UNIVERSIDADE FEDERAL DOS VALES DO JEQUITINHONHA E MUCURI

Programa de Pós-Graduação em Reabilitação e Desempenho Funcional

Angélica de Fatima Silva

EFICÁCIA DO FORTALECIMENTO DO QUADRIL NA INTENSIDADE DA DOR, INCAPACIDADE E FORÇA EM CONDIÇÕES MUSCULOESQUELÉTICAS CRÔNICAS DO TRONCO E MEMBROS INFERIORES: UMA REVISÃO SISTEMÁTICA COM META-ANÁLISE

Diamantina

2021

Angélica de Fatima Silva

EFICÁCIA DO FORTALECIMENTO DO QUADRIL NA INTENSIDADE DA DOR, INCAPACIDADE E FORÇA EM CONDIÇÕES MUSCULOESQUELÉTICAS CRÔNICAS DO TRONCO E MEMBROS INFERIORES: UMA REVISÃO SISTEMÁTICA COM META-ANÁLISE

Dissertação apresentada ao Programa de Pós-graduação em Reabilitação e Desempenho Funcional da Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM) como requisito para obtenção do título de Mestre.

Orientadora: Prof[a]. Dra. Ana Cristina Rodrigues Lacerda
Coorientador: Prof. Dr. Vinícius Cunha Oliveira

Diamantina
2021

Catalogação na fonte - Sisbi/UFVJM

S578 silva, [redacted]
2021 EFICÁCIA DO FORTALECIMENTO DO QUADRIL NA INTENSIDADE DA DOR, INCAPACIDADE E FORÇA EM CONDIÇÕES MUSCULOESQUELÉTICAS CRÔNICAS DO TRONCO E MEMBROS INFERIORES: UMA REVISÃO SISTEMÁTICA COM META-ANÁLISE [manuscrito] : Efficacy of hip strengthening on pain intensity, disability and strength in musculoskeletal conditions of the trunk and lower limbs: A systematic review with meta-analysis and GRADE recommendations. / [redacted]. -- Diamantina, 2021.
62 p.

Orientadora: Prof.ª Ana Cristina Rodrigues Lacerda.
Coorientador: Prof. Vinícius Cunha Oliveira.

Dissertação (Mestrado em Reabilitação e Desempenho Funcional) -- Universidade Federal dos Vales do Jequitinhonha e Mucuri, Programa de Pós-Graduação em Reabilitação e Desempenho Funcional, Diamantina, 2021.

1. Quadril. 2. Reabilitação. 3. Intensidade da dor. 4. Funcionalidade. 5. Força. I. Lacerda, Ana Cristina Rodrigues . II. Oliveira, Vinícius Cunha . III. Universidade Federal dos Vales do Jequitinhonha e Mucuri. IV. Título.

Elaborada pelo Sistema de Geração Automática de Ficha Catalográfica da UFVJM
com os dados fornecidos pelo(a) autor(a).
Bibliotecário Rodrigo Martins Cruz / CRB6-2886
Técnico em T.I. Thales Francisco Mota Carvalho

MINISTÉRIO DA EDUCAÇÃO
UNIVERSIDADE FEDERAL DOS VALES DO JEQUITINHONHA E MUCURI

ANGÉLICA DE FATIMA SILVA

EFICÁCIA DO FORTALECIMENTO DO QUADRIL NA INTENSIDADE DA DOR, INCAPACIDADE E FORÇA EM CONDIÇÕES MUSCULOESQUELÉTICAS CRÔNICAS DO TRONCO E MEMBROS INFERIORES: UMA REVISÃO SISTEMÁTICA COM META-ANÁLISE

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

Orientador (a): Prof.ª Dr.ª Ana Cristina Rodrigues Lacerda

Co-orientador: Prof. Dr. Vinicius Cunha de Oliveira

Data da aprovação: 30/04/2021

Prof.Dr.ª ANA CRISTINA RODRIGUES LACERDA - UFVJM

Prof.Dr. VINICIUS CUNHA DE OLIVEIRA - UFVJM

Prof.Dr. JONATAS FERREIRA DA SILVA SANTOS - UFVJM

Prof.Dr. RENAN ALVES RESENDE - UFMG

DIAMANTINA

Documento assinado eletronicamente por **Ana Cristina Rodrigues Lacerda**, **Servidor**, em 30/04/2021, às 16:10, conforme horário oficial de Brasília, com fundamento no art. 6º, § 1º, do Decreto nº 8.539, de 8 de outubro de 2015.

Documento assinado eletronicamente por **Jonatas Ferreira Da Silva Santos**, **Servidor**, em 30/04/2021, às 16:11, conforme horário oficial de Brasília, com fundamento no art. 6º, § 1º, do Decreto nº 8.539, de 8 de outubro de 2015.

Documento assinado eletronicamente por **Renan Alves Resende**, **Usuário Externo**, em 03/05/2021, às 20:27, conforme horário oficial de Brasília, com fundamento no art. 6º, § 1º, do Decreto nº 8.539, de 8 de outubro de 2015.

Documento assinado eletronicamente por **Vinicius Cunha De Oliveira**, **Servidor**, em 04/05/2021, às 12:12, conforme horário oficial de Brasília, com fundamento no art. 6º, § 1º, do Decreto nº 8.539, de 8 de outubro de 2015.

A autenticidade deste documento pode ser conferida no site https://sei.ufvjm.edu.br/sei/controlador_externo.php?acao=documento_conferir&id_orgao_acesso_externo=0, informando o código verificador **0338310** e o código CRC **66B96415**.

Referência: Processo nº 23086.004637/2021-19 SEI nº 0338310

“*Continue a nadar....”*

AGRADECIMENTOS

Primeiramente agradeço a Deus, por sempre me guiar, me iluminar e me manter de pé, porque foram várias provações até chegar aqui.

Aos meus pais e irmãos por todo apoio dado, por comemorarem comigo as minhas vitórias e lutarem ao meu lado durante as batalhas.

Ao meu noivo Vinicius Moreira, por me dar a mão e seguir ao meu lado na busca da realização dos nossos sonhos. E toda a sua família, por que sei que vibram junto comigo essa conquista.

À minha orientadora Ana Cristina Rodrigues Lacerda e coorientador Vinicius Cunha Oliveira, por me entenderem, respeitarem meus limites e fraquezas, acreditarem que eu sou capaz, me corrigirem em minhas falhas e me darem todo o suporte necessário para chegar até aqui.

Agradeço também a Jousielle, Laísa, Ana Carolina Coelho. Este trabalho é fruto do nosso esforço em conjunto! Gratidão imensa a vocês.

A todos os professores por todo conhecimento, ensinamento transmitidos durante o mestrado.

Aos meus amigos e amigas que sabem da minha jornada e torcem pelo meu sucesso.

As minhas colegas de trabalho de São João Evangelista, foram muitas e muitas reuniões em horário de trabalho e vocês sempre segurando a barra pra mim, obrigada.

Agradeço a banca examinadora pela a honra em aceitar meu convite para participar dessa defesa.

RESUMO

O exercício de fortalecimento do quadril é frequentemente recomendado na prática clínica para garantir estabilidade articular e melhores padrões de movimento em muitas condições musculoesqueléticas crônicas do tronco e dos membros inferiores. Entretanto, a eficácia do fortalecimento do quadril na intensidade da dor, incapacidade e força muscular em condições musculoesqueléticas crônicas do tronco e membros inferiores não está clara. Logo, o objetivo desse estudo foi investigar a eficácia do fortalecimento do quadril na redução da intensidade da dor e/ou incapacidade e no aumento da força muscular de quadril em condições musculoesqueléticas crônicas traumáticas e não traumáticas. Foram incluídos nesse estudo somente ensaios clínicos randomizados controlados, pesquisados nos bancos de dados MEDLINE, COCHRANE, AMED, Embase, CINAHL, SPORTDiscus e PEDro até 8 de junho de 2021, sem restrições de data e idioma. Dois revisores independentes avaliaram os estudos que incluíram o fortalecimento do quadril para pacientes com condições crônicas musculoesqueléticas do tronco ou membros inferiores na intensidade da dor, incapacidade e força muscular. Um terceiro revisor esclareceu possíveis discordâncias. A qualidade metodológica dos estudos foi verificada por meio da escala PEDro. Os modelos de efeito aleatório estimaram a diferença média (MD) e o intervalo de confiança de 95% (IC). A graduação da qualidade da evidência e força de recomendação para tomada de decisão foi avaliada usando a abordagem GRADE. Os resultados apontam que o fortalecimento do quadril isolado comparado com o grupo controle (placebo, simulação, lista de espera ou nenhuma intervenção) pode melhorar a intensidade da dor e/ou a força muscular do quadril na dor femoropatelar. Além disso, o fortalecimento do quadril adicionado a outra intervenção pode ser benéfico para melhorar a incapacidade em pacientes com dor lombar. Porém, apesar de resultados favoráveis, os estudos apresentaram baixa qualidade metodológica e o nível de evidência foi considerado como muito baixo para todas as váriáveis avaliadas (intensidade da dor, incapacidade e força muscular). O nível de evidência para intensidade da dor e incapacidade foi reduzido devido à imprecisão, inconsistência e risco de viés; enquanto o nível de evidência para força muscular foi reduzida devido à imprecisão e risco de viés. Em resumo, os nossos achados apontam o fortalecimento do quadril como uma intervenção benéfica para os desfechos avaliados. Estudos futuros com tamanho de amostra apropriado provavelmente terão impacto nas estimativas e precisam esclarecer os efeitos em médio e longo prazo.

Palavras-chave: Quadril; Reabilitação; Intensidade da dor; Funcionalidade; Força.

ABSTRACT

The hip strengthening exercise is often recommended in clinical practice to ensure better stability and movement patterns in many chronic musculoskeletal conditions of the trunk and lower limbs. However, the effectiveness of strengthening the hip in the pain intensity, disability, and muscular strength in chronic musculoskeletal conditions of the upper body and lower limbs is not clear. Therefore, this study aimed to investigate the effectiveness of hip strengthening in reducing the pain intensity and/or disability, and increasing the hip strength in chronic traumatic and non-traumatic musculoskeletal conditions. Only randomized controlled clinical trials were searched in the MEDLINE, COCHRANE, AMED, Embase, CINAHL, SPORTDiscus, and PEDro databases until June 8, 2021, without date and language restrictions were included in this study. Two independent reviewers evaluated studies including hip strengthening for patients with chronic musculoskeletal diseases of the trunk or lower limbs in the pain intensity pain, disability, and muscular strength. A third reviewer clarified possible disagreements. The methodological quality of clinical trials was assessed using the PEDro scale. The random effect models estimated the mean difference (MD) and the 95% confidence interval (CI). The strength of the evidence was assessed using the GRADE approach. The results show that strengthening the isolated hip compared to a control group (placebo, simulation, waiting list, or no intervention) can improve hip pain and/or muscular strength in patellofemoral pain. In addition, hip strengthening added to another intervention may be beneficial in improving disability in patients with low back pain. However, despite favorable results, the studies had low methodological quality and the evidence level was very low for all variables evaluated (pain intensity, disability, and muscular strength). The evidence level was decreased due to inaccuracy, inconsistency, and risk of bias, while strength decreased due to inaccuracy and bias risk. We can conclude that results point to hip strengthening as a beneficial intervention. Future works with appropriate sample size are likely to have an impact on estimates and need to clarify the medium and long-term effects.

Keywords: Hip; Rehabilitation; Intensity of pain; Functionality; Strength.

LISTA DE FIGURAS

LISTA DE TABELAS

SUMÁRIO

1 INTRODUÇÃO

O glúteo médio (GMed), o glúteo mínimo (GMin) e o tensor da fáscia lata (TFL) formam o que é comumente denominado grupo de músculos abdutores do quadril (FLACK *et al.,* 2012). É importante notar que as funções específicas de um músculo são parcialmente determinadas por sua morfologia e características arquitetônicas, como locais de inserção, volume do músculo e área seccional fisiológica. Nesse sentido, os músculos do quadril fornecem estabilidade pélvica no plano frontal, como por exemplo, a parte posterior do GMed descrita como importante na rotação externa e estabilização da pelve para que haja uma manutenção da cinemática adequada do joelho (SEMCIW *et al.*, 2016; RUSSELL *et al.,* 2006). Em situações típicas, os músculos abdutores do quadril, neutralizam a rotação da pelve, produzindo uma força oposta que, redireciona assim o centro de massa corporal na tentativa de manter o equilíbrio. (WARRENER *et al.*,2015). Alguns estudos já mostram que uma disfunção dessa musculatura promove diminuição no controle pélvico (SEMCIW *et al*., 2016).

