PROGRAMA
DE CIÊNCIAS
DA REABILITAÇÃO

CENTRO UNIVERSITÁRIO AUGUSTO MOTTA

Programa de Pós-Graduação *Stricto Sensu* em Ciências da Reabilitação Mestrado Acadêmico em Ciências da Reabilitação

JENNIFER MARIA DE ALMEIDA AGUIAR

Efeitos do treinamento muscular inspiratório de média e alta intensidades em indivíduos com apneia obstrutiva do sono: Revisão sistemática e meta-análise

RIO DE JANEIRO

2025

JENNIFER MARIA DE ALMEIDA AGUIAR

Efeitos do treinamento muscular inspiratório de média e alta intensidades em indivíduos com apneia obstrutiva do sono: Revisão sistemática e meta-análise

Dissertação apresentada ao Programa de Pós-graduação em Ciências da Reabilitação, do Centro Universitário Augusto Motta, como parte dos requisitos para obtenção do título de **Mestre** em Ciências da Reabilitação.
Linha de Pesquisa: Abordagem terapêutica em Reabilitação.
Orientador: Luis Felipe da Fonseca Reis.
Coorientadora: Clara Pinto Diniz

RIO DE JANEIRO
2025

Autorizo a reprodução e a divulgação total ou parcial deste trabalho, por qualquer meio, convencional ou eletrônico, para fins de estudo e de pesquisa, desde que citada a fonte.

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

615.8 Aguiar, Jennifer Maria de Almeida.
A283e Efeitos do treinamento muscular inspiratório de média e alta intensidades em indivíduos com apnéia obstrutiva do sono: Revisão sistemática e meta-análise. / Jennifer Maria de Almeida Aguiar – Rio de Janeiro, 2025.
75p.

Dissertação (Mestrado em Ciências da Reabilitação) - Centro Universitário Augusto Motta, 2025.

1. Treinamento muscular inspiratório.2.Apneia obstrutiva do sono.
3.Síndrome da apneia obstrutiva do sono. I. Título.

CDD 22.ed.

Jennifer Maria de Almeida Aguiar

Efeitos do treinamento muscular inspiratório de média e alta intensidades em indivíduos com apneia obstrutiva do sono: Revisão sistemática e meta-análise.

Examinada em: 15/12/2025

Documento assinado digitalmente
LUIS FELIPE DA FONSECA REIS
Data: 14/07/2026 18:47:23-0300
Verifique em https://validar.iti.gov.br

Prof. Dr. Luís Felipe da Fonseca Reis

Programa de Pós-Graduação em Ciências da Reabilitação - Centro Universitário Augusto Motta – UNISUAM

Documento assinado digitalmente
LEANDRO MIRANDA DE AZEREDO
Data: 27/07/2026 00:04:07-0300
Verifique em https://validar.iti.gov.br

ndro Miranda de Azeredo

Hospital Central da Polícia Militar do Estado do Rio de Janeiro – PMERJ

Documento assinado digitalmente
FLAVIA MAZZOLI DA ROCHA
Data: 03/08/2026 08:59:21-0300
Verifique em https://validar.iti.gov.br

Prof.ª. Dra. Flavia Mazzoli da Rocha

Evandro Chagas National Institute of Infectious Disease - Oswaldo Cruz Foundation

RIO DE JANEIRO
2025

Agradecimentos

Agradeço, com profunda sinceridade, a todas as pessoas que fizeram parte desta caminhada e que, de diferentes formas, contribuíram para que este projeto de mestrado se tornasse realidade.

Ao meu orientador, Luís Felipe, pela confiança, pela paciência e pela generosidade intelectual. Obrigada por acreditar no meu potencial e por me guiar com firmeza, respeito e acolhimento em cada etapa deste trabalho.

À Clara, que topou embarcar comigo na aventura — e no desafio — de realizar uma revisão sistemática. Sua parceria tornou tudo mais leve, possível e até bonito de ver acontecer.

Ao Leandro, que, desde o primeiro momento em que falei sobre a ideia do mestrado, disse sem hesitar: *"Tenho um tema de grande relevância para pesquisarmos"*. Foi o início de uma jornada que mudou minha trajetória profissional e me permitiu descobrir uma área pela qual me apaixonei profundamente.

Aos meus colegas de trabalho Felipe e Anderson, que sempre me apoiaram, vibraram comigo e entenderam meus dias de correria e cansaço. Vocês foram essenciais para que eu pudesse seguir.

Ao meu pai, pela força, pela presença que me sustenta e pelo amor que nunca falha. Muito do que conquistei até aqui é reflexo do que aprendi com você.

À minha avó, cujo carinho nos dias mais difíceis me trouxe paz e me lembrou quem eu sou. O amor dela sempre me acolheu quando o nervosismo apertava.

À minha melhor amiga Adria, que me impulsiona, me escuta e me acompanha em tudo — inclusive nas infinitas vezes em que ensaiei minhas apresentações de pôster. Obrigada por ser porto seguro, incentivo e risada em meio ao caos acadêmico.

E deixo um agradecimento especial à Camila, cuja presença sensível e constante me ajudou a manter o equilíbrio, a clareza e a serenidade necessárias para atravessar esses dois anos. Sua escuta, suas palavras e seu apoio foram fundamentais para que eu chegasse até aqui.

Sou imensamente grata a cada pessoa que fez parte dessa etapa. Este trabalho também é de vocês.

Resumo

Introdução: A apneia obstrutiva do sono (AOS) é o distúrbio respiratório do sono mais prevalente, sendo considerada um problema de saúde pública devido à sua associação com maior risco de morbimortalidade cardiovascular. O treinamento muscular inspiratório (TMI) tem se mostrado uma intervenção coadjuvante e promissora na redução da gravidade da AOS, por meio da melhora da força e resistência dos músculos respiratórios. **Objetivo:** Analisar, por meio de uma revisão sistemática e meta-análise, os efeitos de diferentes intensidades de TMI na pressão inspiratória máxima (PImax), no índice de apneia-hipopneia (IAH), no Índice de Qualidade do Sono de Pittsburgh (PSQI) e na Escala de Sonolência de Epworth (ESE), além de descrever os achados relacionados ao volume expiratório forçado no primeiro segundo (VEF1) e ao desempenho em exercício cardiopulmonar (VO_2máx) em adultos com AOS. **Métodos:** Foram incluídos ensaios clínicos randomizados (ECR) envolvendo adultos com AOS submetidos ao TMI. Nove bases de dados foram pesquisadas utilizando descritores pré-definidos. Dois revisores independentes realizaram a seleção dos estudos, a extração de dados e a avaliação do risco de viés utilizando a ferramenta RoB 2. A metanálise foi conduzida utilizando o RevMan 5.4 e a qualidade da evidência foi avaliada pelo sistema GRADE. Análises de subgrupos foram realizadas com base na intensidade do TMI. **Resultados:** Entre 594 registros recuperados nas bases de dados, 7 ECR foram considerados elegíveis. Foram incluídos estudos que recrutaram pacientes diagnosticados com AOS em todos os níveis de IAH, com TMI como intervenção primária. O TMI aumentou significativamente a PImax (d = 1,698; IC 95%: 0,182 a 3,214; p = 0,035) e melhorou a qualidade do sono (PSQI: d = -0,636; IC 95%: -1,133 a -0,139; p = 0,012) e a sonolência diurna (ESE: d = -0,629; IC 95%: -1,043 a -0,215; p = 0,003), com efeitos mais consistentes em intensidade moderada. Não houve efeito significativo no IAH (d = 0,406; IC 95%: -0,687 a 1,499; p = 0,528). A capacidade cardiorrespiratória (VO_2máx) foi avaliada em três estudos, porém não foi possível realizar metanálise devido ao número reduzido de investigações e à heterogeneidade dos protocolos. Conclusões: O TMI mostrou-se eficaz no aumento da força inspiratória e na melhora da qualidade do sono e da sonolência diurna em indivíduos com AOS, especialmente em protocolos de intensidade moderada. Embora os efeitos sobre o IAH permaneçam inconclusivos e as evidências sobre a capacidade cardiorrespiratória ainda sejam limitadas, esses achados corroboram o potencial do TMI como abordagem terapêutica adjuvante no manejo da AOS e destacam a necessidade de estudos com maior rigor metodológico e padronização dos protocolos.

Palavras-chave: Treinamento muscular inspiratório; Treinador muscular inspiratório; TMI; Apneia obstrutiva do sono; Síndrome da apneia obstrutiva do sono; AOS. (Http://decs.bvs.br/).

Abstract

Introduction: Obstructive sleep apnea (OSA) is the most prevalent sleep-related breathing disorder and is considered a public health concern due to its association with increased cardiovascular morbidity and mortality. Inspiratory muscle training (IMT) has emerged as a promising adjunctive intervention for OSA, potentially reducing disease severity through improvements in respiratory muscle strength and endurance. **Objective:** To analyze, through a systematic review and meta-analysis, the effects of different IMT intensities on maximal inspiratory pressure (MIP), apnea–hypopnea index (AHI), Pittsburgh Sleep Quality Index (PSQI), and Epworth Sleepiness Scale (ESS), and to describe findings related to forced expiratory volume in the first second (FEV_1) and cardiopulmonary exercise performance (VO_2max) in adults with OSA. **Methods:** Randomized controlled trials (RCTs) involving adults with OSA undergoing IMT were included. Nine databases were searched using predefined descriptors. Two independent reviewers performed study selection, data extraction, and risk-of-bias assessment using the Cochrane RoB 2 tool. Meta-analysis was conducted using RevMan 5.4, and certainty of evidence was assessed using the GRADE framework. Subgroup analyses were performed according to IMT intensity. **Results**: Of the 594 records identified, seven RCTs met the eligibility criteria. Studies included participants with OSA across all AHI severity levels, with IMT as the primary intervention. IMT significantly increased MIP (d = 1.698; 95% CI: 0.182 to 3.214; p = 0.035) and improved sleep quality (PSQI: d = −0.636; 95% CI: −1.133 to −0.139; p = 0.012) and daytime sleepiness (ESS: d = −0.629; 95% CI: −1.043 to −0.215; p = 0.003), with more consistent effects observed in moderate-intensity protocols. No significant effect was found for AHI (d = 0.406; 95% CI: −0.687 to 1.499; p = 0.528). Cardiorespiratory fitness (VO_2max) was assessed in three studies; however, quantitative synthesis was not performed due to the limited number of studies and protocol heterogeneity. Conclusions: IMT appears to be effective in improving inspiratory muscle strength, sleep quality, and daytime sleepiness in adults with OSA, particularly when moderate-intensity protocols are applied. Although effects on AHI remain inconclusive and evidence regarding aerobic capacity is limited, these findings support IMT as a potential adjunctive therapeutic strategy in OSA management and highlight the need for further well-designed trials with standardized protocols.

Keywords: Inspiratory muscle training; Inspiratory muscle trainer; IMT; Obstructive sleep apnea; Obstructive sleep apnea syndrome; OSA.

Lista de Ilustrações

Figura 1 - Fluxograma PRISMA 2020 das informações com as diferentes fases de uma revisão sistemática.

Figura 2 – Forest plot da meta-análise do efeito do TMI sobre o Índice de Apneia-Hipopneia

Figura 3 – Forest plot da meta-análise do efeito do TMI sobre a Pressão Inspiratória Máxima.

Figura 4 – Forest plot da meta-análise do efeito do TMI sobre o Índice de Qualidade do Sono de Pittsburgh

Figura 5 – Forest plot da meta-análise do efeito do TMI sobre a Escala de Sonolência de Epworth.

Lista de Quadros e Tabelas

Quadro 1. Cronograma de execução.

Tabela 1. Características dos ensaios clínicos randomizados incluídos na meta-análise

Tabela 2. Características dos protocolos de treinamento dos músculos respiratórios.

Tabela 3. Risk of Bias (RoB 2) por estudo

Tabela 4. Resumo GRADE – Treinamento de Músculos Inspiratórios na Apneia Obstrutiva do Sono

Lista de Abreviaturas e Siglas

AOS Apneia obstrutiva do sono

CAPES Coordenação de Aperfeiçoamento de Pessoal de Nível Superior.

CEP Comitê de Ética em Pesquisa.

DRS Distúrbio Respiratório do sono

ECR Ensaio clínico randomizado

EPWORTH Escala de Sonolência de Epworth.

ESS Escala de sonolência diurna

IAH Índice de apneia e hipopneia

LILACS Literatura Latino-americana e do Caribe em Ciências da Saúde.

MESH Medical Subject Headings.

PIMÁX Pressão inspiratória máxima

PRISMA Preferred Items for Systematic Reviews and Meta-analyses.

PROSPERO Prospectivo Internacional de Revisões Sistemáticas .

PSQI Pittsburgh Sleep Quality Index

PubMed Base de dados de pesquisa médica SciELO Scientific Electronic Library Online

TCLE Termo de Consentimento livre e esclarecido

TMI Treinamento muscular inspiratório

Sumário

Agradecimentos	iii
Resumo	v
Abstract	vi
Lista de Ilustrações	vii
Lista de Quadros e Tabelas	viii
Lista de Abreviaturas e Siglas	ix
PARTE I – PROJETO DE PESQUISA	**11**
Capítulo 1 Revisão de Literatura	**12**
1. Introdução	**12**
1.1. Justificativas	16
1.1.1 Relevância para as Ciências da Reabilitação	16
1.1.2 Relevância para o Desenvolvimento Sustentável	17
1.2 Objetivos	17
1.2.1. Primário	17
1.2.2 secundários	17
1.3 Hipóteses	**18**
Capítulo 2: Participantes e Métodos	**18**
2.1 Delineamento do estudo	18
2.1.1 Registro do protocolo	18
2.2 Amostra	18
2.2.1 Critérios de inclusão para a seleção dos estudos	18
2.2.2 Critérios de exclusão	19
2.3 Metodologia	19
2.3.1 Estratégia de busca	19
2.3.2 Seleção de estudos	20
2.3.3 Extração de dados	20
2.3.4 Desfecho primário	20
2.3.5 Desfecho secundário	21
2.3.6 Disponibilidade e acesso aos dados	21
2.3.7 Métodos de síntese e heterogeneidade	21
2.4 Apoio financeiro	21
2.5 Cronograma	21
PARTE II– PRODUÇÃO INTELECTUAL	**23**
Capítulo 3 Resultados	24
3. Manuscrito	24
6.Considerações Finais	54
Referências	54
Anexo 1:	
Registro Prospectivo do Protocolo da revisão Sistemática no PROSPERO	69
Anexo 2:	
Checklist PRISMA	66
Produção intelectual: Outras produções acadêmicas	68

PARTE I – PROJETO DE PESQUISA

Capítulo 1. Revisão de Literatura

1. Introdução

A apneia obstrutiva do sono (AOS) é definida por paradas respiratórias iguais ou superiores a 10 segundos, acompanhada de redução do fluxo inspiratório acima de 90%, ou por reduções do fluxo inspiratório entre 30% e 90%, caracterizando, respectivamente, as apneias ou hipopneias obstrutivas do sono (Isaac S, Rodrigo P, 2013; De Backer, 2013). Completando o diagnóstico, as apneias ou hipopneia obstrutivas do sono são acompanhadas de redução da saturação de oxigênio ($SpaO^2$) em 3% ou 4%, seguidas de micro despertares, responsáveis por alterações da qualidade do sono e de vida (Jordan et al., 2014; Pack et al., 2006).

A carga epidemiológica da apneia obstrutiva do sono apresenta taxas de prevalência elevadas, com importante variação geográfica e relevantes implicações para a saúde pública. A análise global conduzida por Benjafield et al. (2019), considerada o primeiro estudo a estimar sistematicamente a carga mundial da AOS, indicou que aproximadamente um bilhão de indivíduos são afetados pela doença. Evidências mais recentes reforçam esses achados, destacando que a elevada prevalência e o expressivo subdiagnóstico da AOS permanecem como desafios globais, sugerindo que a magnitude real da doença pode ser ainda maior do que a previamente estimada (Benjafield et al., 2019; Alharbi et al., 2024).

No Brasil, um estudo populacional conduzido por (Tufik et al., 2010) em São Paulo revelou que 33% da população adulta preenche os critérios diagnósticos para AOS, estabelecendo essa condição como uma prioridade crítica de saúde pública que requer atenção urgente dos sistemas de saúde e dos formuladores de políticas públicas (Tufik et al., 2010). Essa prevalência brasileira é particularmente preocupante, visto que a diversidade demográfica de São Paulo — abrangendo diferentes estratos socioeconômicos, origens étnicas e distribuições urbano-rurais,

e justifica a realização da presente revisão sistemática com meta-análise. esses achados podem ser razoavelmente extrapolados para outras grandes áreas metropolitanas brasileiras e potencialmente refletir a carga nacional da doença.

Ampliando essa perspectiva para a América Latina, evidências epidemiológicas sugerem que a região apresenta elevada carga de apneia obstrutiva do sono, embora estudos populacionais abrangentes ainda sejam escassos. O subdiagnóstico permanece significativo, sendo associado ao acesso limitado a métodos diagnósticos, à baixa conscientização dos profissionais de saúde e às barreiras socioeconômicas que dificultam a realização da polissonografia, especialmente em contextos com recursos limitados (Benjafield et al., 2019; Duarte et al., 2022).

A convergência de dados provenientes de diferentes regiões geográficas e contextos socioeconômicos indica que a apneia obstrutiva do sono constitui um relevante problema de saúde pública em escala global. A elevada prevalência, o importante subdiagnóstico e a associação consistente com desfechos cardiovasculares e metabólicos reforçam a necessidade de estratégias diagnósticas e terapêuticas mais amplas e acessíveis (Benjafield et al., 2019; Gottlieb et al., 2020).

Além dos critérios diagnósticos, a AOS se manifesta por meio de um conjunto de sintomas que impactam profundamente a homeostase diurna e noturna. Os pacientes geralmente relatam sonolência diurna excessiva, sono não reparador, boca seca ao despertar, cefaleias matinais, comprometimento neurocognitivo afetando a memória e a concentração, distúrbios de humor e disfunção sexual. Os sintomas noturnos incluem apneias testemunhadas, ronco, fragmentação do sono, despertares frequentes, sufocamento noturno, noctúria, insônia, refluxo, ressecamento oral e sudorese.

