UNIVERSIDADE FEDERAL DO RIO GRANDE DO NORTE

CENTRO DE CIÊNCIAS DA SAÚDE

DEPARTAMENTO DE FISIOTERAPIA

EFEITO DA PLATAFORMA VIBRATÓRIA NA ATIVIDADE ELETROMIOGRÁFICA DOS MÚSCULOS ESTABILIZADORES DO TRONCO

Sâmara Raquel Alves Gomes

NATAL/RN - 2017

SÂMARA RAQUEL ALVES GOMES

EFEITO DA PLATAFORMA VIBRATÓRIA NA ATIVIDADE ELETROMIOGRÁFICA DOS MÚSCULOS ESTABILIZADORES DO TRONCO

Trabalho de conclusão de curso, apresentado ao curso de Fisioterapia do Centro de Ciências da Saúde da Universidade Federal do Rio Grande do Norte, como requisito para obtenção do título de Graduação em Fisioterapia.

Orientador: Prof. Dr. Jamilson Simões Brasileiro.

C0- orientadora: M.a. Liane de Brito Macedo.

NATAL/RN - 2017

AVALIAÇÃO DA BANCA EXAMINADORA

Trabalho apresentado por Sâmara Raquel Alves Gomes

Em 05 de dezembro de 2017

1º Examinador (a) ORIENTADOR: Prof. Dr. Jamilson Simões Brasileiro

2º Examinador (a): M.a. Liane de Brito Macedo

3ºExaminador (a): Prof. Dr. Gildasio Lucas de Lucena

APROVADA COM MÉDIA = 9,4

RESUMO

Introdução: Na prática clínica, o treinamento dos músculos do core tem sido considerado uma forma eficaz no tratamento de lombalgias e na prevenção de lesões, principalmente no meio esportivo. O uso da plataforma vibratória surge como uma nova forma de estimular os músculos do core com objetivo de intensificar sua ativação. **Objetivo:** Analisar o efeito da plataforma vibratória sobre a atividade eletromiográfica dos músculos estabilizadores do core. **Métodos:** Trata-se de um estudo observacional analítico transversal, composto por 30 indivíduos do sexo masculino, praticantes de atividade física. Foi avaliada a *Root Mean Square* (RMS) dos músculos reto abdominal (porções superior e inferior), oblíquo externo, longuíssimo e multífidus durante os exercícios de ponte, prancha lateral e prancha frontal nas condições sem vibração e com vibração (frequência: 50Hz e amplitude: 4mm). Para análise da normalidade dos dados foi utilizado o teste de Kolmogorov-Smirnov, e para as comparações entre as condições com vibração e sem vibração foi utilizado uma ANOVA de medidas repetidas, atribuindo-se um nível de significância de 5%. **Resultados:** Neste estudo obteve-se p valor maior que 0,05 quando comparado com vibração e sem vibração em todos os exercícios realizados (prancha lateral, prancha frontal e ponte) e todos os músculos avaliados (multífidus, longuíssimo, oblíquo externo, reto abdominal porções superior e inferior), não demonstrando diferenças significativas entre as condições com vibração e sem vibração. **Conclusão:** A plataforma vibratória não alterou os valores de RMS dos músculos do core, sugerindo que a utilização da vibração do corpo inteiro não é necessária como método aditivo para aumentar a atividade eletromiográfica durante os exercícios de estabilização.

Palavras-chave: vibração; eletromiografia; estabilização.

ABSTRACT

Background: In clinical practice, muscles core training has been considered an effective way treating low back pain and preventing injuries, especially in sports. The use of the vibrating platform comes as a new way to stimulate the core muscles with the objective of intensify their activation.**Objective:** To analyze the effect of the vibratory platform on electromyographic activity of the trunk stabilizing muscles. **Methods**: This is an observational, cross-sectional study, consisting of 30 male individuals practicing physical activity. The *Root Mean Square* (RMS) of the muscles rectus abdominis (upper and lower portions), external oblique, longissimus and multifidus were assessed during bridge, lateral and frontal plank exercises in conditions without vibration and with vibration (frequency: 50Hz and amplitude: 4mm). To analyze the normality of the data, the Kolmogorov-Smirnov test was used, for comparisons between vibration and non-vibration conditions repeated-measures ANOVA was used, and in all the tests was adopted level of significance of 5%.**Results:** In this study, the p-value was greater than 0.05 ($p > 0,05$) in all exercises performed (lateral plank, frontal plank and bridge) and all muscles (multifidus, longissimus, external oblique, rectus abdominis superior and lower), certifying the absence of statistically significant differences between as conditions with vibration and without vibration. **Conclusion:** According to the study, it is concluded that the use of vibratory platform did not affect the RMS values of the core muscles, certifying that the use of whole-body vibration is not necessary as an additive method to increase electromyographic activity during exercise stabilization.

Key words: vibration; electromyography; stabilization.

INTRODUÇÃO

O core ou Powerhouse é constituído por músculos globais produtores de torque como o reto abdominal, obliquo externo, fibras anteriores do obliquo interno, parte torácica do iliocostal, e por músculos locais estabilizadores segmentares como os multífidos, psoas maior, transverso do abdome, quadrado lombar, diafragma, fibras posteriores do obliquo interno, parte lombar do iliocostal e longuíssimo.[1] Sendo determinado como fundação motora dos movimentos dos membros, o core funciona como centro da cadeia cinética funcional e atua em conjunto com o sistema fascial fornecendo suporte e controle do movimento para manutenção da zona neutra, gerando um processo de estabilidade.[2] Essa estabilidade está associada à manutenção de um estado de equilíbrio mesmo quando submetido à estímulos externos.[3] Na coluna esse processo ocorre de forma complexa para conservação das estruturas, o que permite melhor alinhamento articular em situações estáticas e dinâmicas,[4,5] onde os músculos participantes atuam através da co–contração e são classificados como subsistema ativo, proporcionando maior eficiência na ação do core.[6]

Na prática clínica, o treinamento dos músculos do core tem sido considerado uma forma eficaz no tratamento de lombalgias [7,8,9,10] e na prevenção de lesões, principalmente no meio esportivo, onde a busca por aumento da performance e promoção da saúde é algo constante. [11,12,13,14,15] O que leva a um aumento na busca por exercícios e métodos que ativem essa musculatura concomitantemente ao surgimento de evidências que comprovam a importância do treinamento de estabilização. Técnicas para ativação e treinamento dessa musculatura variam de acordo com a especificidade de cada caso clínico ou objetivo de treino. É fundamental que o treinamento inicie com consciência do padrão motor e da contração da musculatura alvo antes de seguir para os protocolos sugeridos, sejam eles estáticos ou dinâmicos. De maneira geral, utiliza-se exercícios que aumentem o controle motor dos músculos superficiais e profundos, priorizando programas de resistência, cargas leves, contração isométrica, contração isotônica com velocidade lenta e exercícios proprioceptivos, levando em consideração a predominância do tipo de fibra muscular encontrada na região do powerhouse.[12]

O uso da plataforma vibratória, ou vibração do corpo inteiro aparece entre as técnicas de treinamento como uma nova alternativa de estimular os músculos do core com o objetivo de intensificar sua ativação.[16,17] Leva-se em consideração que, assim como a prática de atividade física, a vibração provocada pela plataforma vibratória produz estímulos mecânicos capazes de provocar adaptações no sistema musculoesquelético, e seu uso como forma de treinamento apresenta-se como possível potencializador do desempenho neuromuscular.[18] Sabe-se que plataformas destinadas ao treinamento produzem oscilações constantes em formato de sino, gerando ondas simétricas que se deslocam no eixo vertical. Sendo assim, a vibração pode ser determinada como o "movimento alternado de um corpo sólido em relação ao seu centro de equilíbrio".[19] Seus efeitos são produzidos por uma atuação indireta, ocasionando influência da vibração em vários grupos musculares a partir do momento em que as extremidades distais entram em contato com o estímulo vibratório, o que permite também a modificação da extensão do estímulo, ou seja, sua dissipação de acordo com a variação da posição e ângulos articulares sobre o aparelho. [19,20]

Estudos afirmam que durante o treinamento na plataforma, há uma potencialização do circuito neural, já que a vibração sinusoidal é transmitida ao corpo estimulando os receptores sensoriais Ia, mais especificamente do fuso muscular. Isto conduz a um aumento da taxa de disparo, que por sua vez ativa os potenciais motores, causando uma ativação dos motoneurônios alfa (α) gerando modificações rápidas e longitudinais nos músculos homônimos e sinergistas, além de inibir a ação dos motoneurônios α dos antagonistas, seguido de contrações musculares comparáveis ao reflexo vibratório tônico. Consequentemente, quanto maior o número de motoneurônios ativos, maior será o recrutamento de unidades motoras e a geração de força muscular no indivíduo.[21,22,23] Com base nestes achados, e levando-se em consideração que as contribuições iniciais nos ganhos de força e potência muscular durante um treinamento de resistência se devem principalmente às adaptações neurais, é relatado que estes ganhos ocorreriam de maneira mais eficaz combinando-se um programa de exercícios regular ao uso da plataforma vibratória.[24]

Desta forma o presente estudo teve como objetivo avaliar o efeito da plataforma vibratória na atividade eletromiográfica dos músculos estabilizadores de tronco de sujeitos ativos e saudáveis. Hipotetizamos que a realização de exercícios na plataforma vibratória aumenta a ativação eletromiográfica dos músculos estabilizadores do tronco em comparação aos exercícios sem vibração.