Clinicamente, a adução femoral excessiva, durante atividades dinâmicas, pode resultar na fraqueza dos músculos abdutores do quadril, como glúteo médio, fibras superiores do glúteo máximo e o tensor da fáscia lata. Portanto, a diminuição da função da musculatura do quadril combinada com a carga repetitiva do membro inferior pode aumentar as lesões não apenas do joelho, mas de todo o membro inferior (STEINBERG *et al.,* 2017; SEMCIW *et al*., 2016; RUSSELL *et al*., 2006).

Déficits de força de músculos do quadril são comumente relatados em pessoa com dor lombar, dor patelofemoral, osteoartrite do joelho entre outras disfunções musculoesqueléticas crônicas (DE JESUS *et al*., 2020; ROGAN *et al*., 2019; DEASY *et al.,* 2016). A etiologia das lesões em tronco, perna, tornozelo e pé é considerada multifatorial com uma interação entre fatores intrínsecos, por exemplo desempenho muscular, sincronização muscular, e extrínsecos, por exemplo, frequência, intensidade e taxa de progressão (STEINBERG *et al*., 2017).

Os movimentos do membro inferior são interdependentes e essa interdependência é observada durante tarefas cotidianas como durante a marcha, corrida e tarefas de descer (ARAUJO *et al*., 2017). Logo, falhas no alinhamento dinâmico provocadas por déficits de força do quadril, ativação reduzida ou ambos afetam a estabilidade contribuindo para um padrão de movimento irregular durante realização de tarefas cotidianas (LEWIS *et al*., 2018; NGUYEN *et al*., 2011).

Com base na literatura apresentada, pode-se notar a associação da fraqueza de músculos do quadril em diversas disfunções musculoesqueléticas (REIMAN *et al*., 2012). Intervenções utilizando programas de fortalecimento de quadril são descritas na literatura e utilizadas na prática clínica. Entretanto, ainda há necessidade de entender o real efeito do fortalecimento de quadril em disfunções musculoesqueléticas crônicas, avaliando o nível de evidência dos estudos publicados e sua qualidade metodológica. Assim, propusemos a realização de uma revisão sistemática com metanálise para avaliar a eficácia do fortalecimento isolado de quadril e seu efeito aditivo a outra intervenção em condições musculoesqueléticas crônicas traumáticas e não traumáticas.

2 REFERÊNCIAS

DE JESUS, F. L. A; FUKUDA, T. Y; SOUZA, C; *et al*. Addition of specific hip strengthening exercises to conventional rehabilitation therapy for low back pain: a systematic review and meta-analysis. **Clin Rehabil**. 2020;34:1368-1377.

ROGAN, S; HAEHNI, M; LUIJCKX, E. *et al*. Effects of hip abductor muscles exercises on pain and function in patients with patellofemoral pain: A systematic review and meta-analysis. **J Strength Cond Res**., 2019;33:3174-318.

FLACK, N. A. M. S; NICHOLSON, H. D; WOODLEY, S. J. A review of the anatomy of the hip abductor muscles, gluteus medius, gluteus minimus, and tensor fascia lata. **Clinical anatomy**, 2012; v. 25, n. 6, p. 697-708.

RUSSELL, K. A; PALMIERI, R. M; ZINDER, S. M; *et al*. Sex Differences in Valgus Knee Angle During a Single-Leg Drop Jump. **J Athl Train**, 2006; 41:166-71.

SEMCIW, A; NEATE, R; PIZZARI, T**.** Running related gluteus medius function in health and injury: A systematic review with meta-analysis. **Journal of Electromyography and Kinesiology**, 2016; v. 30, p. 98-110.

ARAÚJO, V. L; SOUZA, T. Z; CARVALHAIS, V. O. C; *et al*. Effects of hip and trunk muscle strengthening on hip function and lower limb kinematics during step-down task. **Clin Biomech (Bristol, Avon)**, 2017; May;44:28-35.

DEASY, M; LEAHY, E; SEMCIW, A. I. Hip strength deficits in people with symptomatic knee osteoarthritis: a systematic review with meta-analysis. **Journal of Orthopaedic & Sports Physical Therapy**, 2016; v. 46, n. 8, p. 629-639.

WARRENER, A. G; LEWTON, K. L; PONTZER, H; *et al*. A wider pelvis does not increase locomotor cost in humans, with implications for the evolution of childbirth. **PLoS One**, 2015; 11;10(3):e0118903.

STEINBERG, N; DAR, G; DUNLOP, *et al*. The relationship of hip muscle performance to leg, ankle and foot injuries: a systematic review. **The Physician and sportsmedicine**, v. 45, n. 1, p. 49-63, 2017.

LEWIS, C. L; FOLEY, H. D; LEE, T. S; *et al*. Hip-Muscle Activity in Men and Women During Resisted Side Stepping With Different Band Positions. **J Athl Train.**, 2018;53(11):1071-1081.

NGUYEN, A. D; SHULTZ, S. J; SCHMITZ, R. J; *et al*. A preliminary multifactorial approach describing the relationships among lower extremity alignment, hip muscle activation, and lower extremity joint excursion. **J Athl Train**., 2011; May-Jun;46(3):246-56.

REIMAN, M. P; BOLGLA, L. A; LOUDON, J. K. A literature review of studies evaluating gluteus maximus and gluteus medius activation during rehabilitation exercises**. Physiother Theory Pract**., 2012;28(4):257-68.

3 ARTIGO CIENTÍFICO

Artigo a ser submetido à revista *Journal of Orthopaedic & Sports Physical Therapy* (JOSPT), fator de impacto 3,84.

Title: Efficacy of hip strengthening on pain intensity, disability and strength in musculoskeletal conditions of the trunk and lower limbs: A systematic review with meta-analysis and GRADE recommendations.

Authors: Angélica de Fátima Silva, PT[a]; Laísa Braga Maia, PT[a]; Vanessa Amaral Mendonça, PT, PhD[ab]; Jousielle Márcia dos Santos, PT, MSc[a]; Ana Carolina Coelho-Oliveira, PT, MSc[a]; Joyce Noelly Vitor Santos, PT, MSc[a]; Leticia Lana Vieira Moreira, SPT[b]; Vinícius Cunha Oliveira, PT, PhD[ab]; Ana Cristina Rodrigues Lacerda, PT, PhD[ab]

[a]Postgraduate Program in Rehabilitation and Functional Performance, Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM), Diamantina, Minas Gerais, Brazil.

[b]Department of Physiotherapy, Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM), Diamantina, Minas Gerais, Brazil.

FUNDING

There was no funding for this study.

COMPETING INTERESTS

The authors declare that they have none competing interests or personal relationships that could have appeared to influence the work reported in this paper.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

THE PUBLIC TRIAL REGISTER AND THE REGISTRATION NUMBER

The protocol was registered at PROSPERO (CRD42021227725) and at the Open Science Framework (DOI 10.17605/OSF.IO/3MCW8).

CORRESPONDING AUTHOR

Ana Cristina Rodrigues Lacerda

Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM)

Campus JK - Rodovia MGT 367- Km 583, nº 5000 - Alto da Jacuba – Diamantina, Minas Gerais, Brazil 39100-000 E-mail lacerda.acr@ufvjm.edu.br

Title: Efficacy of hip strengthening on pain intensity, disability and strength in musculoskeletal conditions of the trunk and lower limbs: A systematic review with meta-analysis and GRADE recommendations.

FUNDING

There was no funding for this study.

COMPETING INTERESTS

The authors declare that they have none competing interests or personal relationships that could have appeared to influence the work reported in this paper.

ACKNOWLEDGMENTS

We thank the Universidade Federal dos Vales do Jequitinhonha e Mucuri for institutional support, and the CNPq, CAPES- Finance Code 001, and FAPEMIG for support and scholarships.

ABSTRACT

Background: The effectiveness of hip strengthening in musculoskeletal conditions of the trunk and lower limbs is unclear. This study aims to investigate the efficacy of hip strengthening on pain intensity, disability and strength of hip abductors in musculoskeletal conditions. Methods: We searched MEDLINE, COCHRANE, AMED, Embase, CINAHL, SPORTDiscus, and PEDro databases for randomized controlled clinical trials up to June 8nd 2021 without date and language restrictions. Two independent reviewers evaluated studies and discrepancies were resolved by a third reviewer. The methodological quality of clinical trials was assessed using the 0- 10 PEDro scale. Random-effect models estimated mean differences (MDs), and 95% confidence intervals (CIs). The quality of the evidence was assessed using the GRADE approach. Results: Seven clinical trials met the eligibility criteria and were included (n = 357 patients). Very low quality evidence was found for all evaluated outcomes. For the pain intensity and hip strength, there was a clinically relevant effect of hip strengthening compared to the control in patellofemoral pain (DM = 4.1 points; 95% CI 2.1 to 6.2;) (MD = 3, 9 points; 95% CI 2.8 to 5.1;) respectively. No additional effect to another intervention was observed in the hip strengthening in patellofemoral pain (MD = 0.4 points; 95% CI -0.9 to 1.7) or in low back pain (MD = -0.3 points; 95% CI -1.7 to 1.1). For disability, there was no effect on strengthening the hip in patellofemoral pain when compared to the control (MD = 29.3 points; 95% CI -9.2 to 67.8) and no additional effect to another intervention (95% CI -10.7 to 10.7). Evidence suggested that the addition of hip strengthening to another intervention may achieve clinical importance in low back pain (MD = 7.5 points; 95% CI 2.9 to 12.1). Conclusion: Despite a level of evidence classified as very low, in the short term, strengthening the autonomous hip improves pain intensity and hip muscular strength in patients with patellofemoral pain, as well as strengthening the hip added to another

intervention may be beneficial to improve disability in patients with low back pain. Future high-quality assays with appropriate sample sizes are likely to impact the estimates and need to clarify the medium and long-term effects.

Keywords: Hip strengthening, rehabilitation, musculoskeletal conditions.

INTRODUCTION

The stability of the lumbopelvic complex depends on the gluteal muscles' efficiency in the sagittal, transverse and frontal planes. [10,12,38] The weakness and/or reduced activation of the gluteal muscles was previously described as responsible for changes in the kinetics and/or kinematics of the trunk, hips and/or lower limbs, leading to instability. [19,34] Moreover, their weakness and inadequate neuromuscular function may result in dynamic valgus and have been reported to be a potential risk factor[34] and associated with pain intensity, disability and/or reduced hip strength in patients with musculoskeletal conditions; e.g., patellofemoral pain, and low back pain. [1,6,12] In this context, hip strengthening exercise, focusing on the gluteus muscles, is often recommended in clinical practice to improve stability and movement patterns in many musculoskeletal conditions of the trunk and lower limbs. [12]

Preliminary basic and clinical research suggest effects of hip strengthening focusing on the gluteus muscles[1,6,12]; however, its efficacy to improve pain intensity, disability and/or hip strength in different musculoskeletal conditions in the trunk and lower limbs, and the certainty of the current evidence is still unclear. [31,38,40] In this sense, despite previous systematic review evaluated the addition of specific hip strengthening exercises to conventional rehabilitation therapy for different chronic conditions, i.e., low back pain and patellofemoral pain, non-randomized clinical trial studies and / or case studies with low methodological quality were included impacting the interpretation of the evaluation of the quality and strength of the evidence. [40,38,32] In addition, there was a misinterpretation regarding the eligibility criterion since were inserted works evaluating hip strengthening compared to other intervention than the

condition of interest. [35] Finally, remains a gap regarding the efficacy of hip strengthening on gluteus strength for chronic conditions justifying a systematic review with this focus. Therefore, the aim of this systematic review was to investigate the efficacy and the quality of current evidence of hip strengthening on pain intensity, disability and gluteus strength in people with traumatic and non-traumatic musculoskeletal disorders of the trunk and lower limbs.

METHODS

Search strategy and inclusion criteria

This systematic review of randomized controlled trials followed the PRISMA checklist[30], and the protocol was registered at PROSPERO (CRD42021227725) and at the Open Science Framework (DOI 10.17605/OSF.IO/3MCW8).

Search strategy was conducted on MEDLINE, COCHRANE - Central Register of Controlled Trials, COCHRANE - Database of Systematic Reviews, AMED - Allied and Complementary Medicine, Embase, CINAHL, SPORTDISCUS, and PEDRO database up to June 8nd 2021 without date and language restrictions. Detailed search strategy is in Appendix 1 on the Addenda, and descriptors were related to 'randomized controlled trial' and 'hip exercise'. In addition, we hand searched previous systematic reviews identified in the field for potentially relevant full texts.

