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AVALIAÇÃO DA ARQUITETURA MUSCULAR E ASPECTOS BIOPSICOSSOCIAIS EM INDIVÍDUOS COM OSTEOARTRITE DE JOELHO EM DIFERENTES FAIXAS ETÁRIAS

Jéssica Bianca Aily

São Carlos

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Jéssica Bianca Aily

Dissertação apresentada ao Programa de Pós-Graduação em Fisioterapia da Universidade Federal de São Carlos como parte dos requisitos para a obtenção do título de Mestre em Fisioterapia na área de concentração Fisioterapia e Desempenho Funcional.

Orientadora: Profa. Dra. Stela Márcia Mattiello

Co-orientadora: Profa. Dra. Ana Cláudia Mattiello-Sverzut

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“Tente uma, duas, três vezes e se possível tente a quarta,
a quinta e quantas vezes for necessário. Só não desista
nas primeiras tentativas, a persistência é amiga da
conquista. Se você quer chegar aonde a maioria não
chega, faça o que a maioria não faz.”

Bill Gates

RESUMO

O objetivo dessa dissertação foi investigar a influência da arquitetura muscular e força extensora do joelho em indivíduos com osteoartrite (OA) de joelho em diferentes faixas etárias. Também foi objetivo dessa dissertação comparar os grupos etários a fim de identificar diferenças na função física, intensidade de dor e fatores biopsicossociais, nos indíviduos com OA de joelho. Assim, foram realizados dois estudos: **Estudo I**: Avaliação da arquitetura muscular em indivídus com osteoartrite de joelho e sua influência na força muscular em diferentes faixas etárias e **Estudo II**: Contribuições clínicas e funcionais para a presença de fatores biopsicossociais em pacientes com osteoartrite de joelho em diferentes faixas etárias. **Estudo I:** Participaram desse estudo oitenta indivíduos com e sem OA de joelho: grupo osteoartrite de meia idade (KL II / III) com idade entre 40 a 50 anos (n = 20), grupo controle de meia idade com idade entre 40 a 50 anos (n = 20), grupo osteoartrite idoso (KL II / III) com 70 anos ou mais (n = 20) e grupo controle idoso com 70 anos ou mais (n = 20). Todos os participantes foram submetidos a análise: do torque isométrico e isocinético dos extensores do joelho, nível de atividade física, medidas auto-relatadas e arquitetura muscular do músculo vasto lateral por meio do ultrassom. Após análise estatística intergrupos, observou-se similaridade entre o grupo osteoartrite de meia-idade e o grupo controle idoso para todas as variáveis do estudo. Já os grupos de idade avançada apresentaram parâmetros de arquitetura muscular e picos de torque isométricos e concêntricos menores em comparação aos grupos de meia-idade, independentemente da OA de joelho. Nesse sentido, os grupos com OA de joelho tabém apresentaram uma fraqueza muscular significativa comparados aos grupos controle tanto no teste de força isométrico como no concêntrico. No entanto, os grupos de osteoartrite de meia-idade e idosos apresentaram diferenças apenas no ângulo do penação e na espessura muscular em comparação aos grupos controle, pareados pela idade. Com relação as análises de regressão, o sexo, a idade, a presença de OA de joelho e o ângulo de penação, foram associados independentemente com o pico de torque isométrico e concêntrico. **Estudo II:** Quarenta indivíduos com OA de joelho (KL II/III) participaram desse estudo: grupo osteoartrite de meia-idade (40 a 50 anos) (n=20) e grupo osteoartrite idoso (≥70 anos) (n = 20). Os participantes completaram medidas auto-relatadas (WOMAC e escala visual analógica) e biopsicossociais (TAMPA e Escala de Pensamento Catastrófico da Dor), bem como realizaram três testes funcionais. Após análise intergrupo, não foram observadas diferenças estatísticas entre os grupos etários, exceto que o grupo osteoartrite idoso apresentou maior tempo nos testes de subir e descer escadas e caminhada de 40 m comparado ao grupo osteoartrite de meia-idade. Já os resultados das análises de regressão linear múltipla demonstraram que o WOMAC total e a escala visual analógica (VAS) foram associadas de forma independente ao escore do questionário TAMPA. No entanto, apenas a pontuação total do questionário WOMAC foi associado à pontuação da escala de pensamento catastrófico da dor. A partir dos resultados pudemos concluir que há envelhecimento precoce muscular em indivíduos com OA de joelho, caracterizado por mudanças na arquitetura muscular e força isométrica e concêntrica. Além disso, foi demonstrado uma significativa associação entre fatores biopsicossociais, clínicos e funcionais, independente da idade.

Palavras-chave: osteoartrite de joelho, arquitetura muscular, dor, força muscular, cinesiofobia, catastrofização, função física.

ABSTRACT

The aim of this dissertation was to investigate the influence of muscle architecture parameters and knee extensor strength in individuals with knee osteoarthritis (OA) in different age groups. It was also objective of this dissertation to compare different age groups in order to verify differences in physical function, pain intensity and biopsychosocial factors in individuals with knee OA. Thus, two studies were conducted: **Study I:** Evaluation of muscle architecture in knee osteoarthritis individuals and its influence on muscle strength in different age groups and **Study II:** Clinical and functional contributions to the presence of biopsychosocial aspects in patients with knee osteoarthritis in different age groups. **Study I:** Eighty individuals with and without knee OA: middle-aged osteoarthritis group (KL II / III) aged 40-50 years (n = 20), middle-aged control group aged 40-50 years (n = 20), old-aged osteoarthritis group (KL II / III) with 70 years or more (n = 20) and old-aged control group with 70 years or more (n = 20). All participants were submitted to analysis of isometric and isokinetic knee extensors torques, physical activity level, self-reported measures and muscular architecture of the vastus lateralis muscle by ultrasound. After intergroup statistical analysis, similarity was observed between the middle-aged osteoarthritis group and the old-aged control group for all study variables. The old-aged groups presented muscular architecture parameters and isometric and concentric peak torques smaller in comparison to the middle-age groups, independently of knee OA. In this sense, groups with knee OA also presented significant muscle weakness compared to the control groups in both isometric and concentric strength tests. However, the middle-aged and old-aged osteoarthritis groups showed differences only in the pennation angle and muscle thickness compared to the control groups, matched by age. Regarding the regression analyzes, gender, age, presence of knee OA and pennation angle were independently associated with isometric and concentric peak torques. **Study II:** Forty knee OA (KL II/III) patients were included in this study: middle-aged osteoarthritis group (40-50 years) (n = 20) and old-aged osteoarthritis group (≥70 years) (n = 20). Participants completed self-reported (WOMAC and visual analog scale) and biopsychosocial measures, as well as performance-based tests. After intergroup analysis, no statistical differences were observed between the age groups, except that the old-aged osteoarthritis spent more time in the stair-climb and 40m fast-paced walk tests compared to the middle-aged osteoarthritis group. The results of the multiple linear regression analyzes showed that the WOMAC total score and the visual analog scale (VAS) were independently associated to Tampa Scale of Kinesiophobia score. However, only the WOMAC total score was associated with the Pain Catastropizing Scale score. Thus, the results of the present dissertation suggest an early muscular aging in individuals with knee OA, characterized by lower pennation angle, fascicle length, muscle thickness, and isometric and concentric strength. In addition, a significant association between biopsychosocial, clinical and functional factors has been demonstrated, regardless of age.

Keywords: knee osteoarthritis, muscular architecture, pain, muscular strength, kinesiophobia, catastrophization, physical function.

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1. CONTEXTUALIZAÇÃO

Essa dissertação foi desenvolvida com o intuito de avaliar a arquitetura muscular, força e aspectos biopsicossociais de indivíduos com osteoartrite (OA) do joelho em diferentes faixas etárias. Trata-se de uma temática relevante no âmbito clínico-social considerando que a doença é um dos diagnósticos mais comuns na prática clínica e uma das principais causas de incapacidade na população em envelhecimento.

A literatura referente a esta temática, apresentada na revisão da literatura dessa dissertação, tem reportado que indivíduos com OA de joelho apresentam dor e comprometimento funcional como principais características clínicas da doença. Além disso, há uma intrínseca relação entre a intensidade de dor, desempenho nas atividades de vida diária e fraqueza muscular.

Neste sentindo, a força muscular tem sido amplamente associada com as características musculares arquitetônicas em idosos. Porém, não está claro na literatura como se apresentam as características da arquitetura muscular em pacientes com OA de joelho e sua influência na produção de força em diferentes faixas etárias.

Considerando a importância da dor e função física em indivíduos com OA de joelho, há um crescente interesse nos fatores biopsicossoais nesta população. Acredita-se que a presença desses fatores pode estar relacionada a intensidade de dor auto-relatada e função física. Porém, não há evidências sobre a relação entre os fatores clínicos, funcionais e biopsicossoais, nos indivíduos com OA de joelho em diferentes faixas etárias.

Assim, a investigação da arquitetura muscular, fatores clínicos, funcionais e biopsicossoais em indivíduos com OA de joelho em diferentes faixas etárias, podem auxiliar no desnvolvimento de programas de reabilitação específicos e precoces que contribuam para minimizar ou retardar a progressão da doença.

Tendo em vista o exposto acima, esta dissertação compreende dois manuscritos que buscaram abordar tais aspetos.

2. REVISÃO DA LITERATURA

A osteoartrite (OA) é a doença inflamatória crônico-degenerativa articular mais comum a partir dos 40 anos (ARDEN; LEYLAND, 2013; BLAGOJEVIC et al., 2010), caracterizando-se por degeneração progressiva da cartilagem articular (JONES et al., 2013) e comprometimento dos tecidos articulares adjacentes (ROOS et al., 2011). Dentre todas as articulações do corpo, a articulação do joelho destaca-se como uma das mais acometidas (MESSIER et al., 2013; SCOPAZ et al., 2009), resultando em significativas consequências na saúde pública (ARDEN; LEYLAND, 2013; MA; CHAN; CARRUTHERS, 2014).

Numerosos fatores de risco têm sido associados ao desenvolvimento da OA de joelho como a idade, o sexo, traumas prévios nos membros inferiores, a ocupação e a obesidade (LITWIC et al., 2013). Porém, a idade destaca-se como o fator de risco mais importante no desenvolvimento e progressão da doença (CHAGANTI; LANE, 2011; LOESER, 2010).

Clinicamente a OA de joelho é caracterizada por dor, rigidez matinal, crepitação óssea e progressiva perda funcional (ALNAHDI; ZENI; SNYDER-MACKLER, 2012). Neste sentido, os pacientes com OA de joelho geralmente buscam cuidados médicos devido a dor na articulação e a dificuldade na realização de atividades funcionais tais como, sentar por períodos prolongados, subir e descer escadas, caminhar, agachar e ajoelhar (BENNELL et al., 2003). Assim, considerando o aumento da expectativa de vida e a incidência precoce (>40 anos) da OA de joelho, torna-se relevante compreender como os fatores clínicos, funcionais e psicológicos apresentam-se em diferentes faixas etárias.

O diagnóstico clínico da OA de joelho geralmente é baseado nos critérios do *American College of Rheumatology*, o qual é composto por dor no joelho e presença de osteófitos, associados a pelo menos um dos seguintes aspectos: idade igual ou superior a 50 anos, rigidez matinal com duração menor que trinta minutos e crepitação (ALTMAN et al., 1986). Além disso, a fim de graduar a severidade e a progressão da doença, utiliza-se a classificação radiográfica conforme proposto por Kellgren e Lawrence (1957). O critério Kellgren e Lawrence (KL), a partir da avaliação do espaço articular, do osso subcondral e da presença de osteófitos, classifica a OA em diferentes graus, sendo eles: grau I, presença de mínimos osteófitos de presença duvidosa; grau II, osteófitos definidos, porém, sem redução do espaço intra-articular; grau III, osteófitos definidos e diminuição do espaço intra-articular; e grau IV, importante redução do espaço intra-articular e esclerose do osso subcondral (KELLGREN; LAWRENCE, 1957).

Além do comprometimento intra-articular característico da OA de joelho, a doença também apresenta alterações extra-articulares, tais como sinóvia, meniscos, ligamentos e músculos (ROOS et al., 2011). Desta forma, a OA afeta negativamente a função muscular, tornando a fraqueza muscular, principalmente do músculo quadríceps, uma das características mais frequententes nos indivíduos com OA de joelho (PALMIERI-SMITH et al., 2010).

Ligado a fraqueza muscular comumente observada nos indivíduos com OA de joelho, observa-se também uma fraqueza muscular decorrente do processo de envelhecimento (BEYER; OLIVEIRA; HOFFMAN, 2014). Ressalta-se ainda que a população com OA está em constante processo de envelhecimento, possivelmente potencializando o déficit na produção de força.

A força muscular, é um importante fator influenciador das atividades de vida diária e funcionalidade (NEWMAN et al., 2006). Porém, ela normalmente é resultado de uma complexa interação de fatores, sejam eles anatômicos, fisiológicos ou morfológicos (TREZISE; COLLIER; BLAZEVICH, 2016).

A arquitetura muscular, caracterizada por ângulo de penação, comprimento do fascículo e espessura muscular, tem sido relacionada como um fator importante na produção de força isométrica e isocinética em idosos (STRASSER et al., 2013). No entanto, na literatura consultada foram encontrados dois estudos apenas explorando a arquitetura muscular de pacientes com OA de joelho. Taniguchi *et al.* (2015), estudando apenas mulheres idosas com e sem OA de joelho, encontraram uma correlação positiva entre a força extensora do quadríceps e a espessura muscular dos músculos reto femoral e vasto lateral da coxa, no grupo com OA. Entretando, os autores avaliaram apenas espessura muscular, sendo esta uma única variável da arquitetura muscular. Malas et al. (2013) realizaram um estudo randomizado controlado, por 5 semanas de exercícios, em indivíduos com OA de joelho com idade entre 50 e 70 anos, de ambos os sexos. Neste estudo os autores encontraram um aumento consistente na força isométrica do quadríceps, na espessura muscular e no comprimento do fascículo do músculo vasto lateral. Desta forma, foi identificado que os indíviduos com OA de joelho respondem ao exercício físico, tanto nos aspectos arquitetônicos, como na força muscular. Embora esses estudos tenham identificado possíveis relações entre os parâmetros da arquitetura muscular e a força, não existe um consenso na literatura sobre as características arquitetônicas musculares de indivíduos com OA de joelho de diferentes faixas etárias e sua influência sobre a força muscular. Além disso, não foram encontrados estudos na literatura identificando o quanto a presença de OA de joelho potencializa as mudanças musculares comumente observadas no envelhecimento.

A dor, principal característica clínica da OA de joelho, também apresenta grande importância no desempenho das atividades de vida diária, bem como na qualidade de vida dos indivíduos com OA de joelho (HUANG; HSIEH; LEE, 2015). Neste sentido, estudos tem relatado que a presença de dor caracteriza um estilo de vida menos ativo, podendo intensificar a fraqueza muscular associada a OA de joelho (HEUTS et al., 2004). Ligado a isso, a presente literatura científica tem mostrado que há uma relação direta entre o avançar da idade e a prevalência de dor em indivíduos saudáveis (ANDERSEN et al., 1999). Porém, pouco se sabe sobre indíviduos com OA de joelho em diferentes faixas etárias.