Essas manifestações clínicas refletem as consequências abrangentes do distúrbio, que vão desde a desregulação do sistema nervoso autônomo até alterações hormonais, metabólicas, inflamatórias, vasculares, imunológicas e cognitivas que, coletivamente, contribuem para a redução da expectativa de vida e morbidade cardiovascular. (Gottlieb, D. J et al., 2020; Epstein et al., 2009; Young et al., 2008; Nieto et al., 2000).

A compreensão atual da fisiopatologia da apneia obstrutiva do sono evoluiu de um modelo puramente anatômico para um modelo fenotípico multifatorial, no qual diferentes mecanismos interagem para determinar a colapsibilidade das vias aéreas superiores durante o sono. Entre esses mecanismos, destaca-se o comprometimento anatômico das estruturas orofaríngeas, como redução do calibre da via aérea superior e aumento da complacência faríngea, que favorecem o colapso inspiratório.

Além disso, muitos indivíduos apresentam compensação neuromuscular inadequada, caracterizada por ativação insuficiente dos músculos dilatadores da faringe durante o sono, o que reduz a capacidade de manter a patência da via aérea. Outro componente relevante é a propensão aumentada ao despertar, conhecida como baixo limiar de despertar, que contribui para fragmentação do sono e instabilidade ventilatória. Por fim, o controle ventilatório instável, representado pelo aumento do *loop gain*, promove oscilações excessivas na ventilação, favorecendo a recorrência de eventos respiratórios.

Essa heterogeneidade fenotípica possui importantes implicações terapêuticas, uma vez que sugere que intervenções distintas podem ser mais eficazes dependendo do perfil fisiopatológico predominante de cada indivíduo, reforçando a necessidade de abordagens individualizadas no manejo da AOS (Dempsey et al., 2010; Amal et al., 2018).

O diagnóstico da AOS baseia-se na monitorização objetiva do sono. De acordo com a Academia Americana de Medicina do Sono, recomenda-se a realização da polissonografia tipo I, em ambiente laboratorial, ou da polissonografia tipo III, em ambiente domiciliar, em pacientes adultos que apresentem sinais e sintomas clínicos sugestivos de AOS. A polissonografia tipo I é considerada o padrão-ouro diagnóstico, pois registra múltiplos parâmetros fisiológicos sob supervisão técnica durante toda a noite, enquanto a polissonografia tipo III utiliza um número reduzido de canais e é indicada apenas para pacientes com alta probabilidade clínica e ausência de comorbidades significativas (Kapur et al., 2017).

Embora a terapia com pressão positiva contínua nas vias aéreas (CPAP/BIPAP) continue sendo o tratamento padrão-ouro, o arsenal terapêutico expandiu-se para incluir dispositivos de avanço mandibular, terapia miofuncional,

intervenções cirúrgicas como uvulopalatofaringoplastia e estimulação do nervo hipoglosso, programas estruturados de exercícios aeróbicos e treinamento muscular inspiratório (TMI). (Epstein et al., 2009; Yao et al., 2014; Azeredo. M et al., 2022).

O TMI representa uma estratégia terapêutica adjuvante promissora para o tratamento da disfunção subjacente da musculatura respiratória que contribui para a fisiopatologia da AOS. Ao fortalecer sistematicamente a musculatura ventilatória por meio de carga resistiva progressiva, o TMI visa melhorar a eficiência mecânica dessa bomba muscular, aumentar a função dos músculos dilatadores da faringe por meio de mecanismos diretos e indiretos e, em última análise, reduzir a gravidade dos sintomas relacionados à AOS (Ries et al., 2005; O'Driscoll et al., 2011; Azeredo. M et al., 2022).

O regime de treinamento padrão emprega diferentes dispositivos que geralmente impõem cargas inspiratórias ajustáveis, calibradas de acordo com a capacidade individual e os objetivos terapêuticos (Kovelis et al., 2009).

Os protocolos atuais normalmente incorporam sessões diárias de 20 a 30 minutos com intensificação progressiva da carga, começando com limiares de carga conservadores, o que pode facilitar a adesão ao treinamento e a adaptação neuromuscular antes de progredir para intensidades mais altas à medida que os pacientes desenvolvem força e resistência (McCool FD at al., 2013).

O equilíbrio entre o estímulo do treinamento e a tolerância do paciente é fundamental, exigindo ajustes individualizados na frequência e na intensidade para otimizar a eficácia, minimizar o desconforto e maximizar a adesão (MacIntyre et al., 1995). Estudos mostram que a personalização dos protocolos é essencial para garantir a eficácia do treinamento, pois diferentes pacientes podem responder de maneiras variadas à carga e aos exercícios (Ries et al., 2005).

O TMI tem sido utilizado em indivíduos com apneia obstrutiva do sono com o objetivo de melhorar a força muscular inspiratória; entretanto, os resultados descritos na literatura são heterogêneos. Essa variabilidade pode estar relacionada, em parte, à ausência de personalização dos protocolos de treinamento, uma vez que diferentes estudos adotam estratégias padronizadas aplicadas de forma uniforme a todos os participantes, sem considerar características individuais e necessidades específicas de treinamento. Estudos prévios demonstram que os efeitos do TMI variam entre populações e desfechos avaliados, com resultados discrepantes quanto aos benefícios clínicos e fisiológicos observados (Lin et al.,

2020; Azeredo et al., 2022).

Nesse contexto, aprofundar o conhecimento sobre as modalidades de intervenção, bem como sobre os parâmetros de prescrição do TMI — incluindo intensidade, frequência e duração — torna-se fundamental para compreender quais estratégias são capazes de promover adaptações fisiológicas relevantes e benefícios clínicos consistentes nessa população (McConnell, 2013).

Nesses contextos, fatores como frequência, duração e modalidade, afetam a carga geral de treinamento e influenciarão o resultado. A intensidade de treinamento é talvez o fator mais importante na otimização da prescrição de TMI.

Revisões sistemáticas com meta-análise publicadas recentemente já investigaram os efeitos do TMI em indivíduos com AOS. Chen et al (2023) analisaram ensaios clínicos randomizados que avaliaram o TMI, observando melhora em desfechos subjetivos do sono e em parâmetros cardiovasculares, porém sem demonstrar redução consistente do IAH.

De forma semelhante, a revisão sistemática e meta-análise conduzida por Silva de Sousa et al. (2023) sintetizou os efeitos do TMI na AOS, identificando benefícios clínicos pontuais, mas com elevada heterogeneidade entre os estudos incluídos. Cabe destacar que, em ambas as revisões, os protocolos de treinamento foram avaliados de forma global, sem a análise específica do impacto das diferentes intensidades do TMI sobre os desfechos avaliados. (Dessa forma, permanece uma lacuna na literatura quanto ao papel da intensidade do TMI, o que fundamenta e justifica a realização sistemática com meta-análise).

1.1 Justificativas

1.1.1 Relevância para as Ciências da Reabilitação

A AOS é uma condição crônica e multifatorial que compromete não apenas a ventilação, mas também aspectos cardiorrespiratórios, metabólicos e funcionais do indivíduo (Jordan et al., 2014; Heinzer et al., 2015). O TMI tem se mostrado uma ferramenta promissora dentro da reabilitação respiratória, atuando no fortalecimento da musculatura inspiratória e promovendo melhora na eficiência ventilatória e na resistência à fadiga (McConnell, 2013; Illi et al., 2012).

Em indivíduos com AOS, essa abordagem representa uma alternativa complementar ou substitutiva a terapias convencionais, como o uso do CPAP, sobretudo em casos de baixa adesão (Kapur et al., 2017; Heinzer et al., 2015).Apesar dos avanços recentes, ainda há lacunas na literatura quanto à intensidade ideal do TMI e à magnitude dos seus efeitos sobre desfechos clínicos relevantes, como o índice de apneia-hipopneia, a força muscular inspiratória, a sonolência diurna e a qualidade do sono (Moiz et al., 2022; Nóbrega-Júnior et al., 2020; Labeix et al., 2022).

Assim, o presente estudo é relevante para as Ciências da Reabilitação por oferecer uma base científica robusta que apoia o uso do TMI como intervenção segura, acessível e potencialmente eficaz na melhora da função ventilatória e dos sintomas associados à AOS, ampliando o escopo de atuação da fisioterapia respiratória baseada em evidências (Vranish & Bailey, 2016; Lin et al., 2019).

1.1.2 Relevância para o Desenvolvimento Sustentável[1]

Dentre os dezessete “Objetivos de Desenvolvimento Sustentável (ODS)” destaca-se o Objetivo “Saúde e Bem-estar” (ODS3) que busca fortalecer medidas de melhorias na qualidade de atendimento, visando melhor adesão e eficácia do tratamento tendo em vista que o tratamento inadequado está relacionado com o desenvolvimento de comorbidades e piora na qualidade de vida.

1.2 Objetivos

1.2.1 Objetivo Primário

Revisar na literatura os efeitos dos protocolos de TMI com baixa, média e alta intensidade e comparar seus efeitos clínicos.

1.2.2 Objetivos Secundários

1. Avaliar o impacto no índice de apneia e hipopneia;
2. Mensurar o efeito na força muscular inspiratória;
3. Analisar o desempenho na qualidade do sono
4. Aferir os resultados na sonolência diurna;

5. Conhecer alterações na capacidade pulmonar;
6. Verificar a Capacidade cardiorrespiratória

1.3 Hipóteses

Hipótese nula: Não há diferença nos resultados encontrados nos diferentes protocolos.
Hipótese alternativa: Há diferença nos resultados encontrados nos diferentes protocolos.

Capítulo 2 Participantes e Métodos

2.1 Delineamento do estudo

Esta revisão foi estruturada de acordo com o Manual Cochrane para Revisões Sistemáticas de Intervenções e relatada seguindo as diretrizes PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) (Shamseer L *et al.,* 2015).

2.1.1 Registro do protocolo

A revisão sistemática foi registrada no *International prospective register of systematic reviews* - PROSPERO - CRD420251013583 em 20 de março de 2025, para que os títulos fossem selecionados e analisados pelos revisores.

2.2 Amostra

2.2.1 Critérios de inclusão para a seleção dos estudos

Os estudos foram elegíveis para inclusão se atendessem aos seguintes critérios: ensaios clínicos randomizados (ECR) publicados nos últimos 10 anos; participantes com idade ≥ 18 anos diagnosticados com AOS de qualquer nível de

gravidade; TMI como intervenção primária, independentemente do local de prescrição (domiciliar ou institucional). Não foram aplicadas restrições de idioma.

2.2.2 Critérios de exclusão

Os critérios de exclusão foram: artigos de revisão, monografias, resumos de congressos, capítulos de livros, diretrizes clínicas e opiniões de especialistas; estudos com animais; estudos com desfechos clínicos incertos ou coortes de pacientes duplicadas; participantes com condições clínicas que pudessem afetar a melhora da musculatura inspiratória, como doenças neurológicas, respiratórias, cardíacas e/ou metabólicas; e estudos nos quais a TMI fazia parte de uma intervenção multicomponente que impedisse a avaliação separada do efeito.

2.3 Metodologia

2.3.1 Estratégia de busca

Os estudos foram identificados por meio de busca sistemática nas seguintes bases de dados e registros de ensaios clínicos: Registro Central de Ensaios Controlados da Cochrane (CENTRAL) via Biblioteca Cochrane, EMBASE, Sistema Online de Análise e Recuperação da Literatura Médica (MEDLINE) via PubMed, Caribbean Health Sciences (LILACS) através do Portal da Biblioteca Virtual em Saúde, Biblioteca Eletrônica Científica Online - SciELO e Banco de Dados de Evidências em Fisioterapia (PEDro) para todos os ensaios clínicos randomizados.
Foi realizada uma busca com descritores selecionados a partir dos termos MeSH (Medical Subject Headings). Os termos-chave para a estratégia de busca no PubMed foram baseados no acrônimo PICO, onde População (apneia obstrutiva do sono OU síndrome da apneia obstrutiva do sono OU AOS), Intervenção (treinamento muscular inspiratório OU treinador muscular inspiratório OU TMI).

O desfecho não foi adicionado, pois não foi descrito nos artigos e as buscas foram limitadas. Os termos MeSH foram interligados utilizando os operadores booleanos "E" e "OU" para melhor aproveitamento deles. As referências de todos os artigos primários foram rastreadas e revisadas em busca de referências adicionais.

2.3.2 Seleção de estudos

Inicialmente, os estudos foram identificados por um revisor (LFFR), e os artigos encontrados em bases de dados foram armazenados, gerenciados e analisados, e as duplicatas foram removidas usando o Rayyan® (Ouzzani M et al., 2016). Após um teste de calibração, dois revisores (JMAA e CPD) examinaram de forma independente e cega os títulos e resumos de todas as referências potencialmente elegíveis na primeira etapa. Na segunda etapa, os textos completos dos estudos que passaram pela triagem inicial foram obtidos e avaliados independentemente por ambos os revisores, de acordo com os critérios de inclusão e exclusão predefinidos.

Um formulário padronizado foi utilizado para garantir que cada elemento de elegibilidade fosse devidamente avaliado. Os estudos excluídos na etapa de texto completo tiveram os respectivos motivos (por exemplo, desenho do estudo inadequado, população inelegível) registrados e apresentados no fluxograma PRISMA. Quaisquer divergências entre os dois revisores em qualquer uma das etapas foram resolvidas por meio de consulta a um terceiro revisor (LMA). Todos os estudos incluídos foram documentados no fluxograma PRISMA para ilustrar o processo final de seleção dos estudos.

2.3.3 Extração de dados

Os dados foram extraídos independentemente por dois revisores (JMAA e CPD), que coletaram informações gerais sobre o estudo (autor, ano de publicação, país), características dos participantes (tamanho da amostra, idade, sexo), detalhes da intervenção (tipo, intensidade, frequência, duração, número de sessões, supervisão), condição de controle. Quaisquer discrepâncias entre os revisores foram resolvidas por meio de consulta a um terceiro revisor (LMA).

2.3.4 Desfecho primário

Os desfechos primários desta revisão sistemática e meta-análise foram a variação do IAH, a PImax, a qualidade do sono e a sonolência diurna.

2.3.5 Desfecho secundário

Os desfechos secundários incluíram variáveis fisiológicas e clínico-funcionais associadas à apneia obstrutiva do sono e ao treinamento muscular inspiratório: função pulmonar, por meio do volume expiratório forçado no primeiro segundo (VEF_1) e capacidade funcional ou desempenho cardiorrespiratório, conforme testes aplicados pelos estudos incluídos.

2.3.6 Disponibilidade e acesso aos dados

Os dados coletados e o resultado desta pesquisa serão disponibilizados e divulgados após a realização do estudo no artigo produzido posteriormente.

2.3.7 Métodos de síntese e heterogeneidade

As meta-análises foram realizadas utilizando o modelo de efeitos aleatórios, considerando a heterogeneidade clínica esperada entre os estudos. A heterogeneidade estatística foi avaliada por meio do teste Q de Cochran e do índice I^2, sendo considerados valores acima de 50% indicativos de heterogeneidade substancial. As análises estatísticas foram realizadas no software Review Manager (RevMan, versão 5.4). Não foram realizadas análises de sensibilidade devido ao número reduzido de estudos incluídos. Os vieses de publicação assim como o risco de viés decorrente de resultados ausentes não foram formalmente avaliados por meio de gráficos de funil (funnel plot) devido ao número reduzido de estudos incluídos na meta-análise.

2.4 Apoio financeiro

Este estudo não recebeu financiamento.

2.5 Cronograma

Quadro 1: Cronograma de execução.

Quadro 1: Cronograma de execução.

	ETAPA	INÍCIO	FIM
Projeto de pesquisa	Elaboração do projeto de pesquisa	10/24	12/24
	Realização de busca sistemática de literatura	03/25	05/25
Coleta de dados	Seleção dos estudos elegíveis com base nos critérios de inclusão/exclusão e realização de triagem baseada nos resumos.	06/25	06/25
	Extração dos dados a partir dos artigos selecionados.	07/25	07/25
	Análise dos resultados extraídos dos estudos incluídos.	09/25	09/25
	Síntese dos resultados e produção de tabelas, figuras.	09/25	09/25
	Revisão dos procedimentos metodológicos	10/25	10/25
	Realização de atualizações sistemáticas da base de dados	10/25	10/25
Produção	Elaboração de manuscrito	10/25	10/25
	Submissão de manuscrito	11/25	11/25
	Exame de Defesa	11/25	11/25
	Submissão de manuscrito (resultados)	11/25	12/25
	Elaboração de mídias para disseminação	12/25	12/25
	Entrega da versão final do trabalho de conclusão	12/25	12/25

PARTE II– PRODUÇÃO INTELECTUAL

Capítulo 3. Resultados

3.Manuscrito

EFFECTS OF INSPIRATORY MUSCLE TRAINING AT MODERATE AND HIGH INTENSITIES IN INDIVIDUALS WITH OBSTRUCTIVE SLEEP APNEA: A SYSTEMATIC REVIEW AND META-ANALYSIS.

Jennifer Maria de Almeida Aguiar[1,2], Leandro Miranda de Azeredo[2], Flavia Mazzoli Rocha[3,4], Arthur de Sá Ferreira[1]; Clara Pinto Diniz[4,5], Luis Felipe da Fonseca Reis[1,2,6]

[1] Postgraduate Program in Rehabilitation Sciences – UNISUAM; [2] Intensive Care Unit - Central Hospital of the Military Police of the State of Rio de Janeiro (HCPM); [3] German Sport University Cologne; [4] Evandro Chagas National Institute of Infectious Disease - Oswaldo Cruz Foundation; [5] Cardiac Intensive Care Unit - Pedro Ernesto University Hospital (HUPE) – UERJ; [6] Intensive Care Unit - Gafrée Guinle University Hospital (HUGG-EBSERH-UNIRio).