To be included, randomized controlled trials had to investigate the effectiveness of any gluteus strength exercise training defined according to the American College of Sports Medicine (ACSM) as strength exercise, which could generate a muscle power representing the product of the strength, and speed that a muscle can produce per unit of time. [3] The population of interest was patient with any traumatic or non-traumatic musculoskeletal conditions of the trunk and/or lower limbs. Trials investigating serious conditions were excluded (e.g., neurological disorders, rheumatoid arthritis, tumor). The comparator of interest (control group) was placebo, sham, waiting list or no intervention to investigate the isolated effects of the intervention of interest. In addition, we included trials investigating whether hip strengthening combined with other active intervention enhances effectiveness of the other active intervention stand alone. The outcomes of interest were neuromuscular function (e.g., muscle strength, power, muscle activation of the gluteus muscle), pain intensity (evaluated by any Numerical Rating Scale – NRS or Visual Analog Scale - VAS) and disability (evaluated by any valid instrument).

Selection of trials and assessment of methodological quality

After the searches, identified references were exported to an Endnote® file and the duplicates were removed. Two independent reviewers (AFS, JMS) screened titles and abstracts, and assessed potential full texts considering our eligibility criteria. The eligible full texts were included in the systematic review. A third reviewer (LBM) resolved between-reviewer discrepancies.

Methodological quality was assessed independently by two reviewers (AFS, JMS) using the 0-10 Physiotherapy Evidence Database (PEDro) scale. [13,42] The PEDro scale is widely used to evaluate risk of bias of clinical trials in systematic reviews in physiotherapy[13] and is valid and reliable. [31] When possible, we used scores already available in the Physiotherapy Evidence Database (https://www.pedro.org.au/). [13,42]

Data extraction

Two independent reviewers (AFS, JMS) extracted characteristics and outcome data from the included trials. A third reviewer (LBM) resolved between-reviewer discrepancies. Characteristics extracted included: participants (i.e., gender, age, setting); description of the intervention of interest (i.e., types and dosages) and comparators; outcomes; instrument measures; and follow-ups. Outcome data extracted at short-, medium- and long-term effects included: sample sizes; means; and standard deviations (SDs) for all groups of interest. Post-intervention scores were preferably used. When not available, we extracted changes from baseline. [14,18] The short-term effect was considered a follow-up up to three months after the baseline, the medium-term effect was considered a follow-up over three months and less than twelve months after the baseline, and the long-term effect was considered a follow-up of at least 12 months after the randomization. When more than one time point was available at short-, medium- or long-terms, the one closer to the end of the intervention was considered. [2,22]

Missing outcome data were imputed following the Cochrane recommendations[9] SDs were imputed from confidence intervals and values of MDs differences shown in graphs and tables. [22]

When trials investigated more than one similar exercise compared with control[39], we combined outcome data also following the Cochrane recommendations. [9] When possible, we transformed outcome data measured with different scales to a similar scale before pooling (i.e., 11-point pain scale, 101-point disability scale). [9]

Data analysis

Meta-analysis was conducted using random-effects model (DerSimonian and Laird method) when possible, and mean differences (MDs) with 95% confidence intervals (CIs) were presented for each specific health condition in forest-plots. The effect was evaluated by the Z test, and a p-value <0.05 was considered statistically significant. The clinical importance of the intervention was interpreted by comparing the estimated effect sizes and 95% CIs with the minimal clinically important difference (MCID)[27] $\geq$10% of the pain intensity and disability scales. [38] When pooling was not possible, data from individual trials were reported.

Two independent reviewers (AFS and JMS) assessed the quality of the current evidence using the GRADE methodology [5,20], and between-reviewer discrepancies were resolved by a third author (LBM). After appraising the evidence, each meta-analysis was classified as 1 of the following levels:

• High-quality evidence: further research is very unlikely to change our confidence in the estimate of effect.

133 • Moderate-quality evidence: further research is likely to have an important impact on our
134 confidence in the estimate of effect and may change the estimate.

135 • Low-quality evidence: further research is very likely to have an important impact on our
136 confidence in the estimate of effect and is likely to change the estimate

137 • Very low–quality evidence: any estimate of effect is very uncertain.

138

139 Randomized controlled trials began with a high-quality evidence classification but were
140 downgraded based on 5 domains: (1) study design and risk of bias (downgraded if greater than
141 25% of the participants were from studies with a high risk of bias, which we defined as PEDro
142 scale scores of less than 6) [15]; (2) inconsistency of results (downgraded if significant
143 heterogeneity was present on visual inspection or the I^2 value was greater than 50%); (3)
144 indirectness (generalizability of the findings downgraded if greater than 50% of the participants
145 were outside the target group); (4) imprecision (downgraded if fewer than 400 participants were
146 included in the comparison for continuous data; <200 were considered very serious imprecision
147 and downgraded in two levels) [21]; and (5) other (publication bias). We reduced the quality of
148 evidence by 1 level for each domain not met in the comparison to determine the overall quality
149 rating of the evidence for each meta-analysis performed. [22] We planned to evaluate publication
150 bias using the visual inspection of funnel plots and the Egger's test adopting an $\alpha = 0.1$; however,
151 it was not possible because of the small number of included trials (i.e., <10 trials analyzed). [24]

152

We planned sensitivity analyses to investigate the impact of poor methodological quality on the estimates by removing trials scored <6 on the 0−10 PEDro scale, following the recommendations. [22] Meta-regression was not possible because of the small number of included trials. [22] All analyses were conducted using the Comprehensive Metanalysis software, version 2.2.04 (Biostat, Englewood, NJ).

RESULTS

Searches identified a total of 1,354 studies after removing duplicates, 133 potential full texts were evaluated, and 7 original trials (357 patients) were included in the review. Main reasons for excluding potential full texts were non-randomized trials (n = 10), not condition of interest (n = 106), and not comparison of interest (n = 10). **FIGURE 1** detailed the flow of studies throughout the review.

Study characteristics

This systematic review included seven original trials published between 2010 and 2018: one conducted in Europe; three conducted in South America; and two in Asia. All trials investigated non-traumatic musculoskeletal conditions: three investigated patellofemoral pain[16,28,37]; and four investigated chronic low back pain. [4,25,27,29] The sample size of the included trials ranged from 20 to 90 participants and consisted of patients aged between 22 and 61 years old. Five trials included only female[16,25,27,28,37], one included both sex[4], and the remaining study did not report sex distribution. [29] Three trials investigated efficacy of hip strengthening when compared with

control group of interest (i.e., placebo, sham, waiting list or no intervention), and four trials investigated whether hip strengthening combined with other active intervention enhances effect of the other active intervention stand alone. Numeric Pain Rating Scale[4,16], Visual Analogue Scale[27,28,29,37], and Anterior knee pain scale measured pain intensity. [37] The self-reported disability was assessed by the Modified Oswestry Disability Index[4,27,29], Lower Extremity Functional Scale[16], Western Ontario and McMaster Universities. [28] The hip strength was assessed by Handheld Isometric Dynamometer, Force Dynamometer. [27,37] Only short-term effects (i.e., ≤ 3 months) were investigated. The characteristics of the hip strengthening programs included the duration of the intervention programs (which ranged from two to eight weeks), frequency (from 2 to 3 times per week; one trial[27] did not report the frequency of the week) and the duration of the session (on average 20min per session to 50min per session). Detailed characteristics of the seven trials are in **TABLE 1**.

Methodological quality of the included trials

The PEDro scores for the included trials ranged from 4 to 9 points on the 0 to 10 scale, resulting in a median of 6 points. Three out of the seven trials scored at least 6 points on the 0-10 PEDro scale. The main issues were lack of blinding of participants (n = 7, 100%), lack of blinding of therapists (n = 4, 57.1%), lack of blinding of assessors (n = 4, 57.1%) and absence of intention to treat analysis (n = 5, 71.4%). Detailed methodological quality of included trials is in **TABLE 2.**

Summary of evidence

All seven studies investigated the short-term effects (i.e. ≤ 3 months) and were rated with a very low quality of evidence for pain intensity, disability and hip strength. The reasons for downgrading the quality of the evidence were inaccuracy (four times), inconsistency (four times) and risk of bias (four times).

For pain intensity (11-point pain scale), we found very-low quality evidence for a clinically relevant effect of hip strengthening on patellofemoral pain intensity compared with control (MD = 4.1 points; CI 95 % 2.1 to 6.2; two trials, n = 48 patients). Very-low quality evidence suggested no additional effect of hip strengthening on patellofemoral pain (MD = 0.4 points; 95% CI -0.9 to 1.7; one trial, n = 41 patients) or on low back pain (MD = -0.3 points; 95% CI -1.7 to 1.1; three trials, 200 participants). **FIGURE 2**

For disability (101-point disability scale), we found very-low quality evidence for no effect of hip strengthening on patellofemoral pain compared with control (MD = 29.3 points; 95% CI -9.2 to 67.8; two trials, n = 48 participants). Very-low quality evidence also suggested an additional effect that may reach clinical importance on low back pain (MD = 7.5 points; 95% CI 2.9 to 12.1; four trials, 240 participants), and no additional effect on patellofemoral pain (95% CI -10.7 to 10.7; one trial, 41 participants). **FIGURE 3**

In addition, very low quality evidence suggested an effect of isolated strengthening on hip strength compared to control in patients with patellofemoral pain (MD = 3.9 points; 95% CI 2.8

to 5.1; two trials, n = 48 participants). It was not possible to conduct planned sensitivity analyses because of the small number of included trials. **FIGURE 4**

DISCUSSION

This systematic review with meta-analysis investigated the effectiveness of hip strengthening in reducing the intensity of pain and / or disability and increasing the gluteus strength in chronic musculoskeletal conditions, e.g., low back pain and patellofemoral pain. The results for the pain intensity and hip strength suggest an improvement regarding the hip strengthening compared to the control on patellofemoral pain. No additional effect to another intervention was observed in the hip strengthening in musculoskeletal chronic conditions. For disability, there was no effect on strengthening the hip in patellofemoral pain compared to the control and no additional effect to another intervention. Evidence suggested that the addition of hip strengthening to another intervention may achieve clinical importance on low back pain.

This review followed the recommendations of Cochrane, Prisma and analysis of the strength of evidence by GRADE[5]. Despite extensive research to address all possible interventions aimed at strengthening the hip in different chronic musculoskeletal conditions and populations, the literature presents a lack of evidence. Our systematic review reinforces the need for improvement in methodological quality, level of evidence and understanding of the size of the effect of strengthening hip abductors in musculoskeletal conditions. In addition, because the works reported insufficiently details about interventions not allowing their replications, we recommend future works follows the TIDieR checklist seeking to making easier for authors to structure

reports of their interventions, reviewers and editors to evaluate descriptions and for readers to use the information. [23]

Although there were previous systematic reviews that investigated the influence of hip strengthening on pain intensity and disability in patients with chronic musculoskeletal disorders, non-randomized studies and / or case studies were included as inclusion criteria and did not perform meta-regression[35,40], others defined the patient's condition instead of considering a set of chronic musculoskeletal conditions. [8,43]

A recent study [8] provided evidence of moderate quality for level of evidence for a modest effect size of pain intensity and disability in the treatment of patients with low back pain. Our results demonstrated a favorable effect of strengthening the hip as an active intervention in the short term with a level of evidence classified as very low. These differences can be partially explained by differences in data analysis and inclusion criteria, e.g., we did not include studies with another active therapy as a comparison group. The literature[3] define exercise modalities that can be considered such as resistance exercises, strength exercises, and this definition was adopted for our study. On the other hand, previous reviews found evidence including different modalities of exercises for the hip, not specifically for strength gain. Thus, the inclusion criteria may have led to less heterogeneity between the studies found in our estimates compared to previous reviews that downgraded the evidence due to inconsistency.

Five studies [4,16,25,27,29] evaluated hip strengthening as an additive effect to another intervention, and after an analysis of subgroups by condition, patellofemoral pain and chronic low back pain, there was no significant difference. The level of evidence in all trials was rated low. In this context, future high-quality studies are needed, which may alter the results and effects estimated by this review. A previous meta-analysis performed by Rogan and colleagues[35], focused on the evaluation of the isolated and additive effect of hip strengthening in patients with patellofemoral pain, found positive effect of hip strengthening for pain intensity and disability; however, the result of the quality and strength of the evidence may have been overestimated because non-randomized clinical trial works were included.