MÉTODOS

Participantes

O estudo foi composto por 30 voluntários do gênero masculino, praticante de atividade física de caráter recreacional por pelo menos 3 vezes na semana,[25] com idade média de 23,7 ± 2,2 anos, índice de massa corpórea de 24,3 ± 1,1 Kg/m², recrutados de forma não probabilística. De acordo com os critérios de inclusão, participaram do estudo homens praticantes de atividade física, que não apresentavam histórico de lesão osteomioarticular nos últimos 6 meses ou dor atual na coluna vertebral, bem como disfunção neurológica, vestibular ou visual não corrigida. Os voluntários poderiam ser excluídos do estudo, caso apresentassem desconforto durante o procedimento de coleta ou não conseguissem executar corretamente os procedimentos de avaliação, entretanto, segundo esses critérios, nenhum voluntário foi excluído.

Este estudo foi aprovado pelo Comitê de Ética em Pesquisa da Universidade Federal do Rio Grande do Norte (com número do parecer: 2.353.146) e está em conformidade com os aspectos éticos com base na Resolução 466/12 do Conselho Nacional de Saúde e Declaração de Helsinki. Todos os voluntários que participaram do estudo deram seu consentimento por escrito depois de serem explicados sobre os objetivos, riscos e benefícios da pesquisa.

Desenho do estudo

Trata-se de um estudo observacional analítico transversal, e a ordem dos exercícios (prancha frontal, lateral e ponte, com e sem vibração) foi previamente randomizada por um pesquisador independente para realização do protocolo nas condições sem vibração e com vibração. Todos os voluntários assinaram o TCLE e preencheram uma ficha de avaliação padronizada, formulada especificamente para esse estudo, contendo informações sobre dados pessoais e antropométricos dos voluntários, bem como condições gerais de saúde e nível de atividade física.

Instrumentação e procedimentos

Para aquisição e processamento dos sinais eletromiográficos foi utilizado um módulo condicionador de sinais (Telemyo direct transmission system) de 8 canais (Noraxon®, USA) com resolução de 16 bits e razão de rejeição de modo comum (RRMC) >100 Db. O processamento do sinal eletromiográfico foi realizado com o software Matlab - version R2012a (Math Works, Inc., Massachusetts, USA). Os sinais foram captados numa frequência de amostragem ajustada para 1500 Hz, filtrada numa frequência entre 20 e 500 Hz e amplificada 1000 vezes. Para o momento com vibração também foi utilizado um filtro adicional aplicado na frequência de vibração efetiva específica de 50 e 60 Hz e para seus múltiplos harmônicos. A variável analisada foi o *Root Mean Square* (RMS), sendo esta normalizada pelo pico dos exercícios realizados sem vibração. Foram utilizados eletrodos autoadesivos de superfície passivos, com dimensão de 4 cm x 2,2 cm de área adesiva, separados por uma distância intereletrodo de 2 cm, e aplicados no lado dominante de cada voluntário após limpeza da pele com álcool a 70% e tricotomia. Para o músculo multífidus e longuíssimo o posicionamento dos eletrodos foi de acordo com recomendações do *Surface*

ElectroMyoGraphy for the Non-Invasive Assessment of Muscles (SENIAM) [26] (Figura 1-A). E para aplicação dos eletrodos nos músculos obliquo externo e reto abdominal porção superior e porção inferior, usamos as recomendações de Freiwald J. et al em 2007 [27] (Figura 1-B).

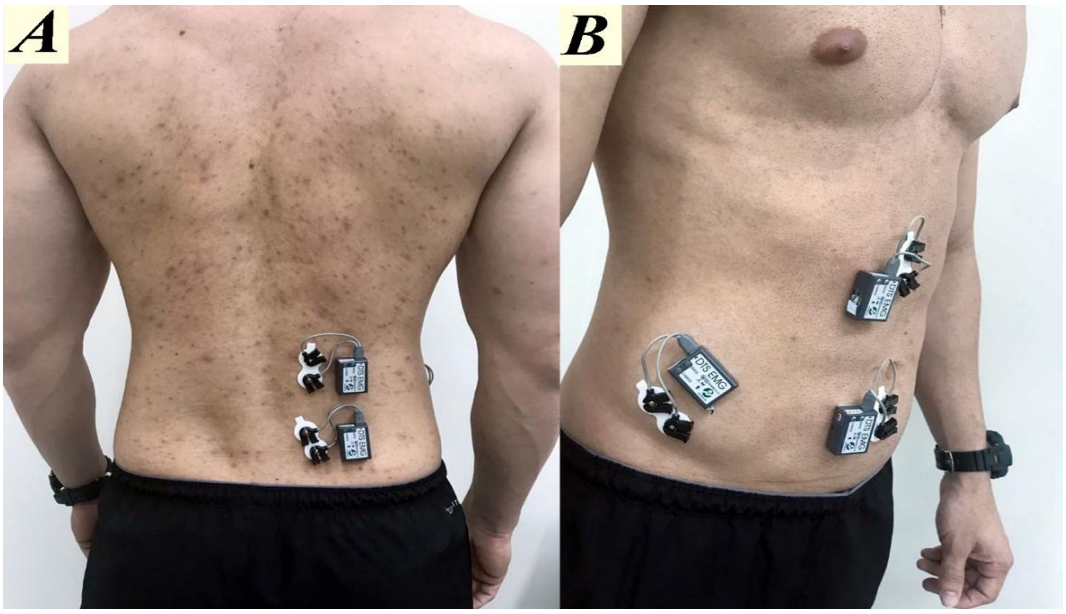

Figura 1: Posicionamento dos eletrodos nos músculos longuíssimo (A), multífidus (A), oblíquo externo (B), reto abdominal superior (B) e reto abdominal inferior (B).

Para a aplicação do protocolo de intervenção foi utilizada uma plataforma vibratória modelo *Power Plate® pro5™* (*Power Plate International Ltd.*, Power Plate North America, Inc.) com frequência configurável de 25 a 50 Hertz (com incremento manual a cada Hertz), amplitude de pico a pico configurável entre baixa ou alta e seleções de tempo entre 30, 45 ou 60 segundos.

Protocolo de intervenção

Após aplicação dos eletrodos, os voluntários dirigiram-se para a plataforma vibratória para realização dos exercícios de prancha frontal, prancha lateral e ponte. Para cada exercício foi realizada uma familiarização e em seguida o mesmo movimento foi repetido quatro vezes, cada uma com duração de dez segundos e trinta segundos de repouso entre eles. Duas repetições foram realizadas sem vibração (plataforma desligada) e duas com vibração (frequência de 50Hz, amplitude de 4mm), sendo esta ordem previamente randomizada.

Para o exercício de ponte, os pés do voluntário foram posicionados sobre a plataforma vibratória com distância pré-estabelecida, tronco encostado no chão e braços ao lado do corpo. Foi solicitado para o voluntário realizar uma extensão de quadril, retirando-o do chão formando um ângulo de 90° de joelho (Figura 2-A). No exercício de prancha lateral, o voluntário apoiou o antebraço do lado dominante (mesmo a ser avaliado) sobre a plataforma vibratória em local demarcado, ombro e cotovelos alinhados e ombro abduzido a 90°. O membro superior contralateral apoiado na cintura, cabeça em posição neutra, tronco ereto e membros inferiores estendidos (Figura 2-B). Na realização do exercício de prancha frontal, os antebraços do voluntário estavam apoiados sobre a plataforma vibratória, ombro e cotovelos alinhados e ombro flexionado a 90°, cabeça em posição neutra, membros inferiores estendidos e tronco ereto (Figura 2-C). Todas as angulações de posicionamento foram controladas por um goniômetro manual.