ABSTRACT

Objective: To analyze, through a systematic review and meta-analysis, the effects of different intensities of inspiratory muscle training (IMT) on maximal inspiratory pressure (MIP), apnea–hypopnea index (AHI), sleep quality (PSQI), and daytime sleepiness (ESS) in adults with obstructive sleep apnea (OSA).

Methods: Randomized controlled trials involving adults with OSA undergoing IMT were included. Nine databases were searched using predefined descriptors. Two independent reviewers performed study selection, data extraction, and risk of bias assessment using the Cochrane RoB 2 tool. Meta-analysis was conducted using RevMan 5.4, and certainty of evidence was assessed using GRADE. Subgroup analyses were performed according to IMT intensity.

Results: Seven RCTs (n = 221 participants) were included. IMT significantly increased MIP (d = 1.69; 95% CI: 0.18 to 3.21; p = 0.03) and improved sleep quality (PSQI: d = −0.61; 95% CI: −1.03 to −0.19; p = 0.01) and daytime sleepiness (ESS: d = −0.55; 95% CI: −0.86 to −0.24; p = 0.01). No significant effect was observed on

AHI (d = 0.40; 95% CI: −1.14 to 1.95; p = 0.53). Cardiorespiratory fitness (VO,max) was reported in three studies but could not be synthesized quantitatively due to insufficient data.

Conclusions: IMT improves inspiratory muscle strength and patient-reported outcomes in adults with OSA. No significant effect was observed on AHI, and the impact on aerobic capacity remains inconclusive. IMT may represent a useful adjunctive strategy in OSA management; however, further well-designed trials are needed to define optimal training parameters.

Keywords: Inspiratory muscle training; Inspiratory muscle trainer; IMT; Obstructive sleep apnea; Obstructive sleep apnea syndrome; OSA.

INTRODUCTION

Obstructive sleep apnea (OSA) represents a frequently underdiagnosed condition and a pressing public health challenge, characterized by recurrent episodes of total or partial collapse of the upper airways during sleep. It is clinically defined by respiratory events lasting ≥10 seconds, including complete cessation of airflow (apneas) with a reduction of >90% in inspiratory flow, or partial reductions of 30-90% (hypopneas), typically accompanied by oxygen desaturation ≥3-4% and subsequent cortical arousals that fragment sleep architecture [1,2].

The epidemiological burden of obstructive sleep apnea (OSA) is characterized by high prevalence rates, marked geographic variability, and significant public health implications. The global analysis conducted by Benjafield et al. (2019), regarded as the first systematic estimation of the worldwide burden of OSA, reported that approximately one billion individuals are affected by the condition. More recent evidence reinforces these findings, indicating that the high prevalence and substantial underdiagnosis of OSA remain major global challenges, suggesting that the true magnitude of the disease may be even greater than previously estimated [3,4].

In Brazil, a population-based study conducted by Tufik et al. in São Paulo revealed that 33% of the adult population meets the diagnostic criteria for OSA, establishing this condition as a critical public health priority requiring urgent attention from health systems and policymakers [5]. This Brazilian prevalence is particularly concerning, given that the diverse demographic composition of São

Paulo—encompassing different socioeconomic strata, ethnic origins, and urban-rural distributions—suggests that these findings can be reasonably extrapolated to other large Brazilian metropolitan areas and potentially reflect the national burden.

Extending this perspective to Latin America, emerging epidemiological data suggest that the region faces an equally substantial burden of OSA, although comprehensive population-based studies are still scarce. Available evidence from countries such as Chile, Mexico, and Argentina indicates prevalence rates ranging from 24% to 37% in adult populations, with significant underdiagnosis attributed to limited access to diagnostic facilities, inadequate awareness among healthcare professionals, and socioeconomic barriers restricting the availability of polysomnography in resource-limited settings. These regional challenges are compounded by the high prevalence of risk factors for OSA in Latin America, including high rates of obesity, metabolic syndrome, and cardiovascular disease, which create a synergistic effect that amplifies the disease burden.

The convergence of data from diverse geographic regions, socioeconomic contexts, and ethnic populations establishes OSA not only as a clinical concern but as a global health crisis that demands coordinated public health responses, improved diagnostic capacity, and innovative therapeutic approaches that can be scaled up to meet population needs.

In addition to diagnostic criteria, OSA manifests through a set of symptoms that profoundly impact nighttime and daytime homeostasis. Patients generally report excessive daytime sleepiness, non-restorative sleep, morning headaches, neurocognitive impairment affecting memory and concentration, mood disorders, and sexual dysfunction. Nighttime symptoms include witnessed apneas, resuscitation snoring, sleep fragmentation, nighttime suffocation, nocturia, and insomnia [6,7,8]. These clinical manifestations reflect the comprehensive consequences of the disorder, ranging from autonomic nervous system dysregulation to hormonal, metabolic, inflammatory, vascular, immunological, and cognitive alterations that collectively contribute to reduced life expectancy and cardiovascular morbidity [9,10].

Current understanding of the pathophysiology of OSA has evolved to a multifactorial phenotypic framework. Four primary phenotypes contribute to upper airway collapse: anatomical impairment of oropharyngeal structures, impaired neuromuscular compensation with inadequate activation of pharyngeal dilator muscles, increased arousal propensity (low arousal threshold), and unstable

ventilatory control [11,12]. This phenotypic heterogeneity has important therapeutic implications, suggesting that treatment approaches should be tailored to individual pathophysiological profiles.

Diagnosis is based on objective sleep monitoring, with the American Academy of Sleep Medicine recommending Type I polysomnography in a laboratory or Type III polysomnography at home for patients presenting with clinical features and physical examination findings suggestive of OSA [13]. Although continuous positive airway pressure (CPAP/BIPAP) therapy remains the gold standard treatment, the therapeutic arsenal has expanded to include mandibular advancement devices, myofunctional therapy, surgical interventions such as uvulopalatopharyngoplasty and hypoglossal nerve stimulation, structured aerobic exercise programs, and inspiratory muscle training (IMT) [14,15,16].

Recent systematic reviews with meta-analyses have investigated the effects of respiratory muscle training in individuals with obstructive sleep apnea. Chen et al. (2023) analyzed randomized controlled trials evaluating inspiratory muscle training and reported improvements in subjective sleep-related outcomes and cardiovascular parameters, without demonstrating a consistent reduction in the apnea–hypopnea index. Similarly, the systematic review and meta-analysis conducted by Silva de Sousa et al. (2023) synthesized the effects of respiratory muscle training in obstructive sleep apnea and identified modest clinical benefits, accompanied by substantial heterogeneity among the included studies. Notably, in both reviews, training protocols were evaluated globally, without a specific analysis of the impact of different inspiratory muscle training intensities on the assessed outcomes. Consequently, a gap remains in the literature regarding the role of inspiratory muscle training intensity, which underpins and justifies the present systematic review and meta-analysis[17,18] .

METHODS

Protocol and Registration

The systematic review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO; registration number: CRD420251013583) on March 20, 2025. This review was conducted in accordance with the Cochrane Handbook for Systematic Reviews of Interventions and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines

19,20.

Eligibility Criteria

Studies were eligible for inclusion if they met the following criteria: randomized controlled trials (RCTs) published within the past 10 years; participants aged ≥ 18 years diagnosed with OSA of any severity levels; IMT as the primary intervention, regardless of the prescription setting (home-based or institutional). No language restrictions were applied.

Exclusion criteria were any type of review articles, monographs, conference abstracts, book chapters, clinical guidelines and expert opinions; animal studies; studies with unclear clinical outcomes or duplicate patient cohort; participants with clinical conditions that could affect inspiratory muscle improvement, such as neurological, respiratory, cardiac, and/or metabolic diseases; and studies in which IMT was part of a multicomponent intervention precluding separate effect evaluation.

Search Strategy and Information Sources

Relevant studies were identified through systematic searches of the following databases and trial registries: Cochrane Central Register of Controlled Trials (CENTRAL) via Cochrane Library, EMBASE, Medical Literature Analysis and Retrieval System Online (MEDLINE) via PubMed, Caribbean Health Sciences (LILACS) through the Virtual Health Library Portal, Scientific Electronic Library Online - SciELO, and Physiotherapy Evidence Database (PEDro) for all randomized controlled trials.

The search strategy employed descriptors based on Medical Subject

Headings (MeSH) terms. The key terms for the primary search strategy (e.g., in PubMed) were structured using the PICO framework, focusing on population (obstructive sleep apnea OR obstructive sleep apnea syndrome OR OSA) and intervention (inspiratory muscle training OR inspiratory muscle trainer OR IMT). The outcome was not specified in the search string, as relevant outcomes were not consistently detailed in article title/abstracts, and preliminary searches indicated its inclusion would overly restrict the results.

Terms were combined using the Boolean operators "AND" and "OR" to optimize sensitivity.

Review Procedure

Initially, a single reviewer (LFFR) conducted the primary database search. The retrieved records were imported into Rayyan® software for deduplication and initial management. [21]

Following a calibration test, two reviewers (JMAA and CPD) independently and blindly screened the titles and abstracts of all records against the eligibility criteria. In the second stage, the full texts of potentially relevant studies were obtained. Both reviewers then independently assessed these full texts against the predefined inclusion and exclusion criteria using a standardized data extraction form to ensure consistent evaluation. Furthermore, the reference lists of all included articles were manually screened to identify any additional references.

All studies excluded after the full-text review were documented with their primary reason for exclusion (e.g., wrong study design, ineligible population). Any disagreements between reviewers at either the screening or full-text assessment stage were resolved through discussion and, if necessary, arbitration by a third reviewer (LMA).

The entire study selection process, including the number of records at each stage, is documented in the PRISMA flow diagram.

Data Extraction

Data extraction was performed independently by two reviewers (JMAA and

CPD). A standardized form was used to collect the following information from each included study: (1) general study information (author(s), year of publication, country), (2) participant characteristics (sample size, age, sex), (3) intervention details (type, intensity, frequency, duration, number of sessions, and level of supervision), (4) control condition (description), (5) primary outcomes (AHI, MIP, sleep quality, and daytime sleepiness), and (6) secondary outcomes (pulmonary function and functional capacity). Any discrepancies between the reviewers were resolved through discussion and, if necessary, arbitration by a third reviewer (LMA).

Methodological Quality Assessment

Following data extraction, two reviewers (JMAA and LFFR) independently assessed the risk of bias for each included RCT using the Cochrane Risk of Bias tool (RoB 2). The RoB 2 tool evaluates five domains: (1) bias arising from the randomization process, (2) bias due to deviations from intended interventions (performance bias), (3) bias due to missing outcome data, (4) bias in measurement of the outcomes (detection bias), and (5) bias in selection of the reported result (reporting bias). Each domain was classified as having a "Low risk of bias," "Some concerns," or "High risk of bias" according to the RoB 2 algorithm, and an overall risk-of-bias judgment was subsequently derived for each study[22]. Any disagreements between the reviewers were resolved through discussion to reach consensus, with arbitration by a third reviewer (CPD) when necessary. The risk-of-bias judgements for all included studies are summarized by domain.

Evidence Quality: GRADE Criteria

The overall quality of evidence of each outcome was assessed using the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) framework, as recommended by the Cochrane Handbook for Systematic Reviews of Interventions. Following the GRADE approach, the certainty of evidence for each specific outcome was evaluated across five domains: (1) risk of bias (study limitations),

(2) consistency of the results, (3) directness of the evidence, (4) precision of the effect estimates, and (5) publication bias[23].

Statistical analysis and data synthesis

For subgroup analyses, IMT protocols were categorized according to training intensity, defined as moderate (40–60% of MIP and high (≥60% of MIP). Intensity was selected as the primary categorization criterion because it represents the main physiological determinant of inspiratory muscle overload and adaptation. Other training variables, such as session duration, weekly frequency, and total intervention length, showed substantial heterogeneity across studies and were therefore not used as grouping criteria[16, 24–29,,51,52.]

RESULTS

This systematic database search identified 594 records in MEDLINE/PubMed (n=502), Web of Science (n=50), Embase/Elsevier (n=23), and LILACS/BVS (n=19). After removing 17 duplicates, 577 unique records remained for title and abstract screening. Exclusions included studies that did not focus on adults with OSA, those without accessible full text, and studies that were not randomized clinical trials. Of the 577 screened records, 568 were excluded at this stage based on the pre-established eligibility criteria. The remaining nine articles underwent full-text review. After a detailed assessment, three studies were excluded for failing to meet the inclusion criteria. Finally, one additional relevant article was identified through a manual search of the reference lists of the included studies, resulting in seven studies included in our qualitative and quantitative synthesis, as illustrated in Figure 1.

INSERT HERE: Figure 1 – PRISMA flowchart for study selection

The seven included studies comprised a total sample of 221 participants, with individual sample sizes ranging from 16 to 65 participants. Participants' age ranged from 40 to 70 years across studies. Men accounted for approximately 67% of the total sample, indicating a clear male predominance. Body mass index (BMI) values were predominantly within the overweight to obese range, with reported mean values varying between 26 and 33 kg/m², reflecting the typical clinical profile of individuals with obstructive sleep apnea (Table 1).

Regarding disease severity, the AHI showed wide variability, encompassing mild to severe OSA, with reported mean or median values ranging approximately from 20 to 50 events·h^{-1}. Baseline maximal inspiratory pressure (MIP) values ranged from approximately 55 to 110 cmH_2O, indicating substantial heterogeneity in inspiratory muscle strength across participants. Baseline Epworth Sleepiness Scale (ESS) scores generally ranged between 7 and 15 points, while Pittsburgh Sleep Quality Index (PSQI) scores were predominantly above 5 points, indicating poor sleep quality at baseline.

Regarding diagnostic approaches, five studies confirmed the diagnosis of obstructive sleep apnea using polysomnography[16, 24, 25, 26, 27]. Two studies employed validated screening instruments: Nóbrega-Júnior et al. used both the Berlin Questionnaire and STOP-BANG, while Souza et al. relied exclusively on the Berlin Questionnaire, alone or in combination with clinical criteria such as daytime symptoms and known risk factors for OSA [28, 29].

INSERT HERE: Table 1– Characteristics of the randomized controlled trials included in the meta-analysis.

The IMT protocols employed in the included studies showed considerable variation in load intensity, weekly frequency, and total intervention duration. Notably, none of the selected studies used low-intensity protocols (<40% of MIP) as the primary intervention. Four studies employed high-intensity protocols: Moawd et al. [24] used 70% of MIP with 15-minute sessions, once daily, three times per week, for 12 weeks; Labeix et al.[25] implemented 70% of MIP with 30-minute sessions, once daily, six times per week, for six weeks; Vranish and Bailey[26] prescribed 75% of MIP with 5-minute sessions, once daily, seven times per week, for six weeks; and Lin et al.[27] used intensities ranging from 60 to 70% of MIP with sessions lasting 30 to 45 minutes, performed twice daily, five days per week, for 12 weeks.

Three studies used moderate to progressive intensity protocols. Nóbrega-Júnior et al. [28] implemented a progressive approach, starting with 50% of MIP with 30-minute sessions twice a day, seven days a week, for eight weeks, increasing to 60% in weeks 3-4 and 75% in the last four weeks. Souza et al. [29] prescribed moderate to high intensity (50-60% of MIP) with 30-minute sessions twice

a day, seven days a week, for 12 weeks, adjusting the loads in quarterly visits to the laboratory. Azeredo et al. [16] adopted a progressive protocol ranging from 40-70% of MIP, with prescriptions of three sets of 10 repetitions, once a day, for 12 weeks, starting with 40% of MIP, increasing by 10 cmH_2O per week until the fifth week, maintaining the achieved load until week 12. All studies employed sham or minimal load protocols for the control groups, ranging from 0% to 20% of MIP, establishing appropriate comparisons with placebo.

Among the seven included studies, the most frequently assessed clinical outcomes were the AHI, MIP, and excessive daytime sleepiness assessed by the Epworth Sleepiness Scale (ESS). AHI was reported in all seven studies, while MIP and ESS were evaluated in six studies each, reflecting the emphasis on both objective respiratory parameters and patient-reported outcomes.

Regarding supervision, most IMT protocols were predominantly home-based, with limited or partial supervision. Souza et al. (2018), Azeredo et al. (2022), Vranish and Bailey (2016), and Nóbrega-Júnior et al. (2020) conducted fully home-based interventions. Lin et al. (2020) implemented a hybrid model, with one supervised session per week and the remaining sessions performed at home. In contrast, Moawd et al. (2020) delivered a fully supervised IMT protocol, while Labeix et al. (2022) combined supervised sessions within a cardiac rehabilitation program with additional home-based training.

INSERT HERE: Table 2– Characteristics of respiratory muscle training protocol

Our meta-analysis revealed that IMT did not demonstrate a significant overall effect on AHI (d = 0.40, 95% CI: −1.14 to 1.95, p = 0.53). Subgroup analyses did not demonstrate statistically significant effects within either training intensity category. High-intensity training showed no significant effect on AHI (d = 1.41, 95% CI: −2.38 to 5.21, p = 0.25), while moderate-intensity training also did not result in a significant change (d = −0.45, 95% CI: −1.18 to 0.28, p = 0.12). However, the test for subgroup differences indicated a statistically significant difference between intensities (Q = 4.39, p = 0.04). Substantial heterogeneity was identified across studies (I^2 = 92.8%), indicating marked variability in effect estimates.

INSERT HERE: Figure 2 – Forest plot of the meta-analysis of the effect of IMT on the Apnea-Hypopnea Index.

IMT produced a significant positive effect on maximal inspiratory pressure

(MIP) (d = 1.69, 95% CI: 0.18 to 3.21, p = 0.03). Subgroup analysis demonstrated significant differences between training intensities. Moderate-intensity training showed a statistically significant effect (d = 0.67, 95% CI: 0.48 to 0.86, p < 0.001), whereas high-intensity training did not reach statistical significance (d = 2.76, 95% CI: −0.85 to 6.37, p = 0.08). Substantial heterogeneity was observed (I^2 = 90.4%), and the test for subgroup differences was significant (Q = 5.58, p = 0.02).