Fatores biopsicossociais relacionados a dor e a função, como a catastrofização da dor e a cinesiofobia, vem sendo associados principalmente a intensidade de dor auto-relatada e a incapacidade física (KEEFE et al., 2000; SOMERS et al., 2009). Cinesiofobia é um termo para descrever o medo excessivo e irracional ao movimento físico, devido a um sentimento de vulnerabilidade a lesões (VLAEYEN et al., 1995). Já a catastrofização da dor é definida como um conjunto de pensamentos negativos, provocado por experiências dolorosas reais ou antecipadas (SULLIVAN; BISHOP; PIVIK, 1996). No entanto, até o momento, também desconhece-se a relação das características clínicas e dos fatores biopsicossociais em indivíduos com OA de joelho em diferentes faixas etárias.

Tendo em vista o exposto acima, o objetivo desta dissertação foi explorar como a presença de OA de joelho influência os parâmetros da arquitetura muscular e força extensora do joelho em diferentes faixas etárias. Também foi objetivo dessa dissertação comparar os grupos etários para verificar se há alguma diferença na função física, intensidade de dor e fatores biopsicossociais nos indíviduos com OA de joelho. Além de identificar se os fatores clínicos e funcionais estão associados à catastrofização da dor e à cinesiofobia.

REFERÊNCIAS BIBLIOGRÁFICAS

ALNAHDI, A. H.; ZENI, J. A.; SNYDER-MACKLER, L. Muscle Impairments in Patients With Knee Osteoarthritis. **Sports Health**, v. 4, n. 4, p. 284–292, 2012.

ALTMAN, R. et al. Development of criteria for the classification and reporting of osteoarthritis: Classification of osteoarthritis of the knee. **Arthritis & Rheumatism**, v. 29, n. 8, p. 1039–1049, 1986.

ANDERSEN, R. E. et al. Prevalence of significant knee pain among older Americans: Results from the Third National Health and Nutrition Examination Survey. **Journal of the American Geriatrics Society**, v. 47, n. 12, p. 1435–1438, 1999.

ARDEN, N. K.; LEYLAND, K. M. Osteoarthritis year 2013 in review: clinical. **Osteoarthritis and cartilage**, v. 21, n. 10, p. 1409–1413, Oct. 2013.

BENNELL, K. L. et al. Relationship of knee joint proprioception to pain and disability in individuals with knee osteoarthritis. **Journal of orthopaedic research : official publication of the Orthopaedic Research Society**, v. 21, n. 5, p. 792–797, Sep. 2003.

BEYER, K. S.; OLIVEIRA, L. P.; HOFFMAN, J. R. Muscle & Nerve. p. 1–34, [s.d.].

BLAGOJEVIC, M. et al. Risk factors for onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis. **Osteoarthritis and Cartilage**, v. 18, n. 1, p. 24–33, 2010.

CHAGANTI, R. K.; LANE, N. E. Risk factors for incident osteoarthritis of the hip and knee. **Current Reviews in Musculoskeletal Medicine**, v. 4, n. 3, p. 99–104, 2011.

HEUTS, P. H. T. G. et al. Pain-related fear and daily functioning in patients with osteoarthritis. **Pain**, v. 110, n. 1–2, p. 228–235, 2004.

HUANG, K.-H.; HSIEH, R.-L.; LEE, W.-C. Pain, Physical Function, and Health in Patients with Knee Osteoarthritis. **Rehabilitation nursing : the official journal of the Association of Rehabilitation Nurses**, Sep. 2015.

JONES, R. K. et al. A comparison of the biomechanical effects of valgus knee braces and lateral wedged insoles in patients with knee osteoarthritis. **Gait and Posture**, v. 37, n. 3, p. 368–372, 2013.

KEEFE, F. J. et al. The relationship of gender to pain, pain behavior, and disability in osteoarthritis patients: the role of catastrophizing. **Pain**, v. 87, n. 3, p. 325–334, 2000.

KELLGREN, J. H.; LAWRENCE, J. S. Radiological Assessment of Osteo-Arthrosis. **Annals of the Rheumatic Diseases**, v. 16, n. 4, p. 494–502, 1957.

LITWIC, A. et al. Epidemiology and burden of osteoarthritis. **British medical bulletin**, v. 105, p. 185–199, 2013.

LOESER, R. F. Age-related changes in the musculoskeletal system and the development of osteoarthritis. **Clinics in Geriatric Medicine**, v. 26, n. 3, p. 371–386, 2010.

MA, V. Y.; CHAN, L.; CARRUTHERS, K. J. Incidence, prevalence, costs, and impact on disability of common conditions requiring rehabilitation in the united states: Stroke, spinal cord injury, traumatic brain injury, multiple sclerosis, osteoarthritis, rheumatoid arthritis, limb loss, and back pa. **Archives of Physical Medicine and Rehabilitation**, v. 95, n. 5, p. 986–995.e1, 2014.

MALAS, F. Ü. et al. Effects of different strength training on muscle architecture: Clinical and ultrasonographic evaluation in knee osteoarthritis. **PM and R**, v. 5, n. 8, p. 655–662, 2013.

MESSIER, S. P. et al. Strength Training for Arthritis Trial (START): design and rationale. **BMC musculoskeletal disorders**, v. 14, p. 208, Jul. 2013.

NEWMAN, A. B. et al. Strength, But Not Muscle Mass, Is Associated With Mortality in the Health, Aging and Body Composition Study Cohort. **The Journals of Gerontology Series A: Biological Sciences and Medical Sciences**, v. 61, n. 1, p. 72–77, 2006.

PALMIERI-SMITH, R. M. et al. Isometric quadriceps strength in women with mild, moderate, and severe knee osteoarthritis. **American Journal of Physical Medicine and Rehabilitation**, v. 89, n. 7, p. 541–548, 2010.

ROOS, E. M. et al. Muscle weakness, afferent sensory dysfunction and exercise in knee osteoarthritis. **Nature Reviews Rheumatology**, v. 7, n. 1, p. 57–63, 2011.

SCOPAZ, K. A. et al. Effect of baseline quadriceps activation on changes in quadriceps strength after exercise therapy in subjects with knee osteoarthritis. **Arthritis and rheumatism**, v. 61, n. 7, p. 951–957, Jul. 2009.

SOMERS, T. J. et al. Pain Catastrophizing and Pain-Related Fear in Osteoarthritis Patients: Relationships to Pain and Disability. **Journal of Pain and Symptom Management**, v. 37, n. 5, p. 863–872, 2009.

STRASSER, E. M. et al. Association between ultrasound measurements of muscle thickness, pennation angle, echogenicity and skeletal muscle strength in the elderly. **Age**, v. 35, n. 6, p. 2377–2388, 2013.

SULLIVAN, M. J. L.; BISHOP, S.; PIVIK, J. **The Pain Catastrophizing Scale: Development and Validation**. [s.l: s.n.]. v. 7

TANIGUCHI, M. et al. Quantity and Quality of the Lower Extremity Muscles in Women with Knee Osteoarthritis. **Ultrasound in Medicine and Biology**, v. 41, n. 10, p. 2567–2574, 2015.

TREZISE, J.; COLLIER, N.; BLAZEVICH, A. J. Anatomical and neuromuscular variables strongly predict maximum knee extension torque in healthy men. **European Journal of Applied Physiology**, v. 116, n. 6, p. 1159–1177, 2016.

VLAEYEN, J. W. S. et al. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. **Pain**, v. 62, n. 3, p. 363–372, 1995.

3. ESTUDO I

EVALUATION OF MUSCLE ARCHITECTURE IN KNEE OSTEOARTHRITIS INDIVIDUALS AND ITS INFLUENCE ON MUSCLE STRENGTH IN DIFFERENT AGE GROUPS

ABSTRACT

Objectives: The aims of this study were to explore how the presence of knee osteoarthritis (OA) influences muscle architecture characteristics and muscle strength in different age groups. **Methods:** This is a cross-sectional study conducted on eighty individuals with and without knee OA: middle-aged osteoarthritis group (KL II/III) aged between 40 to 50 years (n=20), middle-aged control group aged between 40 to 50 years (n=20), old-aged osteoarthritis group (KL II/III) aged with 70 years or more (n=20), and old-aged control group aged with 70 years or more (n=20). All participants underwent testing for analyze: isometric and isokinetic peak torque of knee extensor, level of physical activity, self-reported measures and vastus lateralis muscle architecture assessed by ultrasound. ANOVA one-way test was used to identify differences between groups followed by the Tukey post-hoc test; two backward multiple linear regression models were used to correlate isometric and isokinetic peak torque with demographic characteristics, muscle architecture parameters (pennation angle, fascicle length and muscle thickness) and presence of knee OA. **Results:** There were no differences between middle-aged osteoarthritis group and old-aged control group. Old-aged groups presented smaller muscle architecture parameters and isometric and concentric peak torques compared to middle-aged groups, regardless of knee OA ($p<0.001$). In this sense, knee osteoarthritis groups presented also decreased muscle strength compared with control groups in both isometric and concentric peak torques ($p<0.001$). However, middle-aged and old-aged osteoarthritis groups presented differences only in the pennation angle and muscle thickness compared to control groups ($p<0.001$) matched by age. Sex ($p<0.001$), age ($p<0.05$), presence of knee OA ($p=0.003$), and pennation angle ($p<0.05$) were independently associated with isometric and concentric peak torques. **Conclusions:** The presence of knee OA modifies negatively muscle architecture and isometric and concentric peak torques, being, therefore associated with early muscular aging, as well as potentiates the normal aging process. Additionally, pennation angle, presence of knee OA, age, and sex are significantly predictors of the variability of isometric and isokinetic peak torques.

Keywords: Muscle architecture, ultrasound, strength, osteoarthritis

INTRODUCTION

Knee osteoarthritis (OA) is one of the most common chronic-degenerative joint disease (ARDEN; LEYLAND, 2013; LITWIC et al., 2013; ZHANG; JORDAN, 2010) causing significant burden on health care system (MA; CHAN; CARRUTHERS, 2014). Gender, aging and quadriceps weakness are some of the numerous factors associated with knee OA incidence and prevalence (M., 2008; MA; CHAN; CARRUTHERS, 2014). In this sense, knee OA patients usually seek medical care due to joint pain and loss of function (ROOS et al., 2011). However, muscle weakness have been described to be the earliest and most frequent finding in this population (PALMIERI-SMITH et al., 2010).

During the aging process, there is also a progressive loss of neuromuscular function (BEYER; OLIVEIRA; HOFFMAN, 2014). It is known that until the eighth decade of life healthy people lose about 30 to 40 percent of their skeletal muscle mass (FRONTERA et al., 2000). Thus, previous studies have shown that changes in skeletal muscle are highly related to a progressive skeletal muscle weakness in old people (HUGHES et al., 2001).

Muscle strength, measured by the ability to produce high forces under isometric or isokinetic conditions (TREZISE; COLLIER; BLAZEVICH, 2016), is an important factor influencing daily activities, disability and morbidity (NEWMAN et al., 2006; RANTANEN, 2003). In addition, muscular strength can not always be associated to one single factor (TREZISE; COLLIER; BLAZEVICH, 2016). In this regard, an approach is needed to explore the complex interactions among factors that can influence muscular strength.

Muscle architecture has been reported to be an important factor to influence muscle strength in old people (STRASSER et al., 2013). Pennation angle, usually associated with muscle strength, is bigger when more contractile material can be package within a certain volume (MALAS et al., 2013). In addition, muscle thickness seems to be highly correlated to the muscle cross-sectional area, given the information of muscle size (ABE et al., 1997). Muscle fascicle length is proportional to maximum contraction velocity (LIEBER, 2011). However, even knowing that muscle architecture is one of the factors related to muscular strength and physical function in old-aged people, it is currently unknown how muscle architecture differs in different ages of patients with knee OA.

The muscle architecture parameters have been assessed using ultrasound imaging, which is a non-invasive, safety, reliable, and accessible method that can provide qualitative information about skeletal muscle (TICINESI et al., 2017). Furthermore, some studies with old aged people have demonstrated that muscle ultrasound measures of quadriceps thickness, pennation angle, and fascicle length are significantly correlated to isometric and isokinetic strength of the quadriceps (ABE et al., 1997; SELVA RAJ; BIRD; SHIELD, 2017; STRASSER et al., 2013). However, to the authors knowledge there are no studies investigating the association between ultrasound measures of vastus lateralis muscle architecture on muscle strength in patients with knee OA compared to individuals without knee OA in different age groups.

The objectives of the present study were (i) to explore how the presence of knee OA influences muscle architecture characteristics and knee extensor strength in different age groups (ii) to explore how demographic characteristics, presence of knee OA and muscle architecture parameters are associated with isometric and concentric knee extensor peak torques. Our main hypothesis was that the presence of knee OA causes an early muscular aging in patients with this disease, characterized by changes in muscle architecture. In addition, we hypothesized that the presence of knee OA would be related with reduced isometric and isokinetic knee extensor peak torques.

MATERIALS AND METHODS

Participants

Forty knee OA, and forty non-knee OA individuals, aged between 40 and 50 years old and aged 70 years or more were recruited in community-dwelling. Anterior–posterior and lateral radiographs during weight-bearing, and skyline radiographs were taken of both knees of all individuals in order to diagnose the grade of knee OA (HORTOBÁGYI et al., 2004). The bilateral tibiofemoral and patellofemoral joints were classified according to the Kellgreen and Lawrence criteria (KL) (KELLGREN; LAWRENCE, 1957) by a radiologist doctor.

Knee OA individuals were considerable eligible if they had radiographic signs of knee OA, unilateral or bilateral, and clinical signs according to the American College Rheumatology criteria (ACR) (ALTMAN et al., 1986). Thus, twenty middle-aged participants (10 men and 10 women, aged between 40 and 50 years) diagnosed with knee OA grades II and III on the KL criteria composed the middle-aged osteoarthritis group. The old-aged osteoarthritis group was composed by twenty individuals (10 men and 10 women) with 70 years or more and also diagnosed with knee OA grades II and III on the KL criteria. The more symptomatic knee was selected for analysis.

Non-knee OA participants who composed the control groups were matched with the knee OA groups by sex and BMI. In this regard, twenty individuals aged between 40 and 50 years old (KL 0 and I) composed the middle-aged control group; and twenty individuals aged 70 years or more (KL 0 and I) composed the old-aged control group. The lower limb selected for analysis was randomly chosen.

The following exclusion criteria were applied for the entire sample: body mass index (BMI) above 30 kg/m^2; presence of systemic inflammatory arthritis; previous history of trauma in lower limbs and/or ligament and meniscus injuries of the knee; undergone to physical therapy treatment for the knee in the previous six months; previous surgery in the lower limbs; use of corticosteroid infiltration in the knees in the previous six months; presence of pain predominantly in another region of the body; any medical condition which precluded participation in the proposed assessments and/or inability to comprehend and follow instructions (HORTOBÁGYI et al., 2004).

Prior to testing this study was approved by the local Human Research Ethics Committee of the Federal University of São Carlos (UFSCar) and a written informed consent was obtained from all participants.

Study design

Participants underwent testing of isometric and isokinetic knee extensor strength, vastus lateralis muscle architecture, level of physical activity and self-reported measures. Muscle architecture and strength were carried out on the same symptomatic or randomly chosen leg. The isometric and isokinetic strength tests and analysis of vastus lateralis muscle architecture were separated by 7 days.

Muscle architecture

Muscle thickness (MT), pennation angle (PA) and fascicle length (FL) were obtained using a two-dimensional (2D) B-mode ultrasonography (*Acuson X300 PE, Siemens*) with a linear array transducer (4-11.4 MHz, 60mm) by a radiologist doctor.