Figura 2: Posicionamento adotado durante os exercícios de prancha frontal (A), prancha lateral (B) e ponte (C).

Um resumo de todas as etapas desse estudo pode ser observado na Figura 3.

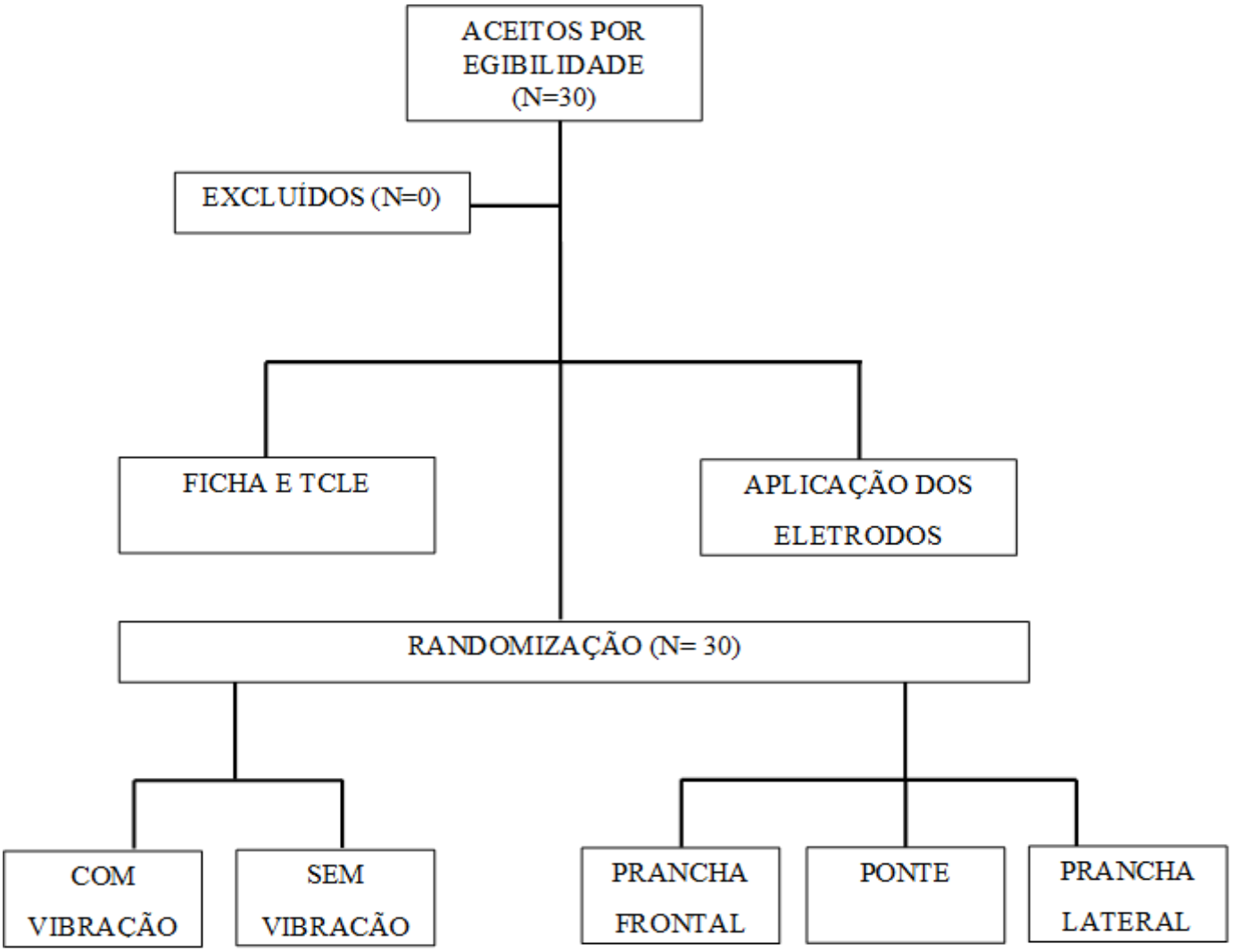

Figura 3: Fluxograma do estudo

Análise estatística

A análise estatística foi realizada por meio do software Statistical Package for the Social Science (SPSS) versão 20.0 para Windows atribuindo-se o nível de significância de 5%. O teste Kolmogorov-Smirnov foi realizado para verificação da normalidade dos dados e para as comparações entre as condições com vibração e sem vibração foi utilizada uma ANOVA de medidas repetidas.

RESULTADOS

O teste de normalidade demonstrou que todas as variáveis apresentaram distribuição normal. Desta forma, o teste de ANOVA de medidas repetidas foi aplicado, não apresentando diferenças significativas entre as condições com vibração e sem vibração. Obteve-se $p>0,05$ em todos os exercícios realizados

(prancha lateral, prancha frontal e ponte) e todos os músculos avaliados (multífidus, longuíssimo, obliquo externo, reto abdominal porções superior e inferior).

Tabela 1: Valores de média e desvio padrão da variável RMS normalizada durante os três exercícios realizados, em todos os músculos analisados e p valor das comparações entre as condições com vibração e sem vibração.

Músculo	Prancha frontal			Prancha lateral			Ponte		
	cv	sv	p valor	cv	sv	p valor	cv	sv	p valor
R.A.S	59,25 ± 4,9	61,75 ± 8,0	1,00	57,13 ± 7,2	57,61 ± 7,2	1,00	47,52 ± 11,6	45,4	1,00
R.A.I	55,12 ± 9,9	58,94 ± 8,7	1,00	54,54 ± 8,4	58,35 ± 7,1	1,00	63,69 ± 16,5	65,99 ± 15,4	1,00
O.E	61,05 ± 5,4	63,67 ± 5,4	1,00	58,48 ± 5,7	58,27 ± 5,6	1,00	60,23 ± 8,8	62,37 ± 9,1	1,00
L O	58,75 ± 6,8	57,04 ± 7,3	1,00	65,36 ± 5,8	66,89 ± 6,0	1,00	73,75 ± 4,4	75,24 ± 4,4	1,00
M U	62,91 ± 9,5	66,80 ± 11,1	1,00	64,43 ± 6,8	66,43 ± 5,3	1,00	74,75 ± 4,1	74,63 ± 5,8	1,00

CV: com vibração; SV: sem vibração; R.A.S: reto abdominal superior; R.A.I: reto abdominal inferior; O.E: oblíquo externo; LO: longuíssimo; MU: multífidus.

DISCUSSÃO

Após a análise dos resultados desse estudo, observamos que a adição da vibração durante os exercícios de prancha frontal, prancha lateral e ponte não alterou a ativação neuromuscular dos músculos multífidus, longuíssimo, oblíquo externo e reto abdominal. Logo, não há diferença em realizar exercícios para o core com ou sem vibração.

Os músculos do core tem papel fundamental na manutenção do alinhamento articular da coluna vertebral, fornecendo suporte em situações estáticas e dinâmicas, garantindo maior conservação das estruturas osteomioarticulares. Eles estão relacionados à prevenção de lesões e tratamento de lombalgias, principalmente aquelas associadas à desordem muscular.[2,28] É por isso que o fortalecimento dessa musculatura tem sido foco de pesquisas que buscam potencializar sua ativação. O uso da plataforma vibratória nos músculos do core aparece com o objetivo de intensificar o circuito neural, aumentando o recrutamento de unidades motoras e colaborando com o aumento da ativação neuromuscular. Entretanto, esses achados não foram comprovados no nosso estudo.

Alguns estudos fornecem informações sobre como o treinamento específico para essa musculatura promove redução da dor lombar crônica, aumento do fluxo sanguíneo local, prevenção de lesões e relaciona-se com aumento da performance de atletas amadores e de alto nível.[29,30,31,32,33] Entretanto, a utilização da vibração é um método relativamente novo no contexto de reabilitação e promoção de saúde. Logo, pesquisas que analisam o efeito da adjunção da plataforma vibratória nessa musculatura são bastante escassas. [16,34,35,36]

Diante de poucos estudos com boa qualidade metodológica, alguns achados apresentam resultados que correspondem aos expostos em nossa pesquisa, ou seja, a ausência de resultados positivos da utilização da plataforma vibratória.[35,36] E nos fornece a informação que a investigação da repercussão da plataforma no core vai além da sua contribuição na ativação muscular e seus efeitos agudos. Osawa et al[35] em 2011, avaliaram a força e resistência dos músculos anteriores e posteriores do core após 12 semanas de exercícios na plataforma vibratória em adultos saudáveis e concluíram que o exercício com adição da vibração quando

comparado ao exercício isoladamente não promove mudanças na força e resistência muscular do powerhouse de jovens saudáveis. Enquanto em 2016, Maeda et al[36] analisaram a repercussão após 8 semanas de treinamento com vibração, sobre a força extensora e flexora de tronco e sua influência nos testes funcionais: *Functional Movement Screen* (FMS), *Y balance test* e distância do salto vertical. Foi registrado em seus resultados que só houve diferença significativa na comparação entre os grupos com vibração e sem vibração para a variável força flexora do tronco, o que limita a determinação se a plataforma vibratória influencia positivamente o desempenho neuromuscular dos músculos core.