Even in a very short-term of a strength training program is expected gains in terms of muscular strength because of the increased muscle activation and frequency of firing, as well as synchronization of the motor units, and reduction in the co-activation of the antagonistic muscles during exercise. In this sense, about the effectiveness of hip strengthen for gluteus strength in chronic musculoskeletal conditions, despite works showed a positive short-term effect, the method employed to evaluate gluteus strength was inappropriate because used the handheld isometric dynamometer instead of a gold standard, i.e., isokinetic dynamometer device. In addition, the works failed to inform about the load prescription including type, duration, frequency, intensity, and load progression. In addition, only two studies mentioned that performed a one-repetition maximum test for the load prescription. [33]

MCID to pain intensity and functionality for patients with chronic musculoskeletal disorders was reported in 10%.[7,11,41] Corroborating our work, van der Heijden and colleagues [42] found very low quality, but consistent evidence that exercise therapy for patellofemoral pain syndrome (PFPS) can result in the reduction of clinically important pain and in the improvement of functional capacity. Dworkin et al[11] considered that the clinically important change varies a lot in the literature for chronic low back pain being the majority presenting an average difference between the groups greater than 10%. Gianola et al[17] investigating patients with chronic low back pain found that 60% (25 RCTs) were statistically significant, while only 36% (15 RCTs) were statistically and clinically significant.

The main reasons for reducing the strength of the evidence in this review are related to inaccuracy, inconsistency and risk of bias, with this review being carefully evaluated by Guideline. In addition, we sought the best methodology to be adopted and strictly follow the protocol, with high precision and reliability in the search, extraction and interpretation of data by the reviewers, and updating the literature with more recent studies.

Our systematic review is reinforced by the fact that we have used a larger number of databases, recent data extraction and inclusion of different chronic musculoskeletal conditions, for example, patellofemoral pain, low back pain and addition of hip strength result. This approach increased the accuracy of our estimates, but had a potential limitation in increasing heterogeneity in our meta-analysis. Thus, other high-quality studies may increase our certainty regarding the effectiveness of strengthening the hip in chronic musculoskeletal conditions.

Strengths and limitations

This systematic review has some strengths, including that it was conducted with strong methodological rigor following the recommendations of the Cochrane Handbook[22] and included trials that investigated the effectiveness of any strength or resistance exercise for the hip defined according to the American College of Sports Medicine as a strength exercise. [3] However, this review has some limitations. Despite the small number of studies included, it was not possible to further explore heterogeneity, as well as a sensitivity analysis of the data. In this context, future high-quality studies are needed, which may alter the results and effects estimated by this review.

CONCLUSION

Our results show the strengthening of the hip as an autonomous active intervention to improve intensity pain and / or strength on patellofemoral pain. In addition, strengthening the hips added to another active intervention can be beneficial in improving disability in patients with low back pain. However, the very low quality of the evidence indicates that, despite a tendency to recommend the hip strengthening exercise, more studies of high methodological quality and level of evidence are still needed. Thus, future trials are likely to affect the estimates and may fill gaps in the literature as to the medium and long-term effects, as well as increase the methodological quality and the level of evidence of the short-term effect.

KEY POINTS

Findings: Seven trial supported by ‘very low’ quality of evidence point hip strengthening, in short-term, as a stand-alone active intervention to improve pain intensity and/or strength in patients with patellofemoral pain. In addition, hip strengthening added to another active intervention stand-alone may be beneficial in short-term for improving disability in patients with low back pain.

Implications: There is a dire need for adequately developing of high-quality studies to investigate the hip strengthening on musculoskeletal chronic conditions. Moreover, researchers should design trials with appropriate sample sizes to estimates and clarify medium- and long-term effects.

Caution: Despite the small number of trials that were included, it was not possible further exploration of heterogeneity as well as a sensitivity analysis of the data.

335 **REFERENCES**

336 1. Akuthota V, Ferreiro A, Moore T, Fredericson, M. Core stability exercise principles. *Curr*
337 *Sports Med Rep*. 2008;7:39-44. https://doi.org/10.1097/01.csmr.0000308663.13278.69
338 2. Amaral LK et al. Efficacy of conservative therapy in older people with nonspecific low back
339 pain: A systematic review with meta-analysis and GRADE recommendations. *Arch Gerontol*
340 *Geriatr*. 2020;104177. https://doi.org/10.1016/j.archger.2020.104177
341 3. American College of Sports Medicine. *ACSM's Resources for the Personal Trainer*. 4th ed.
342 Baltimore, MD: Lippincott Williams & Wilkins; 2013.
343 4. Bade M, Cobo-Estevez M, Neely D, Pandya J, Gunderson T, Cook C. Effects of manual
344 therapy and exercise targeting the hips in patients with low-back pain—A randomized
345 controlled trial. *J Eval Clin Pract*. 2017;23:734-740. https://doi.org/10.1111/jep.12705
346 5. Balshem H et al. GRADE guidelines: 3. Rating the quality of evidence. *J Clin Epidemiol*.
347 2011;64:401-406. https://doi.org/10.1016/j.jclinepi.2010.07.015
348 6. Cashman GE. The effect of weak hip abductors or external rotators on knee valgus kinematics
349 in healthy subjects: a systematic review. *J Sport Rehabil*. 2012;21:273-284.
350 https://doi.org/10.1123/jsr.21.3.273
351 7. Copay AG, Eyberg B, Chung AS, Zuercher KS, Chutkan N, Spangehl, MK. Minimum
352 clinically important difference: current trends in the orthopaedic literature, part II: lower
353 extremity: a systematic review. *JBJS Rev.* 2018;6:e2.
354 https://doi.org/10.2106/JBJS.RVW.17.00160
355 8. De Jesus FLA et al. Addition of specific hip strengthening exercises to conventional
356 rehabilitation therapy for low back pain: a systematic review and meta-analysis. *Clin Rehabil*.
357 2020;34:1368-1377. https://doi.org/10.1177/0269215520941914

9. Deeks JJ, Higgins JP, Altman DG, Cochrane Statistical Methods Group. (2019). Analysing data and undertaking meta-analyses. *Cochrane handbook for systematic reviews of interventions*. 2nd ed. Pondicherry, India: John Wiley& Sons; 2019:241-284.
10. Distefano LJ, Blackburn JT, Marshall SW, Padua DA. Gluteal muscle activation during common therapeutic exercises. *J Orthop Sports Phys Ther*. 2009;39:532-540. https://www.jospt.org/doi/10.2519/jospt.2009.2796
11. Dworkin RH et al. Interpreting the Clinical Importance of Treatment Outcomes in Chronic Pain Clinical Trials: IMMPACT Recommendations. *J Pain*. 2008;9:105-21. https://doi.org/10.1016/j.jpain.2007.09.005
12. Ebert JR, Edwards PK, Fick DP, Janes GC. A Systematic Review of Rehabilitation Exercises to Progressively Load Gluteus Medius. *J Sport Rehabil*. 2017;26:418-436. https://doi.org/10.1123/jsr.2016-0088
13. Elkins MR, Moseley AM, Sherrington C, Herbert RD, Maher CG. Growth in the Physiotherapy Evidence Database (PEDro) and use of the PEDro scale. *Br J Sports Med*. 2013;188-189. http://dx.doi.org/10.1136/bjsports-2012-091804
14. Feldwieser F et al. Evaluation of biofeedback based bridging exercises on older adults with low back pain: A randomized controlled trial. *Physiother Pract Res*. 2018;39:15-25. https://doi.org/10.3233/PPR-170109
15. Foley NC, Teasell RW, Bhogal SK, Speechley MR. Stroke rehabilitation evidence-based review: methodology. *Top Stroke Rehabil*. 2003;10:1-7. https://doi.org/10.1310/Y6TG-1KQ9-LEDQ-64L8
16. Fukuda TY, Rossetto FM, Magalhães E, Bryk FF, Lucareli PRG, Carvalho NAAC. Short-term effects of hip abductors and lateral rotators strengthening in females with patellofemoral

pain syndrome: a randomized controlled clinical trial. *J Orthop Sports Phys Ther*. 2010;40:736-742. https://www.jospt.org/doi/10.2519/jospt.2010.3246

17. Gianola S, Castellini G, Corbetta D, Moja L. Rehabilitation interventions in randomized controlled trials for low back pain: proof of statistical significance often is not relevant. *Health Qual Life Outcomes*.2019;17:1-8. https://doi.org/10.1186/s12955-019-1196-8
18. Goode AP, Taylor SS, Hastings SN, Stanwyck C, Coffman CJ, Allen KD. Effects of a home-based telephone-supported physical activity program for older adult veterans with chronic low back pain. *Phys Ther.* 2018;98:369-380. https://doi.org/10.1093/ptj/pzy026
19. Goto S, Aminaka N, Gribble PA. Lower Extremity Muscle Activity, Kinematics, and Dynamic Postural Control in Individuals With Patellofemoral Pain. *J Sport Rehabil*. 2017;1-29. https://doi.org/10.1123/jsr.2016-0100
20. Guyatt GH et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ*. 2008;336:924-926. https://doi.org/10.1136/bmj.39489.470347.AD
21. Hart RG, Pearce LA, Aguilar MI. Meta-analysis: antithrombotic therapy to prevent stroke in patients who have nonvalvular atrial fibrillation. *Ann Intern Med*. 2007;146:857-867. https://doi.org/10.7326/0003-4819-146-12-200706190-00007
22. Higgins JPT, T.J., Chandler, J., Cumpston, M., Li, T., Page, M.J., & Welch, V.A. (2019). Cochrane handbook for systematic reviews of interventions version 6.0. (updated July 2019). Cochrane. https://doi.org/Available.from www.training.cochrane.org/ handbook
23. Hoffmann TC et al. Better reporting of interventions: template for intervention de scription and replication (TIDieR) checklist and guide. *BMJ*, 2014, v. 348. https://doi.org/10.1136/bmj.g1687

403 24. Ioannidis JP. Integration of evidence from multiple meta-analyses: a primer on umbrella
404 reviews, treatment networks and multiple treatments meta-analyses. *CMAJ*. 2009;181:488-
405 493. https://doi.org/10.1503/cmaj.081086
406 25. Jeong UC, Sim JH, Kim CY, Hwang-Bo G, Nam CW. The effects of gluteus muscle
407 strengthening exercise and lumbar stabilization exercise on lumbar muscle strength and
408 balance in chronic low back pain patients. *J Phys Ther Sci*. 2015;27:3813-3816.
409 https://doi.org/10.1589/jpts.27.3813
410 26. Kamper SJ. Showing confidence (intervals). *Braz J Phys Ther*. 2019;23:277.
411 https://dx.doi.org/10.1016%2Fj.bjpt.2019.01.003
412 27. Kendall KD, Emery CA, Wiley JP, Ferber R. The effect of the addition of hip strengthening
413 exercises to a lumbopelvic exercise programme for the treatment of non-specific low back
414 pain: A randomized controlled trial. *J Sci Med Sport*. 2015;18:626-631.
415 https://doi.org/10.1016/j.jsams.2014.11.006
416 28. Khayambashi K, Mohammadkhani Z, Ghaznavi K, Lyle MA, Powers CM. The Effects of
417 Isolated Hip Abductor and External Rotator Muscle Strengthening on Pain, Health Status, and
418 Hip Strength in Females With Patellofemoral Pain: A Randomized Controlled Trial. *J Orthop*
419 *Sports Phys Ther*. 2012;42:22-29. https://www.jospt.org/doi/10.2519/jospt.2012.3704
420 29. Lee SW, Kim SY. Effects of hip exercises for chronic low-back pain patients with lumbar
421 instability. *J Phys Ther Sci*. 2015;27:345-348. https://doi.org/10.1589/jpts.27.345
422 30. Liberati A et al. The PRISMA statement for reporting systematic reviews and meta-analyses
423 of studies that evaluate health care interventions: explanation and elaboration. *J Clin*
424 *Epidemiol*. 2009;62:e1-e34. https://doi.org/10.1016/j.jclinepi.2009.06.006

31. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. *Phys Ther*. 2003;83:713-721. https://doi.org/10.1093/ptj/83.8.713

32. Neto WK et al. Gluteus Maximus Activation during Common Strength and Hypertrophy Exercises: A Systematic Review. *J Sports Sci Med*. 2020;19:195-203.