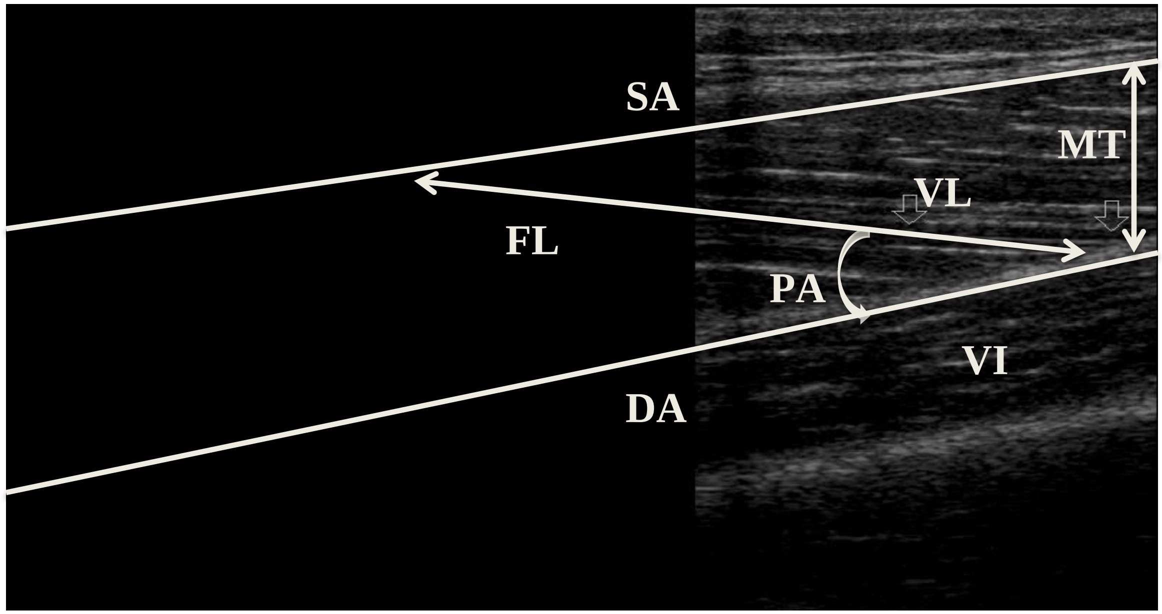
The vastus lateralis muscle was assessed due to the relatively simple alignment of the muscle fascicles, minimizing measurement errors commonly observed in the others quadriceps muscles (BLAZEVICH et al., 2007). Thus, images were obtained with the participants lying supine with their legs fully extended and their muscle relaxed. Prior to images acquisition, participants had rested in this position for 20 min to ensure fluid redistribution (BERG;

TEDNER; TESCH, 1993). A water-soluble gel was applied between the transducer and the skin to support acoustic coupling, without applying pressure to the muscle.

The point corresponding to the middle of the thigh, 50% of the distance between the greater trochanter and the lateral epicondyle of the femur, was used for the muscle architecture parameters of the vastus lateralis muscle acquisition (BLAZEVICH et al., 2007). Three scans at this location were performed on the more symptomatic or randomly chosen leg, with the transducer oriented parallel to the muscle fascicles and perpendicular to the skin; the average of these values was used for analysis. A single investigator acquired the images from all participants with the same parameters. The collected images were downloaded for further analysis.

All measurements were manually traced using ImageJ software (National Institutes of Health, USA) by a second investigator (Figure 1). MT was defined by the distance between deep and superficial aponeurosis (BLAZEVICH et al., 2007; SELVA RAJ; BIRD; SHIELD, 2017). The FA was defined as the angle of muscle fascicle insertion in the deep aponeurosis (TREZISE; COLLIER; BLAZEVICH, 2016). FL was defined as the length of the fascicular path between the superficial and deep aponeurosis (MALAS et al., 2013; TREZISE; COLLIER; BLAZEVICH, 2016). In almost all images, the fascicles extended off the acquired image. Thus, the length of the missing portion was estimated by linear extrapolation of the fascicular path and the aponeurosis (BLAZEVICH et al., 2007; KARAMANIDIS; ARAMPATZIS, 2006). To confirm the reliability, we estimated the intra-class correlation coefficients (ICCs) for the test-re-test reliability of MT, FA and FL of the vastus lateralis muscle. Reliability was evaluated using 10 healthy subjects' ultrasound images acquired on separated days. ICC values of MT, FA and FL ranged from 0.97 to 0.99, from 0.91 to 0.97, and from 0.88 to 0.95, respectively.

Figure 1. Ultrasonographic imaging of the vastus lateralis muscle demonstrating the measurement of the pennation angle, fascicle length and muscle thickness



Abbreviations: SA, superficial aponeurosis; DA, deep aponeurosis; VL, vastus lateralis; VI, vastus intermedius; PA, pennation angle; FL, fascicle length; MT, muscle thickness

Isokinetic and isometric knee extensor testing

Concentric and isometric knee extensor peak torques of the more symptomatic or randomly chosen leg were determined using a Biodex System isokinetic dynamometer (Biodex Medical Systems 3 Pro, Shirley, New York, USA) and recorded with a sampling frequency of 100 Hz. The knee extensors were chosen for strength testing for two reasons: quadriceps weakness is usually associated with knee OA (ALNAHDI; ZENI; SNYDER-MACKLER, 2012), and knee extensors are the most commonly assessed muscle group in research investigating the relationships between muscle architecture parameters obtained with ultrasound and strength (ABE; LOENNEKE; THIEBAUD, 2015).

The evaluations were conducted with the volunteers seated upright on the device chair, with knees flexed at 90 degrees. The participants were stabilized in the dynamometer's chair with a seat belt around the hips, two shoulder straps that crossed the participant’s chest, and a strap across the thigh of the tested leg. The dynamometer's axis of rotation was aligned with the lateral epicondyle of the femur and the dynamometer's ankle pad was positioned 5 cm above the medial malleolus. Participants were instructed to hold onto handles positioned on either side of the seat during contractions.

Before each test, and after some instructions, the volunteers performed a set of submaximal contractions, 5 for the isokinetic concentric test and 3 for the isometric test, in order to familiarize with the test mode. Participants rested 2 min between the familiarization and the tests. The isokinetic concentric test consisted of five maximal contractions at 60º /s. Isometric contractions were performed at 60º of knee flexion, 3 times and participants were required to hold each maximal voluntary contraction for 3 s, with a 1-min rest between them (STRASSER et al., 2013; TANIGUCHI et al., 2015). In addition, the test sequences were randomly assigned to the participants and a standard verbal encouragement was given in all the trials.

Data from all tests were exported and stored on computer. The isometric peak torque was determined as the average of the three maximal contractions, and the isokinetic peak torque as the average of the three central maximal contractions (SELVA RAJ; BIRD; SHIELD, 2017). Isometric and isokinetic average peak torque was normalized by individual body mass (kg) (peak torque/ body mass * 100) and used for statistical analysis.

Level of physical activity

The level of physical activity of the knee OA and control groups were monitored through a triaxial accelerometry system (activPAL3™, PAL Technologies Ltd., Glasgow, UK). This compact detection equipament (35x53x7mm and 20g) was attached on the participant's middle thigh using Tegaderm (3M) adhesive. The participants were oriented about equipment's care and they were requested to use the monitor continuously for a week. Data from actigraph were transferred by a USB interface to the specific activPAL software (version 7.2.32), which estimates the time spent in hours on daily activities (sitting/lying, standing and walking), number of steps and transitions performed, and the energy expenditure in MET/hour. These data were expressed through the average activity per day, excluding the first and the last day.

Self-reported disability and pain

In the knee OA groups, self-reported measures were applied. Disability and severity of pain were assessed by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) (BELLAMY et al., 1988). This questionnaire is composed of 24 items divided into three subscales: pain, stiffness and physical function, where higher scores (0-96) indicate worse symptoms. Furthermore, pain intensity was measured through the visual analog scale (VAS), which consists of a 100-mm line on which the volunteer placed a mark between the left side (0), representing "no pain" and the right side (100), representing "the worst pain imaginable" to characterize their pain intensity (BIJUR; SILVER; GALLAGHER, 2001).

Statistical analysis

The sample size was calculated through a pilot study with 10 individuals in each group with similar characteristics to those of the sample evaluated in this study (age, BMI< activity level, OA severity). It was considered a significance level of 0.05 and power of 0.95 to detect a minimal pennation angle difference of 2.96º (SD=2.5º). Thus, based on these criteria, at least 7 participants were required for each group. Descriptive statistics were obtained by calculating means and standard deviations by groups for all variables. In addition, normal distribution was assessed using the Kolmogorov-Smirnov test, and Skewness values, where values inside the range -1.0 to 1.0 indicate a normal distribution (GAMST; MEYERS; GUARINO, 2008).

The one-way analysis of variance (ANOVA) was used to compare age, BMI, accelerometer variables, ultrasound parameters, and isometric and concentric peak torques, followed by a post-hoc Tukey test. Differences between WOMAC scores and VAS were examined using the independent t-test. The effect size (ES) was calculated for each variable to estimate the magnitude of differences among groups. The interpretation suggested by Cohen (COHEN, 1988) for effect sizes is that values approximately 0.20 are small, approximately 0.50 are medium, and those of 0.80 are considered high .

To correlate isometric and concentric knee extensor peak torque, with muscle architecture parameters, demographics characteristics and presence of knee OA, two backward multiple linear regression analyses were used. SPSS statistical software, version 21.0 (SPSS, Chicago, IL) was used for all statistics analyses with a significance level set at 5%.

RESULTS

Eighty volunteers were included in the present study. The characteristics of the 80 participants of the study are summarized in Table 1. BMI and accelerometers variables demonstrated homogeneity between groups. In this sense, WOMAC score and VAS also demonstrated homogeneity between middle-aged osteoarthritis group and old-aged osteoarthritis group.

The vastus lateralis muscle architecture parameters are summarized in Table 2. With respect to the pennation angle, the middle-aged OA group presented significantly smaller pennation angle than the control group with the same age ($p<0.05$; ES = 1.193). The old-aged OA group presented significantly the smallest pennation angle compared to the other groups of the present study ($p<0.05$) with high effect sizes (OAM = 1.016, GCM = 2.071, GCI = 1.903). Furthermore, the middle-aged control group had significantly bigger pennation angle than the old-aged control group ($p<0.05$; ES = -0.819). Regarding to the fascicle length, the old-aged OA group also presented a significantly smaller fascicle length compared to the middle-aged OA and middle-aged control group ($p<0.05$) with high effect sizes (OAM = -0.987, GCM = 1.739). The middle-aged and the old-aged control groups also presented statistical differences related to the fascicle length ($p<0.05$; ES = 1.2). Finally, with respect to the muscle thickness, the old-aged OA group presented the smallest muscle thickness compared to all other groups ($p<0.05$) also with high effect sizes (OAM = 1.474, GCM = 1.937, GCI = 1.005). The middle-aged control group, as in the others US parameters, had a bigger muscle thickness compared to the old-aged control group ($p<0.05$; ES = -1.266). In addition, it should be noted that middle-aged OA group did not present differences in any muscle architecture parameters compared to the old-aged control group.

Table 3 shows the differences between groups related to knee joint isometric and concentric peak torque. Regarding to the isometric peak torque, the middle-aged OA group was

Table 1. Characteristics of participants in the knee osteoarthritis and control groups

	Middle-aged OA group (n=20)	Old-aged OA group (n=20)	Middle-aged control group (n=20)	Old-aged control group (n=20)	*p* Value
Age (y)	45.35 (2.70)[ac]	74.35 (2.82)[b]	45.20 (3.75)[c]	74.60 (3.12)	<0.001
Body Mass Index (kg/m2)	26.79 (2.73)	27.21 (2.95)	26.02 (3.30)	25.41 (3.02)	0.246
Accelerometer					
Sitting/Lying down, h	16.55 (1.99)	16.44 (2.60)	17.08 (1.12)	15.69 (1.97)	0.185
Standing, h	5.41 (1.37)	5.82 (2.00)	4.93 (1.21)	6.18 (1.61)	0.084
Walking, h	1.82 (0.71)	1.72 (0.86)	1.95 (0.54)	2.13 (0.67)	0.291
Number of steps	8188.09 (3094.62)	7456.52 (4729.01)	9291.84 (3631.06)	9923.72 (4021.45)	0.199
Transitions	56.20 (14.91)	48.80 (15.92)	56.41 (16.39)	56.54 (16.29)	0.338
MET.h	33.79 (1.86)	33.82 (2.02)	34.37 (1.33)	34.85 (1.67)	0.175
WOMAC total score	37.90 (18.07)	39.15 (16.44)			0.820
VAS	5.30 (1.53)	6.20 (1.91)			0.174

Abbreviations: VAS, visual analog scale

Values are expressed as mean (SD);

[a] $p<0.05$, significantly different compared with Old-aged OA group

[b] $p<0.05$, significantly different compared with Middle-aged control group

[c] $p<0.05$, significantly different compared with Old-aged control group

Table 2. Measurements of vastus lateralis muscle architecture in the knee osteoarthritis and control groups

	Middle-aged OA group (n=20)	Old-aged OA group (n=20)	Middle-aged control group (n=20)	Old-aged control group (n=20)	*p* Value
Pennation Angle (^{o})	12.17 (2.35)[ab]	10.07 (1.74)[bc]	15.65 (3.39)[c]	13.43 (1.79)	<0.001
Fascicle Length (cm)	5.80 (1.22)[a]	4.69 (1.02)[b]	6.49 (1.05)[c]	5.37 (0.80)	<0.001
Muscle Thickness (cm)	1.50 (0.29)[a]	1.05 (0.32)[bc]	1.72 (0.37)[c]	1.33 (0.23)	<0.001

Values are expressed as mean (SD);
[a] p<0.05, significantly different compared with Old-aged OA group
[b] p<0.05, significantly different compared with Middle-aged control group
[c] p<0.05, significantly different compared with Old-aged control group

Table 3. Measurements of isometric and concentric peak torques in the knee osteoarthritis and control groups

	Middle-aged OA group (n=20)	Old-aged OA group (n=20)	Middle-aged control group (n=20)	Old-aged control group (n=20)	*p* Value
Isometric torque (N.m/kg*100)	170.72 (63.61)[b]	131.65 (39.61)[bc]	238.34 (63.99)[c]	186.39 (45.79)	<0.001
Concentric torque (N.m/kg*100)	139.53 (57.89)[ab]	100.00 (31.99)[bc]	191.95 (48.42)[c]	145.81 (41.68)	<0.001

Values are expressed as mean (SD);
[a] p<0.05, significantly different compared with Old-aged OA group
[b] p<0.05, significantly different compared with Middle-aged control group
[c] p<0.05, significantly different compared with Old-aged control group

significantly weaker than the middle-aged control group ($p<0.05$; ES = 1.06). In this sense, the old-aged OA group was significantly weaker than both control groups ($p<0.05$) with high effect sizes (GCM = 2.005, GCI = 1.279). On the other hand, the middle-aged control group was significantly stronger than the old-aged control-group ($p<0.05$; ES = -0.934). With respect to the concentric peak torque, the middle-aged OA group was significantly weaker than the control group of the same range ($p<0.05$; ES = 0.982). The old-aged OA group was significantly weaker than the three other groups ($p<0.05$) also with high effect sizes (OAM = -0.845, GCM = 2.241, GCI = 1.233), and the middle-aged control group was significantly stronger than the old-aged control group ($p<0.05$; ES = -1.021). Thus, it is highlight the absence of difference between the middle-aged OA group and the old-aged control group.