Apesar dos estudos citados analisarem variáveis distintas do nosso, deve-se levar em consideração que o aumento da ativação neuromuscular é uma das primeiras mudanças neurofisiológicas que ocorre quando a fibra muscular é estimulada, [37] e isso infere nas adaptações secundárias ao treinamento. Considera-se também que a proposta sugerida pela plataforma vibratória é que devido ao estimulo mecânico com oscilações constantes em formato de sino, há um aumento da taxa de disparo que por sua vez ativa os potenciais motores. Como consequência desse aumento, há maior ativação dos motoneurônios alfa (α) intensificando a contração muscular, [21,22,23] que pode ter sua variação detectada através da análise da eletromiografia realizada pelo nosso estudo. Logo, a avaliação do RMS realizada em nossa pesquisa torna-se suficiente para afirmar se há aumento da ativação muscular que levaria a possíveis adaptações secundárias analisadas em outros estudos.

Com relação à avaliação eletromiográfica dos músculos do core através da eletromiografia, há menos contribuição na literatura quanto aos impactos ocasionados pela vibração. Wirth et al[16] em 2011 avaliaram os efeitos da plataforma vibratória sobre os músculos do core de 25 sujeitos do sexo masculino e feminino, utilizando uma frequência de 30Hz e 8 exercícios estáticos. Em contraste com este estudo, avaliamos 30 sujeitos apenas do sexo masculino e utilizamos uma frequência de 50Hz como recomendado por Petit et al[38] e 3 exercícios estabilizadores (prancha frontal, prancha lateral e ponte) que são os mais utilizados no início do programa de treinamento e reabilitação. Os pesquisadores relataram que houve um aumento de baixo a moderado nos valores de RMS, porém os efeitos mais altos foram encontrados nos exercícios em que os sujeitos estavam diretamente sentados na plataforma, o que corrobora com a pesquisa

de Roelants et al[39] (2006) sobre a influência da distância entre os músculos alvos e a superfície de contato com a plataforma. Entretanto, esses exercícios não foram desenvolvidos em nosso estudo considerando também o fato dos possíveis efeitos danosos causados pela exposição à plataforma, como a transmissão da vibração para a cabeça.[40] Em 2015, outro estudo foi desenvolvido por Perchthaler et al[34] com a avaliação eletromiográfica dos músculos eretores da coluna, reto abdominal e esplênio de 28 sujeitos, entretanto o protocolo de exercícios se resumia a variações de angulação no agachamento sobre plataforma vibratória por 25 segundos. Foi observado um aumento no RMS desses músculos, porém não foram utilizados filtros adicionais que são essenciais na análise do processamento do sinal e para remoção de artefatos, como descrito por Borges et al[40] (2017), o que gera dúvidas em relação a determinação do real valor de ativação muscular e se a vibração realmente foi eficaz.

Apesar dos estudos citados anteriormente mostrarem melhora na ativação eletromiográfica dos músculos do core, estes apresentam metodologias distintas do estudo desenvolvido, em relação aos tipos de exercícios, utilização ou não de filtros adicionais, amostra com ambos os sexos e tempo de exposição na vibração, o que pode justificar a diferença dos resultados obtidos. Como a plataforma é um equipamento relativamente novo no mercado, com grande variedade de protocolo sem padronização de teor científico, e escasso na literatura quando relacionado à ativação dos músculos do core, ainda não podemos concluir os reais efeitos na ativação neuromuscular do powerhouse. Percebemos assim que essa é uma área que ainda há muito para ser explorada e sugerimos que novos estudos sejam realizados para que maiores comparações sejam possíveis.

CONCLUSÃO

Com o fim desse estudo, concluímos que a utilização da plataforma vibratória não é necessária como método aditivo para aumentar a ativação neuromuscular dos músculos do core. O que nos leva à rejeição da hipótese que a utilização da vibração aumentaria a ativação dos músculos avaliados. Entretanto,

esses resultados limitam-se ao efeito da plataforma no powerhouse durante os exercícios de estabilização na população de homens saudáveis e praticantes de atividade física.

REFERÊNCIAS BIBLIOGRÁFICAS

1- Adukota V, Nadler SF. Core Strengthening. Am J Phys Med Rehabil. 2004; 85 (1): 86-92.

2- Panjabi MM. The Stabilizing of The Spine Part II Neutral Zone and Instability Hypothesis. Clin Spine Surg. 1992; 5 (4): 390-397.

3- Wagner H, Blickhan R. Stabilizing Function of Skeletal Muscles: an Analytical Investigation. J. Theor. Biol. 1999; 199: 163-179.

4- Granata KP, England SA. Stability of Dynamic Trunk Movement. Spine J. 2006; 31(10): 271-276.

5- Granata KP, Wilson SE. Trunk Posture and Spinal Stability. Clin Biomech. 2001; 16: 650-659.

6- Panjabi MM. The Stabilizing System of The Spine Part I Function, Dysfunction, Adaptation and Enhancement. Clin Spine Surg. 1992; 5(4): 383-389.

7- Kobill AFM, Silveira ALA, Lima AI, Paidosz A, Siqueira AF, Penteado D, et al. Influence of segmental core stabilization in pain and spinal lumbar functionality. Rev Bras Fisioter. 2017; 18 (2): 148-153.

8- Hodges PW. Core Stability Exercise in Chronic Low Back Pain. Orthop Clin North Am. 2003; 34: 245-254.

9- McGill SM. Low Back Stability: From Formal Description to Issues for Perfomace and Rehabilitation. Exerc. Sport Sci. Rev. 2001; 29 (1): 26-31.

10- Barr KP, Griggs M, Cadby T. Lumbar Stabilization a Review of Core Concepts and Current Literature Part 2. Am J Phys Med Rehabil. 2007; 86 (1): 72-80.

11- Kibler WB, Press J, Sciascia A. The Role of Core Stability in Athletic Function. Sports Med. 2006; 36 (3): 189-198.

12- Hibbs AE, Thompson KG, French D, Wrigley A, Spears I. Optimizing Performace by Improving Core Stability and Core Strength. Sports Med. 2008; 38 (12): 995-1008.

13- Leetun DT, Ireland ML, Wilson JD. Core Stability Measures as Risk Factors for Lower Extremity Injury in Athletes. Med Sci Sports Exerc. 2004; 36 (6): 926-934

14- Blaiser C, Roosen P, Willems T, Danneels L, Bossche LV, Ridder Roel. Is core stability a risk factor for lower extremity injuries in an athletic population? A systematic review. Phys Ther Sport. 2017.

15- Prieske O, Muehlbauer T, Borde R, Gube M, Bruhn S, Behm DG et al. Neuromuscular and Athletic Performace Following Core Strength Training in Elite Youth Soccer: Role of Instability. Scand J Med Sci Sports. 2015; 26: 48–56.

16- Wirth B, Zurfluh S, Müller R. Acute Effects of Whole-Body Vibration on Trunk Muscles in Young Healthy Adults. J Electromyogr Kinesiol. 2011; 21: 450-457.

17- Maddalozzo GF, Kuo B, Maddalozzo W A, Maddalozzo C D, Galver J W. Comparison of 2 Multimodal Interventions With and Without Whole Body Vibration Therapy Plus Tractions on Pain and Disability in Patients With Nonspecific Chronic Low Back Pain. J Chiropr Med. 2016; 15: 243-251.

18- Torvinen S, Kannus P, Sievanen H, Jarvinen TAH, Pasanen M, Kontulainen S, et al. Effect of a vibration exposure on muscular performance and body balance. Randomized cross-over study. Clin Physiol Funct Imaging. 2002; 22(2): 145-52.

19- Batista MAB, Wallerstein LF, Dias RG, Ugrinowtsch C, Tricoli V. Effects of Training With Vibratorys Platforms. R Bras Ci e Mov. 2007; 15(3): 103-113.