33. Pareja-Blanco F et al. Effects of velocity loss in the bench press exercise on strength gains, neuromuscular adaptations, and muscle hypertrophy. *Scandinavian Journal of Medicine & Science in Sports* 2020; v. 30, n. 11, p. 2154-2166. https://doi.org/10.1111/sms.13775

34. Parr M, Price PDB, Cleather DJ. Effect of a gluteal activation warm-up on explosive exercise performance. *BMJ Open Sport Exerc Med*. 2017;3:e000245. http://dx.doi.org/10.1136/bmjsem-2017-000245

35. Rogan S, Haehni M, Luijckx E, Dealer J, Reuteler S, Taeymans J. Effects of hip abductor muscles exercises on pain and function in patients with patellofemoral pain: A systematic review and meta-analysis. *J Strength Cond Res*. 2019;33:3174-3187. https://doi.org/10.1519/JSC.0000000000002658

36. Rubinstein SM, van Middelkoop M, Assendelft WJ, de Boer MR, van Tulder MW. Spinal manipulative therapy for chronic low-back pain: an update of a Cochrane review. *Spine*. 2011;36:E825-E846. https://doi.org/10.1097/BRS.0b013e3182197fe1

37. Saad MC, Vasconcelos RA, Mancinelli LVO, Munno MSB, Liporaci RF, Grossi DB. Is hip strengthening the best treatment option for females with patellofemoral pain? A randomized controlled trial of three different types of exercises. *Braz J Phys Ther*. 2018;22:408-416. https://doi.org/10.1016/j.bjpt.2018.03.009

38. Sadler S, Cassidy S, Peterson B, Spink M, Chuter V. Gluteus medius muscle function in people with and without low back pain: a systematic review. *BMC Musculoskelet Disord*. 2019;20:463. https://doi.org/10.1186/s12891-019-2833-4

39. Shirazi M et al. The effect of topical Rosa damascena (rose) oil on pregnancy-related low back pain: a randomized controlled clinical trial. *J Evid Based Complementary Altern Med.* 2017;22:120-126. https://doi.org/10.1177%2F2156587216654601

40. Thomson C, Krouwel O, Kuisma R, Hebron C. The outcome of hip exercise in patellofemoral pain: a systematic review. *Man Ther*. 2016;26:1-30. https://doi.org/10.1016/j.math.2016.06.003

41. van der Heijden RA, Lankhorst NE, van Linschoten R, Bierma-Zeinstra SM, van Middelkoop M. Exercise for treating patellofemoral pain syndrome. *Cochrane Database Syst Rev*. 2015;1. https://doi.org/10.1002/14651858.CD010387.pub2

42. Yamato TP, Maher C, Koes B, Moseley A. The PEDro scale had acceptably high convergent validity, construct validity, and interrater reliability in evaluating methodological quality of pharmaceutical trials. *J Clin Epidemiol.* 2017;86:176-181. https://doi.org/10.1016/j.jclinepi.2017.03.002

43. Zacharias A, Green RA, Semciw AI, Kingsley MIC, Pizzari T. Efficacy of rehabilitation programs for improving muscle strength in people with hip or knee osteoarthritis: a systematic review with metaanalysis. *Osteoarthritis Cartilage*. 2014;22:1752-1773. https://doi.org/10.1016/j.joca.2014.07.005

TABLE 1. Characteristics of the included trials (n=7).

Study	Source	Participants	Intervention	Outcome measures
Bade et al. (2017)	Patients with low back pain Location: Germany	N = 90 Age 46.4 (SD 2.8) Gender M: 53 F: 37	Exp1 =Lumbar strengthening (Exercises to low-back pain treatment). 2x/weeks, 50 min/session, over 2weeks (n=43, age: 48.1 (SD 2.4)) Exp2 =Lumbar + hip strengthening (Exercises to low-back pain treatment associated with exercises to strengthen hip stabilizing muscles). 2x/weeks, 50 min/session, over 2weeks (n=47, age: 44.8 (SD 2.3))	Pain intensity: NPRS (0-10) Disability: ODI (0-50) Follow-up: 2 weeks (short-term)
Fukuda et al. (2010)	Patients with patellofemoral pain Location: Brazil	N = 66 Age 24.6 (SD 6.6) Gender M: 0	Exp1= Knee strengthening (Exercises to strengthen quadriceps). 3x/weeks, 50 min/session, over 4 weeks (n=20, age: 25.0 (SD 6.0)) Exp2 = Knee + hip strengthening (Exercises to strengthen quadriceps and exercises to strengthen the hip abductor and lateral rotator muscles). 3x/weeks, 50 min/session, over 4 weeks (n=21, age: 25.0 (SD 7.0)) Con = No intervention (n = 25, age 24.0 (SD 7.0))	Pain intensity: NPRS (0-10) Disability: LEFS (0-80) Follow-up: 4 weeks (short-term)

		F: 66		
Jeong et al. (2015)	Patients with low back pain Location: Korea	N = 40 Age 41.2 (SD 6.1) Gender M: 0 F: 40	Exp1= Lumbopelvic muscles + gluteus strengthening (Exercises to strengthen gluteus). 3x/weeks, 50 min/session, over 6 weeks (n=20, age: 41.2 (SD 5.5)) Exp2 = Lumbopelvic muscles strengthening (Exercises to strengthen lumbopelvic muscles). 3x/weeks, 50 min/session, over 6 weeks (n=20, age: 41.2 (SD 6.7))	Disability: ODI (0-50) Follow-up: 6 weeks (short-term)
Kendall et al. (2014)	Patients with low back pain Location: Brazil	N = 80 Age 37 (SD 35.5) Gender M: 0 F: 80	Exp1 = Lumbopelvic muscles strengthening (Focused on the performance of the motor skill of co-contracting the transversus abdominis, multifidus, and pelvic floor muscles). 6 weeks (n=40, age: 33 (SD 33.4)) Exp2 = Lumbopelvic muscles + hip strengthening (Co-contracting the transversus abdominis, multifidus, and pelvic floor muscles associated with open and closed kinetic chain hip strengthening exercises). 6 weeks (n=40, age: 41 (SD 37.45))	Pain intensity: VAS (0-100) Disability: ODI (0-50) Strength: Force dynamometer Follow-up: 6 weeks (short-term)
Khayambashi et al. (2012)	Patients with patellofemoral	N = 28	Exp1= hip strengthening (Exercises to strengthen hip external rotator muscles). 3x/weeks, 30 min/session, over 8 weeks (n=14, age: 28.9 (SD	Pain intensity: VAS (0-10)

	pain (PFP) Location: Iran	 Age 29.7 (SD 5.3) Gender M: 0 F: 28	5.8)) Con = No intervention (n = 14, age 30.5 (SD 4.8))	 Disability: WOMAC (0-100) Strength: Handheld isometric dynamometer Follow-up: 6 weeks (short-term)
Lee & Kim (2015)	Patients with low back pain Location: Iran	N = 33 Age 60.46 (SD 14.4) Gender: S/N	Exp = Hip strengthening + lumbar strengthening (Exercises to strengthen hip including flexion, extension, abduction, and adduction, internal rotation and external rotation). 3x/weeks, 20 min/session, over 6 weeks (n= 22, age:61.0 (SD 13.2)) Con = Lumbar strengthening (Exercises for lumbar stabilization). 3x/weeks, 20 min/session, over 6 weeks (n= 11, age:59.38 (SD 17.3))	Pain intensity: VAS (0-100) Disability: ODI (0-50) Follow-up: 3 weeks (short-term)
Saad et al. (2018)	Patients with patellofemoral pain (PFP) Location: Brazil	N = 20 Age 22.85 (SD 1.1) Gender	Exp2 = Hip strengthening (Exercises to strengthen hip stabilizing muscles). 2x/weeks, 50 min/session, over 8 weeks (n=10, age: 22.5 (SD 1.08)) Con = No intervention (n = 10, age 23.2 (SD 1.03))	Pain intensity: VAS (0- 10) Disability: AKPS (0-100) Strength: Handheld isometric dynamometer

	M: 0 F: 20	Follow-up: 8 weeks (short-term)

Abbreviations: M: male; F: female; Exp: experimental group; Con: control group; VAS: Numeric Pain Rating Scale; ODI: Modified Oswestry Disability Index; NPRS: Numeric Pain Rating Scale; LEFS: Lower extremity functional scale; AKPS: Anterior knee pain scale; WOMAC: Western Ontario and McMaster Universities.

TABLE 2. PEDro Scale Scores for individual trials* (n=7).

Study	1	2	3	4	5	6	7	8	9	10	Total
Bade et al. (2017)	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	5
Fukuda et al. (2010)	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	8
Jeong et al. (2015)	Yes	No	No	No	No	No	Yes	No	Yes	Yes	4
Kendall et al. (2014)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	9
Khayambashi et al.(2012)	Yes	Yes	No	No	No	No	Yes	No	Yes	Yes	5
Lee & Kim (2015)	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	5
Saad et al. (2018)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	9
Total, n (%)	7 (100)	4 (57.1)	5 (71.4)	0 (0)	3 (42.8)	3 (42.8)	7 (87.5)	2 (28.5)	7 (100)	7 (100)	

Abbreviation: PEDro, Physiotherapy Evidence

Database: (Scores range from 0 to 10).
*Criterion 1 was not added to the total score, which is out of 10. Median, 5; interquartile range, 4; range, 4 to 9.
1, random allocation; 2, concealed allocation; 3, baseline comparability; 4, blinding of subjects;5, blinding of therapists; 6, blinding of assessors; 7, more than 85% follow-up; 8, intention-to-treat analysis; 9, reporting of between-group statistical comparisons; 10, reporting of point measures and measures of variability.

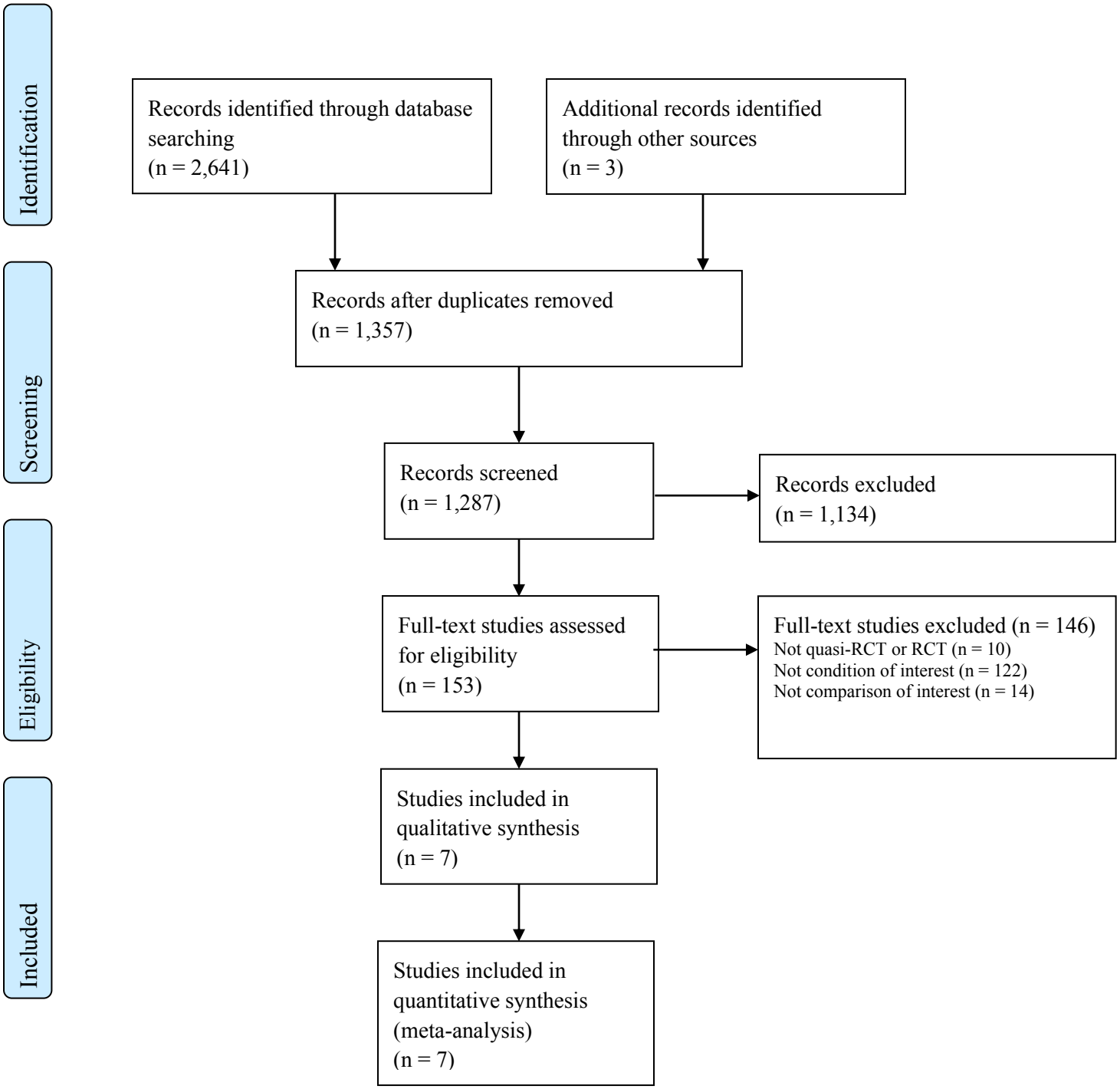
Identification
Screening
Eligibility
Included
Records identified through database searching (n = 2,641)
Additional records identified through other sources (n = 3)
Records after duplicates removed (n = 1,357)
Records screened (n = 1,287)
Records excluded (n = 1,134)
Full-text studies assessed for eligibility (n = 153)
Full-text studies excluded (n = 146)
Not quasi-RCT or RCT (n = 10)
Not condition of interest (n = 122)
Not comparison of interest (n = 14)
Studies included in qualitative synthesis (n = 7)
Studies included in quantitative synthesis (meta-analysis) (n = 7)

FIGURE 1. Flow of studies through the review. RCT: randomized clinical trial.