Table 4 describes the variability of the isometric peak torque according to muscle architecture parameters, demographic characteristics, and presence of knee OA. The final model, composed of age, presence of knee OA, sex, and pennation angle, is able to explain 66% of the isometric peak torque variability. If the age, the presence of knee OA, and the pennation angle are stable, the sex can predict 41% of the isometric peak torque ($p<0.001$). If the age, the presence of knee OA, and the sex are stable, the VL pennation angle can predict 37% of the isometric peak torque ($p<0.001$). If the age, the sex, and the pennation angle are stable, the presence of knee OA can predict 27% of the isometric peak torque ($p<0.003$). On the other hand, if the sex, the pennation angle, and the presence of knee OA are stable, age can predict 19% of the isometric peak torque ($p<0.014$).

Table 4. Linear regression models explaining the variability in isometric peak torque by presence of knee OA, muscle architecture parameters and demographic characteristics

	B	SE B	β	p	R2	Adjusted R2
Model 1					0.658	0.630
Constant	-12.754	47.551		0.789		
Age	-0.775	0.426	-0.177	0.073		
Knee OA	33.362	12.218	0.255	0.008		
Sex	53.169	10.117	0.407	<0.001		
Muscle thickness	-3.036	18.712	-0.017	0.872		
Pennation angle	7.806	2.096	0.371	<0.001		
Fascicle length	2.726	4.908	0.050	0.580		
Model 2					0.658	0.635
Constant	-15.346	44.492		0.731		
Age	-0.745	0.381	-0.170	0.055		
Knee OA	32.930	11.845	0.252	0.007		
Sex	52.764	9.740	0.404	<0.001		
Pennation angle	7.767	2.068	0.369	<0.001		
Fascicle length	2.424	4.51	0.045	0.593		
Model 3					0.657	0.638
Constant	0.852	32.576		0.979		
Age	-0.843	0.334	-0.192	0.014		
Knee OA	34.733	11.306	0.266	0.003		
Sex	53.473	9.605	0.409	<0.001		
Pennation angle	7.723	2.056	0.367	<0.001		

The variability of the concentric peak torque according to muscle architecture parameters, demographic characteristics, and presence of knee OA are described in Table 5. The final model is able to explain 58% of the concentric peak torque variability. If the age, the presence of knee OA, and the pennation angle are stable, the sex can predict 38% of the isometric peak torque ($p<0.001$). If the age, the sex, and the pennation angle are stable, the presence of knee OA can predict 30% of the isometric peak torque ($p<0.003$). If the sex, the pennation angle, and the presence of knee OA are stable, age can predict 28% of the isometric peak torque ($p<0.001$). Thus, if the age, the presence of knee OA, and the sex are stable, the VL pennation angle can predict 26% of the isometric peak torque ($p<0.017$).

Table 5. Linear regression models explaining the variability in concentric peak torque by presence of knee OA, muscle architecture parameters and demographic characteristics

	B	SE B	β	p	R2	Adjusted R2
Model 1					0.595	0.562
Constant	-9.158	43.917		0.835		
Age	-0.696	0.393	-0.187	0.081		
Knee OA	27.389	11.284	0.247	0.018		
Sex	38.812	9.344	0.350	<0.001		
Muscle thickness	19.480	17.282	0.131	0.263		
Pennation angle	4.526	1.935	0.253	0.022		
Fascicle length	1.878	4.532	0.041	0.680		
Model 2					0.594	0.567
Constant	-0.740	38.717		0.985		
Age	-0.734	0.380	-0.197	0.057		
Knee OA	28.197	11.052	0.254	0.013		
Sex	38.920	9.288	0.351	<0.001		
Pennation angle	22.200	15.897	0.150	0.167		
Fascicle length	4.461	1.918	0.250	0.023		
Model 3					0.583	0.561
Constant	32.897	30.451		0.282		
Age	-1.042	0.312	-0.280	0.001		
Knee OA	33.000	10.569	0.298	0.003		
Sex	42.525	8.978	0.384	<0.001		
Fascicle angle	4.711	1.922	0.264	0.017		

DISCUSSION

To the best of authors' knowledge, this is the first study assessing how the presence of knee OA potentiates the differences in muscle architecture and strength between middle-aged and old-aged individuals. Thus, our main finding was that knee OA is associated with an early muscle aging, since muscle architecture and strength are similar between middle-aged individuals diagnosed with knee OA and old-aged without knee OA. Furthermore, the results also demonstrated that the presence of knee OA is a great contributor to the decrease of isometric and concentric strength.

The hypothesis of similar muscle architecture between middle-aged OA and old-aged non-knee OA individuals, characterizing the early muscular aging, were based on studies that describes an altered muscle architecture in old age people (MORSE et al., 2005; NARICI et al., 2003; STRASSER et al., 2013) and a possible relationship between knee OA and quadriceps morphological changes (IKEDA; TSUMURA; TORISU, 2005). In this sense, the present study confirms this hypothesis and shows that middle-aged patients (40 to 50 years), diagnosed with knee OA, present pennation angle, fascicle length and muscle thickness similar to old individuals without knee OA. Furthermore, regarding to muscle architecture parameters, the results also showed that the presence of knee OA might intensify muscular architectural changes, usually observed in the aging process, since knee OA individuals are different in almost all muscle architecture parameters compared to non-knee OA individuals with matched age.

Previous studies have shown that with aging process there are remarkable alterations in muscle architecture, characterized by muscles less thick, shorter fascicle length, and fascicles less pennate (MORSE et al., 2005). Strasser et al., in a study comparing 26 young (18 to 35 years) with 26 old (60 to 80 years) individuals found that pennation angle and muscle thickness of the vastus lateralis muscle were significantly lower in the old group than the young group (STRASSER et al., 2013). Similarly, even though being compared with middle-aged sample, our results showed that pennation angle, muscle thickness, and fascicle length were significantly lower in the old-aged than in the middle-aged, regardless of presence of knee OA.

It has been reported that skeletal muscle strength is depending on muscle size (NARICI et al., 1996), architectural arrangement of its fibers (BLAZEVICH et al., 2007), and composition (STRASSER et al., 2013). In addition, it is known that loss of skeletal muscle strength is commonly observed in old people, as consequence of aging (THOMPSON, 2007); but it can also be found in patients with knee OA, mainly in the quadriceps muscle (CONROY et al., 2012).

However, although these statements are well established on scientific literature, it is still poorly explored how the presence of knee OA intensify the loss of the knee extensors strength.

With respect to the isometric and concentric peak torques, the results of the present sample agree with the previous findings of the muscle architecture parameters. The middle-aged knee OA individuals did not present statistical differences compared with old-aged individuals without knee OA. Thus, these findings also support our hypothesis and characterize the early muscle aging. Furthermore, we found that isometric and concentric torque productions were significantly lower in knee OA patients compared to non-knee OA individuals, regardless of age; showing that the presence of knee OA seems to be a great contributor to muscle strength changes. Taniguchi et al., in a study with 21 women diagnosed with knee OA and 21 healthy women, also reported that the knee OA group presented significantly lower knee extension force than the healthy group, confirming the findings of the present study (TANIGUCHI et al., 2015).

Also related to concentric peak torque, the old-aged individuals were weaker than the middle-aged participants, with and without knee OA. In this sense, numerous prior studies have described a decline in concentric peak torque on old-aged people (CUNNINGHAM et al., 1987; HORTOBAGYI et al., 1995; ROELOFS et al., 2011; VANDERVOORT; HAYES, 1989). The old-aged participants without knee OA also presented lower isometric peak torque compared to the middle-aged individuals without knee OA. Corroborating our finding, Strasser et al., in a population without knee OA, demonstrated that young participants reached significantly higher isometric peak torque compared to the old participants (STRASSER et al., 2013). However, surprisingly, the old-aged individuals diagnosed with knee OA from the present sample, presented similar isometric torque production than middle-aged individuals also diagnosed with knee OA, confronting the literature’s finding. Thus, knowing that there was no difference in pain intensity (VAS) between these groups, and that force generation by the quadriceps is affected by knee pain in individuals with knee OA (RIDDLE; STRATFORD, 2011), we can infer that the level of pain intensity can explain this finding.

Although it is possible to list a number of factors that may be related to the decrease in strength and consequent functionality; understanding the interactions between muscle architecture parameters, demographics characteristics, and presence of knee OA, as well as how they influence strength seems to be essential for the development of specific rehabilitation programs. In this respect, the regression analysis of the present study revealed that age, sex, presence of knee OA, and pennation angle were significantly associated with isometric torque production. Trezise et al., in a study with healthy young men, showed that the best regression model, composed by cross-sectional area, pennation angle of the vastus lateralis muscle, and percent voluntary activation, explained 72% of the variance of knee extension peak torque (TREZISE; COLLIER; BLAZEVICH, 2016). Furthermore, Strasser et al., as in the present study, described that sex had influence in isometric torque, meaning men are significantly stronger than women (STRASSER et al., 2013). In contrast with our findings, in this same study, Strasser et al., aimed to investigate which muscle architecture parameters had a significantly influence on isometric maximum voluntary contraction force, found that muscle thickness of all quadriceps muscle are associated with the variability of isometric torque production (STRASSER et al., 2013). In another study with older adults, the authors also reported that only vastus lateralis muscle thickness was a significant contributor to the regression models, predicting isometric (SELVA RAJ; BIRD; SHIELD, 2017). Thus, although muscle architecture parameters seem to be good predictors of isometric strength, it is possible to note that there is still no consensus about this.

Through the regression analysis, a substantial association was also demonstrated between age, sex, presence of knee OA, muscle architecture parameters, and concentric peak torque. Muscle thickness and fascicle length were not associated with concentric strength. This results contrast with the findings of Selva Raj et al., who perceived an association between vastus lateralis muscle thickness and concentric torque production (SELVA RAJ; BIRD; SHIELD, 2017). On the other hand, Trezise et al., noticed in their study that pennation angle predicted significantly better concentric torque (TREZISE; COLLIER; BLAZEVICH, 2016), establishing an association with our findings.

It should be noted that muscle strength is influenced by demographics characteristics, presence of knee OA in addition to muscle architectural characteristics. Nevertheless, as evidenced by the present study the presence of knee OA and pennation angle accounts for a significant variance of strength, adding knowledge to clinicians and researchers in order to improve focus on rehabilitation programs.

The authors recognize some limitations of this study. The cross-sectional design of the present study does not allow for the establishment of cause-and-effect relationship among the variables explored. In other words, it was not possible to identify whether the variability in the strength of knee extensors, as well as muscle architecture of the vastus lateralis precede knee OA or are a consequence of this chronic disease. Furthermore, although the vastus lateralis muscle had been considered for minimizing measurement errors, muscle architecture from others quadriceps muscles should be assessed in order to investigate their associations with isometric and isokinetic strength in knee OA individuals with different ages.

In conclusion, our study demonstrated that knee OA is associated with the early muscular aging, as well as potentiate the normal effects of the aging process. In addition, isometric and concentric peak torques can be predicted by age, sex, knee OA and pennation angle. Thus, these results suggest that vastus lateralis muscle architecture measured by ultrasound is a safety, reliable, and accessible method to evaluate strength indirectly and obtain an early muscle diagnosis in patients with knee OA, in order to develop clinical strategies to reduce the disease progression. However, lager researches are needed to establish reference values and to investigate if muscular ultrasound is able to detect muscle strength increases due to a specific rehabilitation program.

REFERENCES

ABE, T. et al. Effects of 20 days bed rest on muscle morphology. **Journal of gravitational physiology : a journal of the International Society for Gravitational Physiology**, v. 4, n. 1, p. S10-4, Jan. 1997.

ABE, T.; LOENNEKE, J. P.; THIEBAUD, R. S. Morphological and functional relationships with ultrasound measured muscle thickness of the lower extremity: A brief review. **Ultrasound**, v. 23, n. 3, p. 166–173, 2015.

ALNAHDI, A. H.; ZENI, J. A.; SNYDER-MACKLER, L. Muscle Impairments in Patients With Knee Osteoarthritis. **Sports Health**, v. 4, n. 4, p. 284–292, 2012.

ALTMAN, R. et al. Development of criteria for the classification and reporting of osteoarthritis: Classification of osteoarthritis of the knee. **Arthritis & Rheumatism**, v. 29, n. 8, p. 1039–1049, 1986.

ARDEN, N. K.; LEYLAND, K. M. Osteoarthritis year 2013 in review: clinical. **Osteoarthritis and cartilage**, v. 21, n. 10, p. 1409–1413, Oct. 2013.

BELLAMY, N. et al. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. **The Journal of rheumatology**, v. 15, p. 1833–1840, Dec. 1988.

BERG, H. E.; TEDNER, B.; TESCH, P. A. Changes in lower limb muscle cross???sectional area and tissue fluid volume after transition from standing to supine. **Acta Physiologica Scandinavica**, v. 148, n. 4, p. 379–385, 1993.

BEYER, K. S.; OLIVEIRA, L. P.; HOFFMAN, J. R. Muscle & Nerve. p. 1–34, [s.d.].

BIJUR, P.; SILVER, W.; GALLAGHER, E. Reliability of the visual analog scale for measurement of acute pain. **Academic Emergency Medicine**, v. 8, n. 12, p. 1153–1157, 2001.

BLAZEVICH, A. J. et al. Influence of concentric and eccentric resistance training on architectural adaptation in human quadriceps muscles. **Journal of Applied Physiology**, v. 103, n. 5, p. 1565–1575, 2007.

COHEN, J. **Statistical power analysis for the behavioral sciencesStatistical Power Analysis for the Behavioral Sciences**, 1988. Disponível em: <http://books.google.com/books?id=Tl0N2lRAO9oC&pgis=1>

CONROY, M. B. et al. Muscle strength, mass, and quality in older men and women with knee osteoarthritis. **Arthritis Care and Research**, v. 64, n. 1, p. 15–21, 2012.

CUNNINGHAM, D. A. et al. Ageing and isokinetic plantar flexion. **European Journal of Applied Physiology and Occupational Physiology**, v. 56, n. 1, p. 24–29, 1987.

FRONTERA, W. R. et al. Aging of skeletal muscle: a 12-yr longitudinal study. **Journal of applied physiology (Bethesda, Md. : 1985)**, v. 88, n. 4, p. 1321–1326, Apr. 2000.

GAMST, G.; MEYERS, L. S.; GUARINO, A. J. **Analysis of Variance Designs: A Conceptual and Computational Approach with SPSS and SAS**. 1. ed. New York, NY, USA: Cambridge University Press, 2008.

HORTOBAGYI, T. et al. The influence of aging on muscle strength and muscle fiber characteristics with special reference to eccentric strength. **J Gerontol A Biol Sci Med Sci**, v. 50, n. 6, p. B399-406, 1995.

HORTOBÁGYI, T. et al. Aberrations in the control of quadriceps muscle force in patients with knee osteoarthritis. **Arthritis Care & Research**, v. 51, n. 4, p. 562–569, 2004.

HUGHES, V. A. et al. Longitudinal muscle strength changes in older adults: influence of muscle mass, physical activity, and health. **The journals of gerontology. Series A, Biological sciences and medical sciences**, v. 56, n. 5, p. B209-17, May 2001.

IKEDA, S.; TSUMURA, H.; TORISU, T. Age-related quadriceps-dominant muscle atrophy and incident radiographic knee osteoarthritis. **Journal of Orthopaedic Science**, v. 10, n. 2, p. 121–126, 2005.

KARAMANIDIS, K.; ARAMPATZIS, A. Mechanical and morphological properties of human quadriceps femoris and triceps surae muscle-tendon unit in relation to aging and running. **Journal of Biomechanics**, v. 39, n. 3, p. 406–417, 2006.

KELLGREN, J. H.; LAWRENCE, J. S. Radiological Assessment of Osteo-Arthrosis. **Annals of the Rheumatic Diseases**, v. 16, n. 4, p. 494–502, 1957.