20- Artero EG, Porcel FBO, Ruiz JR, Galvez FC. Entrenamiento vibratório. Base Fisiologica y efectos funcionales. Selección. 2006;15(2): 78-86.

21- Cochrane DJ. The Potential Neural Mechanisms of Acute Indirect Vibration. J Sports Sci Med. 2011; 10: 19-30.

22- Cardinale M, Bosco C. The use of vibration as an exercise intervention. Exerc. Sport Sci. Rev. 2003; 31(1): 3-7.

23- Albasini A, Krause M, Rembitzki I. Using whole body vibration in physical therapy and sport. 1th ed. London: Churchill Livingstone; 2010.

24- Luo J, McNamara B, Moran K. The use of vibration training to enhance muscle strength and power. Sports Med. 2005; 35 (1): 23-41.

25- Pincivero DM, Gandaio GB, Ito Y. Gender-specific Knee Extensor Torque, Flexor Torque, and Muscle Fatigue Responses During Maximal Effort Contractions. Eur J Appl Physiol. 2003; 89: 134-141.

26- Hermens HJ, Freriks B, Disselhorst-Klug C, Rau G. Development of recommendations for SEMG sensors and sensor placement procedures. J Electromyogr Kinesiol. 2000; 10: 361-374.

27- Freiwald J, Baumgart C, Konrad P. Introduction to electromyography. Balingen: Spitta Verlag. 2007.

28- Nachemson AL. Advances in low-back pain. Clin Orthop. 1985; 200: 266-78.

29- Maaswinkel E, Griffioen M, Perez RSGM, van Dieën JH. Methods for assessment of trunk stabilization, a systematic review. J Electromyogr Kinesiol. 2016; 26: 18-35.

30- Barbado D, Barbado LC, Elvira JLL, van Dieën JH, Vera-Garcia FJ. Sports-related testing protocols are required to reveal trunk stability adaptations in high-level athletes. Gait & Posture. 2016; 49: 90-96.

31- Shahvarpour A, Henry SM, Preuss R, Mecheri H, Larivière C. The effect of an 8-week stabilization exercise program on the lumbopelvic rhythm and flexion-relaxation phenomenon. Clin Biomech. 2017; 48: 1-8.

32- Yoon JO, Kang MH, Kim JS, Oh JS. Effect of modified bridge exercise on trunk muscle activity in healthy adults: a cross sectional study. Braz J Phys Ther. 2017; 73: 1-7.

33- Paungmali A, Henry LJ, Sitilertpsan P, Pirunsan U, Uthaikhup S. Improvements in tissue blood flow and lumbopelvic stability after lumbopelvic core stabilization training in patients with chronic non-specific low back pain. J. Phys. Ther. Sci. 2016; 28: 635–640.

34- Perchthaler D, Hauser S, Heitkamp HC, Hein T, Grau S. Acute Effects of Whole-Body Vibration on Trunk and Neck Muscle Activity in Consideration of Different Vibration Loads. J Sports Sci Med. 2015; 14: 155-162.

35- Osawa Y, Oguma Y, Onishi S. Effects of whole-body vibration training on bone-free lean body mass and muscle strength in young adults. J Sports Sci Med. 2011; 10: 97-104.

36- Maeda N, Urabe Y, Sasadai J, Miyamoto A, Murakami M et al. Effect of Whole-Body-Vibration Training on Trunk-Muscle Strength and Physical Performance in Healthy Adults: Preliminary Results of a Randomized Controlled Trial. J Sport Rehabil. 2016; 25: 357-363.

37- Folland JP, Williams AG. The Adaptations to Strength Training Morphological and Neurological Contributions to Increased Strength. Sports Med. 2007; 37(2): 145-168.

38- Petit PD, Pensini M, Tessaro J, Desnuelle C, Legros P, Colson SS. Optimal whole-body vibration settings for muscle strength and power enhancement in human knee extensors. J Electromyogr Kinesiol. 2010; 20 (6): 1186–1195.

39- Roelants M, Verschueren SM, Delecluse C, Levin O, Stijnen V. Whole body vibration induced increase in leg muscle activity during different squat exercises. J Strength Cond Res. 2006; 20:124–129.

40- Mester J, Kleinoder H, Yue Z. Vibration training: benefits and risks. J Biomech. 2006; 39: 1056–1065.

41- Borges DT, Macedo LB, Lins CAA, Sousa CO, Brasileiro JS. Effects of Whole Body Vibration on the Neuromuscular Amplitude of Vastus Lateralis Muscle. J Sports Sci Med. 2017; 16(3): 414–420.

ANEXO 1

BRAZILIAN JOURNAL OF PHYSICAL THERAPY

AUTHOR INFORMATION PACK

TABLE OF CONTENTS

- Description p.1
- Impact Factor p.1
- Abstracting and Indexing p.1
- Editorial Board p.1
- Guide for Authors p.4

ISSN: 1413-3555

DESCRIPTION

The *Brazilian Journal of Physical Therapy* (BJPT) is the official publication of the Brazilian Society of Physical Therapy Research and Graduate Studies (ABRAPG-Ft). It publishes original research articles on topics related to the areas of physical therapy and rehabilitation sciences, including clinical, basic or applied studies on the assessment, prevention, and treatment of movement disorders.

IMPACT FACTOR

2016: 1.226 © Thomson Reuters Journal Citation Reports 2017

ABSTRACTING AND INDEXING

CINAHL
Cambridge Scientific
Abstracts MEDLINE®
Web of Science
Scopus

EDITORIAL BOARD

Carlos Marcelo Pastre, Universidade Estadual Paulista, Presidente Prudente, SP, Brazil **Celso Ricardo Fernandes de Carvalho**, Universidade de São Paulo, São Paulo, SP, Brazil **Cláudia Santos Oliveira**, Universidade Nove de Julho, São Paulo, SP, Brazil

Cristiane Shinohara Moriguchi, Universidade Federal de São Carlos, São Carlos, SP, Brazil **Cristina Maria Nunes Cabral**, Universidade Cidade de São Paulo, São Paulo, SP, Brazil **Cristine Homsi Jorge Ferreira**, Universidade de São Paulo, Ribeirão Preto SP, Brazil **Daniela Cristina Carvalho de Abreu**, Universidade de São Paulo, Ribeirão Preto SP, Brazil

Guide for Authors

All journal information and instructions compiled in one document (PDF) in just one mouse-click Author information pack

INTRODUCTION
• Types of article
• Submission checklist
BEFORE YOU BEGIN
• Ethics in publishing
• Human and animal rights
• Declaration of interest
• Submission declaration and verification
• Authorship
• Changes to authorship

• Clinical trial results
• Copyright
• Role of the funding source
• Informed consent and patient details
• Submission
PREPARATION
• Double-blind review
• Article structure
• Essential title page information
• Abstract

• Keywords
• Artwork
• Tables
• References
• Video
• Supplementary material
• RESEARCH DATA
AFTER ACCEPTANCE
• Proofs
AUTHOR INQUIRIES

Types of article

The Brazilian Journal of Physical Therapy (BJPT) publishes original research articles, reviews, and brief communications on topics related to physical therapy and rehabilitation, including clinical, basic or applied studies on the assessment, prevention and treatment of movement disorders. Our Editorial Board is committed to disseminate high-quality research in the field of physical therapy. The BJPT follows the principle of publication ethics included in the code of conduct of the Committee on Publication Ethics (COPE).The BJPT accepts the submission of manuscripts with up to 3,500 words (excluding title page, abstract, references, tables, figures and legends). Information contained in appendices will be included in the total number of words allowed. A total of five (5) combined tables and figures is allowed.