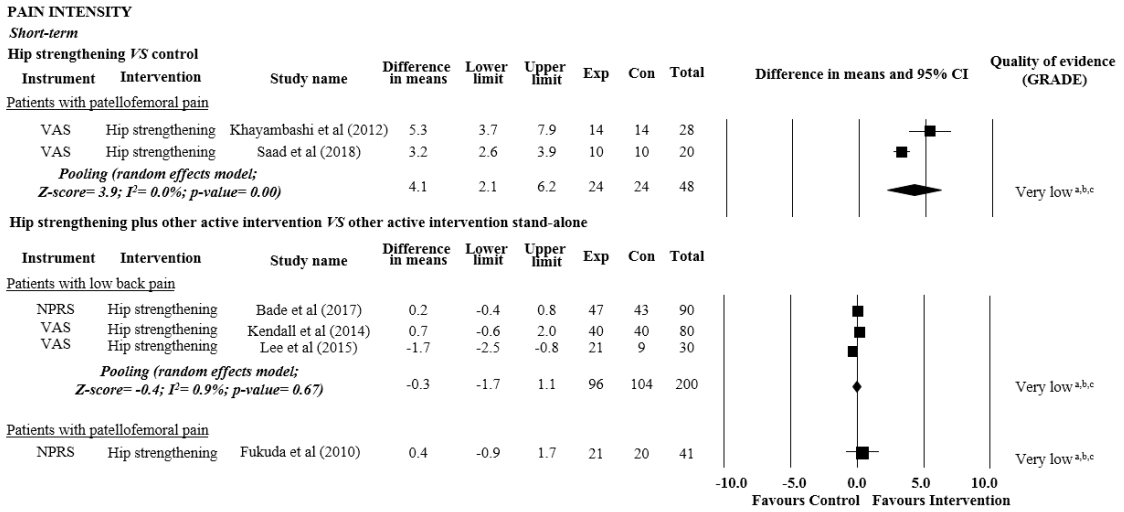

Figure 2. Summary of evidence of hip strengthening on pain. Control: sham, placebo, no intervention or waiting list.
[a] Downgraded owing to imprecision: less than 400 participants included in the meta-analysis (sample of less than 200 was considered serious imprecision and downgraded in two levels).
[b] Downgraded owing to inconsistency: I^2 statistic was higher than 50% or pooling was not possible (poor overlap between the confidence intervals of the effects of the included studies in the meta-analysis was considered serious inconsistency and downgraded in two levels).
[c] Downgraded owing to risk of bias: more than 25% of the participants in the meta-analysis were from trials with a high risk of bias (i.e., PEDro score <6 of 10).

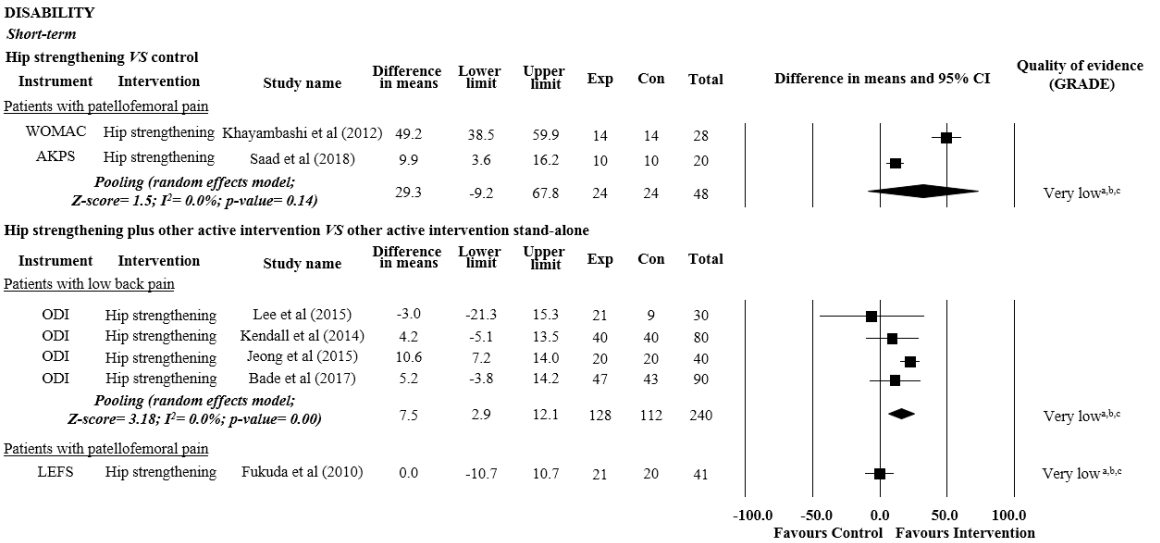

Figure 3. Summary of evidence of hip strengthening on disability. Control: sham, placebo, no intervention or waiting list.
[a] Downgraded owing to imprecision: less than 400 participants included in the meta-analysis (sample of less than 200 was considered serious imprecision and downgraded in two levels).
[b] Downgraded owing to inconsistency: I^2 statistic was higher than 50% or pooling was not possible (poor overlap between the confidence intervals of the effects of the included studies in the meta-analysis was considered serious inconsistency and downgraded in two levels).
[c] Downgraded owing to risk of bias: more than 25% of the participants in the meta-analysis were from trials with a high risk of bias (i.e., PEDro score <6 of 10).

STRENGTH

Short-term

Hip strengthening *VS* control

Instrument	Intervention	Study name	Difference in means	Lower limit	Upper limit	Exp	Con	Total	Difference in means and 95% CI	Quality of evidence (GRADE)
Patients with patellofemoral pain										
HANDHELD DINAMOMETER	Hip strengthening	Khayambashi et al (2012)	4.1	2.5	5.7	14	14	28		
HANDHELD DINAMOMETER	Hip strengthening	Saad et al (2018)	3.7	2.0	5.4	10	10	20		
Pooling (random effects model; Z-score= 6.6; I^2= 0.0%; p-value= 0.00)			3.9	2.8	5.1	24	24	48		Very low [a,c]

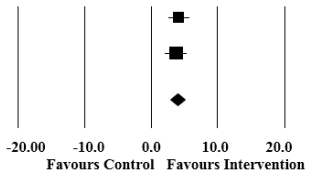

Figure 4. Summary of evidence of hip strengthening on strength. Control: sham, placebo, no intervention or waiting list.

[a] Downgraded owing to imprecision: less than 400 participants included in the meta-analysis (sample of less than 200 was considered serious imprecision and downgraded in two levels).

[c] Downgraded owing to risk of bias: more than 25% of the participants in the meta-analysis were from trials with a high risk of bias (i.e., PEDro score <6 of 10).

Appendix 1. Search strategy conducted on September 30th 2020 and updated on February 2nd 2021.

OVID (AMED - Allied and Complementary Medicine, COCHRANE Central Register of Controlled Trials, COCHRANE Database of Systematic Reviews, EMBASE, MEDLINE)

1. randomised controlled trial*.mp. [mp=ab, hw, ti, ot, sh, kw, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, ui, sy]
2. Randomized Controlled Trial.mp. [mp=ab, hw, ti, ot, sh, kw, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, ui, sy]
3. random allocation.mp. [mp=ab, hw, ti, ot, sh, kw, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, ui, sy]
4. Comparative Stud*.mp. [mp=ab, hw, ti, ot, sh, kw, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, ui, sy]
5. Controlled Clinical Trial*.mp. [mp=ab, hw, ti, ot, sh, kw, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, ui, sy]
6. double-blind method*.mp. [mp=ab, hw, ti, ot, sh, kw, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, ui, sy]
7. single-blind method*.mp. [mp=ab, hw, ti, ot, sh, kw, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, ui, sy]
8. Clinical Trial*.mp. [mp=ab, hw, ti, ot, sh, kw, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, ui, sy]
9. crossover stud*.mp. [mp=ab, hw, ti, ot, sh, kw, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, ui, sy]
10. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11. Hip strength*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]
12. hip exercise*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]
13. hip resistance training.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]
14. hip resistance exercise*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]
15. Hip-Strengthening Exercise*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]

16. Buttocks exercise*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]

17. Gluteus strength*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]

18. gluteus.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]

19. strength*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]

20. resistance training.m_titl.

21. weight training.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]

22. workout.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]

23. exercise*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy]

24. 19 or 20 or 21 or 22 or 23

25. 18 and 24

26. 11 or 12 or 13 or 14 or 15 or 16 or 17 or 25

27. 10 and 26

EBSCO (SPORTDISCUS and CINAHL)

S1. (((gluteus) OR (hip exercise*) OR (Hip-Strengthening Exercise*) OR (Hip strength*))) AND (((randomized controlled trial*) OR (randomised controlled trial*) OR (clinical trial*) OR (random allocation) OR (comparative stud*) OR (crossover stud*)))

PEDro

Abstract & Title: gluteus OR hip exercise* OR Hip-Strengthening Exercise* OR Hip strength*

Therapy: not applicable

Problem: not applicable

Body Part: not applicable

Subdiscipline: musculoskeletal

Topic: not applicable

Method: clinical trial

Author/Association: not applicable

Title Only: not applicable

Source: not applicable

Published Since: not applicable

New records added since: not applicable

Score of at least: not applicable.

4 CONSIDERAÇÕES FINAIS

Esta revisão sistemática foi primordial para o entendimento da literatura atual sobre estudos que abordam o fortalecimento de quadril em disfunções musculoesqueléticas crônicas. A presente revisão sistemática, desenvolvida com alto rigor metodológico, evidenciou que apesar da recomendação de fortalecimento de quadril, as evidências encontradas são classificadas como de baixa qualidade metodológica.

Ao entender melhor sobre os efeitos do fortalecimento, possibilita-se informações mais eficientes na tomada de decisão para estratégias de reabilitação / prevenção na prática clínica. Assim, esse estudo se faz importante, pois permite ilustrar as lacunas ainda existentes na literatura a respeito do efeito do fortalecimento isolado e o efeito aditivo do fortalecimento de quadril em disfunções musculoesqueléticas crônicas. Ainda são necessários estudos com alto rigor metodológico para esclarecer efeitos a curto, médio e longo prazo. Espera-se ainda que os resultados deste trabalho guiem estudos futuros.

Apesar das limitações do estudo ele foi de suma importância para o crescimento pessoal e profissional e ampliação do conhecimento científico.

ANEXOS

ANEXO I – Normas da Revista

Artigo submetido na revista JOSPT, fator de impacto 3,84

INSTRUCTIONS TO AUTHORS

These instructions cover the types of manuscripts *JOSPT* publishes and detail how authors should prepare manuscripts for submission and review, including requirements for the protection of human subjects and animals. The instructions outline additional required documents, list *JOSPT*'s editorial policies, and provide a manuscript submission checklist.

MANUSCRIPT SUBMISSION

All manuscripts must be submitted directly at https://mc.manuscriptcentral.com/JOSPT. JOSPT's editors are not able to respond to presubmission queries, including those on scope of manuscripts, possible interest in manuscripts, or choice of manuscript type (please note, though, that JOSPT will never reject a manuscript, or review it unfavorably, because of incorrect choice of article type). Please direct questions about online submission to the JOSPT office at 1-877-766-3450 or e-mail manuscripts@jospt.org.