LIEBER, R. L. **Skeletal muscle structure, function, and plasticity**. [s.l: s.n.].

LITWIC, A. et al. Epidemiology and burden of osteoarthritis. **British medical bulletin**, v. 105, p. 185–199, 2013.

M., M. Obesity and arthritis. **Menopause International**, v. 14, n. 4, p. 149–154, 2008.

MA, V. Y.; CHAN, L.; CARRUTHERS, K. J. Incidence, prevalence, costs, and impact on disability of common conditions requiring rehabilitation in the united states: Stroke, spinal cord injury, traumatic brain injury, multiple sclerosis, osteoarthritis, rheumatoid arthritis, limb loss, and back pa. **Archives of Physical Medicine and Rehabilitation**, v. 95, n. 5, p. 986–995.e1, 2014.

MALAS, F. Ü. et al. Effects of different strength training on muscle architecture: Clinical and ultrasonographic evaluation in knee osteoarthritis. **PM and R**, v. 5, n. 8, p. 655–662, 2013.

MORSE, C. I. et al. Changes in triceps surae muscle architecture with sarcopenia. **Acta Physiologica Scandinavica**, v. 183, n. 3, p. 291–298, 2005.

NARICI, M. V. et al. Effect of aging on human muscle architecture. **Journal of Applied Physiology**, v. 95, n. 6, p. 2229–2234, 2003.

NARICI, M. V et al. Human quadriceps cross-sectional area, torque and neural activation during 6 months strength training. **Acta physiologica Scandinavica**, v. 157, p. 175–186, 1996.

NEWMAN, A. B. et al. Strength, But Not Muscle Mass, Is Associated With Mortality in the Health, Aging and Body Composition Study Cohort. **The Journals of Gerontology Series A: Biological Sciences and Medical Sciences**, v. 61, n. 1, p. 72–77, 2006.

PALMIERI-SMITH, R. M. et al. Isometric quadriceps strength in women with mild, moderate, and severe knee osteoarthritis. **American Journal of Physical Medicine and Rehabilitation**, v. 89, n. 7, p. 541–548, 2010.

RANTANEN, T. Muscle strength, disability and mortality. **Scandinavian Journal of Medicine and Science in Sports**, v. 13, n. 1, p. 3–8, 2003.

RIDDLE, D. L.; STRATFORD, P. W. Impact of Pain Reported During Isometric Quadriceps Muscle Strength Testing in People With Knee Pain: Data From the Osteoarthritis Initiative. **Physical Therapy**, v. 91, n. 10, p. 1478–1489, 2011.

ROELOFS, J. et al. Norming of the Tampa Scale for Kinesiophobia across pain diagnoses and various countries. **Pain**, v. 152, n. 5, p. 1090–1095, 2011.

ROOS, E. M. et al. Muscle weakness, afferent sensory dysfunction and exercise in knee osteoarthritis. **Nature Reviews Rheumatology**, v. 7, n. 1, p. 57–63, 2011.

SELVA RAJ, I.; BIRD, S. R.; SHIELD, A. J. Ultrasound Measurements of Skeletal Muscle Architecture Are Associated with Strength and Functional Capacity in Older Adults. **Ultrasound in Medicine and Biology**, v. 43, n. 3, p. 586–594, 2017.

STRASSER, E. M. et al. Association between ultrasound measurements of muscle thickness, pennation angle, echogenicity and skeletal muscle strength in the elderly. **Age**, v. 35, n. 6, p. 2377–2388, 2013.

TANIGUCHI, M. et al. Quantity and Quality of the Lower Extremity Muscles in Women with Knee Osteoarthritis. **Ultrasound in Medicine and Biology**, v. 41, n. 10, p. 2567–2574, 2015.

THOMPSON, D. D. Aging and sarcopenia. **Journal of musculoskeletal & neuronal interactions**, v. 7, n. 4, p. 344–345, 2007.

TICINESI, A. et al. Muscle Ultrasound and Sarcopenia in Older Individuals: A Clinical Perspective. **Journal of the American Medical Directors Association**, v. 18, n. 4, p. 290–300, 2017.

TREZISE, J.; COLLIER, N.; BLAZEVICH, A. J. Anatomical and neuromuscular variables strongly predict maximum knee extension torque in healthy men. **European Journal of Applied Physiology**, v. 116, n. 6, p. 1159–1177, 2016.

VANDERVOORT, A. A.; HAYES, K. C. Plantarflexor muscle function in young and elderly women. **European Journal of Applied Physiology and Occupational Physiology**, v. 58, n. 4, p. 389–394, 1989.

ZHANG, Y.; JORDAN, J. M. Epidemiology of Osteoarthritis. **Clinics in geriatric medicine**, v. 26, n. 3, p. 355–369, Aug. 2010.

4. ESTUDO II

CLINICAL AND FUNCTIONAL CONTRIBUTIONS TO THE PRESENCE OF BIOPSYCHOSOCIAL ASPECTS IN PATIENTS WITH KNEE OSTEOARTHRITIS IN DIFFERENT AGE GROUPS

Artigo submetido ao periódico *Clinical Rheumatology*

ABSTRACT

Objectives: The aims of this study were to compare clinical, functional, and biopsychosocial factors in individuals with knee osteoarthritis (KOA) in different age groups and genders, and to investigate the association between clinical and functional factors with pain catastrophizing and kinesiophobia. **Methods:** This is a cross-sectional study conducted on forty individuals (KL II/III): middle-aged group (40-50 years) (n=20) and old-aged group (≥70 years) (n=20). A posteriori, the sample was divided into men (n=20) and women (n=20). Participants completed self-reported and psychosocial measures and performance-based tests. Independent test-t and Kruskal-Wallis test were used to identify differences between groups; two backward multiple linear regression models were used to correlate Pain Catastrophizing Scale (PCS) and Tampa Scale of Kinesiophobia (TSK) scores with clinical and functional factors. **Results:** There were no differences between age groups, except that the old-aged group (19.88±3.91) presented a higher time in the 40m fast-paced walk and stair climb tests compared to the middle-aged group (15.01±3.64; p<0.00001). Women only presented higher scores in the TSK (45.15±10.39) than men (37.65±9.74; p=0.024) and spent more time performing the 40m fast-paced walk test (19.26±4.57) compared to men (15.63±3.64; p=0.008). WOMAC and visual analog scale (VAS) were independently associated with the TSK score (p=0.026;p=0.018). However, only WOMAC total was associated with PCS score (p<0.0001). **Conclusions:** The middle-aged KOA people have similar biopsychosocial impairment factors to old-aged KOA people, as well as men and women. Additionally, WOMAC total score and VAS are associated with TSK score, while only WOMAC total is associated with PCS score.

Keywords: Pain catastrophizing, kinesiophobia, pain, function, osteoarthritis

INTRODUCTION

Osteoarthritis (OA) is one of the most common chronic-degenerative joint diseases in individuals from the fourth decade of life, reaching its greatest prevalence in the old population (ARDEN; LEYLAND, 2013; ZHANG; JORDAN, 2010). Among all joints of the human body, the knee stands out as one of the most affected (LITWIC et al., 2013; SCOPAZ et al., 2009) and causes significant consequences in public health (ARDEN; LEYLAND, 2013; MA; CHAN; CARRUTHERS, 2014). Given the increase in life expectancy and the increasingly early incidence of knee OA, it is important to expand the knowledge about how clinical, functional, and psychological factors may influence the clinical presentation of the disease in different age groups.

Pain and functional impairment are the main clinical factors for individuals with knee OA to seek treatment (HELMINEN et al., 2016). The increase in pain intensity leads to reduced physical function and consequently challenges the performance of daily living activities, such as walking at different speeds and on different surfaces, climbing stairs, and sitting to stand tasks (GONÇALVES et al., 2017; HUANG; HSIEH; LEE, 2015). Therefore, since pain has great importance in the performance of daily life activities and quality of life, individuals with knee OA tend to initiate a cycle of immobility in order to reduce pain. This cycle, characterized by a less active lifestyle, may accelerate muscular weakness and decrease functional reserve, causing even more pain (HEUTS et al., 2004).

The prevalence of pain in patients with knee OA increases with age (ANDERSEN et al., 1999). However, studies tend not to explore people with more advanced ages (>70 years old). Related to this, some studies reported that pain in older adults may be associated with several factors including muscle strength and biopsychosocial features such as emotional distress and activity avoidance (CARLESSO et al., 2016; HADJISTAVROPOULOS et al., 2007). However, there is no evidence on the differences between individuals in different age groups with knee OA.

In recent years, biopsychosocial factors related to pain and function, such as pain catastrophizing and fear of movement, have become of major interest in osteoarthritis research. Kinesiophobia is a term to describe an excessive, irrational, and debilitating fear of physical movement due to a feeling of vulnerability to injury or re-injury (VLAEYEN et al., 1995). Pain catastrophizing is defined as a negative mental set brought to bear during actual or anticipated painful experiences (SULLIVAN; BISHOP; PIVIK, 1996).

Understanding the main contribution of clinical and functional features in the presence of biopsychosocial factors of individuals in different age groups diagnosed with knee OA is important since psychosocial factors may influence rehabilitation as modifiers, thus underestimating gains (BAERT et al., 2017). In this regard, in a cross-sectional study with overweight and obese patients with knee OA, Somers *et al.* (SOMERS et al., 2009) showed that pain catastrophizing was associated with pain intensity, physical disability, and decrease in gait velocity. Furthermore, it has been observed that both pain catastrophizing and kinesiophobia have been associated with increasing physical disability, resulting in increased pain (KEEFE et al., 2000). However, it is currently unknown whether clinical and functional features can predict an increment in biopsychosocial factors, especially in different age groups.

Thus, the primary aim of this study was to compare middle-aged with old-aged groups with knee OA, and women with men also diagnosed with knee OA to verify if there is any difference in the WOMAC total score, performance-based test, visual analog scale, level of physical activity, pain catastrophizing score, and kinesiophobia score. The secondary purpose was to identify whether clinical and functional factors are associated with pain catastrophizing and kinesiophobia. Our main hypothesis was that the middle-aged group would be similar to the old-aged group in biopsychosocial, clinical and functional factors. Similarly, we hypothesized that there would be no difference between women and men for any variable. In addition, we also believed that worse scores in clinical and functional factors would be related to higher scores in pain catastrophizing and kinesiophobia.

MATERIALS AND METHODS

Study design and participants

This study is a secondary analysis from a cross-sectional study conducted in São Carlos, Brazil. People from the general community were invited to participate in the study through the Federal University of São Carlos (UFSCar) website, local radio news, and newspaper advertisements. Individuals were eligible for the study if they were aged between 40 and 50 or more than 70 years old with radiographic signs of knee OA, unilateral or bilateral, and clinical signs according to the American College of Rheumatology criteria (ACR) (ALTMAN et al., 1986).

The following exclusion criteria were applied: body mass index (BMI) over 30 kg/m^2; presence of systemic inflammatory arthritis; previous history of trauma in the lower limbs and/or ligament and meniscus injuries of the knee; having undergone physical therapy treatment for the knee in the previous six months; previous surgery in the lower limbs; use of corticosteroid infiltration in the knees in the previous six months; presence of pain predominantly in another region of the body; any medical condition which precluded participation in the proposed assessments; and/or the inability to comprehend and follow instructions (HORTOBÁGYI et al., 2004).

Anterior–posterior and lateral radiographs during weight-bearing, and skyline radiographs were taken of both knees in order to identify the grade of knee OA (HORTOBÁGYI et al., 2004). The tibiofemoral and patellofemoral joints were classified by a radiologist according to the Kellgren and Lawrence criteria (KL) (KELLGREN; LAWRENCE, 1957) . This scale comprises five levels of severity as follows: Grade 0, no radiographic signs; Grade 1, doubtful narrowing of joint space and possible osteophyte lipping; Grade 2, definite osteophytes and possible joint space narrowing; Grade 3, moderate multiple osteophytes, definite joint space narrowing, some sclerosis, and possible deformity of bone ends; Grade 4, large osteophytes, marked joint space narrowing, severe sclerosis, and definite deformity of bone ends.

Two hundred twenty-one individuals contacted the research group by telephone, and during the screening 92 were excluded. From these, 36 were aged between 51 and 69 years or younger than 40 years, 39 had a BMI higher than 30 kg/m^2, and 17 had previous ligament and meniscus injuries. Thus, 129 individuals were initially invited for clinical assessment in our research laboratory and radiographic exam, of which 100 were available to attend the exams. Of these, 43 were excluded based on exclusion criteria: 1 subject had osteochondroma, 6 were diagnosed with knee OA grade IV, 16 presented positive ligament tests, and 20 were classified as obese (BMI higher than 30 kg/m^2), resulting in 57 participants. From these and considering the matching criteria (gender and BMI) between groups, 40 individuals (20 women and 20 men) comprised the final sample.

Middle-aged participants (n=20, between 40 and 50 years old) diagnosed with knee OA grades II and III on the KL composed the middle-aged osteoarthritis group. The old-aged osteoarthritis group was composed of individuals (n=20) of 70 years or over and with knee OA grades II and III on the KL. For the second analysis, the present sample was divided into men (n=20) and women (n=20) with knee OA. Ethical approval for the original study was obtained from the local Human Research Ethics Committee of the Federal University of São Carlos (UFSCar), and all participants included in this study provided written informed consent.

Procedures

All participants completed the self-reported and psychosocial measures, and carried out performance-based tests. For participants with bilateral knee OA, the more symptomatic knee was used in the assessments.

Independent variables of interest

Self-reported measures

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) was used to assess knee disability and severity of pain (BELLAMY et al., 1988). This questionnaire is composed of 24 items divided into three subscales: pain (5 items), stiffness (2 items), and physical function (17 items). Higher scores indicate worse symptoms with scores ranging from 0 to 96 (BELLAMY et al., 1988).

Pain intensity was measured using the visual analog scale (VAS), which consists of a 100-mm line on which the participants place a mark between the left side (0), representing “no pain” and the right side (100), representing “the worst pain imaginable”, to characterize their pain intensity. The VAS has been found to be a reliable measure of pain (BIJUR; SILVER; GALLAGHER, 2001).

Performance-based tests

The three principal performance-based tests recommended to access physical function in people with knee OA were carried out: 30s chair stand test, 40m fast-paced walk test, and stair climb test (DOBSON et al., 2013).

For the 30s chair stand test, participants were instructed to sit in a chair with their feet flat on the floor, knees flexed, and arms crossed on the chest. From the sitting position, they were instructed to stand up completely, then sit down again, repeating this for 30 seconds (DOBSON et al., 2013).

For the 40m fast-paced walk test, participants were requested to walk along a 10m walkway, turn around an obstacle, and return to the start position, repeating the route once more to give a total distance of 40m, while walking as quickly as possible, without running (DOBSON et al., 2013).

For the stair-climb test, participants were required to go up and down a flight of stairs as quickly as possible, but in a safe manner (DOBSON et al., 2013). The flight of stairs used in the present study consisted of 11 steps with a step rise of 17 cm, step width of 202 cm, and step tread of 31 cm.

For all tests, the participants wore habitual and comfortable footwear. The use of any walking aid or handrail was prohibited. Before each test, a practice trial was performed for familiarization, and to verify the comprehension and safety of participants. Subsequently, the time and number of repetitions were recorded, respectively. All performance-based tests were performed once and normalized by participant height.

Level of Physical Activity

The level of physical activity of all participants was monitored through an accelerometer system by the triaxial activPAL3™ actigraph (PAL Technologies Ltd., Glasgow, UK). This is a light and compact detection component (35x53x7mm and 20g) that was attached on the middle thigh of each individual using Tegaderm (3M) adhesive. The volunteer received guidance on the necessary care and was requested to use the monitor continuously for a week, except during immersion in water (swimming and bathing).