INSERT HERE: Figure 3 – Forest plot of the meta-analysis of the effect of IMT on Maximum Inspiratory Pressure

IMT significantly improved sleep quality, as measured by the Pittsburgh Sleep Quality Index (PSQI) (d =−0.61, 95% CI: −1.03 to −0.19, p = 0.01), with negative values indicating improvement. Subgroup analysis showed a significant effect for moderate-intensity training (d = −0.44, 95% CI: −0.63 to −0.24, p = 0.01), whereas high-intensity training did not reach statistical significance (d = −1.27, 95% CI: −4.31 to 1.77, p = 0.12). Heterogeneity for this outcome was low (I^2 = 0.8%), and the test for subgroup differences was significant (Q = 4.25, p = 0.04).

INSERT HERE: Figure 4 – Forest plot of the meta-analysis of the effect of IMT on the Pittsburgh Sleep Quality Index

Similarly, we observed a significant reduction in excessive daytime sleepiness with IMT (d = -0.55, 95% CI:-0.86 to -0.24, p = 0.01). Moderate-intensity training demonstrated a statistically significant effect (d =-0.39, 95% CI: -0.61 to -0.17, p = 0.01), while high-intensity training did not reach statistical significance (d= −0.91, 95% CI: −2.52 to 0.70, p = 0.09). The difference between subgroups was not statistically significant (Q = 1.95, p = 0.16).

INSERT HERE: Figure 5 – Forest plot of the meta-analysis of the effect of IMT on the Epworth Sleepiness Scale.

Cardiorespiratory fitness (VO_2max)

Cardiorespiratory fitness, assessed by VO_2max, was reported in three of the seven included studies. Due to the small number of studies and the heterogeneity in training protocols and intensity classification, a meta-analysis was not performed. Two studies using moderate-intensity IMT did not demonstrate significant changes in VO_2max, while one study employing a high-intensity protocol reported a significant improvement. Given the limited and heterogeneous evidence, no definitive conclusions can be drawn regarding the effects of IMT on VO_2max in individuals with OSA.

Risk of bias assessment using the Cochrane RoB 2 tool indicated that most included studies presented low risk or some concerns across domains. The randomization process was judged as low risk in three studies (Souza et al., 2018; Azeredo et al., 2022; Nóbrega-Júnior et al., 2020), while four studies presented some concerns due to limited reporting of allocation concealment or blinding procedures (Vranish & Bailey, 2016; Labeix et al., 2022; Lin et al., 2020; Moawd et al., 2020).

Risk of bias due to deviations from intended interventions was generally low, as most studies employed sham or minimal load control protocols. Missing outcome data were judged as low risk in all studies due to minimal attrition and adequate follow-up reporting. Outcome measurement bias was considered low in studies that used objective measures such as polysomnography with blinded assessors, although some concerns were noted in studies including subjective questionnaires (PSQI and ESS). Regarding selection of reported results, most studies were judged as low risk, particularly when trial registration or pre-specified outcomes were reported.

Overall, one study (Azeredo et al., 2022) was classified as low risk of bias across domains, while the remaining studies were judged as presenting some concerns, primarily related to small sample sizes, partial blinding, or indirect populations. The detailed domain-level judgments are presented in Table 3.

INSERT HERE: Table 3. Risk of Bias (RoB 2) per Study

The GRADE assessment of certainty of evidence revealed that the outcomes

presented different levels of reliability. MIP and sleep quality (PSQI) were classified as having moderate certainty of evidence, downgraded mainly due to imprecision related to relatively small sample sizes and, for MIP, the inclusion of populations with relevant comorbidities (coronary artery disease and diabetic peripheral neuropathy)

. AHI and excessive daytime sleepiness (ESS) were classified as having low certainty of evidence, downgraded due to substantial inconsistency between studies (heterogeneous protocols and variable sample sizes) and imprecision, with wide confidence intervals in studies with a small number of participants. No signs of publication bias were detected for any of the outcomes assessed, although the limited number of studies (n=7) reduces the power to detect such bias conclusively.

DISCUSSION

This systematic review and meta-analysis demonstrates that IMT, when used as an adjunctive intervention for obstructive sleep apnea (OSA), provides clear benefits for inspiratory muscle strength and for improving patient-reported outcomes, including daytime sleepiness and sleep quality, as assessed by the Epworth Sleepiness Scale (ESS) and Pittsburgh Sleep Quality Index (PSQI). However, its effects on objective sleep parameters remain uncertain. These findings contribute to a more comprehensive understanding of the role of IMT in OSA management and underscore the importance of considering training characteristics when interpreting clinical outcomes.

The significant increase in maximal inspiratory pressure (MIP) confirms that IMT effectively strengthens inspiratory muscles in individuals with OSA.[16,24–26] Although subgroup analyses revealed variability in effect magnitude across different training intensities, these results should be interpreted with caution due to the limited number of studies and the substantial heterogeneity observed ($I^2 = 90.4\%$). Protocols were categorized according to training intensity, given the central role of load magnitude in determining inspiratory muscle adaptations, although variations in training volume, session duration, and overall intervention length likely contributed to the heterogeneity observed across studies.[53,54,59,60]

Importantly, increases in inspiratory muscle strength do not necessarily translate into proportional improvements in upper airway stability during sleep. The pathophysiology of OSA involves multiple mechanisms beyond inspiratory muscle

performance, including neural control of pharyngeal dilator muscles, upper airway collapsibility, arousal threshold, and ventilatory control instability. These mechanisms are relatively independent of peripheral inspiratory muscle strength and may help explain the absence of a consistent effect of IMT on objective sleep parameters such as the apnea–hypopnea index (AHI).

A consistent finding of this review was the improvement in patient-reported outcomes. Both sleep quality and excessive daytime sleepiness improved significantly following IMT, with remarkably low heterogeneity for ESS and PSQI outcomes.[38,39] These results suggest that IMT may improve subjective sleep-related symptoms through mechanisms not fully captured by conventional polysomnographic indices, such as reduced respiratory effort, improved breathing comfort, or enhanced daytime functional capacity.[43,44]

Improvements in sleep quality and daytime alertness have important clinical implications. Excessive daytime sleepiness is one of the most disabling symptoms of OSA, negatively affecting quality of life, cognitive performance, work productivity, and driving safety.[45–47] Similarly, poor sleep quality is associated with adverse physical and mental health outcomes.[47,48] The consistency of these patient-centered benefits across studies suggests that IMT may offer meaningful symptomatic relief, particularly for individuals who are intolerant to or refuse continuous positive airway pressure (CPAP) therapy.[49,50]

The effects of IMT on aerobic capacity remain inconclusive. Only a limited number of studies assessed VO_2max, and no consistent improvements were observed following moderate-intensity IMT. Given the localized nature and relatively short duration of IMT sessions, this finding is physiologically plausible, as IMT alone may not provide sufficient cardiovascular stimulus to induce systemic aerobic adaptations.[51–54]

Several methodological limitations should be considered when interpreting these findings. The relatively small total sample size and the limited number of studies within each subgroup restricted statistical power, particularly for subgroup analyses.[62,63] In addition, the high heterogeneity observed for most outcomes likely reflects variability in participant characteristics, disease severity, intervention protocols, and outcome assessment methods.[59,60] The evaluation of cardiorespiratory fitness was also limited, as VO_2max was reported in only three studies and could not be synthesized quantitatively due to insufficient data and imbalance across training

intensity categories.

Therefore, conclusions regarding the effects of IMT on aerobic capacity should be interpreted with caution. Future studies using standardized protocols and larger, well-characterized samples are needed to better define optimal training parameters and to clarify which patient phenotypes may derive the greatest benefit from inspiratory muscle training.

From a clinical perspective, IMT appears to be a valuable adjunctive intervention for OSA, primarily improving inspiratory muscle strength and patient-reported outcomes rather than objective respiratory event indices. While IMT should not replace established therapies such as CPAP, it may represent a useful complementary strategy for selected patients, particularly those with persistent symptoms or limited treatment tolerance.[49,50,70,71]

CONCLUSION

This systematic review and meta-analysis demonstrated that inspiratory muscle training is associated with improvements in inspiratory muscle strength, sleep quality, and daytime sleepiness in adults with obstructive sleep apnea, based on moderate-quality evidence. These beneficial effects were observed across studies employing different training intensities.

No significant effect was observed on the apnea–hypopnea index, and substantial heterogeneity was identified among the included studies. The effects of IMT on aerobic capacity could not be conclusively determined due to the limited number of available studies, highlighting an important gap for future research. Due to variability in training protocols and study designs, it was not possible to determine an optimal training intensity. Further well-designed randomized controlled trials are needed to clarify the most effective inspiratory muscle training protocols for this population.

The authors declare that there are no financial or personal conflicts of interest that could have influenced the conduct of this study.

REFERENCES

1. YAO, Q. et al. Treatment of obstructive sleep apnea with mandibular advancement devices. **Journal of Clinical Sleep Medicine**, Darien, v. 10, n. 6, p. 693-701, 2014.

2. ISAAC, S.; RODRIGO, P. Obstructive sleep apnea: how to diagnose. **Revista Brasileira de Hipertensão**, São Paulo, p. 18-22, 2013.

3. DE BACKER, W. Obstructive sleep apnea/hypopnea syndrome. **Panminerva Medica**, Turin, v. 55, p. 191-195, 2013.

4. BENJAFIELD, A. V. et al. Estimation of the global prevalence and burden of obstructive sleep apnea: a literature-based analysis. **The Lancet Respiratory Medicine**, London, v. 7, p. 687-698, 2019.

5. ALHARBI, R. et al. Global prevalence, burden, and challenges of obstructive sleep apnea: implications for public health. **Healthcare**, Basel, v. 13, n. 17, p. 2115, 2024.

6. TUFIK, S. et al. Obstructive sleep apnea syndrome in the Sao Paulo Epidemiologic Sleep Study. **Sleep Medicine**, Amsterdam, v. 11, p. 441-446, 2010.

7. JORDAN, A. S. et al. Adult obstructive sleep apnoea. **The Lancet**, London, v. 383, p. 736-747, 2014.

8. PACK, A. I. et al. Characteristics of crashes attributed to the driver having fallen asleep. **Accident Analysis & Prevention**, Oxford, v. 38, p. 769-775, 2006.

9. GOTTLIEB, D. J. et al. Diagnosis and management of obstructive sleep apnea: a review. **JAMA**, Chicago, v. 323, n. 14, p. 1389-1400, 2020.

10. YOUNG, T. et al. Sleep disordered breathing and mortality: eighteen-year follow-up of the Wisconsin sleep cohort. **Sleep**, Darien, v. 31, p. 1071-1078, 2008.

11. NIETO, F. J. et al. Association of sleep-disordered breathing, sleep apnea, and hypertension in a large community-based study. **JAMA**, Chicago, v. 283, p. 1829-1836, 2000.

12. DEMPSEY, J. A. et al. Pathophysiology of sleep apnea. **Physiological Reviews**, Bethesda, v. 90, p. 47-112, 2010.

13. AMAL, M. O. et al. Obstructive sleep apnea: current perspectives. **Nature and Science of Sleep**, Auckland, v. 10, p. 21-34, 2018.

14. KAPUR, V. K. et al. Clinical practice guideline for diagnostic testing for adult obstructive sleep apnea: an American Academy of Sleep Medicine clinical practice guideline. **Journal of Clinical Sleep Medicine**, Darien, v. 13, n. 3, p. 479-504, 2017.

15. EPSTEIN, L. J. et al. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. **Journal of Clinical Sleep Medicine**, Darien, v. 5, p. 263-276, 2009.

16. AZEREDO, L. M. et al. Inspiratory muscle training as adjuvant therapy in obstructive sleep apnea: a randomized controlled trial. **Brazilian Journal of Medical and Biological Research**, Ribeirão Preto, v. 55, p. e12331, 2022.

17. CHEN, T. A. et al. Effects of inspiratory muscle training on blood pressure- and sleep-related outcomes in patients with obstructive sleep apnea: a meta-analysis of randomized controlled trials. **Sleep and Breathing**, Heidelberg, v. 27, n. 5, p. 1953-1966, 2023.

18. SILVA DE SOUSA, A. et al. Respiratory muscle training for obstructive sleep apnea: systematic review and meta-analysis. **Journal of Sleep Research**, Oxford, v. 33, p. e13941, 2024.

19. HIGGINS, J. P. T. et al. (ed.). **Cochrane Handbook for Systematic Reviews of Interventions**. 2. ed. Chichester: John Wiley & Sons, 2019.

20. SHAMSEER, L. et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. **BMJ**, London, v. 349, p. g7647, 2015.

21. OUZZANI, M. et al. Rayyan—a web and mobile app for systematic reviews. **Systematic Reviews**, London, v. 5, p. 210, 2016.

22. STERNE, J. A. C. et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. **BMJ**, London, v. 366, p. l4898, 2019.

23. GUYATT, G. H. et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. **BMJ**, London, v. 336, n. 7650, p. 924-926, 2008.

24. MOAWD, S. A. et al. Inspiratory muscle training in obstructive sleep apnea: a randomized controlled trial. **Annals of Thoracic Medicine**, Mumbai, v. 15, n. 3, p. 123-129, 2020.

25. LABEIX, P. et al. Effects of short-term inspiratory muscle training on inspiratory function and maximal exercise capacity in patients with obstructive sleep apnoea. **Respiratory Physiology & Neurobiology**, Amsterdam, v. 300, p. 103869, 2022.

26. VRANISH, J. R.; BAILEY, E. F. Inspiratory muscle training improves sleep and mitigates cardiovascular dysfunction in obstructive sleep apnea. **Sleep**, Darien, v. 39, n. 6, p. 1179-1185, 2016.

27. LIN, Y. Y. et al. Effect of inspiratory muscle training in patients with obstructive sleep apnea: a systematic review and meta-analysis. **Respiratory Care**, Irving, v. 65, n. 10, p. 1537-1550, 2020.

28. NÓBREGA-JÚNIOR, J. M. et al. Inspiratory muscle training improves maximal inspiratory pressure and quality of life in patients with obstructive sleep apnea. **Sleep and Breathing**, Heidelberg, v. 24, n. 3, p. 997-1004, 2020.

29. SOUZA, H. et al. Effects of inspiratory muscle training in elderly women with obstructive sleep apnea. **Respiratory Medicine**, Oxford, v. 135, p. 11-17, 2018.

30. MCCONNELL, A. K.; ROMER, L. M. Respiratory muscle training in healthy humans: resolving the controversy. **International Journal of Sports Medicine**, Stuttgart, v. 25, n. 4, p. 284-293, 2004.

31. ENRIGHT, S. J. et al. Effect of high-intensity inspiratory muscle training on lung volumes, diaphragm thickness, and exercise capacity in subjects who are healthy. **Physical Therapy**, Alexandria, v. 86, n. 3, p. 345-354, 2006.

32. ECKERT, D. J. et al. Defining phenotypic causes of obstructive sleep apnea: identification of novel therapeutic targets. **American Journal of Respiratory and Critical Care Medicine**, New York, v. 188, n. 8, p. 996-1004, 2013.

33. CARBERRY, J. C. et al. Upper airway collapsibility (Pcrit) and pharyngeal dilator muscle activity are sleep stage dependent. **Sleep**, Darien, v. 39, n. 3, p. 511-521, 2016.

34. PATIL, S. L. et al. Adult obstructive sleep apnea: pathophysiology and diagnosis. **Chest**, Glenview, v. 132, n. 1, p. 325-337, 2007.

36. SCHWARTZ, A. R. et al. Obesity and obstructive sleep apnea: pathogenic mechanisms and therapeutic approaches. **Proceedings of the American Thoracic Society**, New York, v. 5, n. 2, p. 185-192, 2008.

37. BAILEY, E. F.; FREGOSI, R. F. Coordination of intrinsic and extrinsic tongue muscles during spontaneous breathing in the rat. **Journal of Applied Physiology**, Bethesda, v. 96, n. 2, p. 440-449, 2004.

38. HUANG, L. et al. Biomechanics of snoring. **Endeavor**, Oxford, v. 19, n. 3, p. 96-100, 1995.

39. BUYSSE, D. J. et al. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. **Psychiatry Research**, Shannon, v. 28, n. 2, p. 193-213, 1989.

40. JOHNS, M. W. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. **Sleep**, Darien, v. 14, n. 6, p. 540-545, 1991.

41. GUILLEMINAULT, C. et al. A cause of excessive daytime sleepiness: the upper airway resistance syndrome. **Chest**, Glenview, v. 104, n. 3, p. 781-787, 1993.

42. MARTIN, S. E. et al. The effect of sleep fragmentation on daytime function. **American Journal of Respiratory and Critical Care Medicine**, New York, v. 153, n. 4 Pt 1, p. 1328-1332, 1996.

43. ECKERT, D. J.; YOUNES, M. K. Arousal from sleep: implications for obstructive sleep apnea pathogenesis and treatment. **Journal of Applied Physiology**, Bethesda, v. 116, n. 3, p. 302-313, 2014.

44. ONEN, S. H. et al. The effects of total sleep deprivation, selective sleep interruption and sleep recovery on pain tolerance thresholds in healthy subjects. **Journal of Sleep Research**, Oxford, v. 10, n. 1, p. 35-42, 2001.

45. NARKIEWICZ, K.; SOMERS, V. K. Sympathetic nerve activity in obstructive sleep apnea. **Acta Physiologica Scandinavica**, Oxford, v. 177, n. 3, p. 385-390, 2003.

46. GARBARINO, S. et al. Risk of occupational accidents in workers with obstructive sleep apnea: systematic review and meta-analysis. **Sleep**, Darien, v. 39, n. 6, p. 1211-1218, 2016.

47. TREGEAR, S. et al. Obstructive sleep apnea and risk of motor vehicle crash: systematic review and meta-analysis. **Journal of Clinical Sleep Medicine**, Darien, v. 5, n. 6, p. 573-581, 2009.

48. BALDWIN, C. M. et al. The association of sleep-disordered breathing and sleep symptoms with quality of life in the Sleep Heart Health Study. **Sleep**, Darien, v. 24, n. 1, p. 96-105, 2001.