General Requirements

All manuscripts must meet the following basic requirements to be eligible for review by *JOSPT*:

- Written in English
- Include a cover letter
- Not previously published either in print or digitally, or widely disseminated in a form other than abstracts at scientific conferences and meetings
- Undergo exclusive review by *JOSPT*
- Address scientific, clinical, or professional issues relevant to musculoskeletal or sports-related physical therapy practice
- Written in accordance with the "Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals" by the International Committee of Medical Journal Editors (ICMJE), December 2018 (http://www.icmje.org/recommendations/)
- Formatted according to AMA style guidelines (*American Medical Association Manual of Style, 10th Edition*), except for references.
- Number references consecutively in alphabetical order.
- Include, as appropriate to the study, statements referenced on the title page and detailed in a Study Details section before the references about:
  - Institutional Review Board approval
  - registration with ClinicalTrials.gov
  - the contribution of each author to the manuscript. Authorship is defined according to ICMJE criteria (http://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html)
  - data sharing (when writing a data-sharing statement, please consult the ICMJE recommendations for guidance at http://www.icmje.org/recommendations/browse/publishing-and-editorial-issues/clinical-trial-registration.html#two)
  - outlining how patients/athletes/public partners were involved in the research. If patients/athletes/public partners were not involved, please state this.

Submissions that do not initially satisfy these general requirements must meet them in response to review comments and prior to acceptance. In the peer-review process, *JOSPT* reviewers are unaware of the author's identity and affiliation. Associate editors are not blinded to author identity and vice versa.

Protection of Human Participants

The name of the Institutional Review Board or Ethics Committee that approved the research protocol involving human participants must be included on the title page and in the Methods section. The Methods section must also contain a statement that informed consent was obtained and that the rights of participants were protected.

JOSPT mandates that clinical trials initiated on or after January 1, 2018 be prospectively registered (ie, the protocol was registered before the first participant was recruited) in a public trials registry. In these cases, authors should provide the name of the registry and the registration number on the title page.

Manuscripts should include, when required by the appropriate Institutional Review Board or Ethics Committee, a statement that each participant was informed that data about him or her would be submitted for publication or a statement indicating approval by the Board or Committee. In all cases, patient confidentiality must be protected.

Data Sharing

JOSPT asks authors to choose the standard Data Sharing Statement appropriate for their manuscript.

- **Data are available in a public, open access repository.** Please provide the repository name, URL, and any conditions for access (eg, license, embargo).
- **Data are available upon request.** Please provide a description about which data are available, from whom the data are available and how they should be contacted, and how data may be reused.
- **There are no data in this manuscript.** An appropriate statement for editorials, clinical commentaries, and viewpoints.
- **All data relevant to the study are included in the article or are available as supplementary files.** Please ensure that no patient-identifiable data are available.
- **There are no data available.**

Patient and Public Involvement in Research

JOSPT encourages and promotes active patient and public involvement in research. Authors are asked to include a statement in the Methods section of their manuscript

outlining how patients/athletes/public partners were involved in the design, conduct, interpretation, and/or translation of the research.

JOSPT appreciates that not all manuscripts have patient and public involvement. The partnership intended here is different from patients being research participants (the type of patient involvement that is covered by research ethics approval, ie, the IRB). This is a relatively new theme; therefore, *JOSPT* will continue to consider manuscripts where there was no patient and/or public involvement.

For further information on *JOSPT*'s approach, please see the September 2019 editorial titled "Patients as Partners in Research: It's the Right Thing to Do" (https://www.jospt.org/doi/abs/10.2519/jospt.2019.0106). Authors may find helpful guidance for best reporting of patient and public engagement in research in the long and short versions of the Guidance for Reporting Involvement of Patients and the Public (GRIPP2) checklist found in Tables 1 and 2 at this link: https://www.ncbi.nlm.nih.gov/pubmed/28768629.

Revised Manuscripts

When the editors suggest that a manuscript be revised and resubmitted, the same guidelines outlined for the preparation of the original manuscript apply. All resubmitted manuscripts must be accompanied by a cover letter. The cover letter must include a list of all revisions made as a result of suggestions provided by the reviewers and editors. Changes made to the text and tables must be highlighted in the manuscript.

ARTICLE TYPES

Research Report

- Original clinical research that advances the field of rehabilitation. *JOSPT* prioritizes clinical research with direct implications for the decisions that rehabilitation clinicians working in the fields of orthopaedics or sports and patients make in practice.
- Abstract structured to include 6 sections: Objective, Design, Methods, Results, and Conclusion, for a maximum of 250 words plus Key Words
- Text to include 6 sections: Introduction, Methods, Results, Discussion, Conclusion, and Key Points. *JOSPT* asks authors to minimize the Introduction section to 3 or 4 paragraphs plus a statement of the aim/purpose of the research.
- Article length up to 3000 words
- Total of 5 tables and figures. Additional tables and/or figures may be submitted as supplementary files.
- The checklists and guidelines we expect authors to use when preparing research reports are listed here. Authors must choose the appropriate checklists for their study design and upload the completed checklists as a supplementary file in ScholarOne. Completed checklists are for the review process only and will not appear in published papers. Manuscripts submitted without completed checklists will be returned to the authors.
  - Randomized controlled trials (RCTs): CONSORT
    - RCTs should include the CONSORT related extension for trials of nonpharmacological treatments, with a flow diagram in the manuscript as a figure and the checklist appended to the manuscript (http://www.consort-statement.org/).
  - Intervention studies (randomized and non-randomized): TIDIER and CERT
    - Authors should follow the template for intervention description and replication (TIDIER) checklist (http://www.consort-statement.org/resources/tidier-2) when reporting interventions (in randomized or nonrandomized intervention studies), and the Consensus on Exercise Reporting Template (CERT) checklist (https://bjsm.bmj.com/content/bjsports/50/23/1428/DC1/embed/inline-supplementary-material-1.pdf?download=true) when reporting exercise interventions. An explanation of CERT can be found here: https://www.ncbi.nlm.nih.gov/pubmed/27707738. Authors should upload these completed checklists, as appropriate, when submitting intervention studies.
  - Observational studies: STROBE
    - Observational studies (cohort, case-control, cross-sectional studies) should comply with the STROBE statement (https://www.strobe-statement.org/index.php?id=strobe-home) and require a completed STROBE checklist with the manuscript.
  - Diagnostic accuracy studies: STARD
    - Preparation of studies investigating the diagnostic accuracy of clinical tests will benefit from consulting the STARD statement, checklist, and flow diagram (http://www.equator-network.org/reporting-guidelines/stard/). Authors must include a copy of the completed STARD checklist appended to the manuscript. The flow diagram illustrating the progress of the study sample should be included as a figure in the manuscript.

Literature Review

- A synthesis of evidence, based on a well-defined review question, that is relevant and applicable to rehabilitation clinicians. *JOSPT* prioritizes systematic reviews and scoping reviews that address the key question, "How will the findings help clinicians to help patients/athletes?"
- A systematic review should address a focused clinical question; a scoping review should address broader/exploratory questions about the scope of a body of literature. For detailed guidance, *JOSPT* recommends reading Munn et al (https://bmcmedresmethodol.

INSTRUCTIONS TO AUTHORS (CONTINUED)

biomedcentral.com/articles/10.1186/s12874-018-0611-x).
- Final literature search completed within 12 months of manuscript submission. *JOSPT* strongly encourages prospective registration of systematic review protocols in the PROSPERO database (https://www.crd.york.ac.uk/prospero/).
- Abstract structured to include 8 sections: Objective, Design (eg, intervention systematic review, prognosis systematic review with meta-analysis, scoping review, etc), Literature Search, Study Selection Criteria, Data Synthesis, Results, and Conclusion, for a maximum of 250 words plus Key Words
- Text to include 6 sections: Introduction, Methods, Results, Discussion, Conclusion, and Key Points
  - *JOSPT* asks authors to minimize the Introduction section to 3 or 4 paragraphs plus a statement of the review's questions, aims, and purpose.
  - The Methods section must detail the search strategy, selection criteria, evaluation of the risk of bias in the included articles, etc.
  - The Discussion section must include a section with the subheading Limitations and a section with the subheading Clinical Implications.
- The checklist/guideline for systematic reviews is PRISMA (https://www.prisma-statement.org). The guideline for scoping reviews is the PRISMA Scoping Review Extension (https://www.prisma-statement.org/Extensions/ScopingReviews). Authors must complete and upload the relevant PRISMA checklist as part of their manuscript submission. Manuscripts without a completed PRISMA checklist will be returned to the authors.
- Article length up to 4500 words and must include the PRISMA flow diagram illustrating the progress of study selection and exclusion (as well as reasons for exclusion) as a manuscript figure, along with any required tables.
- Total of up to 7 tables and figures. Additional tables and/or figures may be submitted as supplementary files.

Clinical Commentary

- Commentaries and perspectives on topics that affect the decisions rehabilitation clinicians and patients/athletes/coaches (or others) make about care. *JOSPT* prioritizes topics with implications for musculoskeletal, orthopaedics, and sports practice.
- Abstract structured to include 5 sections: Background, Clinical Question, Key Results, and Clinical Application, for a maximum of 250 words plus Key Words
- Text structured to include an Introduction, Clinical Question, other sections as dictated by the article content, and Key Points
- Article length up to 3000 words
- Total of up to 4 tables and figures, depending on the subject matter

Case Series and Case Report/Case Study

- Large therapy or prevention studies that use a case series design should be submitted as research reports and include a STROBE checklist (http://www.equator-network.org/reporting-guidelines/strobe/).
- JOSPT no longer publishes case reports or resident's case problems in the primary *Journal*. However, JOSPT affirms the value of these articles and has launched *JOSPT Cases*, a peer-reviewed, online quarterly journal that expands the educational value of case reports in clinical practice. Go to www.jospt.org/josptcases for details and instructions for authors.

Editorial

- Presents a new perspective on topics relevant to rehabilitation clinicians, patients/athletes, or researchers in the musculoskeletal, orthopaedics, or sports fields
- Abstract unstructured, providing a short summary of the article's key points, for a maximum of 150 words
- Text unstructured, with no mandatory sections
- Article length up to 1000 words
- Total of up to 2 tables and figures and a maximum of 10 references

Viewpoint

- Opinions and/or perspectives relevant to musculoskeletal and sports physical therapy. Viewpoint articles are editorial/perspective/professional commentary-type articles, intended to put research/clinical practice into context for readers by delivering clinically meaningful synopsis, debate, and discussion. These articles should contain thought-provoking and sometimes controversial new ideas, interpretations, and opinions.
- Provides a balanced view of the topic considering the evidence, perhaps by presenting contrasting perspectives. Viewpoint articles are intended to be constructive and have intellectual substance and rigor. In style and tone, they should be accessible to a wide audience and address serious topics in a respectful manner.
- Abstract unstructured, providing a short summary of the article's key points, for a maximum of 150 words
- Text unstructured, with no mandatory sections; however, 2 to 5 Key Points should conclude the paper
- Article length no more than 1500 words
- Total of up to 4 tables and figures, and a maximum of 10 references

Musculoskeletal Imaging

JOSPT no longer publishes musculoskeletal imaging cases in the primary Journal. However, JOSPT affirms the value of these articles and has launched *JOSPT Cases*, a peer-reviewed, online quarterly journal that expands the educational value of case reports in clinical practice. Go to www.jospt.org/josptcases for details and instructions for authors.

Letter

- Letters related to professional issues or articles published in the *Journal*
- Text unstructured and no more than 600 words in length
- Includes a summary statement of any conflict of interest, including financial support related to the issue addressed
- Authors of the relevant manuscript dis-

cussed are given the opportunity to respond to the content of the letter.

MANUSCRIPT PREPARATION

All manuscripts submitted to *JOSPT* should:

- Be on letter-sized paper (8.5 by 11 inches), double spaced, and have 2.54-cm (1-inch) margins on all sides of the page
- Have consecutively numbered pages, starting with the title page
- Be continuously line numbered, with line numbers starting at 1 on the abstract
- Have all measurements in the manuscript presented in SI units, except for angular measures, which should be presented in degrees rather than radians

The manuscript should be arranged as follows:

Title Page (separate page)

- Title of the manuscript
- Names of each author with their highest academic credential (ie, PhD), or most relevant professional designation (eg, PT), or both (eg, PT, PhD)
- Institution, city, state/country for each author
- Statement of the sources of grant support (if any)
- Statement of financial disclosure and conflict of interest
- Statement of Institutional Review Board or Ethics Committee approval of the study protocol
- Name of the public trials registry and the registration number
- Corresponding author's name, address, and e-mail address
- Word count of the text portion of the manuscript

Anonymous Title Page (separate page)

- Title of the manuscript
- Statement of financial disclosure and conflict of interest (see item 6 of the Author Agreement and Publication Rights Form)
- Acknowledgments (on a separate page)

Abstract

- Structured or unstructured, as detailed in the article-type descriptions above
- All abstracts should end with a Key Words section (no more than 6 key words).

Text

- Structured or unstructured, as detailed in the article-type descriptions above
- All manuscripts should adhere to the stated word limits and include the specified number of tables and figures.