The data relating to the actigraph were transferred by a USB interface to the specific activPAL software version 7.2.32, which performs the data analysis and estimates the energy expenditure in MET/hour, the time spent in hours on daily activities such as sitting/lying, standing, and walking, and the number of steps and transitions performed. These data were expressed through the average activity per day, excluding days that did not total 24 full hours.

Dependent variables of interest

Pain Catastrophizing

The Pain Catastrophizing Scale (PCS) (SULLIVAN; BISHOP; PIVIK, 1996) is a valid and reliable self-reported questionnaire, which allows assessment of the degree that each participant engages in pain catastrophizing (OSMAN et al., 1997; SULLIVAN; BISHOP; PIVIK, 1996). The PCS contains 13 items describing thoughts and feelings that people can experience when they feel pain. Items are rated using a 5-point Likert scale, ranging from 0 to 4. The total score is calculated by summing the scores of all items (range, 0-52). Higher scores indicate greater catastrophic thoughts about pain (SULLIVAN; BISHOP; PIVIK, 1996). According to Sullivan *et al.* (SULLIVAN; BISHOP; PIVIK, 1995), a total PCS score of 30 represents a clinically relevant level of catastrophizing. The PCS has been demonstrated to present acceptable psychometric properties (OSMAN et al., 2000).

Kinesiophobia

The Tampa Scale of Kinesiophobia (TSK) is a valid and reliable self-reported questionnaire with 17 items that assess fear of movement. Items are rated using a 4-point Likert scale, ranging from 1 to 4. The total score is calculated by summing all item scores, after inversion of the scores of items 4, 8, 12, and 16. Total scores range from 17 to 68 with scores higher than 37 indicating the presence of fear of movement (GOUBERT et al., 2004).

Statistical analysis

Means and standard deviations by group (middle-aged group/old-aged group and men/women) were calculated for all variables. Normal distribution of data was assessed using the Shapiro-Wilk test, and skewness values, which indicate a normal distribution when the values are inside the range -1.0 to 1.0 (GAMST; MEYERS; GUARINO, 2008). As they presented normal distribution, differences in age, weight, height, BMI, WOMAC scores, performance-based tests, PCS, and TSK were examined using the independent t-test. Differences in VAS were examined using the Kruskal-Wallis test.

Two separate backward multiple linear regression models were used to correlate PCS and TSK scores with demographic data, WOMAC total score, VAS, and the 40m fast-paced walk test. The Statistical Package for the Social Sciences, version 21.0 (SPSS, Chicago, IL), was used for all statistical analyses with a significance level set at 5%.

RESULTS

Sample characteristics and anthropometric variables of the middle-aged and old-aged osteoarthritis groups are summarized in Table 1. There was no difference between groups in BMI, WOMAC subscales and total score, 30s chair stand test, and VAS. On the other hand, the old-aged group presented higher time in both performance-based tests; the 40m paced-walk test and stair climb test.

Table 1. Anthropometric variables and characteristics of the middle-aged group and old-aged group.[a]

Characteristics	Middle-aged group Participants (n = 20)	Old-aged group Participants (n = 20)	*p*
Age, y	45.35 (2.70)	74.35 (2.82)	0.000 [b]
Weight, kg	78.10 (12.18)	70.00 (12.15)	0.042 [b]
Height, m	1.70 (0.10)	1.60 (0.08)	0.001 [b]
BMI, kg/m^2	26.79 (2.73)	27.21 (2.95)	0.638
WOMAC			
Pain	8.45 (4.57)	8.60 (3.10)	0.904
Stiffness	3.60 (1.88)	2.70 (1.95)	0.145
Function	25.30 (13.99)	27.95 (12.69)	0.534
Total score	37.90 (18.07)	39.15 (16.44)	0.820
Performance-based tests			
30s chair stand test, n/m	6.50 (1.62)	6.54 (1.92)	0.935
40m fast-paced walk test, s/m	15.01 (3.64)	19.88 (3.91)	0.000 [b]
Stair climb test, s/m	7.55 (2.45)	18.46 (7.42)	0.000 [b]
VAS	5.30 (1.53)	6.20 (1.91)	0.174
Accelerometer			
Sitting/Lying down, h	16.55 (1.99)	16.44 (2.60)	0.888
Standing, h	5.41 (1.37)	5.82 (2.00)	0.449
Walking, h	1.82 (0.71)	1.72 (0.86)	0.693
Number of steps	8188.09 (3094.62)	7456.52 (4729.01)	0.566
Transitions	56.20 (14.91)	48.80 (15.92)	0.137
MET.h	33.79 (1.86)	33.82 (2.02)	0.965
PCS	31.30 (12.81)	29.10 (14.81)	0.618
TSK	39.20 (10.95)	43.60 (10.12)	0.195

Abbreviations: BMI, body mass index; VAS, visual analog scale; PCS, Pain Catastrophizing Scale; TSK, Tampa Scale of Kinesiophobia.
[a]Data are presented as mean (SD). The *p* values correspond to an independent t-test or the Kruskal-Wallis test followed by the post-hoc Mann Whitney test.
[b]Significant differences at $p<0.05$.

In the PCS and TSK questionnaires, there were no statistical differences between the middle-aged and old-aged groups, p=0.618 and p=0.195, respectively. However, the high scores in both questionnaires for the entire sample deserve to be highlighted. Thus, the middle-aged osteoarthritis group presented an average score of 31.30 (SD: 12.81), while the old-aged osteoarthritis group achieved an average score of 29.10 (SD: 14.81) in the PCS. Regarding TSK scores, the middle-aged group presented an average score of

39.20 (SD: 10.95), and the old-aged group of 43.60 (SD: 10.12).

In order to further explore the present sample, the participants were divided into men and women. The characteristics and anthropometric variables of these groups are summarized in Table 2. Age (p=0.819), BMI (p=0.263), WOMAC pain (p=0.312), stiffness (p=0.631), function (p=0.550), and total score (p=0.518), 30s chair stand test (p=0.970), stair climb test (p=0.064), VAS (p=0.221), and PCS (p=0.305) presented no differences between men and women. On the other hand, differences were found between women and men in the TSK score (p=0.024) and time in the 40m fast paced-walk test (p=0.008).

Multivariable linear regression results

Table 3 describes the variability in TSK scores according to demographic variables, WOMAC total score, VAS, and physical function. The final model, composed of the 40m fast-paced walk test, WOMAC total score, and VAS, is able to explain 42% of TSK variability. If the 40m fast-paced walk test and the WOMAC total score are stable, the VAS can predict 34% of TSK scores (p<0.014). On the other hand, when the 40m fast-paced walk test and the VAS are stable, the WOMAC total score can predict 32% of the TSK scores (p<0.023). Finally, it is possible to note that the 40m fast-paced walk test influenced 23% of TSK scores, but without significance (p<0.090).

The variability in PCS scores according to demographic variables, WOMAC total score, VAS, and physical function are described in Table 4. The final model is able to explain 31% of PCS variability. In addition, the WOMAC total score alone can predict 56% of PCS scores.

Table 2. Anthropometric variables and characteristics of men and women.[a]

Characteristics	Men Participants (n = 20)	Women Participants (n = 20)	*p*
Age, y	59.30 (14.76)	60.40 (15.47)	0.819
Weight, kg	80.88 (11.40)	67.21 (10.11)	0.000 [b]
Height, m	1.71 (0.94)	1.59 (0.80)	0.000 [b]
BMI, kg/m^2	27.50 (2.63)	26.50 (2.95)	0.263
WOMAC			
Pain	7.90 (3.88)	9.15 (3.83)	0.312
Stiffness	3.00 (1.78)	3.30 (2.13)	0.631
Function	25.35 (14.21)	27.90 (12.45)	0.550
Total score	36.75 (17.78)	40.30 (16.58)	0.518
Performance-based tests			
30s chair stand test, n/m	6.53 (1.54)	6.51 (1.98)	0.970
40m fast-paced walk test, s/m	15.63 (3.64)	19.26 (4.57)	0.008 [b]
Stair climb test, s/m	10.90 (6.77)	15.51 (8.29)	0.064
VAS	5.35 (1.42)	6.15 (2.01)	0.221
Accelerometer			
Sitting/Lying down, h	17.05 (1.68)	15.94 (2.69)	0.129
Standing, h	5.15 (1.28)	6.08 (1.97)	0.084
Walking, h	1.78 (0.83)	1.86 (0.73)	0.741
Number of steps	7780.39 (3997.20)	7864.22 (4029.96)	0.948
Transitions	55.97 (16.64)	49.03 (14.21)	0.164
MET.h	33.85 (1.62)	33.75 (2.21)	0.873
PCS	27.95 (14.45)	32.45 (12.90)	0.305
TSK	37.65 (9.74)	45.15 (10.39)	0.024 [b]

Abbreviations: BMI, body mass index; VAS, visual analog scale; PCS, Pain Catastrophizing Scale; TSK, Tampa Scale of Kinesiophobia.

[a]Data are presented as mean (SD). The *p* values correspond to an independent t-test or the Kruskal-Wallis test followed by the post-hoc Mann Whitney test.

[b]Significant differences at $p<0.05$.

Table 3. Linear regression models explaining the variability in TSK scores by WOMAC total score, physical function, visual analog scale, and demographic variables.

	B	SE B	β	*p*	R^2	Adjusted R^2
Model 1					0.420	0.354
Constant	11.514	7.16		0.117		
40m FPWT	0.529	0.378	0.222	0.170		
WOMAC	0.203	0.087	0.326	0.026		
VAS	2.074	0.832	0.344	0.018		
Age	0.015	0.11	0.021	0.894		
Model 2					0.420	0.372
Constant	11.916	6.415		0.071		
40m FPWT	0.556	0.319	0.233	0.090		
WOMAC	0.201	0.085	0.323	0.023		
VAS	2.094	0.807	0.347	0.014		

Abbreviations: VAS, visual analog scale; TSK, Tampa Scale of Kinesiophobia.

Table 4. Linear regression models explaining the variability in PCS scores by WOMAC total score, physical function, visual analog scale, and demographic variables.

	B	SE B	β	*p*	R^2	Adjusted R^2
Model 1					0.373	0.301
Constant	11.033	9.6		0.258		
40m FPWT	0.186	0.507	0.061	0.716		
WOMAC	0.389	0.117	0.484	0.002		
VAS	1.786	1.116	0.230	0.118		
Age	-0.156	0.148	-0.170	0.299		
Model 2					0.370	0.318
Constant	11.995	9.123		0.197		
WOMAC	0.402	0.111	0.500	0.001		
VAS	1.806	1.101	0.232	0.110		
Age	-0.128	0.125	-0.139	0.313		
Model 3					0.352	0.317
Constant	5.649	6.689		0.404		
WOMAC	0.408	0.111	0.507	0.001		
VAS	1.537	1.070	0.198	0.159		
Model 4					0.316	0.298
Constant	12.795	4.535		0.008		
WOMAC	0.452	0.108	0.562	0.000		

Abbreviations: VAS, visual analog scale; PCS, Pain Catastrophizing Scale.

DISCUSSION

The present study was designed to increase understanding of the contribution of clinical and functional factors in the presence of biopsychosocial factors in individuals of different age groups and diagnosed with knee OA. The most important finding of the present study was the absence of differences between the middle-aged group and the old-aged group, except in the 40m fast-paced walk test and stair climb test. In addition, there were no differences between men and women in almost any variables, except the TSK scores and 40m fast-paced walk test. Results also indicated that two of the clinical and functional factors (WOMAC total score and VAS) are independently associated with the TSK score. However, only WOMAC total is associated with the PCS score. Thus, the findings of the present study increase the knowledge about the involvement of biopsychosocial factors and possible associations.

Osteoarthritis, in particular knee OA, is one of the most common diagnoses in clinical practice and an important public health problem due to the high incidence of disability and health care costs (LAWRENCE et al., 2008; MA; CHAN; CARRUTHERS, 2014). Despite increasing research, patient attitude and beliefs about pain, as well as biopsychosocial factors, differences between age groups, and between men and women are still poorly explored.

The main outcomes of this paper confirm the proposed hypothesis and show that the middle-aged group is similar to the old-aged group regarding pain, TSK scores, PCS scores, WOMAC total scores, and level of physical activity. On the other hand, they presented differences in two performance-based tests: 40m fast-paced walk test and stair climb test. The normal aging process, characterized by loss of neuromuscular function that often leads to loss of independence and disability, may explain this difference (THOMPSON, 2007). Thus, this decrease of function associated with knee OA might be a great predictor of disability in older adults compared to middle-aged adults with knee OA. Furthermore, the results also showed that WOMAC total scores (pain, stiffness and function) and the visual analog scale are associated with variability of fear of physical movement (TSK scores), while variability in pain catastrophizing (PCS scores) is associated only with WOMAC total score.

Previous research has shown that an increase in age assumes a linear positive effect on knee symptoms (ANDERSEN et al., 1999; BLAGOJEVIC et al., 2010; MA; CHAN; CARRUTHERS, 2014). Pain in old people might be associated with decreases in balance and muscle strength, emotional distress, increases in physical frailty, and activity avoidance (CARLESSO et al., 2016; HADJISTAVROPOULOS et al., 2007). In this regard, higher levels of kinesiophobia and pain catastrophism have been found among older adults with chronic pain (ISHAK; ZAHARI; JUSTINE, 2017; LARSSON et al., 2016). Differently to these points, although the means of the old-aged group in the present sample were higher for pain, kinesiophobia, and catastrophism compared to the middle-aged group, there were no significant differences between groups for these same variables. The absence of differences between groups might be explained in two ways: the same symptom duration (DUNN; CROFT, 2006), which although it was not controlled in the present study, may have influenced the results; and biopsychosocial adaptations by older adults to pain and fear of movement (ALVARADO GARCIA; SALAZAR MAYA, 2015).

It is well know that during the normal aging process, there is an expected decrease in performance of daily activities, such as walking, climbing up and down stairs, and sitting to stand tasks (MILANOVIC et al., 2013). However, the presence of knee OA and higher levels of kinesiophobia, potentially, may further influence functional activities (ISHAK; ZAHARI; JUSTINE, 2017). Although the groups presented the same level of kinesiophobia, our results appear to concur with the points regarding a decrement in physical function in older people, since the old-aged group took more time to perform the 40m fast-paced walk test and the stair climb test compared to the middle-aged group. On the other hand, both age groups presented similar caloric expenditure through the accelerometer, characterizing a low level of physical activity in patients with knee OA, regardless of age group. Corroborating our findings, Dunlop *et al.* (DUNLOP et al., 2011) in a study with 1111 adults with radiographic knee OA aged 49 to 84 years, demonstrated that individuals with knee OA participated in little physical activity from early ages.

Several studies have reported greater differences in the catastrophizing level according to sex in individuals with knee OA or other musculoskeletal conditions (JENSEN et al., 1994; KEEFE et al., 2000; SULLIVAN et al., 2001), demonstrating a higher prevalence of catastrophism in women. For this reason, the present study performed an extra analysis, comparing men and women, even though the groups were matched by sex. Surprisingly, there was no difference in the pain catastrophizing between men and women, which can be explained by the same intensity of pain in both groups measured by the visual analog scale, as previous studies have established a positive relationship between pain catastrophizing and pain perception (SULLIVAN et al., 2002;

SULLIVAN; BISHOP; PIVIK, 1996). Conversely, higher scores of kinesiophobia were observed in women than men, corroborating the findings of Back *et. al*. (BÄCK et al., 2017). However, some previous studies with different chronic diseases, such as low back pain, have demonstrated higher scores of kinesiophobia in men (ROELOFS et al., 2011; VLAEYEN et al., 1995). Thus, there is still no consensus in the literature on this aspect.