49. FINN, L. et al. Sleep-disordered breathing and self-reported general health status in the Wisconsin Sleep Cohort Study. **Sleep**, Darien, v. 21, n. 7, p. 701-706, 1998.

50. WEAVER, T. E. ; GRUNSTEIN, R. R. Adherence to continuous positive airway pressure therapy: the challenge to effective treatment. **Proceedings of the American Thoracic Society**, New York, v. 5, n. 2, p. 173-178, 2008.

51. ROTENBERG, B. W. ; MURARIU, D. ; PANG, K. P. Trends in CPAP adherence over twenty years of data collection: a flattened curve. **Journal of Otolaryngology - Head & Neck Surgery**, London, v. 45, n. 1, p. 43, 2016.

52. MCCONNELL, A. K. **Respiratory muscle training: theory and practice**. Edinburgh: Churchill Livingstone/Elsevier, 2013.

53. SHEEL, A. W. Respiratory muscle training in healthy individuals: physiological rationale and implications for exercise performance. **Sports Medicine**, Auckland, v. 32, n. 9, p. 567-581, 2002.

54. KLINE, C. E. et al. The effect of exercise training on obstructive sleep apnea and sleep quality: a randomized controlled trial. **Sleep**, Darien, v. 34, n. 12, p. 1631-1640, 2011.

55. MENDELSON, M. et al. Obstructive sleep apnea syndrome, objectively measured physical activity and exercise training interventions: a systematic review and meta-analysis. **Frontiers in Neurology**, Lausanne, v. 9, p. 73, 2018.

56. GOSSELINK, R. et al. Impact of inspiratory muscle training in patients with COPD: what is the evidence? **European Respiratory Journal**, Sheffield, v. 37, n. 2, p. 416-425, 2011.

57. BEAUMONT, M. et al. Effects of inspiratory muscle training in COPD patients: a systematic review and meta-analysis. **The Clinical Respiratory Journal**, Oxford, v. 12, n. 7, p. 2178-2188, 2018.

58. LANGER, D. et al. A clinical practice guideline for physiotherapists treating patients with chronic obstructive pulmonary disease based on a systematic review of available evidence. **Clinical Rehabilitation**, London, v. 23, n. 5, p. 445-462, 2009.

59. CHARUSUSIN, N. et al. Inspiratory muscle training protocol for patients with chronic obstructive pulmonary disease (IMTCO Study): a multicenter randomized controlled trial. **BMJ Open**, London, v. 3, n. 8, p. e003101, 2013.

60. THOMPSON, S. G.; HIGGINS, J. P. T. How should meta-regression analyzes be adopted and interpreted? **Statistics in Medicine**, Chichester, v. 21, n. 11, p. 1559-1573, 2002.

61. BAKER, W. L. et al. Understanding heterogeneity in meta-analysis: the role of meta-regression. **International Journal of Clinical Practice**, Oxford, v. 63, n. 10, p. 1426-1434, 2009.

62. BOUTRON, I.; ESTELLAT, C.; RAVAUD, P. A review of blinding in randomized controlled trials found results inconsistent and questionable. **Journal of Clinical Epidemiology**, Oxford, v. 58, n. 12, p. 1220-1226, 2005.

63. MANCINI, G. B.; SCHULZER, M. Reporting risks and benefits of therapy by use of the concepts of unqualified success and unmitigated failure: applications to highly cited trials in cardiovascular medicine. **Circulation**, Hagerstown, v. 99, n. 3, p. 377-383, 1999.

64. SCHULZ, K. F.; GRIMES, D. A. Sample size calculations in randomized trials: mandatory and mystical. **The Lancet**, London, v. 365, n. 9467, p. 1348-1353, 2005. [1]

65. CAMPBELL, M. K. et al. Consort 2010 statement: extension to cluster randomized trials. **BMJ**, London, v. 345, p. e5661, 2012.

66. PATSOPOULOS, N. A. A pragmatic view on pragmatic trials. **Dialogues in Clinical Neuroscience**, Neuilly-sur-Seine, v. 13, n. 2, p. 217-224, 2011.

67. TUNIS, S. R.; STRYER, B. D.; CLANCY, C. M. Practical clinical trials: increasing the value of clinical research for decision making in clinical and health policy. **JAMA**, Chicago, v. 290, n. 12, p. 1624-1632, 2003.

68. MOHER, D. et al. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomized trials. **BMJ**, London, v. 340, p. c869, 2010.

69. ZINCHUK, A. V. et al. Phenotypes in obstructive sleep apnea: a definition, examples and evolution of approaches. **Sleep Medicine Reviews**, Amsterdam, v. 35, p. 113-123, 2017.

70. RANDERATH, W. et al. Definition, discrimination, diagnosis and treatment of central breathing disturbances during sleep. **European Respiratory Journal**, Sheffield, v. 49, n. 1, p. 1600959, 2017.

71. WEAVER, T. E. et al. Relationship between hours of CPAP use and achieving normal levels of sleepiness and daily functioning. **Sleep**, Darien, v. 30, n. 6, p. 711-719, 2007.

72. SAWYER, A. M. et al. A systematic review of CPAP adherence across age groups: clinical and empirical insights for developing CPAP adherence interventions. **Sleep Medicine Reviews**, Amsterdam, v. 15, n. 6, p. 343-356, 2011.

73. EPSTEIN, L. J. et al. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. **Journal of Clinical Sleep Medicine**, Darien, v. 5, n. 3, p. 263-276, 2009.

74. QASEEM, A. et al. Management of obstructive sleep apnea in adults: a clinical practice guideline from the American College of Physicians. **Annals of Internal Medicine**, Philadelphia, v. 159, n. 7, p. 471-483, 2013.

75. RANDERATH, W. J. et al. Non-CPAP therapies in obstructive sleep apnoea. **European Respiratory Journal**, Sheffield, v. 37, n. 5, p. 1000-1028, 2011.

76. CAPLES, S. M. et al. Surgical modifications of the upper airway for obstructive sleep apnea in adults: a systematic review and meta-analysis. **Sleep**, Darien, v. 33, n. 10, p. 1396-1407, 2010.

77. KUSHIDA, C. A. et al. Practice parameters for the use of continuous and bilevel positive airway pressure devices to treat adult patients with obstructive sleep apnea. **Sleep**, Darien, v. 29, n. 3, p. 375-380, 2006.

78. AURORA, R. N. et al. Practice parameters for the surgical modifications of the upper airway for obstructive sleep apnea in adults. **Sleep**, Darien, v. 33, n. 10, p. 1408-1413, 2010. [1]

79. HILL, K. et al. High-intensity inspiratory muscle training in COPD. **European Respiratory Journal**, Sheffield, v. 27, n. 6, p. 1119-1128, 2006.

80. SHOEMAKER, M. J.; DONKER, S.; LAPOE, A. Inspiratory muscle training in patients with chronic obstructive pulmonary disease: the state of the evidence. **Cardiopulmonary Physical Therapy Journal**, Alexandria, v. 20, n. 3, p. 5-15, 2009.

Table 1. Characteristics of the randomized controlled trials included in the meta-analysis

Studies (year)	Loc.	N	G (M/F)	Age (years)	BMI	AHI (events·h^{-1})	MIP (cmH_2O)	ESS	PSQI
Souza et al., 2018	Brazil	IMT:8 SHAM:8	4/4 6/2	54.8±6.9 49.9±11.6	NR NR	27.6±11.9 34.0±18.4	85.0±23.5 87.1±23.7	11.1±4.5 11.1±6.8	7.0±4.7 8.8±4.2
Azeredo et al., 2022	Brazil	IMT:22 SHAM:21	17/13 21/14	67±13 55±15	29.5±5.2 31.2±5.2	29(21-34) 53(31–63)	93(66-120) 109(82–132)	4(4-10) 11(9-15)	6(4-9) 7(5-10)
Vranish & Bailey, 2016	USA	IMT:12 SHAM:12	8/4 8/4	61.5±3.9 69.1±3.4	27.0±1.0 28.5±1.6	21.9±4.4 29.9±8.9	80.7±7.1 75.33±12.3	NR NR	9.1±0.9 NR
Nóbrega-Júnior et al., 2020	Brazil	IMT:8 SHAM:8	3/5 1/7	58.6±5.6 60.1±2.7	33.4(30.3-34.5) 32.7(23.8-34.9)	31.7±15.9 31.4±20.8	83.6±26.5 74.6±25.4	12.5±4.0 14.9±5.2	7.2±3.6 7.5±3.2
Lin et al., 2020	Taiwan	IMT:16 SHAM:6	13/3 5/1	47.9±12.2 56.2±11.5	26.2±3.3 27.3±3.6	29.0±2.8 6%(21.8)	NR NR	10.5±5.7 13.0±2.5	8.2±4.9 8.6±2.1
Moawd et al., 2020	Egypt	IMT:28 SHAM:27	20/8 22/5	55.5±9.8 59.5±4.8	29.2±3.9 27.9±4.8	32.0±11.7 31.0±10.8	56±13 52±10	NR NR	NR NR
Labeix et al., 2022	France	IMT:22 SHAM:23	18(4) 4(1)	61.0±8.4 59.3±10.3	27.9±4.1 28.19±5.7	24.9±7.8 22.0±7.1	97.6±29.7 89.6±17.7	7.3±5.2 6.4±3.6	6.1±3.7 6.0±3.7

Abbreviations: BMI, body mass index; AHI, apnea–hypopnea index; MIP, maximal inspiratory pressure; ESS, Epworth Sleepiness Scale; PSQI, Pittsburgh Sleep Quality Index; M, male; F, female; NR, not reported. Data are presented as mean ± standard deviation or median (interquartile range), as reported in the original studies.

Table 2. Characteristics of respiratory muscle training protocols.

Estudos (ano)	Intervenção	Carga	Progressão da intensidade	Comparação (Carga placebo)	Frequência	Duração
Souza et al., 2018	IMT	50–60 % MIP	NR	<20% MIP	90 inspirações/dia (7 dias/sem)	12 semanas
Azeredo et al., 2022	IMT	40–70 % MIP	40% MIP (2 sem) +10 cmH_2O (1 sem) +10 cmH_2O (1 sem) +10 cmH_2O (1 sem)	10% MIP	30 inspirações/dia	12 semanas
Vranish & Bailey, 2016	IMT	75% MIP	NR	15% MIP	30 inspirações/dia	6 semanas
Nóbrega-Júnior et al., 2020	IMT	50%–75% MIP	50% MIP (2 sem) 60% MIP (2 sem) 75% MIP (4 sem)	0% MIP	180 inspirações/dia (7 dias/sem)	8 semanas
Lin et al., 2020	IMT	30% MIP	11 e 21 cmH_2O (1 sem) +5% na MIP a cada semana	NR	30–45 min/dia (5 dias/sem)	12 semanas
Moawd et al., 2020	IMT	75% MIP	Fixa	<10% MIP	120 inspirações/dia (3 dias/sem)	12 semanas
Labeix et al., 2022	IMT + Reabilitação cardíaca	70% MIP	NR	10% MIP	60 inspirações/dia	6 semanas

Abbreviations: IMT, inspiratory muscle training; MIP, maximal inspiratory pressure; cmH_2O, centimeters of water; NR, not reported; w, weeks; day, days; min, minutes. Placebo load refers to sham inspiratory load.

Table 3.Risk of Bias (RoB 2) per Study

Study (Year)	Randomization process	Deviations from intended interventions	Missing outcome data	Measurement of outcome	Selection of reported result	Overall bias judgment
Azeredo et al., 2022	Low – computerized randomization; blinding of PSG technician, participants, and analyst.	Low – 40–70% MIP vs 10 cmH_2O.	Low	Low – PSG readers blinded.	Low – analysis pre-registered.	Low
Labeix et al. 2022	Some concerns – random 1:1 allocation; blinding of assessors only.	Some concerns – concurrent cardiac rehab may confound.	Low	Low – central blind reading of polygraph.	Low/Some – protocol registered.	Some concerns (indirect population).
Lin et al. 2020	Some concerns – randomization reported; blinding unclear.	Low – progressive threshold training.	Low	Low/Some – PSG + questionnaires.	Low	Some concerns (small sample).
Moawd et al. 2020	Some concerns – RCT; blinding not fully described.	Low – 12-week IMT, 3×/week.	Low	Low/Some – non-OSA primary outcomes.	Low	Some concerns (indirect sample).
Nóbrega-Júnior et al. 2020	Low – computer randomization; opaque envelopes; double-blind.	Low – supervised home protocol; placebo no load.	Low – minimal loss.	Low/Some – PSG + PSQI subjective.	Low – registered trial.	Some concerns (small sample).
Souza et al. 2018	Low – randomized, double-blind, sealed envelopes.	Low – 50–60% vs <20% MIP	Low	Low/Some – subjective scales.	Low – pre-specified outcomes.	Some concerns (small sample).
Vranish & Bailey. 2016	Some concerns – single-blind.	Low – device logs training adherence.	Low (~92% retention).	Low – PSG objective.	Low	Some concerns (partial blinding).

Abbreviations: CAD = coronary artery disease; D1–D5 = domains 1 through 5 of the Cochrane Risk of Bias 2 (RoB 2) tool; DPN = diabetic peripheral neuropathy; IMT = inspiratory muscle training; MIP = maximal inspiratory pressure; OSA = obstructive sleep apnea; PSG = polysomnography; PSQI = Pittsburgh Sleep Quality Index; RCT = randomized controlled trial; RoB 2 = Cochrane Risk of Bias 2 tool.

Notes: Risk of bias was assessed using the Cochrane RoB 2 tool for randomized trials (Sterne et al., 2019). Each domain was judged as low risk of bias), some concerns, or high risk of bias). The overall judgment reflects the worst domain-level judgment, as per RoB 2 guidance.

Table 4. GRADE Summary: Certainty of evidence for Inspiratory Muscle Training in Obstructive Sleep Apnea

Desfecho	Nº de Participantes (Estudos)	Direção e Magnitude do Efeito	Risco de Viés	Inconsistência	Indireção	Imprecisão	Viés de Publicação	Certeza (GRADE)	Comentários
AHI	243 (7 ECRs)	IMT reduziu o AHI em 6–30%; significativo na maioria dos ensaios (2;4;7)	Algumas preocupações	Séria (protocolos heterogêneos, tamanhos amostrais)	Não séria	Séria (Ics amplos, n pequeno)	Não detectado	⬤⬤◯◯ Baixa	Efeito mais pronunciado em MIP \(\ge \) 70%.
Sonolência	219 (6 ECRs)	Melhora de 2–4 pontos no IMT de média intensidade; alta intensidade em alguns ensaios não é significativa.	Algumas preocupações	Séria	Não séria	Séria	Não detectado	⬤⬤◯◯ Baixa	Clinicamente modesta, sonolência basal heterogênea.
PSQI	188 (6 ECRs)	Melhora no PSQI (−3 a −5 pontos).	Algumas preocupações	Algumas preocupações	Não séria	Séria	Não detectado	⬤⬤⬤◯ Moderada	Certeza moderada entre os ensaios.
MIP (\(cmH_{2}O\))	221 (6 ECRs)	IMT aumentou a MIP em ~ 30–40 \(cmH_{2}O\); grandes ganhos intragrupo (2;4).	Algumas preocupações	Não séria	Algumas preocupações (populações DPN/CAD)	Séria	Não detectado	⬤⬤⬤◯ Moderada	Fisiologicamente consistente, direção homogênea.

GRADE judgments**:** Starting level = High (RCTs). Downgraded for bias (small unblinded trials), inconsistency (different loads/durations), and imprecision (small n, wide CIs). **Sensitivity:**

Excluding CAD (Labeix et., 2022) and DPN (Moawd et al., 2020) reduces indirectness.