Key Points

The brief Key Points section should be provided at the end of the text, prior to the references. These points should be written clearly, consist of brief sentences, and summarize the most important information related to the findings, implications, and caution directly resulting from the work. These 3 subheadings should be used:

- **Findings:** One or 2 statements on what the study found.
- **Implications:** A brief statement (maximum 2 sentences) about how the results add to current knowledge, and the impact on clinical practice.
- **Caution:** A statement about the most important limitations of the study, especially external validity (affecting the generalizability of the results).

References

- References should be numbered consecutively in alphabetical order, according to author last name and initials, title, and year. Where the first-author names are identical, references with 1 author precede those with multiple authors. Where all the author names are identical, the title is the next ordering component, followed by the year.
- All references in the References section must be cited in the text.
- References must be cited in the text by using the reference number in superscript at the end of the sentence or the referenced portion of the sentence. The reference goes after the author's name when the author's name is listed (eg, Davies[1]). If there are only 2 authors in the reference, then the text should include both authors (eg, Davies and Ellenbecker[2]). If the reference has more than 2 authors, the text should include "et al" after the first author's name (eg, Davies et al[3]).
- In the References section, when a reference has 7 or more authors, list the first 3 authors, followed by "et al."
- References must include only material that is retrievable through standard literature searches. References to papers accepted but not published or published ahead of print should be designated "in press" until an updated citation is available. Doctoral and master's theses are considered published material. Information from manuscripts not yet accepted for publication and personal communications will not be accepted as a reference but may be cited parenthetically in the text as (unpublished data) or (personal communication). The use of abstracts and proceedings should be avoided unless they are very recent and the sole source of the information.
- Abbreviations for the journals in the references must conform to those of the National Library of Medicine in Index Medicus (https://www.ncbi.nlm.nih.gov/nlmcatalog/journals).
- References that have Crossref Digital Object Identifiers (DOIs) should include them at the end of the citation.
- References must be verified by the author(s) against the original documents.
- Reference style and punctuation should conform to the examples that follow:

Journal

Essery R, Geraghty AW, Kirby S, Yardley L. Predictors of adherence to home-based physical therapies: a systematic review. *Disabil Rehabil*. 2017;39:519-534. https://doi.org/10.3109/09638288.2016.1153160

Book

Cook CE. *Orthopedic Manual Therapy: An Evidence-Based Approach*. 2nd ed. Boston, MA: Pearson; 2011.

Book Section

Dean E, Söderlund A. Lifestyle and musculoskeletal health. In: Jull G, Moore A, Falla D, Lewis J, McCarthy C, Sterling M, eds.

INSTRUCTIONS TO AUTHORS (CONTINUED)

Grieve's Modern Musculoskeletal Physiotherapy. 4th ed. Edinburgh, UK: Elsevier; 2015:117-126.

Report (With Organization as Author)

Economic Innovation Group. The 2017 Distressed Communities Index. Washington, DC: Economic Innovation Group; 2017.

Master's or Doctoral Thesis

Whitaker JL. *Ultrasound imaging of the abdominal muscles and bladder: implications for the clinical assessment of individuals with lumbopelvic pain* [thesis]. Southampton, UK: University of Southampton; 2012.

Published Abstract of a Paper Presented at a Conference

Ghasemisfeh G, Ebrahimi R, Gao J. Complex contagion and the weakness of long ties in social networks: revisited. In: *Proceedings of the Fourteenth ACM Conference on Electronic Commerce*. New York, NY: ACM Press; 2013:507-524.

Paper Presented at a Conference/Symposium

Ooi CC, Schneider M, Malliaras P, Chadwick M, Connell D. Diagnostic performance of sonoelastography in confirming clinically diagnosed Achilles tendinopathy: comparison with B-mode ultrasound and color Doppler imaging [poster]. 2014 Combined Scientific Meeting: Imaging and Radiation in Personalised Medicine; September 4-7, 2014; Melbourne, Australia.

Electronic Reference

American Academy of Orthopaedic Surgeons. Osteochondroma. Available at: http://orthoinfo.aaos.org/topic.cfm?topic=A00079. Accessed June 30, 2016.

Tables

- Each table must be included at the end of the manuscript and provide standalone information independent of the text.
- See *AMA Manual of Style*, section 4.1, to organize and format tables.
- Table titles should list the table number in uppercase bold (eg, **TABLE 1. Title**), followed by a period, then the title of the table in title case.
- Abbreviations used in each table must be spelled out below the table.
- Footnotes must be listed below the table, after the abbreviations, in order of occurrence in the table (left to right, row to row). According to AMA style, footnotes are cited a-z (lowercase superscript).
- All tables must be referenced in the text in uppercase bold (eg, **TABLE 1**).
- All tables go after the reference list.

Figures

- Figure captions should appear at the end of the manuscript and list the figure number in uppercase bold, followed by a period, and continue with the text of the caption in sentence case (eg, **FIGURE 1.** Caption).
- All abbreviations appearing in the figures should be defined in the caption for each respective figure, and abbreviations appearing only in the figure caption must be defined at first use.
- Digital figures must be at least 300 dpi (dots per inch) and provided as separate files.
- Photographs must be in JPEG file format (.JPG) and graphic art in an EPS file format and at a resolution of at least 350 dpi. If created in Adobe or Microsoft software, provide the native file. If those file types are not available, provide a high-resolution PDF.
- Color figures and graphics are welcome.
- Charts and graphs generated from spreadsheet programs must accompany, or allow access to, the data.
- All figures must be referenced in the text in uppercase bold (eg, **FIGURE 1**).
- Each panel (eg, A, B, C) within the figure must be defined in the figure caption.

Videos

- Authors may wish to consider including supplemental videos to be published online with their manuscript. These videos can describe intervention or examination techniques as well as surgical procedures or other material pertinent to the manuscript.
- Intent to include videos may be mentioned in the cover letter with the initial manuscript submission or may be discussed with the Editor-in-Chief once the manuscript is accepted.
- Video files should fit the following criteria:
  - Standard file type, such as MP4, WMV, MOV, or AVI
  - Not exceeding 5 minutes long per file
  - Include titles to introduce the video and separate sections, as needed
- There is no limit on the number of videos that may be submitted. If you are unable to include titles in the video files, you may submit them in a separate PowerPoint file.

Supplementary Material

JOSPT publishes supplemental material online with accepted articles. All supplemental material must be necessary to a full understanding of the primary article, without repeating what is in the article. Authors must submit supplemental material for review in conjunction with the main manuscript and title it as such. All supplementary material undergoes peer review and may require revision where indicated by the editors. It is the author's responsibility to format, copyedit, and fact check for consistency with the main article prior to publication. Supplemental material will not be edited or formatted by JOSPT staff; thus, authors are responsible for the accuracy and presentation of all such material.

ADDITIONAL REQUIRED DOCUMENTS

For submissions to qualify for review, the following documents must be submitted with a manuscript at https://mc.manuscriptcentral.com/JOSPT, e-mailed (manuscripts@jospt.org), or faxed (1-703-891-9065) to the JOSPT office.

Author Agreement and Publication Rights Form

This document must have original signatures of all authors. Author signatures may be on separate copies or 1 copy of

the form. The form is at the end of these instructions. Please submit the form when you are submitting the manuscript on the manuscript submission website at https://mc.manuscriptcentral.com/jospt. Please contact the JOSPT office with any questions.

Photograph/Video Release Statement

Signed photograph/video release forms should accompany photographs/videos of patients, subjects, and therapists. A photograph/video release statement should contain the following: (1) manuscript title; (2) names of all authors; (3) statement placed below the manuscript title and author names as follows: "I hereby grant to the *Journal of Orthopaedic & Sports Physical Therapy* the royalty-free right to publish photographs and/or videos of me for the stated Journal and the above manuscript in which I appear as subject, patient, or model, and for the stated Journal's website (www.jospt.org). I understand that any figure in which I appear may be modified."; and (4) the original signature and date signed from each subject who appears in the figures. This original signed statement must be submitted to the JOSPT office with the manuscript.

Patient/Author Release Statement

A release form should accompany all manuscripts, where appropriate. This release must be signed either by the patient/subject or by the submitting author, accompanied by a proxy declaration by the author(s) that all necessary efforts have been made to ensure that Standards for Privacy of Individually Identifiable Health Information have been upheld, and that the author accepts any and all liability for any failure to uphold the necessary Standards for Privacy of Individually Identifiable Health Information in the final version of the manuscript.

The release statement should contain the following: (1) manuscript title; (2) names of all authors; (3) a statement from the submitting author, placed below the manuscript title and author names, as follows: "I hereby declare that the patient/subject has granted the author(s) permission to report his or her case in this manuscript; or, in the absence of such permission, that all necessary efforts have been made to ensure that Standards for Privacy of Individually Identifiable Health Information have been upheld, and accept any and all liability for any failure to uphold the necessary Standards for Privacy of Individually Identifiable Health Information in the final version of the manuscript."; and either (4a) the original signature and date signed by each patient/subject presented in the manuscript or (4b) the original signature and date signed by the submitting author. This original signed statement must be submitted to the JOSPT office with the manuscript. Important notes on the Standards for Privacy of Individually Identifiable Health Information, from the US Department of Health and Human Services, can be found at https://www.hhs.gov/hipaa/for-professionals/privacy/laws-regulations/ under Health Information Privacy.

MANUSCRIPT CHECKLIST

When submitting a new or revised manuscript, please include the following:

1. Cover letter identifying the phone, fax, and e-mail address of the corresponding author and the manuscript category.
2. Author Agreement and Publication Rights Form(s) with original signatures of all authors.
3. Photograph/video release statement signed by the individual(s) in the photograph/video.
4. Patient/author release statement signed by either the patient/subject or the submitting author.
5. Full title page and anonymous title page including a statement of financial disclosure and conflict of interest.
6. Name of the Institutional Review Board or Ethics Committee that approved the protocol for the study on the title page.
7. Name of the public trials registry and the registration number on the title page, if applicable.
8. Statement in the Methods section that informed consent was obtained, and the rights of subjects were protected.
9. Properly structured abstract.
10. Continuous line numbering throughout the entire manuscript, starting with the Abstract.
11. References listed and numbered in alphabetical order and cited with superscripts in the text.
12. Inclusion of the appropriate checklist (eg, CONSORT, STARD, PRISMA), if applicable.

Authors are also invited to take advantage of the Author Tools section of the JOSPT website (https://www.jospt.org/page/authors/author_reviewer_tools), which provides useful links related to writing and reviewing manuscripts.

JOSPT'S EDITORIAL POLICIES

1. The recommendations of associate editors, editorial review board members, and reviewers concerning the status of manuscripts under review are advisory to the editors.
2. The final decision concerning the publication of a manuscript is solely the responsibility of the editors.
3. Manuscripts are treated as works in progress and are viewed as new manuscripts each time a revision is submitted; each time a manuscript is reviewed, new issues may be raised for the authors to address.
4. Authors should expect to make multiple revisions of their manuscript before formal acceptance of the manuscript for publication. An invitation to revise a manuscript is not a guarantee of acceptance.
5. Manuscripts submitted for review are a form of privileged communication between the authors and the *Journal* and the authors and the reviewers. Reviewers may share the paper with other professionals only with the intent to seek information intended to enhance the review.
6. Authors are not permitted to make changes during the proof stage of publication except to correct inaccuracies.
7. The editors may refuse to publish a manuscript if the author requests sub-

INSTRUCTIONS TO AUTHORS (CONTINUED)

stantial revisions of the manuscript content after the paper has been through the review process and accepted for publication.

8. The editors may solicit additional reviews to supplement the opinion of the assigned associate editor and reviewers.
9. *JOSPT* welcomes manuscripts that include findings of no statistically significant differences. However, in the event of a null result, the authors need to provide additional information about the statistical properties of the analysis that led to this result (ie, evidence of reasonable protection against type II error).
10. *JOSPT* accords its authors most-favored status where reproduction policies and copyright permissions are concerned. Authors receive e-mailed PDFs of their finished articles. Once the issue is published, authors may make personal photocopies or deposit their article in their institutional repository (intranet only). Authors also have permission, with no fee charged, to reproduce material they created in the past for *JOSPT* for use in books, chapters of books, or articles in other journals, if copyright credit to *JOSPT* is given. Uploading articles to public-access websites (eg, ResearchGate) is not allowed.

CONTACT INFORMATION

Journal of Orthopaedic & Sports Physical Therapy
1020 N Fairfax St, Ste 400
Alexandria, VA 22314
Phone: 1-877-766-3460
Fax: 1-703-891-9065
E-mail: jospt@jospt.org
Website: www.jospt.org