The regression analysis of the present study revealed that pain intensity and OA disability were significantly associated with fear of movement. However, functionality did not present association. Helminen *et al.* (HELMINEN et al., 2016) in a study with subjects diagnosed with knee OA and aged between 35 and 75 years showed an association between the TSK score and function WOMAC subscale. In another study, Heuts *et al.* (HEUTS et al., 2004), also demonstrated a significant association between TSK, WOMAC function, and VAS. Finally, Somers *et al.* (SOMERS et al., 2009), in a study with 106 participants with knee OA, demonstrated that TSK was associated with pain intensity, physical disability measured by the Arthritis Impact Measurement Scales (AIMS), and gait velocity. In addition, Somers *et al.* (SOMERS et al., 2009), reported that TSK is a significant independent predictor of fast speed walking. Therefore, great speeds in the 40m fast-paced walk test, and high scores of pain intensity and disability (WOMAC and VAS) are likely to reflect the fear of movement, which can result in a cycle with a progressive decrease in physical function and an increase in pain intensity, disability, and fear of movement. Thus, it seems relevant to study the role of movement-related fear in patients with knee OA, in order to create strategies to reduce this interactive cycle.

Through the regression analysis, a substantial association was also demonstrated between WOMAC total scores and PCS scores. Age, pain intensity, and the 40m fast-paced walk test were not associated with PCS. This result contrasts with the findings of Somers *et al.* (SOMERS et al., 2009), who perceived a significant association between PCS, pain intensity, and gait velocity. On the other hand, Helminen *et al.* (HELMINEN et al., 2016) noticed in their study that high scores in the PCS predicted significantly higher WOMAC pain levels, establishing an association with our findings.

Therefore, the biopsychosocial model, which suggests that pain is influenced by certain factors, including biological, psychological, and social factors, and not just by structural alterations (GATCHEL et al., 2007), may explain the findings of this study. In addition, a recent meta-analyses demonstrated that psychological factors may play an important role in the pain chronification process (ZALE et al., 2013), highlighting the importance of multicomponent interventions. Pain education is a good example of a multicomponent intervention, based on an active strategy of pain management (CHENG et al., 2017). Thus, the incorporation of a new approach to interventions in patients with knee OA seems to be essential, regardless of age.

This study has some limitations. Firstly, it had a cross-sectional design, thus causal relationships between the predictors and the variable of interest cannot be identified. Further longitudinal studies are necessary to identify the interaction between the predictors and biopsychosocial factors over time in order to understand causal relationships. Lastly, associations between biopsychosocial factors and clinical and functional factors did not account for symptom duration, occupational activities, family income, or the presence of depression symptoms, which could also have influenced TSK and PCS scores.

Despite these limitations, to the authors' knowledge, this is the first study to compare biopsychosocial factors between early and late ages in patients with knee OA. In addition, this is one of the few studies to explore the association of clinical and functional factors with the fear of movement and pain catastrophism. Although our study adds new understanding about different age groups, and some interactions between biopsychosocial, clinical, and functional factors, further studies with a larger sample size are warranted. Clinical factors, such as occupational activities, symptom duration, and level of schooling, not included in the present study, might be considered to establish other associations.

In conclusion, our study demonstrated that the biopsychosocial, clinical, and functional factors present a great similarity between middle-aged and old-aged patients with knee OA. Kinesiophobia can be predicted by pain and disability, but was not associated with age. Furthermore, only WOMAC total score predicted the pain catastrophizing scale scores. Thus, kinesiophobia and pain catastrophism should be continuously assessed in the clinical setting to recognize the barriers that may affect adherence of knee OA patients to rehabilitation programs.

REFERENCES

ALTMAN, R. et al. Development of criteria for the classification and reporting of osteoarthritis: Classification of osteoarthritis of the knee. **Arthritis & Rheumatism**, v. 29, n. 8, p. 1039–1049, 1986.

ALVARADO GARCIA, A. M.; SALAZAR MAYA, A. M. Adaptation to chronic benign pain in elderly adults. **Investigacion y educacion en enfermeria**, v. 33, n. 1, p. 128–137, 2015.

ANDERSEN, R. E. et al. Prevalence of significant knee pain among older Americans: Results from the Third National Health and Nutrition Examination Survey. **Journal of the American Geriatrics Society**, v. 47, n. 12, p. 1435–1438, 1999.

ARDEN, N. K.; LEYLAND, K. M. Osteoarthritis year 2013 in review: clinical. **Osteoarthritis and cartilage**, v. 21, n. 10, p. 1409–1413, Oct. 2013.

BÄCK, M. et al. Relevance of Kinesiophobia in Relation to Changes Over Time Among Patients After an Acute Coronary Artery Disease Event. **Journal of Cardiopulmonary Rehabilitation and Prevention**, p. 1, 2017.

BAERT, I. A. C. et al. Do Psychosocial Factors Predict Muscle Strength, Pain, or Physical Performance in Patients With Knee Osteoarthritis? **JCR: Journal of Clinical Rheumatology**, v. 23, n. 6, p. 308–316, 2017.

BELLAMY, N. et al. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. **The Journal of rheumatology**, v. 15, p. 1833–1840, Dec. 1988.

BIJUR, P.; SILVER, W.; GALLAGHER, E. Reliability of the visual analog scale for measurement of acute pain. **Academic Emergency Medicine**, v. 8, n. 12, p. 1153–1157, 2001.

BLAGOJEVIC, M. et al. Risk factors for onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis. **Osteoarthritis and Cartilage**, v. 18, n. 1, p. 24–33, 2010.

CARLESSO, L. C. et al. Disease-specific pain and function predict future pain impact in hip and knee osteoarthritis. **Clinical Rheumatology**, v. 35, n. 12, p. 2999–3005, 2016.

CHENG, S.-T. et al. A multicomponent intervention for the management of chronic pain in older adults: study protocol for a randomized controlled trial. **Trials**, v. 18, n. 1, p. 528, Nov. 2017.

DOBSON, F. et al. Recommended performance - based tests to assess physical function in people diagnosed with hip or knee osteoarthritis. **OARSI - Osteoarthritis Research Society International**, p. 1–26, 2013.

DUNLOP, D. D. et al. Objective physical activity measurement in the osteoarthritis initiative: Are guidelines being met? **Arthritis and rheumatism**, v. 63, n. 11, p. 3372–3382, Nov. 2011.

DUNN, K. M.; CROFT, P. R. The importance of symptom duration in determining prognosis. **Pain**, v. 121, n. 1–2, p. 126–132, Mar. 2006.

GAMST, G.; MEYERS, L. S.; GUARINO, A. J. **Analysis of Variance Designs: A Conceptual and Computational Approach with SPSS and SAS**. 1. ed. New York, NY, USA: Cambridge University Press, 2008.

GATCHEL, R. J. et al. The biopsychosocial approach to chronic pain: scientific advances and future directions. **Psychological bulletin**, v. 133, n. 4, p. 581–624, Jul. 2007.

GONÇALVES, G. H. et al. Kinematic alterations of the lower limbs and pelvis during an ascending stairs task are associated with the degree of knee osteoarthritis severity. **Knee**, v. 24, n. 2, p. 295–304, 2017.

GOUBERT, L. et al. Confirmatory Factor Analysis of the Tampa Scale for Kinesiophobia. **The Clinical Journal of Pain**, v. 20, n. 2, p. 103–110, 2004.

HADJISTAVROPOULOS, T. et al. An Interdisciplinary Expert Consensus Statement on Assessment of Pain in Older Persons. **The Clinical Journal of Pain**, v. 23, n. Supplement 1, p. S1–S43, 2007.

HELMINEN, E.-E. et al. Determinants of pain and functioning in knee osteoarthritis: a one-year prospective study. **Clinical Rehabilitation**, v. 30, n. 9, p. 890–900, 2016.

HEUTS, P. H. T. G. et al. Pain-related fear and daily functioning in patients with osteoarthritis. **Pain**, v. 110, n. 1–2, p. 228–235, 2004.

HORTOBÁGYI, T. et al. Aberrations in the control of quadriceps muscle force in patients with knee osteoarthritis. **Arthritis Care & Research**, v. 51, n. 4, p. 562–569, 2004.

HUANG, K.-H.; HSIEH, R.-L.; LEE, W.-C. Pain, Physical Function, and Health in Patients with Knee Osteoarthritis. **Rehabilitation nursing : the official journal of the Association of Rehabilitation Nurses**, Sep. 2015.

ISHAK, N. A.; ZAHARI, Z.; JUSTINE, M. Performances among Older Persons with Low Back Pain. v. 2017, 2017.

JENSEN, I. et al. Coping with long-term musculoskeletal pain and its consequences: is gender a factor? **Pain**, v. 57, n. 2, p. 167–172, May 1994.

KEEFE, F. J. et al. The relationship of gender to pain, pain behavior, and disability in osteoarthritis patients: the role of catastrophizing. **Pain**, v. 87, n. 3, p. 325–334, 2000.

KELLGREN, J. H.; LAWRENCE, J. S. Radiological Assessment of Osteo-Arthrosis. **Annals of the Rheumatic Diseases**, v. 16, n. 4, p. 494–502, 1957.

LARSSON, C. et al. Kinesiophobia and its relation to pain characteristics and cognitive affective variables in older adults with chronic pain. **BMC Geriatrics**, v. 16, n. 1, p. 128, 2016.

LAWRENCE, R. C. et al. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part II. **Arthritis and rheumatism**, v. 58, n. 1, p. 26–35, Jan. 2008.

LITWIC, A. et al. Epidemiology and burden of osteoarthritis. **British medical bulletin**, v. 105, p. 185–199, 2013.

MA, V. Y.; CHAN, L.; CARRUTHERS, K. J. Incidence, prevalence, costs, and impact on disability of common conditions requiring rehabilitation in the united states: Stroke, spinal cord injury, traumatic brain injury, multiple sclerosis, osteoarthritis, rheumatoid arthritis, limb loss, and back pa. **Archives of Physical Medicine and Rehabilitation**, v. 95, n. 5, p. 986–995.e1, 2014.

MILANOVIC, Z. et al. Age-related decrease in physical activity and functional fitness among elderly men and women. **Clinical interventions in aging**, v. 8, p. 549–556, 2013.

OSMAN, A. et al. Factor structure, reliability, and validity of the Pain Catastrophizing Scale. **Journal of behavioral medicine**, v. 20, n. 6, p. 589–605, Dec. 1997.

OSMAN, A. et al. The Pain Catastrophizing Scale: further psychometric evaluation with adult samples. **Journal of behavioral medicine**, v. 23, n. 4, p. 351–365, Aug. 2000.

ROELOFS, J. et al. Norming of the Tampa Scale for Kinesiophobia across pain diagnoses and various countries. **Pain**, v. 152, n. 5, p. 1090–1095, 2011.

SCOPAZ, K. A. et al. Effect of baseline quadriceps activation on changes in quadriceps strength after exercise therapy in subjects with knee osteoarthritis. **Arthritis and rheumatism**, v. 61, n. 7, p. 951–957, Jul. 2009.

SOMERS, T. J. et al. Pain Catastrophizing and Pain-Related Fear in Osteoarthritis Patients: Relationships to Pain and Disability. **Journal of Pain and Symptom Management**, v. 37, n. 5, p. 863–872, 2009.

SULLIVAN, M.; BISHOP, S.; PIVIK, J. The pain catastrophizing scale: development and validation. **Psychological assessment**, v. 7, n. 4, p. 524–532, 1995.

SULLIVAN, M. J. L. et al. Theoretical Perspectives on the Relation Between Catastrophizing and Pain. **The Clinical Journal of Pain**, v. 17, n. 1, p. 52–64, 2001.

SULLIVAN, M. J. L. et al. An experimental investigation of the relation between catastrophizing and activity intolerance. **Pain**, v. 100, n. 1–2, p. 47–53, Nov. 2002.

SULLIVAN, M. J. L.; BISHOP, S.; PIVIK, J. **The Pain Catastrophizing Scale: Development and Validation**. [s.l: s.n.]. v. 7

THOMPSON, D. D. Aging and sarcopenia. **Journal of musculoskeletal & neuronal interactions**, v. 7, n. 4, p. 344–345, 2007.

VLAEYEN, J. W. S. et al. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. **Pain**, v. 62, n. 3, p. 363–372, 1995.

ZALE, E. L. et al. The relation between pain-related fear and disability: a meta-analysis. **The journal of pain : official journal of the American Pain Society**, v. 14, n. 10, p. 1019–1030, Oct. 2013.

ZHANG, Y.; JORDAN, J. M. Epidemiology of Osteoarthritis. **Clinics in geriatric medicine**, v. 26, n. 3, p. 355–369, Aug. 2010.

5. CONSIDERAÇÕES FINAIS

Os resultados dessa dissertação contribuíram com a literatura agregando conhecimentos sobre arquitetura muscular, força e fatores biopsicossociais de indivíduos com OA de joelho em diferentes faixas etárias.

Com relação a arquitetura muscular e força, a presença de OA de joelho, está associada ao envelhecimento muscular precoce, caracterizado por diminuição do ângulo de penação, comprimento do fascículo, espessura muscular e força muscular; bem como potencializa os efeitos deletérios musculares do processo de envelhecimento. Relacionado aos fatores biopsicossociais foi demonstrado que os fatores clínicos, funcionais e biopsicossoais apresentam-se similares entre adultos de meia-idade e idosos com OA de joelho. Além disso, pôde-se identificar que a cinesiofobia está fortemente relacionada ao questionário WOMAC e a intensidade de dor, e que a catastrofização da dor também se associa ao questionário WOMAC.

Desta forma, foi identificado que fatores biopsicossociais devem ser avaliados continuamente na clínica, independente da faixa etária, a fim de aumentar a aderência dos pacientes aos programas de reabilitação, assim como possíveis mudanças na intensidade da dor e força muscular. Além disso, foi visto que a arquitetura muscular do músculo vasto lateral, avaliada por meio do ultrassom, é um método de baixo custo, seguro e capaz de avaliar a força indiretamente no ambiente clínico, por medidas indiretas. Além disso, esta avaliação possibilita um diagnóstico muscular precoce, permitindo diferentes protocolos de intervenção.

6. ATIVIDADES RELACIONADAS À DISSERTAÇÃO

Durante o desenvolvimento dos estudos da presente dissertação, outras atividades foram realizadas paralelamente que visaram contribuir para o amadurecimento e aperfeiçoamento do trabalho final:

Visita técnica

Em agosto de 2017 foi realizada visita técnica a La Trobe University, campus rural – Bendigo, Prof. Dr. Marcos de Noronha; bem como a La Trobe University, campus Melbourne, Profa. Dra. Kay Crossley e Dr. Christian Barton; e University of Melbourne, Profa. Dra. Kim Bennell, com recursos do Projeto Temático - FAPESP (Proc. 2013/00798-2), o qual a Profa. Dra. Stela Márcia Mattiello é pesquisadra principal. Durante essas visitas foram realizadas apresentaçõess dos laboratórios de pesquisa e discutidas possíveis parcerias entre a La Trobe University, campus Melbourne e a Universidade Federal de São Carlos. Além disso, houve um planejamento de doutorado sanduíche objetivando a continuidade da formação acadêmica.

Participações em projetos de pesquisa

Projeto temático FAPESP (Proc. 2013/00798-2) intitulado “Matriz extracelular no envelhecimento no exercício e no microambiente tumoral”.

