate	**5**	**5**	**5**	**5**	**5**	**5**	**0**	**5**	**5**
• Multiple comparisons taken into Consideration	**3**	**3**	**3**	**3**	**3**	**3**	**0**	**3**	**3**
• Modeling and multivariate techniques appropriate	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**2**	**0**
• Power calculation provided	**2**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**
• Assessment of confounding	**5**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**
• Dose-response assessment if appropriate	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7. Results	***8***								
• Measure of effect for outcomes and appropriate measure of precision	**5**	**0**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
• Adequacy of follow-up for each study group	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8. Discussion	***5***								
• Conclusions supported by results with possible biases and limitations taken into consideration		**0**	**5**	**5**	**5**	**5**	**0**	**5**	**5**
9. Funding or Sponsorship	***5***								
• Type and sources of support for study		**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
TOTAL SCORE	***100***	***54***	***74***	***64***	***64***	***66***	***39***	***69***	***56***

Anexo II – Carta de submissão do artigo

De: "rbfisio-se@ufscar.br" <rbfisio-se@ufscar.br>
Para: saraposgraduacao@yahoo.com.br
Cc: marcelanmedeiros@hotmail.com; guilhermepinheiro87@hotmail.com; rodrigoroliveira@hotmail.com; fguimaraes_pg@yahoo.com.br; saraposgraduacao@yahoo.com.br
Enviadas: Segunda-feira, 15 de Dezembro de 2014 19:11
Assunto: Brazilian Journal of Physical Therapy - Manuscript ID RBFIS-2014-0459

15-Dec-2014

Dear Prof. Menezes:

Your manuscript entitled "Postural balance and falls in patients with chronic obstructive pulmonary disease – a systematic review" has been successfully submitted online and is presently being given full consideration for publication in the Brazilian Journal of Physical Therapy.

Your manuscript ID is RBFIS-2014-0459.

Please mention the above manuscript ID in all future correspondence or when calling the office for questions. If there are any changes in your street address or e-mail address, please log in to ScholarOne Manuscripts at https://mc04.manuscriptcentral.com/rbfis-scielo and edit your user information as appropriate.

You can also view the status of your manuscript at any time by checking your Author Center after logging in to https://mc04.manuscriptcentral.com/rbfis-scielo.

Thank you for submitting your manuscript to the Brazilian Journal of Physical Therapy.

Sincerely,
Brazilian Journal of Physical Therapy Editorial Office