Figure 1: PRISMA Flowchart

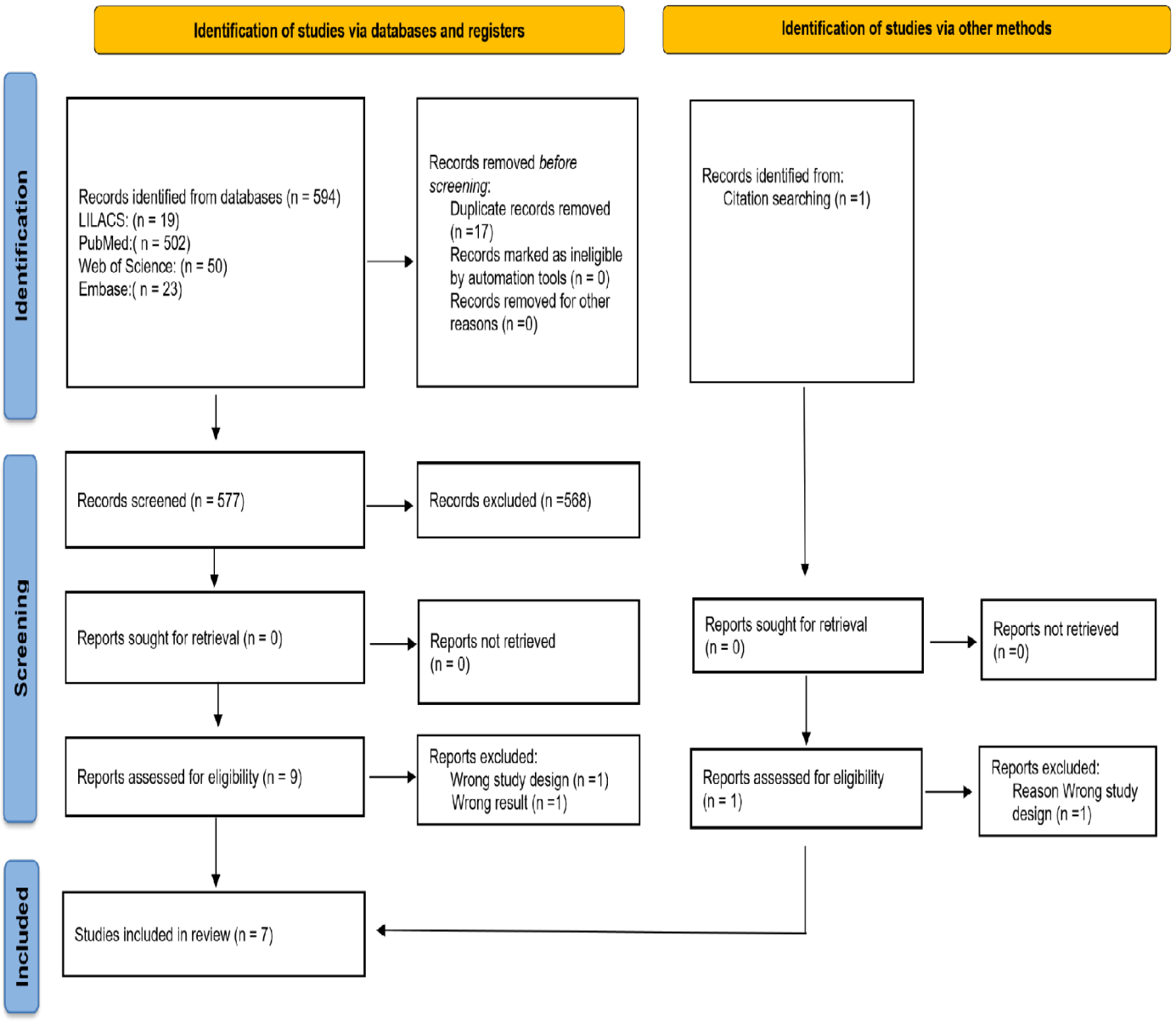


Figure 2 – Forest plot of the meta-analysis of the effect of IMT on the Apnea-Hypopnea Index

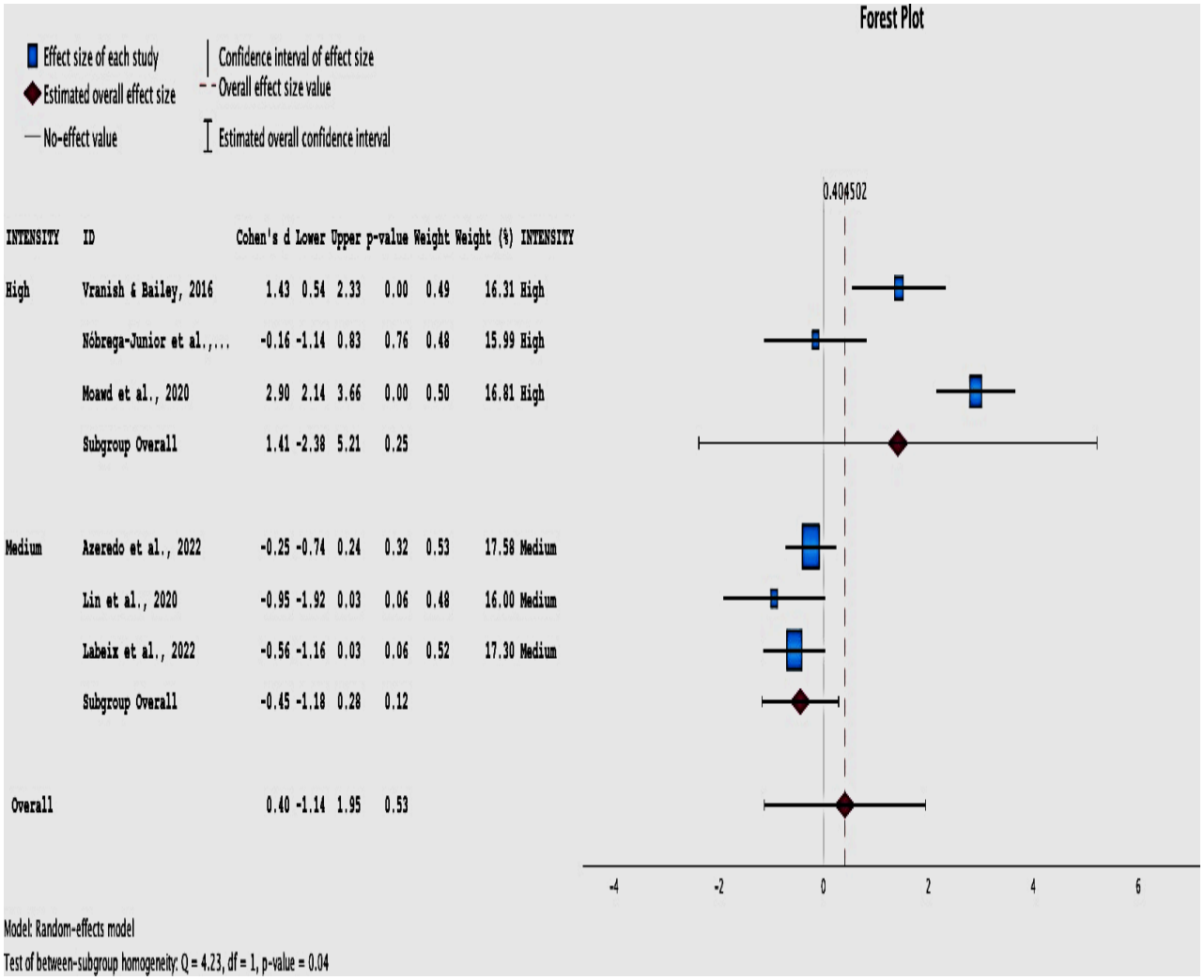


Figure 3 – Forest plot of the meta-analysis of the effect of IMT on Maximum Inspiratory Pressure

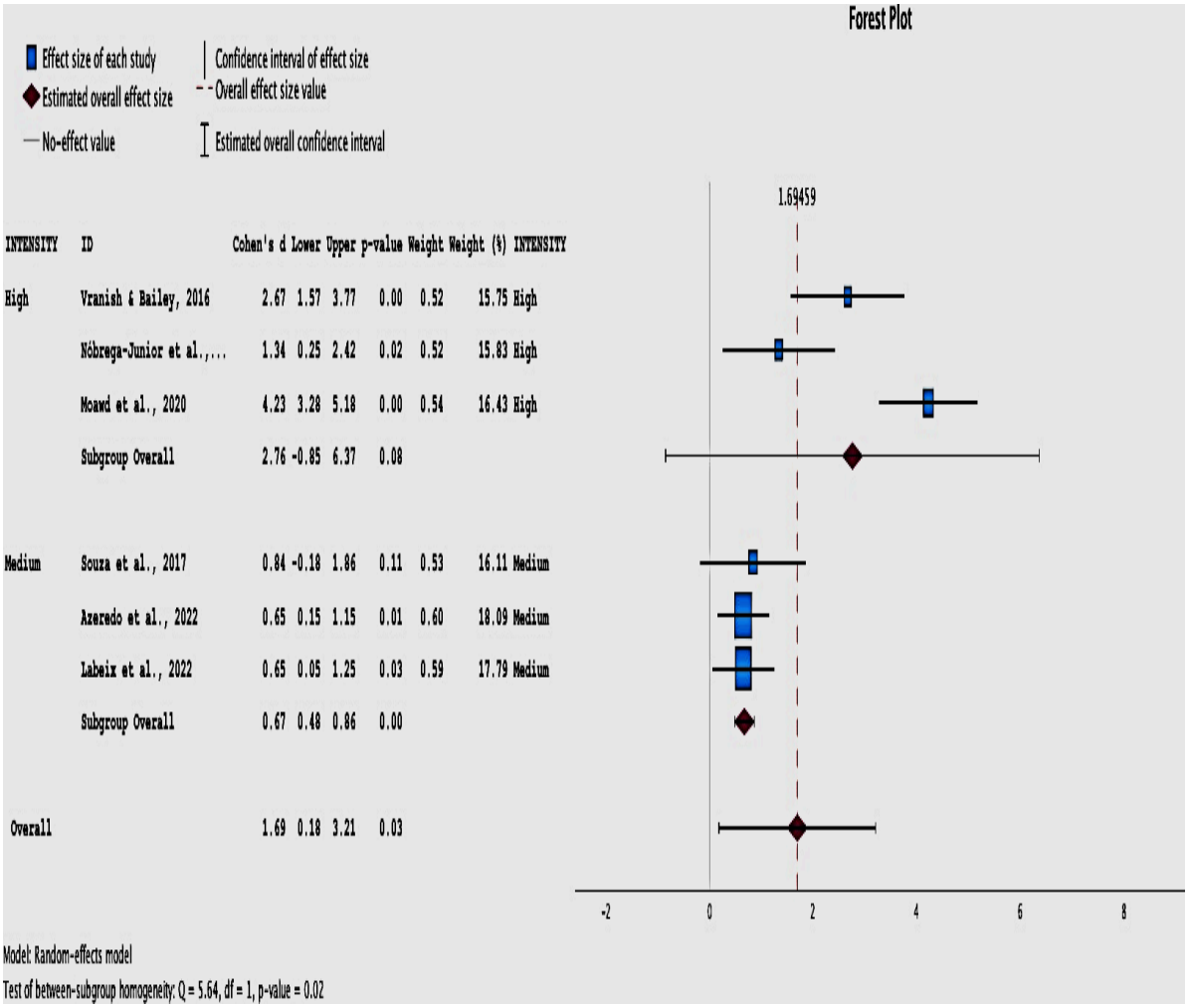


Figure 4 – Forest plot of the meta-analysis of the effect of IMT on the Pittsburgh Sleep Quality Index

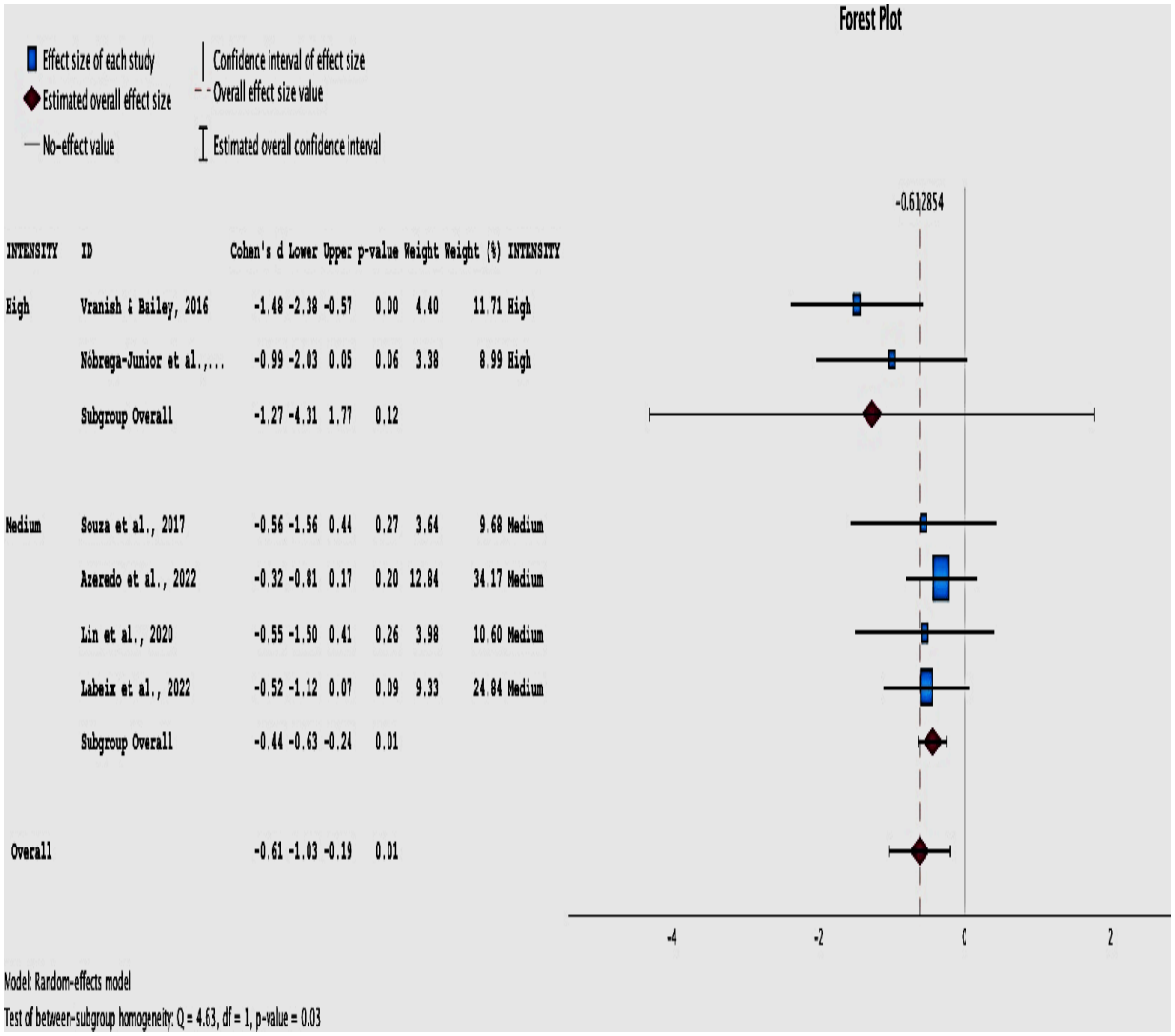
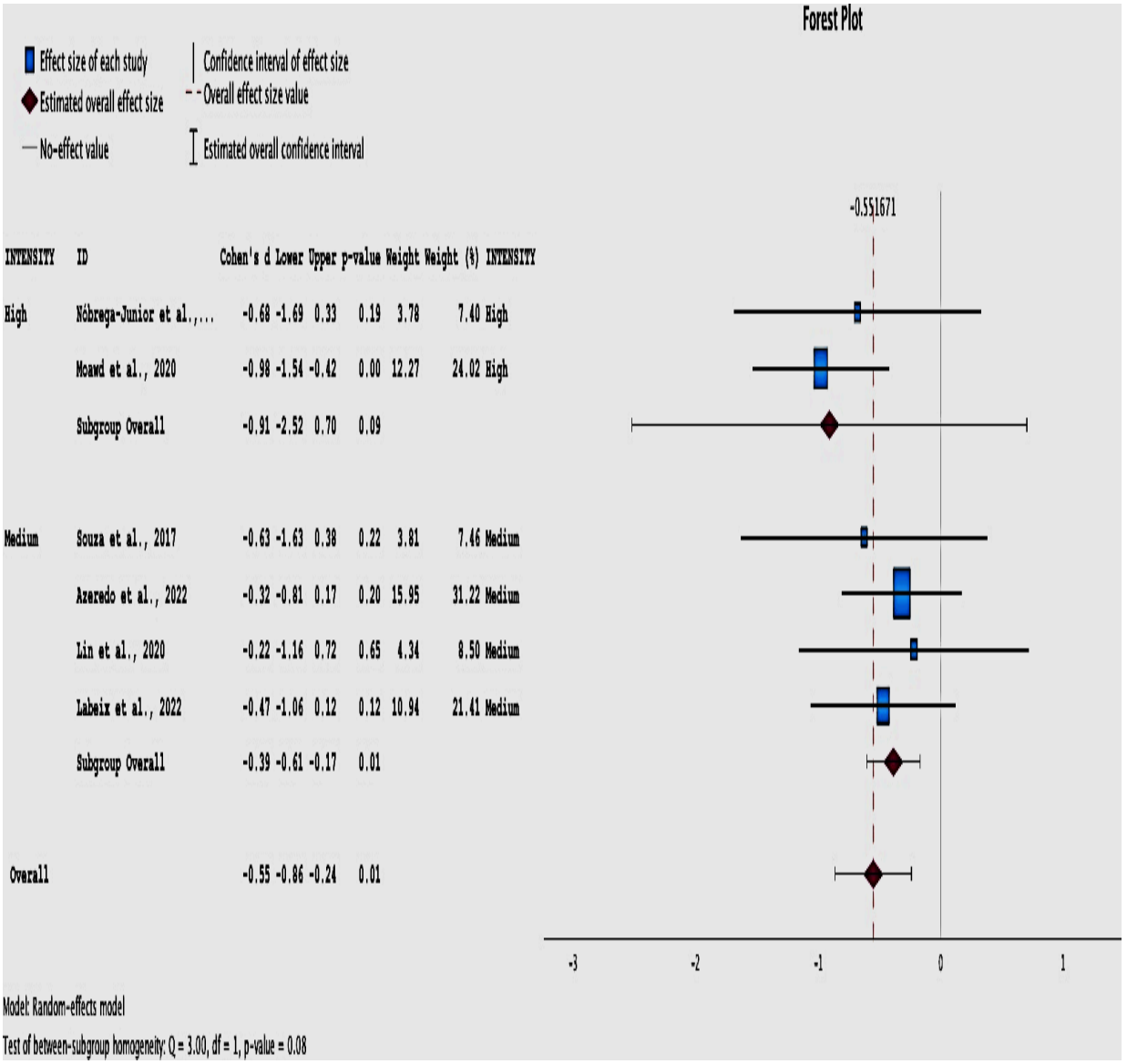


Figure 5 – Forest plot of the meta-analysis of the effect of IMT on the Epworth Sleepiness Scale



Considerações Finais

Esta revisão sistemática e meta-análise demonstrou que o TMI promove aumento significativo da força muscular inspiratória e melhora dos desfechos relatados por pacientes adultos com apneia obstrutiva do sono, com base em evidências de qualidade moderada. Observou-se aumento significativo da PImax e redução da sonolência diurna, com resultados mais consistentes e estatisticamente significativos associados aos protocolos de intensidade moderada (40–60% da PImax).

Os desfechos subjetivos, incluindo qualidade do sono e sonolência diurna, apresentaram baixa heterogeneidade entre os estudos, indicando consistência dos efeitos observados. Em contraste, o TMI não demonstrou efeito significativo sobre o IAH, com elevada heterogeneidade e ausência de resultados consistentes entre os subgrupos de intensidade.