The following types of study can be considered for publication, if directly related to the journal's scope:
a) Intervention studies (clinical trials): studies that investigate the effect(s) of one

or more interventions on outcomes directly related to the BJPT's scope. The World Health Organization defines a clinical trial as "any research study that prospectively allocates human participants or groups of humans to one or more health-related interventions to evaluate the effect(s) on health outcome(s)". Clinical trials include single-case experimental studies, case series, non-randomized controlled trials, and randomized controlled trials. Randomized controlled trials (RCTs) must follow the CONSORT (Consolidated Standards of Reporting Trials) recommendations, which are available at: http://www.consort-statement.org/consort-statement/overview0/. The CONSORT checklist and Statement Flow Diagram, available at http://www.consort-statement.org/consort-statement/flow-diagram, must be completed and submitted with the manuscript. Clinical trials must provide registration that satisfies the requirements of the International Committee of Medical Journal Editors (ICMJE), e.g. http://clinicaltrials.gov/ and/or http://www.anzctr.org.au. The complete list of all clinical trial registries can be found at: http://www.who.int/ictrp/network/primary/en/index.html. We suggest that all authors register clinical trials prospectively via the website http://www.clinicaltrials.gov.
Note: We do not accept single case studies and series of cases (i.e. clinical trials without a comparison group).

b) Observational studies: studies that investigate the relationship(s) between variables of interest related to the BJPT's scope. Observational studies include cross-sectional studies, cohort studies, and case-control studies. All observational studies must be reported following the recommendation from the STROBE statement (http://strobe-statement.org/index.php?id=strobe-home).

c) Qualitative studies: studies that focus on understanding needs, motivations, and human behavior. The object of a qualitative study is guided by in-depth analysis of a topic, including opinions, attitudes, motivations, and behavioral patterns without quantification. Qualitative studies include documentary and ethnographic analysis.

d) Systematic reviews: studies that analyze and/or synthesize the literature on a topic related to the scope of the BJPT. Systematic reviews that include meta-analysis will have priority over other systematic reviews. Those that have an insufficient number of articles or articles with low quality in the Methods section and do not include an assertive and valid conclusion about the topic will not be considered for peer-review analysis.
The authors must follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist to format their systematic reviews. The checklist is available at http://www.prisma-statement.org/PRISMAStatement/Default.aspx and must be filled in and submitted with the manuscript.
Potential authors are encouraged to read the following tutorial, which contains the minimum requirements for publication of systematic reviews in the BJPT: Mancini MC, Cardoso JR, Sampaio RF, Costa LCM, Cabral CMN, Costa LOP. Tutorial for writing systematic reviews for the Brazilian Journal of Physical Therapy (BJPT). Braz J Phys Ther. 2014 Nov-Dec; 18(6):471-480.

e) Studies on the translation and cross-cultural adaptation of questionnaires or assessment tools: studies that aim to translate and/or cross-culturally adapt foreign questionnaires to a language other than that of the original version of existing assessment instruments. The authors must use the checklist (Appendix) to format this type of paper and adhere to the other recommendations of the BJPT. The answers to the checklist must be submitted with the manuscript. At the time of submission, the authors must also include written permission from the authors of the original instrument that was translated and/or cross-culturally adapted.

f) Methodological studies: studies centered on the development and/or evaluation

of clinimetric properties and characteristics of assessment instruments. The authors are encouraged to use the Guidelines for Reporting Reliability and Agreement Studies (GRRAS) to format methodological papers, in addition to following BJPT instructions. Important: Studies that report electromyographic results must follow the Standards for Reporting EMG Data recommended by ISEK (International Society of Electrophysiology and Kinesiology), available at http://www.isek.org/wp-content/uploads/2015/05/Standards-for-Reporting-EMG-Data.pdf.

g) Clinical trial protocols: The BJPT welcomes the publication of clinical trial protocols. We only accept trial protocols that are substantially funded, have ethics approval, have been prospectively registered and of very high quality. We expect that clinical trial protocols must be novel and with a large sample size. Finally, authors have to provide that the clinical trial is on its first stages of recruitment. Authors should use the SPIRIT statement while formatting the manuscript (http://www.spirit-statement.org).

h) Short communications: the BJPT will publish one short communication per issue (up to six a year) in a format similar to that of the original articles, containing 1200 words and up to two figures, one table, and ten references.

i) Masterclass articles: This type of article presents the state of art of any topic that is important to the field of physical therapy. All masterclass articles are invited manuscripts and the authors must be recognized experts in the field. However, authors can send e-mails to the editor in chief with an expression of interest to submit a masterclass article to the BJPT. Submission checklist

You can use this list to carry out a final check of your submission before you send it to the journal for review. Please check the relevant section in this Guide for Authors for more details.

Ensure that the following items are present:

One author has been designated as the corresponding author with contact details:
• E-mail address
• Full postal address

All necessary files have been uploaded:
Manuscript:
• Include keywords
• All figures (include relevant captions)
• All tables (including titles, description, footnotes)
• Ensure all figure and table citations in the text match the files provided
• Indicate clearly if color should be used for any figures in print
Graphical Abstracts / Highlights files (where applicable)
Supplemental files (where applicable)

Further considerations
• Manuscript has been 'spell checked' and 'grammar checked'
• All references mentioned in the Reference List are cited in the text, and vice versa
• Permission has been obtained for use of copyrighted material from other sources (including the Internet)
• A competing interests statement is provided, even if the authors have no competing interests to declare
• Journal policies detailed in this guide have been reviewed
• Referee suggestions and contact details provided, based on journal requirements

For further information, visit our Support Center.

Ethics in publishing

Please see our information pages on Ethics in publishing and Ethical guidelines for journal publication.

Human and animal rights

If the work involves the use of human subjects, the author should ensure that the work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals. Authors should include a statement in the manuscript that informed consent was obtained for experimentation with human subjects. The privacy rights of human subjects must always be observed.

All animal experiments should comply with the ARRIVE guidelines and should be carried out in accordance with the U.K. Animals (Scientific Procedures) Act, 1986 and associated guidelines, EU Directive 2010/63/EU for animal experiments, or the National Institutes of Health guide for the care and use of Laboratory animals (NIH Publications No. 8023, revised 1978) and the authors should clearly indicate in the manuscript that such guidelines have been followed.

Declaration of interest

All authors must disclose any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work. Examples of potential conflicts of interest include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding. Authors must disclose any interests in two places: 1. A summary declaration of interest statement in the title page file (if double-blind) or the manuscript file (if single-blind). If there are no interests to declare then please state this: 'Declarations of interest: none'. This summary statement will be ultimately published if the article is accepted. 2. Detailed disclosures as part of a separate Declaration of Interest form, which forms part of the journal's official records. It is important for potential interests to be declared in both places and that the information matches. More information.

Submission declaration and verification

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see 'Multiple, redundant or concurrent publication' section of our ethics policy for more information), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. To verify originality, your article may be checked by the originality detection service CrossCheck.

Authorship

All authors should have made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

Changes to authorship

Authors are expected to consider carefully the list and order of authors before submitting their manuscript and provide the definitive list of authors at the time of the original submission. Any addition, deletion or rearrangement of author names in the authorship list should be made only before the manuscript has been accepted and only if approved by the journal Editor. To request such a change, the Editor must receive the following from the corresponding author: (a) the reason for the change in author list and (b) written confirmation (e-mail, letter) from all authors that they agree with the addition, removal or rearrangement. In the case of addition or removal of authors, this includes confirmation from the author being added or removed.
Only in exceptional circumstances will the Editor consider the addition, deletion or rearrangement of authors after the manuscript has been accepted. While the Editor considers the request, publication of the manuscript will be suspended. If the manuscript has already been published in an online issue, any requests approved by the Editor will result in a corrigendum.

Clinical trial results

In line with the position of the International Committee of Medical Journal Editors, the journal will not consider results posted in the same clinical trials registry in which primary registration resides to be prior publication if the results posted are presented in the form of a brief structured (less than 500 words) abstract or table. However, divulging results in other circumstances (e.g., investors' meetings) is discouraged and may jeopardise consideration of the manuscript. Authors should fully disclose all posting in registries of results of the same or closely related work.

Reporting clinical trials
Randomized controlled trials should be presented according to the CONSORT guidelines. At manuscript submission, authors must provide the CONSORT checklist accompanied by a flow diagram that illustrates the progress of patients through the trial, including recruitment, enrollment, randomization, withdrawal and completion, and a detailed description of the randomization procedure. The CONSORT checklist and template flow diagram are available online.

Registration of clinical trials
Registration in a public trials registry is a condition for publication of clinical trials in this journal in accordance with International Committee of Medical Journal Editors recommendations. Trials must register at or before the onset of patient enrolment. The clinical trial registration number should be included at the end of the abstract of the article. A clinical trial is defined as any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects of health outcomes. Health-related interventions include any intervention used to modify a biomedical or health-related outcome (for example drugs, surgical procedures, devices, behavioural treatments, dietary interventions, and process-of-care changes). Health outcomes include any biomedical or health-related measures obtained in patients or participants, including pharmacokinetic measures and adverse events. Purely observational studies (those in which the assignment of the medical intervention is not at the discretion of the investigator) will not require registration.

Copyright

Upon acceptance of an article, authors will be asked to complete a 'Journal Publishing Agreement' (see more information on this) to assign to theAssociação

Brasileira de Pesquisa e Pós-Graduação em Fisioterapia (ABRAPG-FT) the copyright in the manuscript and any tables, illustrations or other material submitted for publication as part of the manuscript (the "Article") in all forms and media (whether now known or later developed), throughout the world, in all languages, for the full term of copyright, effective when the Article is accepted for publication. An e-mail will be sent to the corresponding author confirming receipt of the manuscript together with a 'Journal Publishing Agreement' form or a link to the online version of this agreement.

Subscribers may reproduce tables of contents or prepare lists of articles including abstracts for internal circulation within their institutions. Permission of the Publisher and ABRAPG-FT is required for resale or distribution outside the institution and for all other derivative works, including compilations and translations. If excerpts from other copyrighted works are included, the author(s) must obtain written permission from the copyright owners and credit the source(s) in the article.

Author rights
As an author you (or your employer or institution) have certain rights to reuse your work. More information.

Elsevier supports responsible sharing
Find out how you can share your research published in this journal.

Role of the funding source

You are requested to identify who provided financial support for the conduct of the research and/or preparation of the article and to briefly describe the role of the sponsor(s), if any, in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication. If the funding source(s) had no such involvement then this should be stated.

Elsevier Publishing Campus
The Elsevier Publishing Campus (www.publishingcampus.com) is an online platform offering free lectures, interactive training and professional advice to support you in publishing your research. The College of Skills training offers modules on how to prepare, write and structure your article and explains how editors will look at your paper when it is submitted for publication. Use these resources, and more, to ensure that your submission will be the best that you can make it.

Language (usage and editing services)
Please write your text in good English (American or British usage is accepted, but not a mixture of these). Authors who feel their English language manuscript may require editing to eliminate possible grammatical or spelling errors and to conform to correct scientific English may wish to use the English Language Editing service available from Elsevier's WebShop.

Informed consent and patient details

Studies on patients or volunteers require ethics committee approval and informed consent, which should be documented in the paper. Appropriate consents, permissions and releases must be obtained where an author wishes to include case details or other personal information or images of patients and any other individuals in an Elsevier publication. Written consents must be retained by the author and copies of the consents or evidence that such consents have been obtained must be provided to Elsevier on request. For more information, please review the Elsevier Policy on the Use of Images or Personal Information of Patients

or other Individuals. Unless you have written permission from the patient (or, where applicable, the next of kin), the personal details of any patient included in any part of the article and in any supplementary materials (including all illustrations and videos) must be removed before submission.

Submission

Our online submission system guides you stepwise through the process of entering your article details and uploading your files. The system converts your article files to a single PDF file used in the peer-review process. Editable files (e.g., Word, LaTeX) are required to typeset your article for final publication. All correspondence, including notification of the Editor's decision and requests for revision, is sent by e-mail.

Submit your article
Please submit your article via https://www.evise.com/profile/api/navigate/BJPT.

Double-blind review

This journal uses double-blind review, which means the identities of the authors are concealed from the reviewers, and vice versa. More information is available on our website. To facilitate this, please include the following separately:
Title page (with author details): This should include the title, authors' names, affiliations, acknowledgements and any Declaration of Interest statement, and a complete address for the corresponding author including an e-mail address.
Blinded manuscript (no author details): The main body of the paper (including the references, figures, tables and any acknowledgements) should not include any identifying information, such as the authors' names or affiliations.

Use of word processing software
It is important that the file be saved in the native format of the word processor used. The text should be in single-column format. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. In particular, do not use the word processor's options to justify text or to hyphenate words. However, do use bold face, italics, subscripts, superscripts etc. When preparing tables, if you are using a table grid, use only one grid for each individual table and not a grid for each row. If no grid is used, use tabs, not spaces, to align columns. The electronic text should be prepared in a way very similar to that of conventional manuscripts (see also the Guide to Publishing with Elsevier). Note that source files of figures, tables and text graphics will be required whether or not you embed your figures in the text. See also the section on Electronic artwork.
To avoid unnecessary errors you are strongly advised to use the 'spell-check' and 'grammar-check' functions of your word processor.

Article structure

Subdivision - unnumbered sections
Divide your article into clearly defined sections. Each subsection is given a brief heading. Each heading should appear on its own separate line. Subsections should be used as much as possible when cross-referencing text: refer to the subsection by heading as opposed to simply 'the text'.

Introduction
State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Material and methods
Provide sufficient detail to allow the work to be reproduced.

Results
Results should be clear and concise.

Discussion
This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Conclusions
The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

Appendices
If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Essential title page information

• Title. Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.
• Author names and affiliations. Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. You can add your name between parentheses in your own script behind the English transliteration. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.
• Corresponding author. Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. This responsibility includes answering any future queries about Methodology and Materials. Ensure that the e-mail address is given and that contact details are kept up to date by the corresponding author.
• Present/permanent address. If an author has moved since the work described in the article was done, or was visiting at the time, a 'Present address' (or 'Permanent address') may be indicated as a footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.

Abstract

A concise and factual structured abstract is required. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

Highlights
Highlights are mandatory for this journal. They consist of a short collection of bullet

points that convey the core findings of the article and should be submitted in a separate editable file in the online submission system. Please use 'Highlights' in the file name and include 3 to 5 bullet points (maximum 85 characters, including spaces, per bullet point). You can view example Highlights on our information site.

Keywords

Immediately after the abstract, provide a maximum of 6 keywords, using American spelling and avoiding general and plural terms and multiple concepts (avoid, for example, 'and', 'of'). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

Acknowledgements
Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

Formatting of funding sources
List funding sources in this standard way to facilitate compliance to funder's requirements:

Funding: This work was supported by the National Institutes of Health [grant numbers xxxx, yyyy]; the Bill & Melinda Gates Foundation, Seattle, WA [grant number zzzz]; and the United States Institutes of Peace [grant number aaaa].

It is not necessary to include detailed descriptions on the program or type of grants and awards. When funding is from a block grant or other resources available to a university, college, or other research institution, submit the name of the institute or organization that provided the funding.

If no funding has been provided for the research, please include the following sentence:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Units
Follow internationally accepted rules and conventions: use the international system of units (SI). If other units are mentioned, please give their equivalent in SI.

Math formulae
Please submit math equations as editable text and not as images. Present simple formulae in line with normal text where possible and use the solidus (/) instead of a horizontal line for small fractional terms, e.g., X/Y. In principle, variables are to be presented in italics. Powers of e are often more conveniently denoted by exp. Number consecutively any equations that have to be displayed separately from the text (if referred to explicitly in the text).

Footnotes
Footnotes should be used sparingly. Number them consecutively throughout the article. Many word processors can build footnotes into the text, and this feature may be used. Otherwise, please indicate the position of footnotes in the text and list the footnotes themselves separately at the end of the article. Do not include footnotes in the Reference list.

Artwork

Image manipulation
Whilst it is accepted that authors sometimes need to manipulate images for clarity, manipulation for purposes of deception or fraud will be seen as scientific ethical abuse and will be dealt with accordingly. For graphical images, this journal is applying the following policy: no specific feature within an image may be enhanced, obscured, moved, removed, or introduced. Adjustments of brightness, contrast, or color balance are acceptable if and as long as they do not obscure or eliminate any information present in the original. Nonlinear adjustments (e.g. changes to gamma settings) must be disclosed in the figure legend.

Electronic artwork
General points
• Make sure you use uniform lettering and sizing of your original artwork.
• Embed the used fonts if the application provides that option.
• Aim to use the following fonts in your illustrations: Arial, Courier, Times New Roman, Symbol, or use fonts that look similar.
• Number the illustrations according to their sequence in the text.
• Use a logical naming convention for your artwork files.
• Provide captions to illustrations separately.
• Size the illustrations close to the desired dimensions of the published version.
• Submit each illustration as a separate file.
A detailed guide on electronic artwork is available.
You are urged to visit this site; some excerpts from the detailed information are given here.
Formats
If your electronic artwork is created in a Microsoft Office application (Word, PowerPoint, Excel) then please supply 'as is' in the native document format.
Regardless of the application used other than Microsoft Office, when your electronic artwork is finalized, please 'Save as' or convert the images to one of the following formats (note the resolution requirements for line drawings, halftones, and line/halftone combinations given below):
EPS (or PDF): Vector drawings, embed all used fonts.
TIFF (or JPEG): Color or grayscale photographs (halftones), keep to a minimum of 300 dpi.
TIFF (or JPEG): Bitmapped (pure black & white pixels) line drawings, keep to a minimum of 1000 dpi.
TIFF (or JPEG): Combinations bitmapped line/half-tone (color or grayscale), keep to a minimum of 500 dpi.
Please do not:
• Supply files that are optimized for screen use (e.g., GIF, BMP, PICT, WPG); these typically have a low number of pixels and limited set of colors;
• Supply files that are too low in resolution;
• Submit graphics that are disproportionately large for the content.