Com base nesses achados, o TMI pode ser considerado uma terapia adjuvante no manejo da apneia obstrutiva do sono, especialmente em pacientes intolerantes à terapia com pressão positiva contínua ou com sintomas residuais. Protocolos de intensidade moderada (40–60% da PImax), realizados por 20–30 minutos por sessão, de 5 a 7 dias por semana, durante um período mínimo de 8 a 12 semanas, apresentaram os resultados mais consistentes entre os estudos incluídos.

Referências

ALHARBI, R. et al. Global prevalence, burden, and challenges of obstructive sleep apnea: implications for public health. **Healthcare**, Basel, v. 13, n. 17, p. 2115, 2024.

AMAL, M. O.; MANSOUR, A. M.; HUSSEIN, A. S. Obstructive sleep apnea: current perspectives. **Nature and Science of Sleep**, Auckland, v. 10, p. 21-34, 2018.

AZEREDO, L. M. et al. Inspiratory muscle training as adjuvant therapy in obstructive sleep apnea: a randomized controlled trial. **Brazilian Journal of Medical and Biological Research**, Ribeirão Preto, v. 55, p. e12331, 2022.

BAILEY, E. F.; FREGOSI, R. F. Coordination of intrinsic and extrinsic tongue muscles during spontaneous breathing in the rat. **Journal of Applied Physiology**, Bethesda, v. 96, n. 2, p. 440-449, 2004.

BAKER, W. L. et al. Understanding heterogeneity in meta-analysis: the role of meta-regression. **International Journal of Clinical Practice**, Oxford, v. 63, n. 10, p. 1426-1434, 2009.

BALDWIN, C. M. et al. Association of sleep-disordered breathing and sleep symptoms with quality of life. **Sleep**, Darien, v. 24, n. 1, p. 96-105, 2001.

BEAUMONT, M. et al. Effects of inspiratory muscle training in COPD patients. **The Clinical Respiratory Journal**, Oxford, v. 12, n. 7, p. 2178-2188, 2018.

BENJAFIELD, A. V. et al. Estimation of the global prevalence and burden of obstructive sleep apnea. **The Lancet Respiratory Medicine**, London, v. 7, p. 687-698, 2019.

BOUTRON, I.; ESTELLAT, C.; RAVAUD, P. Blinding in randomized controlled trials. **Journal of Clinical Epidemiology**, Oxford, v. 58, n. 12, p. 1220-1226, 2005.

BUYSSE, D. J. et al. The Pittsburgh Sleep Quality Index. **Psychiatry Research**, Shannon, v. 28, n. 2, p. 193-213, 1989.

CAMPBELL, M. K. et al. CONSORT 2010 extension. **BMJ**, London, v. 345, p. e5661, 2012.

CAPLES, S. M. et al. Surgical modifications of the upper airway. **Sleep**, Darien, v. 33, n. 10, p. 1396-1407, 2010.

CHEN, T. A. et al. Effects of inspiratory muscle training on blood pressure- and sleep-related outcomes in patients with obstructive sleep apnea: a meta-analysis of randomized controlled trials. **Sleep and Breathing**, Heidelberg, v. 27, n. 5, p. 1953-1966, 2023.

DE BACKER, W. Obstructive sleep apnea/hypopnea syndrome. **Panminerva Medica**, Turin, v. 55, p. 191-195, 2013.

DEL BEM, V. E. et al. Oxidative stress and arterial dysfunction in OSA. **BMC Pulmonary Medicine**
, London, v. 12, p. 36, 2012.

DEMPSEY, J. A. et al. Pathophysiology of sleep apnea. **Physiological Reviews**, Bethesda, v. 90, p. 47-112, 2010.

DUARTE, R. L. M. et al. Obstructive sleep apnea in Latin America: current perspectives and challenges. **Sleep Science**, São Paulo, v. 15, n. 1, p. 1-10, 2022.

ECKERT, D. J. et al. Defining phenotypic causes of OSA. **American Journal of Respiratory and Critical Care Medicine**, New York, v. 188, p. 996-1004, 2013.

ENRIGHT, S. J. et al. High-intensity inspiratory muscle training. **Physical Therapy**, Alexandria, v. 86, p. 345-354, 2006.

EPSTEIN, L. J. et al. Clinical guideline for evaluation, management and long-term care. **Journal of Clinical Sleep Medicine**, Darien, v. 5, p. 263-276, 2009.

FINN, L. et al. Sleep-disordered breathing and general health. **Sleep**, Darien, v. 21, p. 701-706, 1998.

GARBARINO, S. et al. Occupational accidents in OSA. **Sleep**, Darien, v. 39, p. 1211-1218, 2016.

GOSSELINK, R. et al. IMT in COPD. **European Respiratory Journal**, Sheffield, v. 37, p. 416-425, 2011.

GOTTLIEB, D. J.; PUNJABI, N. M. Diagnosis and management of OSA. **JAMA**, Chicago, v. 323, p. 1389-1400, 2020.

HEINZER, R. et al. HypnoLaus Study. **The Lancet Respiratory Medicine**, London, v. 3, p. 310-318, 2015.

HILL, K. et al. High-intensity inspiratory muscle training in COPD. **European Respiratory Journal**, Sheffield, v. 27, n. 6, p. 1119-1128, 2006.

HUANG, L. et al. Biomechanics of snoring. **Endeavour**, Oxford, v. 19, p. 96-100, 1995.

ILLI, S. K. et al. Effect of respiratory muscle training on exercise performance in healthy individuals: a systematic review and meta-analysis. **Sports Medicine**, Auckland, v. 42, n. 8, p. 707-724, 2012.

ISAAC, S.; RODRIGO, P. Obstructive sleep apnea: how to diagnose. **Revista Brasileira de Hipertensão**, São Paulo, p. 18-22, 2013.

JOHNS, M. W. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. **Sleep**, Darien, v. 14, n. 6, p. 540-545, 1991.

JORDAN, A. S.; MCSHARRY, D. G.; MALHOTRA, A. Adult OSA. **The Lancet**, London, v. 383, p. 736-747, 2014.

KAPUR, V. K. et al. Clinical practice guideline for diagnostic testing. **Journal of Clinical Sleep Medicine**, Darien, v. 13, p. 479-504, 2017.

KLINE, C. E. et al. Exercise training and OSA. **Sleep**, Darien, v. 34, p. 1631-1640, 2011.

KOVELIS, D. et al. Validation of dyspnea scales in COPD. **Jornal Brasileiro de Pneumologia**, Brasília, v. 34, p. 1008-1018, 2009.

LABEIX, P. et al. Short-term IMT in OSA. **Respiratory Physiology & Neurobiology**, Amsterdam, v. 300, p. 103869, 2022.

LANGER, D. et al. Clinical guideline for physiotherapists in COPD. **Clinical Rehabilitation**, London, v. 23, p. 445-462, 2009.

LIN, Y. Y. et al. IMT in OSA. **Respiratory Care**, Irving, v. 65, p. 1537-1550, 2020.

MACINTYRE, N. R. et al. Weaning from ventilatory support. **Chest**, Glenview, v. 107, p. 1599-1618, 1995.

MCCONNELL, A. K. **Respiratory muscle training: theory and practice**. Edinburgh: Churchill Livingstone/Elsevier, 2013.

MCCONNELL, A. K.; ROMER, L. M. Respiratory muscle training in healthy humans: resolving the controversy. **International Journal of Sports Medicine**, Stuttgart, v. 25, n. 4, p. 284-293, 2004.

MCCOOL, F. D.; TZELEPIS, G. E. Inspiratory muscle training in neuromuscular disease. **Physical Therapy**, Alexandria, v. 93, p. 1449-1455, 2013.

MENDELSON, M. et al. Physical activity and exercise in OSA. **Frontiers in Neurology**, Lausanne, v. 9, p. 73, 2018.

MOAWD, S. A. et al. Inspiratory muscle training in OSA. **Annals of Thoracic Medicine**, Mumbai, v. 15, p. 123-129, 2020.

MOHER, D. et al. CONSORT 2010 explanation. **BMJ**, London, v. 340, p. c869, 2010.

MOIZ, J. A. et al. Effects of inspiratory muscle training on functional capacity and pulmonary function in patients with obstructive sleep apnea: a randomized controlled trial. **Journal of Back and Musculoskeletal Rehabilitation**, Amsterdam, v. 35, n. 4, p. 703-710, 2022.

NARKIEWICZ, K.; SOMERS, V. Cult. Sympathetic nerve activity in OSA. **Acta Physiologica Scandinavica**, Oxford, v. 177, p. 385-390, 2003.

NIETO, F. J. et al. Sleep apnea and hypertension. **JAMA**, Chicago, v. 283, p. 1829-1836, 2000.

NÓBREGA-JÚNIOR, J. M. et al. IMT and quality of life in OSA. **Sleep and Breathing**, Heidelberg, v. 24, p. 997-1004, 2020.

O'DRISCOLL, B. R. et al. BTS guideline for oxygen use in adults in healthcare and emergency settings. **Thorax**, London, v. 66, n. Suppl 2, p. ii1-ii21, 2011.

ONEN, S. H. et al. The effects of total sleep deprivation, selective sleep interruption and sleep recovery on pain tolerance thresholds in healthy subjects. **Journal of Sleep Research**, Oxford, v. 10, n. 1, p. 35-42, 2001.

OUZZANI, M. et al. Rayyan web and mobile app. **Systematic Reviews**, London, v. 5, p. 210, 2016.

PACK, A. I. et al. Driver crashes due to sleepiness. **Accident Analysis & Prevention**, Oxford, v. 38, p. 769-775, 2006.

PATIL, S. L. et al. Adult OSA: pathophysiology and diagnosis. **Chest**, Glenview, v. 132, p. 325-337, 2007.

PATSOPOULOS, N. A. A pragmatic view on pragmatic trials. **Dialogues in Clinical Neuroscience**, Neuilly-sur-Seine, v. 13, n. 2, p. 217-224, 2011.

RANDERATH, W. J. et al. Non-CPAP therapies in OSA. **European Respiratory Journal**, Sheffield, v. 37, p. 1000-1028, 2011.

RANDERATH, W. et al. Definition, discrimination, diagnosis and treatment of central breathing disturbances during sleep. **European Respiratory Journal**, Sheffield, v. 49, n. 1, p. 1600959, 2017.

RIES, A. L. et al. Pulmonary rehabilitation: joint ACCP/AACVPR evidence-based clinical practice guidelines. **Chest**, Glenview, v. 128, n. 4 Suppl, p. 295S-302S, 2005.

ROTENBERG, B. W.; MURARIU, D.; PANG, K. P. CPAP adherence trends. **Journal of Otolaryngology - Head & Neck Surgery**, London, v. 45, p. 43, 2016.

SAWYER, A. M. et al. CPAP adherence across age groups. **Sleep Medicine Reviews**, Amsterdam, v. 15, p. 343-356, 2011.

SCHULZ, K. F.; GRIMES, D. A. Sample size in randomized trials. **The Lancet**, London, v. 365, p. 1348-1353, 2005.

SCHWARTZ, A. R. et al. Obesity and obstructive sleep apnea: pathogenic mechanisms and therapeutic approaches. **Proceedings of the American Thoracic Society**, New York, v. 5, n. 2, p. 185-192, 2008.

SHAMSEER, L. et al. PRISMA-P 2015. **BMJ**, London, v. 349, p. g7647, 2015.

SHEEL, A. W. Respiratory muscle training in healthy individuals. **Sports Medicine**, Auckland, v. 32, p. 567-581, 2002.

SHOEMAKER, M. J.; DONKER, S.; LAPOE, A. Inspiratory muscle training in patients with chronic obstructive pulmonary disease: the state of the evidence. **Cardiopulmonary Physical Therapy Journal**, Alexandria, v. 20, n. 3, p. 5-15, 2009.

Anexo 1: Registro Prospectivo do Protocolo da revisão Sistemática no PROSPERO

NIHR | National Institute for Health and Care Research

PROSPERO
International prospective register of systematic reviews

LOW-MEDIUM AND HIGH-INTENSITY INSPIRATORY MUSCLE TRAINING IN INDIVIDUALS WITH SLEEP APNEA: SYSTEMATIC REVIEW AND META-ANALYSIS

Jennifer Maria de Almeida Aguiar, Leandro Miranda de Azeredo, Luis Felipe da Fonseca Reis, Clara Diniz

Citation
Jennifer Maria de Almeida Aguiar, Leandro Miranda de Azeredo, Luis Felipe da Fonseca Reis, Clara Diniz. LOW-MEDIUM AND HIGH-INTENSITY INSPIRATORY MUSCLE TRAINING IN INDIVIDUALS WITH SLEEP APNEA: SYSTEMATIC REVIEW AND META-ANALYSIS. PROSPERO 2025 CRD420251013583. Available from https://www.crd.york.ac.uk/PROSPERO/view/CRD420251013583.

REVIEW TITLE AND BASIC DETAILS

Review title
LOW-MEDIUM AND HIGH-INTENSITY INSPIRATORY MUSCLE TRAINING IN INDIVIDUALS WITH SLEEP APNEA: SYSTEMATIC REVIEW AND META-ANALYSIS

Condition or domain being studied
Obstructive Sleep Apnea Syndrome; Sleep disturbances; Sleep Apnea; Obstructive Sleep Apnea Of Adult; Sleep apnoea syndrome; Respiratory Muscle Training; Inspiratory Muscle Training

Rationale for the review
Obstructive sleep apnea (OSA) is the most prevalent sleep-related breathing disorder (SDB) and is considered a public health problem due to its increased risk of cardiovascular morbidity and mortality. Inspiratory muscle training (IMT) aims to improve inspiratory muscle efficiency and reduce the severity of OSA symptoms. IMT is a promising complementary approach in the treatment of OSA, which aims to strengthen respiratory muscles, such as the diaphragm and intercostal muscles, to improve respiratory efficiency and reduce the severity of symptoms associated with OSA, as well as directly and indirectly the airway dilator muscles. Studies show that personalizing protocols is essential to ensure the effectiveness of training, as different patients may respond differently to load and exercises. Adherence to the IMT protocol can be promoted by adjusting the load and duration of sessions, adapting to the individual needs and the evolution of the patient's condition. Therefore, it is necessary to understand the impact of IMT protocols, that is, the effects of the different protocols.

Review objectives
This systematic review a ms to analyze the effect of different IMT protocols (low-medium and high intensity load) on maximum inspiratory pressure (MIP), Pittsburgh sleep quality index (PSQI), Epworth sleepiness scale (ESS), apnea-hypopnea index (AHI), forced expiratory volume in 1 second (FEV1) and cardiopulmonary exercise test (CPET).

Keywords
inspiratory muscle training; obstructive sleep apnea syndrome; obstructive sleep apnea; inspiratory muscle trainer; OSA; IMT; Respiratory muscle strength training; Respiratory muscle training

Country
Brazil

ELIGIBILITY CRITERIA

Population

Included
With a population over 18 years old; patients with OSA at all AHI levels; They use IMT as the main intervention; Regardless of the administered environment, whether home or institutional;

Excluded
populations with clinical conditions that may affect the magnitude of improvement in inspiratory muscle parameters, such as neurological, respiratory, cardiac and/or metabolic diseases. Studies in which IMT is part of a multicomponent intervention and evaluating the separate effect is not feasible will not be included.

Intervention(s) or exposure(s)

Included
Inspiratory Muscle Training; Respiratory Muscle Training

Randomized controlled trials (RCTs) published in the last 10 years; No language restriction

Excluded
review articles, monographs, studies published only as proceedings of scientific meetings, book chapters, guidelines and expert opinions. Animal studies; Which have unclear clinical results or duplicate reports of patient cohorts,

Comparator(s) or control(s)

Included
PICO tags selected: Placebo; Usual Care; High Intensity Exercise; Low Intensity Exercise

Study design
Only randomized study types will be included.

Included
The review of clinical effectiveness will include only RCTs.

Excluded
Monographs, studies published only as proceedings of scientific events, book chapters, guidelines and expert opinions.

Selection process

Studies will be screened ndependently by at least two people (or person/machine combination) with a process to resolve differences.

Other relevant information about searching and screening

None

DATA COLLECTION PROCESS

Data extraction from published articles and reports

Data will be extracted independently by at least two people (or person/machine combination) with a process to resolve differences.

Authors will be asked to provide any required data not available in published reports.

Study risk of bias or quality assessment

Risk of bias will be assessed using: *Cochrane RoB-2*

Data will be assessed independently by at least two people (or person/machine combination) with a process to resolve differences.

Additional information will be sought from study investigators if required information is unclear or unavailable in the study publications/reports.

Reporting bias assessment

Two authors will assess the risk of bias independently for each study using the risk of bias tool 2 (ROB2) described in the Cochrane Handbook for Systematic Reviews of Interventions. They will resolve any disagreements by discussion or by involving another author.

Risk of bias will be assessed for each relevant outcome according to the following domains: deviations from the intended interventions; bias due to the randomisation process; selection of the reported outcome; outcome measurement; and outcome measurement; The following judgements were used: low risk, high risk or unclear (lack of information or uncertainty about the potential for bias). Any disagreements will be resolved by discussion or by consultation with the third author if necessary.

Certainty assessment

The Grading, Assessment, and Development System (GRADE) software will be used to assess the methodological quality of the studies. To do this, we will use GRADEpro GDT 2015 to import the data from Review Manager and create a summary table of the results. The assessment of the evidence will take into account five main points of GRADE, with the following domains being assessed: random sequence generation (selection bias), allocation concealment (selection bias), blinding of participants and professionals (performance bias), blinding of outcome assessors (detection bias), incomplete outcomes (attrition bias), selective outcome reporting (reporting bias), and other sources of bias. These criteria will be used to assess the strength of the evidence of the studies included in the meta-analysis. If any study has reduced quality, we will justify the decision with explanatory notes and comments that help readers understand the choices made during the review.

Context
This study is a systemat c review of studies that evaluated individuals with OSA who underwent inspiratory muscle training protocols (low-medium and high intensity load) with different devices;

TIMELINE OF THE REVIEW

Date of first submission to PROSPERO
20 March 2025

Review timeline
Start date: 5 November 2024. End date: 4 August 2025.

Date of registration in PROSPERO
20 March 2025

AVAILABILITY OF FULL PROTOCOL

Availability of full protocol
A full protocol has been written and uploaded to PROSPERO. The protocol may be accessed through this link
https://www.crd.york.ac.uk/PROSPEROFILES/bea81f97f628031f807872a15d3e5d76.pdf.

SEARCHING AND SCREENING

Search for unpublished studies
Only published studies will be sought.

Main bibliographic databases that will be searched
The main databases to be searched are *CENTRAL - Cochrane Central Register of Controlled Trials*, *Embase.com*, *LILACS - Latin American and Caribbean Health Sciences Literature*, *MEDLINE*, *PubMed* and *Scopus*.

Other important or specialist databases that will be searched
Physiotherapy Evidence Database (PEDro)

Search language restrictions
There are no language restrictions.

Search date restrictions
There are no search date restrictions.

Other methods of identifying studies
Other studies will be identified by: *contacting authors or experts*, *looking through all the articles that cite the papers included in the review ("snowballing")*, *reference list checking*, *searching dissertation and thesis databases* and *searching trial or study registers*.

Link to search strategy
A full search strategy is available in the full protocol as described in the *Availability of full protocol* section

Main outcomes
The results would be show the effects of different IMT protocols on maximum inspiratory pressure (MIP), Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), apnea-hypopnea index (AHI), forced expiratory volume in 1 second (FEV1) and cardiopulmonary exercise test.

Additional outcomes
There are no additional outcomes.

PLANNED DATA SYNTHESIS

Strategy for data synthesis
In the statistical part, estimates of the pooled effects will be obtained by comparing the mean change between baseline and endpoint in each group, and will be presented as the weighted mean difference between groups. For continuous variables, the mean difference in change between groups will be used to present the results.

If the data are nonparametric, we will convert the means and standard deviation (SD) using recent methods (Wan X et al., doi:10.1186/1471-2288-14-135). If the SD of the change is not available, but the confidence interval is, the conversion will be based on the guidelines of Higgins and Green (Higgins JPT; Green S. Chichester: John Wiley & Sons; 2006).

Analyses will be performed using fixed and random effects models. When the trial is a multi-arm RCT, we will analyze all relevant experimental intervention groups (such as respiratory muscle training, placebo or other types of exercise).

In monitoring reports with multiple endpoints, only data closest to the end of the breathing or exercise program will be considered. Analyses will be performed in Review Manager.

CURRENT REVIEW STAGE

Stage of the review at this submission

Review stage	Started	Completed
Pilot work	✓	✓
Formal searching/study identification	✓	✓
Screening search results against inclusion criteria	✓	✓
Data extraction or receipt of IPD		
Risk of bias/quality assessment		
Data synthesis		

Review status
The review is currently planned or ongoing.

Publication of review results
Results of the review will be published in English.

REVIEW AFFILIATION, FUNDING AND PEER REVIEW

Review team members

Mrs Jennifer Maria de Almeida Aguiar. ORCID: 0009-0000-0319-1023. Centro Universitário Augusto Motta/UNISUAM. Brazil.

No conflict of interest declared.

Dr Leandro Miranda de Azeredo. ORCID: 0000-0002-1264-0377. Hospital da Policia Militar do Rio de Janeiro. Brazil.

No conflict of interest declared.

Dr Luis Felipe da Fonseca Reis (review guarantor). ORCID: 0000-0002-6812-6553. Centro Universitário Augusto Motta/UNISUAM. Brazil.

No conflict of interest declared.

Ms Clara Diniz. ORCID: 0000-0003-1398-7337. Universidade Estadual do Rio de Janeiro (UERJ). Brazil.

No conflict of interest declared.

Named contact

Mrs Jennifer Maria de Almeida Aguiar (jenniferaguiar@souunisuam.com.br). ORCID: 0009-0000-0319-1023. Centro Universitário Augusto Motta/UNISUAM. Brazil.

Review affiliation

Centro Universitário Augusto Motta/UNISUAM

Funding source

Review has no specific/external funding but is supported by guarantor/review team (non-commercial) institutions.

Peer review

The screening will be carried out by a pair of reviewers, independently. If there is disagreement between the reviewers regarding the judgment, a third reviewer will judge whether the articles are in fact eligible. After reading the selected manuscripts, the manuscripts that obtain eligibility confirmed through the complete reading of the articles, confirmed by two independent reviewers. If there is disagreement between the reviewers, this will be resolved by consensus or by a third reviewer.

ADDITIONAL INFORMATION

Review conflict of interest

Declared individual interests are recorded under team member details.. No additional interests are recorded for this review.

Medical Subject Headings

Breathing Exercises; Sleep Apnea Syndromes; Sleep Apnea, Obstructive

Check for similar records already in PROSPERO

PROSPERO identified a number of existing PROSPERO records that were similar to this one (last check made on 18 March 2025). These are shown below along with the reasons given by that the review team for the reviews being different and/or proceeding.

- The Effect of Melatonin on Sleep Quality and Daytime Sleepiness in Parkinson's Disease: A Systematic Review and Meta-analysis of Randomized Placebo-Controlled Trials [published 1 February 2025] [CRD42025641925]. The review was judged **not to be similar**
- Effect of Inspiratory muscle training (IMT) on pulmonary function, respiratory muscle strength, functional capacity in patients with cardiac surgeries – A Systematic review with Meta analysis [published 4 July 2020] [CRD42020179130]. The review was judged **not to be similar**
- Comparative efficacy of pharmacological interventions for adults with obstructive sleep apnea: A systematic review and network meta-analysis [published 23 February 2025] [CRD420250650887]. The review was judged **not to be similar**

Anexo 2- Checklist PRISMA



PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	p.2
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p.7
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	p.21
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	p.22
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	p.23
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	p.24
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	p.24
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	p.24
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	p.25
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	p.25
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	p.23
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	p.29
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	p.35
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	p.24
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	p.23
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	p.23
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	p.23
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	p.54
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	p.24
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	p.24

PRISMA 2020 Checklist

RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	p.33
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	p.33
Study characteristics	17	Cite each included study and present its characteristics.	p.47
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	p.32
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	P.46
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	P. 32-33
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	P.34
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	P.23
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	P.24
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	P.36
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	P.36
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	P.36
	23b	Discuss any limitations of the evidence included in the review.	P.36
	23c	Discuss any limitations of the review processes used.	P.38
	23d	Discuss implications of the results for practice, policy, and future research.	P.38
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	P.20
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	P.20
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	P.20
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	P.23
Competing interests	26	Declare any competing interests of review authors.	P.56
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	P.20

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. This work is licensed under CC BY 4.0. To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

Produção intelectual: Outras produções acadêmicas

V SUDESFIR
2, 3 e 4 de outubro de 2025 | Belo Horizonte
Congresso do Sudeste de Fisioterapia Respiratória, Cardiovascular e em Terapia Intensiva da ASSOBRAFIR
&
IV SONOFIR
ASSOBRAFIR

Certificamos que

JENNIFER MARIA DE ALMEIDA AGUIAR

Participou do **V SUDESFIR - Congresso do Sudeste de Fisioterapia Respiratória, Cardiovascular e em Terapia Intensiva da ASSOBRAFIR e IV SONOFIR – Congresso Brasileiro de Fisioterapia Respiratória nos Distúrbios Respiratórios do Sono e II Congresso Latino-Americano de Fisioterapia Respiratória nos Distúrbios Respiratórios do Sono**, realizado de 02 a 04 de outubro de 2025, na AMMG – Associação Médica de Minas Gerais em Belo Horizonte/MG, com carga horária de 19 horas.

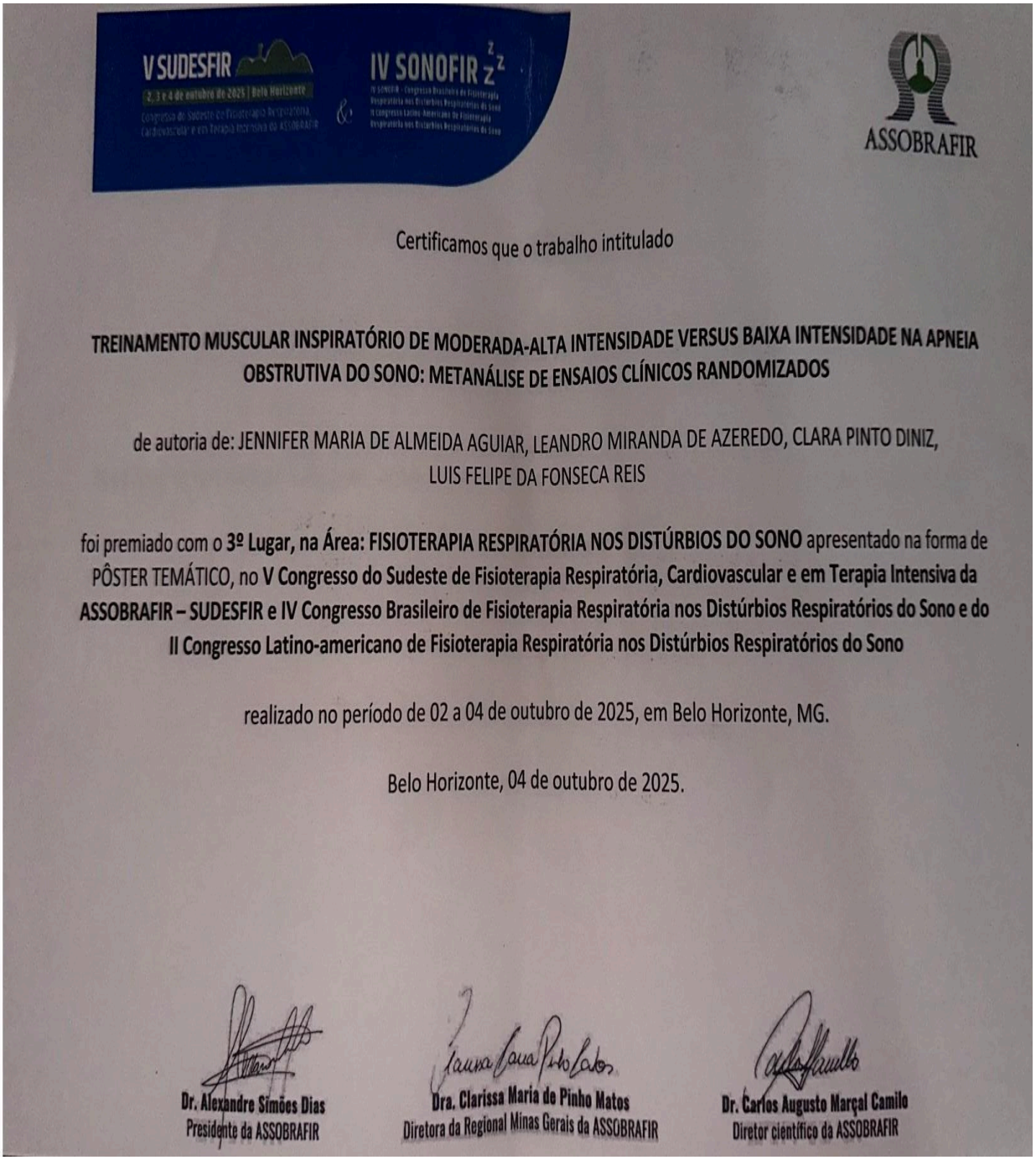
Belo Horizonte, 04 de outubro de 2025.

Validação Online
Código:rb7JiVORnl

Dr. Alexandre Simões Dias
Presidente da ASSOBRAFIR

Dra. Clarissa Maria de Pinho Matos
Diretora da Regional Minas Gerais da ASSOBRAFIR

Dr. Carlos Augusto Marçal Camilo
Diretor científico da ASSOBRAFIR



V SUDESFIR
2, 3 e 4 de outubro de 2025 | Belo Horizonte
Congresso do Sudeste de Fisioterapia Respiratória, Cardiovascular e em Terapia Intensiva da ASSOBRAFIR

&

IV SONOFIR
IV SONOFIR - Congresso Brasileiro de Fisioterapia Respiratória nos Distúrbios Respiratórios do Sono
II Congresso Latino-Americano de Fisioterapia Respiratória nos Distúrbios Respiratórios do Sono

ASSOBRAFIR

Certificamos que o trabalho intitulado

TREINAMENTO MUSCULAR INSPIRATÓRIO DE MODERADA-ALTA INTENSIDADE VERSUS BAIXA INTENSIDADE NA APNEIA OBSTRUTIVA DO SONO: METANÁLISE DE ENSAIOS CLÍNICOS RANDOMIZADOS

de autoria de: JENNIFER MARIA DE ALMEIDA AGUIAR, LEANDRO MIRANDA DE AZEREDO, CLARA PINTO DINIZ, LUIS FELIPE DA FONSECA REIS

foi premiado com o **3º Lugar, na Área: FISIOTERAPIA RESPIRATÓRIA NOS DISTÚRBIOS DO SONO** apresentado na forma de PÔSTER TEMÁTICO, no **V Congresso do Sudeste de Fisioterapia Respiratória, Cardiovascular e em Terapia Intensiva da ASSOBRAFIR – SUDESFIR e IV Congresso Brasileiro de Fisioterapia Respiratória nos Distúrbios Respiratórios do Sono e do II Congresso Latino-americano de Fisioterapia Respiratória nos Distúrbios Respiratórios do Sono**

realizado no período de 02 a 04 de outubro de 2025, em Belo Horizonte, MG.

Belo Horizonte, 04 de outubro de 2025.

Dr. Alexandre Simões Dias
Presidente da ASSOBRAFIR

Dra. Clarissa Maria de Pinho Matos
Diretora da Regional Minas Gerais da ASSOBRAFIR

Dr. Carlos Augusto Marçal Camilo
Diretor científico da ASSOBRAFIR

Hotel Windsor Marapendi | Barra da Tijuca
03 A 05 DE JULHO DE 2025
VIII CONGRESSO CARIOCA
de Fisioterapia Cardiorrespiratória e Fisioterapia em Terapia Intensiva
I ENCONTRO DE FISIOTERAPIA EM DOENÇAS RARAS
I ENCONTRO DE FISIOTERAPIA EM URGÊNCIA E EMERGÊNCIA

ASSOBRAFIR
Regional Rio de Janeiro

Certificamos que

JENNIFER MARIA DE ALMEIDA AGUIAR

participou do **VIII Congresso Carioca de Fisioterapia Cardiorrespiratória e Fisioterapia Terapia Intensiva** do **I Encontro de Fisioterapia em Doenças Raras da Assobrafir e do I de Fisioterapia em Urgência e Emergência da Assobrafir** realizados nos dias 04 e 05 de jull 2025, no Hotel Windsor Marapendi e com carga horária total de 20 horas.

Promoção: Assobrafir - Unidade Regional Rio de Janeiro.

Rio de Janeiro - RJ, 05 de julho de 2025.

Validação Online
Código: [illegible]

Dr. Alexandre Simões Dias
Presidente da ASSOBRAFIR

Dr. Fábio Fajardo Canto
Diretor da Regional Rio de Janeiro

Dr. Carlos Augusto Marçal Camilo
Diretor científico da ASSOBRAFIR


I SIMPÓSIO INTERNACIONAL
DE FISIOTERAPIA EM TERAPIA
INTENSIVA DA UNISUAM
CERTIFICADO
Certificamos que
Jennifer Aguiar
participou do I SIMPÓSIO INTERNACIONAL
DE FISIOTERAPIA EM TERAPIA INTENSIVA DA UNISUAM
no dia 07 de Novembro de 2025.
UNISUAM
PÓS-GRADUAÇÃO
STRICTO SENSU
20 anos de Pós – Graduação de Fisioterapia em Terapia Intensiva da UNISUAM



Aferj
ASSOCIAÇÃO DOS FISIOTERAPEUTAS DO ESTADO DO RIO DE JANEIRO

CERTIFICADO

Certificamos que Jennifer Maria de Almeida Aguiar participou, na qualidade de participante, do IV Congresso da Associação dos Fisioterapeutas do Estado do Rio de Janeiro (AFERJ), denominado FISIOCONNECT 2025, nos dias 24 e 25 de maio de 2025, com carga horária de 20h.

Dr. Leonardo Brito de Oliveira
Presidente da Aferj


I SIMPÓSIO INTERNACIONAL
DE FISIOTERAPIA EM TERAPIA
INTENSIVA DA UNISUAM
CERTIFICADO
Certificamos que
Jennifer Aguiar
participou do I SIMPÓSIO INTERNACIONAL
DE FISIOTERAPIA EM TERAPIA INTENSIVA DA UNISUAM
no dia 07 de Novembro de 2025.
UNISUAM
PÓS-GRADUAÇÃO
STRICTO SENSU
20 anos de Pós – Graduação de Fisioterapia em Terapia Intensiva da UNISUAM

Verifique o código de autenticidade 18467050.8708193.6.8.8467050870819369em https://www.even3.com.br/documentos



CERTIFICADO

Certificamos que **Jennifer Maria de Almeida Aguiar** participou do **II Fórum Discente da Associação Brasileira de Pesquisa e Pós-Graduação em Fisioterapia**, realizado no período de 23 a 25 de maio de 202 com carga horária total de 14 horas.

Dra. Livia Arcêncio do Amaral
Presidente do II Fórum Discente da ABRAPG-Ft

Dra. Rosimeire Simprini Padula
Presidente da ABRAPG-Ft

REALIZ
abr
Associaçã
Pesquisa
Fisioterap



XXV COBRAF

CONGRESSO BRASILEIRO DE FISIOTERAPIA

Certificamos que **JENNIFER MARIA DE ALMEIDA AGUIAR** participou do **XXV COBRAF - Congresso Brasileiro de Fisioterapia** realizado no período de 01 a 03 de agosto de 2024 no Centro de Convenções de Salvador na Bahia, com carga horária total de 24 horas.

Salvador, 03 de agosto de 2024.

Denise Flavio
Presidente da AFB

Lorena Rosa Almeida
Presidente do XXV COBRAF

Elen Beatriz Pinto
Presidente da Comissão Científica


UNISUAM
COMPROMISSO PARA A VIDA TODA