Color artwork
Please make sure that artwork files are in an acceptable format (TIFF (or JPEG), EPS (or PDF) or MS Office files) and with the correct resolution. If, together with your accepted article, you submit usable color figures then the journal will ensure, at no additional charge, that these figures will appear in color online (e.g., ScienceDirect and other sites). Further information on the preparation of electronic artwork.

Illustration services
Elsevier's WebShop offers Illustration Services to authors preparing to submit a

manuscript but concerned about the quality of the images accompanying their article. Elsevier's expert illustrators can produce scientific, technical and medical-style images, as well as a full range of charts, tables and graphs. Image 'polishing' is also available, where our illustrators take your image(s) and improve them to a professional standard. Please visit the website to find out more.

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

Tables

Please submit tables as editable text and not as images. Tables can be placed either next to the relevant text in the article, or on separate page(s) at the end. Number tables consecutively in accordance with their appearance in the text and place any table notes below the table body. Be sparing in the use of tables and ensure that the data presented in them do not duplicate results described elsewhere in the article. Please avoid using vertical rules and shading in table cells.

References

Citation in text
Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. If these references are included in the reference list they should follow the standard reference style of the journal and should include a substitution of the publication date with either 'Unpublished results' or 'Personal communication'. Citation of a reference as 'in press' implies that the item has been accepted for publication.

Reference links
Increased discoverability of research and high quality peer review are ensured by online links to the sources cited. In order to allow us to create links to abstracting and indexing services, such as Scopus, CrossRef and PubMed, please ensure that data provided in the references are correct. Please note that incorrect surnames, journal/book titles, publication year and pagination may prevent link creation. When copying references, please be careful as they may already contain errors. Use of the DOI is encouraged.

A DOI can be used to cite and link to electronic articles where an article is in-press and full citation details are not yet known, but the article is available online. A DOI is guaranteed never to change, so you can use it as a permanent link to any electronic article. An example of a citation using DOI for an article not yet in an issue is: VanDecar J.C., Russo R.M., James D.E., Ambeh W.B., Franke M. (2003). Aseismic continuation of the Lesser Antilles slab beneath northeastern Venezuela. Journal of Geophysical Research, https://doi.org/10.1029/2001JB000884. Please note the format of such citations should be in the same style as all other references in the paper.

Web references
As a minimum, the full URL should be given and the date when the reference was last accessed. Any further information, if known (DOI, author names, dates, reference to a source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if

desired, or can be included in the reference list.

Data references
This journal encourages you to cite underlying or relevant datasets in your manuscript by citing them in your text and including a data reference in your Reference List. Data references should include the following elements: author name(s), dataset title, data repository, version (where available), year, and global persistent identifier. Add [dataset] immediately before the reference so we can properly identify it as a data reference. The [dataset] identifier will not appear in your published article.

References in a special issue
Please ensure that the words 'this issue' are added to any references in the list (and any citations in the text) to other articles in the same Special Issue.

Reference style
Text: Indicate references by (consecutive) superscript arabic numerals in the order in which they appear in the text. The numerals are to be used outside periods and commas, inside colons and semicolons. For further detail and examples you are referred to the AMA Manual of Style, A Guide for Authors and Editors, Tenth Edition, ISBN 0-978-0-19-517633-9.
List: Number the references in the list in the order in which they appear in the text.
Examples:
Reference to a journal publication:
1. Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. J Sci Commun. 2010;163:51–59.
Reference to a book:
2. Strunk W Jr, White EB. The Elements of Style. 4th ed. New York, NY: Longman; 2000.
Reference to a chapter in an edited book:
3. Mettam GR, Adams LB. How to prepare an electronic version of your article. In: Jones BS, Smith RZ, eds. Introduction to the Electronic Age. New York, NY: E-Publishing Inc; 2009:281–304.
Reference to a website:
4. Cancer Research UK. Cancer statistics reports for the UK. http://www.cancerresearchuk.org/aboutcancer/statistics/cancerstatsreport/; 2003 Accessed 13 March 2003.
Reference to a dataset:
[dataset] 5. Oguro, M, Imahiro, S, Saito, S, Nakashizuka, T. Mortality data for Japanese oak wilt disease and surrounding forest compositions, Mendeley Data, v1; 2015. https://doi.org/10.17632/xwj98nb39r.1.

Journal abbreviations source
Journal names should be abbreviated according to the List of Title Word Abbreviations.

Video

Elsevier accepts video material and animation sequences to support and enhance your scientific research. Authors who have video or animation files that they wish to submit with their article are strongly encouraged to include links to these within the body of the article. This can be done in the same way as a figure or table by referring to the video or animation content and noting in the body text where it should be placed. All submitted files should be properly labeled so that they directly relate to the video file's content. . In order to ensure that your video or animation material is directly usable, please provide the file in one of our recommended file formats with a preferred maximum size of 150 MB per file, 1 GB in total. Video and

animation files supplied will be published online in the electronic version of your article in Elsevier Web products, including ScienceDirect. Please supply 'stills' with your files: you can choose any frame from the video or animation or make a separate image. These will be used instead of standard icons and will personalize the link to your video data. For more detailed instructions please visit our video instruction pages. Note: since video and animation cannot be embedded in the print version of the journal, please provide text for both the electronic and the print version for the portions of the article that refer to this content.

Supplementary material

Supplementary material such as applications, images and sound clips, can be published with your article to enhance it. Submitted supplementary items are published exactly as they are received (Excel or PowerPoint files will appear as such online). Please submit your material together with the article and supply a concise, descriptive caption for each supplementary file. If you wish to make changes to supplementary material during any stage of the process, please make sure to provide an updated file. Do not annotate any corrections on a previous version. Please switch off the 'Track Changes' option in Microsoft Office files as these will appear in the published version.

RESEARCH DATA

This journal encourages and enables you to share data that supports your research publication where appropriate, and enables you to interlink the data with your published articles. Research data refers to the results of observations or experimentation that validate research findings. To facilitate reproducibility and data reuse, this journal also encourages you to share your software, code, models, algorithms, protocols, methods and other useful materials related to the project.

Below are a number of ways in which you can associate data with your article or make a statement about the availability of your data when submitting your manuscript. If you are sharing data in one of these ways, you are encouraged to cite the data in your manuscript and reference list. Please refer to the "References" section for more information about data citation. For more information on depositing, sharing and using research data and other relevant research materials, visit the research data page.

Data linking
If you have made your research data available in a data repository, you can link your article directly to the dataset. Elsevier collaborates with a number of repositories to link articles on ScienceDirect with relevant repositories, giving readers access to underlying data that gives them a better understanding of the research described.

There are different ways to link your datasets to your article. When available, you can directly link your dataset to your article by providing the relevant information in the submission system. For more information, visit the database linking page.

For supported data repositories a repository banner will automatically appear next to your published article on ScienceDirect.

In addition, you can link to relevant data or entities through identifiers within the text of your manuscript, using the following format: Database: xxxx (e.g., TAIR: AT1G01020; CCDC: 734053; PDB: 1XFN).

Proofs

One set of page proofs (as PDF files) will be sent by e-mail to the corresponding author (if we do not have an e-mail address then paper proofs will be sent by post) or, a link will be provided in the e-mail so that authors can download the files themselves. Elsevier now provides authors with PDF proofs which can be annotated; for this you will need to download the free Adobe Reader, version 9 (or higher). Instructions on how to annotate PDF files will accompany the proofs (also given online). The exact system requirements are given at the Adobe site.
If you do not wish to use the PDF annotations function, you may list the corrections (including replies to the Query Form) and return them to Elsevier in an e-mail. Please list your corrections quoting line number. If, for any reason, this is not possible, then mark the corrections and any other comments (including replies to the Query Form) on a printout of your proof and scan the pages and return via e-mail. Please use this proof only for checking the typesetting, editing, completeness and correctness of the text, tables and figures. Significant changes to the article as accepted for publication will only be considered at this stage with permission from the Editor. We will do everything possible to get your article published quickly and accurately. It is important to ensure that all corrections are sent back to us in one communication: please check carefully before replying, as inclusion of any subsequent corrections cannot be guaranteed. Proofreading is solely your responsibility.