Projeto piloto em parceria com a La Trobe University (Austrália) intitulado “Análise da eficácia da telereabilitação em indivíduos com osteoartrite de joelho”.

Projeto de Doutorado Regular - Aline Castilho de Almeida - FAPESP (Proc. 2016/05047-3) intitulado “Influência de um protocolo de treinamento em circuito no tecido adiposo intermuscular de pacientes com osteoartrite de joelho: um ensaio clínico randomizado controlado”.

Projeto de Doutorado Direto – Maria Gabriela Pedroso – FAPESP (Proc. 2015/19232-4) intitulado “A influência da gordura intermuscular e da composição corporal no controle postural em pacientes com osteoartrite de joelho”.

Projeto SPRINT – FAPESP (Proc. 2016/50346-9), parceria firmada entre a Universidade Federal de São Carlos (UFSCar) e La Trobe University (Bendigo – Australia), intitulado “The effects of different exercise protocols and different delivery methods on the progression of knee osteoarthrits”.

Artigo completo publicado

AILY, J.B.; CARNAZ, L.; FARCHE, A.C.S.; TAKAHASHI, A.C.M. Perception of barriers to physical exercise in women population over 60. **Motriz, Journal of Physical Education**. 2017.

Artigos completos submetidos

AILY, J.B.; CARVALHO, G.F.; ALMEIDA, A.C.; PEDROSO, M.G.; MATTIELLO-SVERZUT, A.C.; MATTIELLO, S.M. Clinical and functional contributions to the presence of biopsychosocial aspects in patients with knee osteoarthritis in different age groups. Clinical Rheumatology.

ALMEIDA, A.C.; PEDROSO, M.G.; **AILY, J.B**.; GONÇALVES, G.H.; PASTRE, C.M.; MATTIELLO, S.M. Influence of a progressive circuit training protocol in

intermuscular adipose tissue of patients with knee osteoarthritis: protocol for a randomized controlled trial. **BMC Musculoskeletal Disorders**.

FELINTO, J.C.; POLONI, K.M.; FREIRE, P.G.L.; **AILY, J.B.**; ALMEIDA, A.C.; PEDROSO, M.G.; MATTIELLO, S.M.; FERRARI, R.J. Automatic segmentation and quantification of thigh tissues in CT images. **Journal of Signal Processing Systems**.

Resumos publicados em anais de congressos

BERGAMASCHI, J.R.; ALMEIDA, A.C.; PEDROSO, M.G.; **AILY, J.B**.; GONCALVES, G.H.; SILVA, G.C.; GILBERTONI, R.S.; MATTIELLO, S.M. Body mass, adiposity and lean mass indexes as body composition predictors between sexes. In: XV Encontro AAARL de Medicina Esportiva, 2016, Ribeirão Preto. Anais do XV Encontro AAARL de Medicina Esportiva, 2016.

GILBERTONI, R.S.; PEDROSO, M.G.; ALMEIDA, A.C.; GONCALVES, G.H.; **AILY, J.B**.; SILVA, G.C.; BERGAMASCHI, J.R.; MATTIELLO, S.M. Influences of physical activity time in body fat mass between sexes. In: XV Encontro AAARL de Medicina Esportiva, 2016, Ribeirão Preto. Anais do XV Encontro AAARL de Medicina Esportiva, 2016.

SILVA, G.C.; **AILY, J.B.**; ALMEIDA, A.C.; PEDROSO, M.G.; GONCALVES, G.H.; BERGAMASCHI, J.R.; GILBERTONI, R.S.; MATTIELLO, S.M. Body mass index, fat percentage and bone mineral density as predictors of body composition. In: XV Encontro AAARL de Medicina Esportiva, 2016, Ribeirão Preto. Anais do XV Encontro AAARL de Medicina Esportiva, 2016.

ROSA, A.L.; ALMEIDA, A.C.; PEDROSO, M.G.; **AILY, J.B**.; GONCALVES, G.H.; BERGAMASCHI, J.R.; SILVA, G.C.; GILBERTONI, R.S.; MATTIELLO, S.M. Body mass index, android/gynoid ratio and percentage of fat on trunk/lower member's ratio as predictors of body composition. In: XV Encontro AAARL de Medicina Esportiva, 2016, Ribeirão Preto. Anais do XV Encontro AAARL de Medicina Esportiva, 2016.

PEDROSO, M.G.; ALMEIDA, A.C.; **AILY, J.B**.; GONCALVES, G.H.; PETRELLA, M.; SELISTRE, L.F.A.; LIBERATORI JUNIOR, R.M.; MATTIELLO, S.M. The influence of body mass index (BMI) in the stair climbing function in patients with knee osteoarthritis (OA) and healthy people. In: OARSI 2016 World Congress, 2016, Amsterdã. Osteoarthritis and Cartilage, 2016.

AILY, J.B.; ALMEIDA, A.C.; PEDROSO, M.G.; GONCALVES, G.H.; MATTIELLO, S.M. Can fat mass, and lean mass indexes be better predictors of body composition than BMI between sexes in patients with knee osteoarthritis? In: OARSI 2017 World Congress, 2017, Las Vegas. Osteoarthritis and Cartilage, 2017.

ALMEIDA, A.C.; PEDROSO, M.G.; **AILY, J.B**.; GONCALVES, G.H.; MATTIELLO, S.M. Correlation between body composition measures assessed by dual energy x-ray absorptiometry (DXA) on the functional performance of patients with knee osteoarthritis. In: OARSI 2017 World Congress, 2017, Las Vegas. Osteoarthritis and Cartilage, 2017.

PEDROSO, M.G.; ALMEIDA, A.C.; **AILY, J.B**.; MATTIELLO, S.M. Relationship between BMI and adipose tissue content in abdominal and thigh regions in people with knee osteoarthritis. In: OARSI 2017 World Congress, 2017, Las Vegas. Osteoarthritis and Cartilage, 2017.

Co-orientação

Aluno de Iniciação científica – Gabriel de Carvalho Silva - CNPq (Proc. 120934/2016-7) projeto intitulado “Avaliação da sarcopenia em pacientes com osteoartrite de joelho e sua relação com o teste de subir e descer escadas.

APÊNDICE A.

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO
(Resolução 466/2012 do CNS)

Sr (a) está sendo convidado a participar da pesquisa "Avaliação da arquitetura muscular no envelhecimento de pacientes com osteoartrite de joelho – relação com força muscular e concentração de tecido adiposo". Você foi selecionado (a) por estar cadastrado na lista de projetos do Laboratório da Função Articular (LAFAr) do Departamento de Fisioterapia da Universidade Federal de São Carlos (UFSCar) ou por ter entrado em contato conosco pelo telefone, porém, ressalta-se que a sua participação não é obrigatória. Esta pesquisa tem como objetivo avaliar as propriedades estruturais e a quantidade de gordura nos músculos da coxa, e relacionar com a força muscular exercida por esses músculos. Além disso, essa pesquisa tem como objetivo avaliar a dor, rigidez e função física, capacidade funcional, composição corporal e nível de atividade física de pessoas com média idade (40 a 50 anos) e idade avançada (≥ 70 anos), com e sem osteoartrite (OA) de joelho.

Sua participação envolverá algumas avaliações que acontecerão em etapas. Primeiramente será realizada avaliação inicial com dados de peso, altura e histórico de dor na articulação do joelho, bem como a aplicação de 3 questionários que irão rastrear sua capacidade cognitiva, seu equilíbrio, e sua dor, rigidez e função física. Ainda nesta mesma visita, será realizada a avaliação da composição corporal por meio do DXA (aparelho de Absortiometria de Raios-X de Dupla Energia) que utiliza o modelo de três compartimentos (massa corporal magra, gordura e massa mineral corporal). Esta técnica permite estimar a composição corporal no todo e por segmento corporal. Todos os procedimentos realizados na primeira etapa acontecerão no Departamento de Fisioterapia da UFSCar e terão duração de aproximadamente 60 minutos. Ao final desta visita inicial, o (a) sr(a) será encaminhado (a) para realizar o exame de raio-x que consistirá na segunda etapa:

a) Raio-x dos joelhos: pela imagem radiográfica conseguimos analisar alguns desgastes na articulação. Por essa análise conseguimos saber qual o grau da lesão de seus joelhos de 0 (sem lesão) à 4 (lesão grave). Esse exame será realizado no Hospital Universitário – UFSCar. Ressaltamos a importância da realização desse exame nos voluntários que não possuem dor no joelho, pois não há como garantir que indivíduos sem dor no joelho não possuem desgaste ou outros sinais radiográficos da OA. Tempo de duração do exame: 20 minutos. Local de realização: Hospital Universitário de São Carlos.

O exame de raio-x do joelho expõe ao paciente uma dose de radiação aproximada de 0,005 mSv(mili Sievert). Essa dose de radiação está dentro da dose de radiação permitida na população.

A terceira etapa da sua participação será sua segunda visita ao Departamento de Fisioterapia da UFSCar, onde será revelado o resultado do raio-x. Em seguida, o (a) senhor (a) será submetido a um teste de força muscular realizado por meio de um aparelho que irá avaliar a quantidade de força que você consegue fazer para esticar os joelhos. Após o teste de força muscular, será fixado um pequeno equipamento (actígrafo) na sua coxa que tem a função de captar o tempo que você permanece sentado, caminhando e em pé durante 7 dias. Esse equipamento é compacto e leve (35x53x7mm e 20g) e será fixado por um adesivo Tegaderm. Você será orientado quanto aos cuidados com o equipamento e deverá permanecer com o mesmo durante 7 dias. Posteriormente, o (a) sr(a) será encaminhado (a) para realizar o exame de tomografia computadorizada e ultrassom das coxas que deverá ser realizado 7 dias após a terceira etapa. Desta forma, a quarta e última etapa consistirá na retirada do equipamento fixado (actígrafo) e realização dos exames de tomografia computadorizada e ultrassom.

b) Tomografia computadorizada das coxas: O exame de tomografia computadorizada será realizado por um radiologista capacitado, e serão captadas imagens das coxas (direita e esquerda). Com essas imagens nós iremos analisar a quantidade de músculo e gordura presente nesse segmento. O exame consiste em permanecer deitado (a) de barriga para cima por, aproximadamente 3 minutos, na maca pertencente ao aparelho de tomografia computadorizada. Tempo de duração do exame: 10 minutos. Local de realização: Hospital Universitário de São Carlos.
c) Ultrassom dos músculos da coxa: O exame de ultrassom será realizado por um radiologista capacitado, e serão captadas imagens dos músculos vasto lateral e reto femoral da coxa. Com essas imagens nós iremos observar como as fibras musculares estão organizadas e sua relação com a força muscular. O exame consiste em permanecer deitado (a) de barriga para cima por, aproximadamente 20 minutos ao lado do equipamento de ultrassom. Tempo de duração do exame: 20 minutos. Local de realização: Hospital Universitário de São Carlos.

O exame de tomografia computadorizada que iremos realizar expõe uma dose aproximada de 2,81 mSv para a imagem da coxa. Essa dose de radiação, assim como a dose de raio-x, está dentro da dose de radiação permitida para a população.

Os riscos envolvidos neste estudo são mínimos, como por exemplo: dor muscular após a avaliação de força e/ou dor no joelho após os testes funcionais (*Short Physical Performance Battery*). Entretanto, caso isso ocorra o (a) senhor (a) será orientado quanto ao uso de recursos terapêuticos para diminuir a dor (gelo e bolsas de água quente), e caso a dor persista, o (a) senhor (a) receberá tratamento fisioterapêutico até que a dor diminua. Além disso, caso o (a) senhor (a) perceba qualquer risco ou dano a sua saúde, não previstos neste termo, as atividades desta pesquisa serão imediatamente suspensas. Caso seja identificado qualquer problema de saúde, o (a) senhor (a) será encaminhado (a) para o serviço de saúde do município. Caso haja algum desconforto durante a aplicação dos instrumentos, pedimos que nos informe para que possamos corrigi-lo. Antes e durante a sua participação em nosso estudo, estamos à disposição para esclarecer qualquer tipo de dúvida que o (a) senhor (a) tiver a respeito da pesquisa, dos exames ou dos testes a serem realizados.

Ao final do estudo, o (a) senhor (a) será informado sobre a saúde do seu joelho, estrutura do músculo da coxa, os resultados dos testes de força, questionários e composição corporal.

Sua participação é voluntária, isto é, a qualquer momento você pode recusar-se a responder qualquer pergunta ou desistir de participar e retirar seu consentimento. Sua recusa não trará nenhum prejuízo em sua relação com o pesquisador ou com a instituição que forneceu os seus dados. É importante que informe a equipe sobre todo e qualquer tipo de procedimento (e/ou tratamento) externo que está sendo ou será realizado no futuro, para não comprometer os dados coletados durante a pesquisa.

Os resultados obtidos a partir desta pesquisa serão de propriedade exclusiva dos pesquisadores e poderão ser divulgados a critério dos mesmos, entretanto sua identidade estará sempre preservada e não será revelada em momento algum.

Suas respostas serão tratadas de forma anônima e confidencial, isto é, em nenhum momento será divulgado o seu nome em qualquer fase do estudo. Quando for necessário exemplificar determinada situação, sua privacidade será assegurada uma vez que seu nome será substituído de forma aleatória. As informações obtidas nesta pesquisa não serão, de maneira alguma, associadas à sua identidade e não poderão ser consultadas por pessoas leigas sem sua autorização oficial. Estas informações poderão ser utilizadas para fins estatísticos ou científicos, ficando resguardados a sua total privacidade e anonimato. Os responsáveis pelo estudo explicaram ao senhor (a) todos os riscos envolvidos, a necessidade da pesquisa e se prontificam a responder todas as questões sobre o experimento.

O (a) senhor (a) receberá uma cópia deste termo, no qual consta o telefone e o endereço da pesquisadora responsável, podendo tirar suas dúvidas sobre sua participação, agora ou a qualquer momento. Desde já agradecemos!

____

Jéssica Bianca Aily
Pesquisadora
Contato: (19) 98294-9113

____

Prof. Dra. Stela Márcia Mattiello
Orientadora

Departamento de Fisioterapia da Universidade Federal de São Carlos (UFSCar), Rod. Washington Luiz, 235 – CEP: 13565-905- São Carlos – SP. Telefone: (16) 3351 8031

Declaro que entendi os objetivos, riscos e benefícios de minha participação na pesquisa e concordo em participar.

O pesquisador me informou que o projeto foi aprovado pelo Comitê de Ética em Pesquisa em Seres Humanos da UFSCar na Pró-Reitoria de Pós-Graduação e Pesquisa da UFSCar, localizada na Rodovia Washington Luiz, Km. 235 - Caixa Postal 676 - CEP 13.565-905 - São Carlos - SP. Fone (16) 3351-8110. Endereço eletrônico: cephumanos@power.ufscar.br.

São Carlos, ____ de _____________ de _____.

____

Assinatura do participante

ANEXO A.

Aprovação do Comitê de Ética

UFSCAR - UNIVERSIDADE FEDERAL DE SÃO CARLOS

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Avaliação da arquitetura muscular no envelhecimento de pacientes com osteoartrite de joelho - relação com força muscular e concentração de tecido adiposo

Pesquisador: Jéssica Bianca Aily
Área Temática:
Versão: 2
CAAE: 64171617.9.0000.5504
Instituição Proponente: Programa de Pós-Graduação em Fisioterapia - PPGFt
Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 1.958.579

Apresentação do Projeto:
Trata-se de um estudo observacional que será desenvolvido por aluna do Programa de Pós graduação em Fisioterapia da UFSCar em parceria com o Hospital Universitário onde serão selecionados 80 participantes de ambos os sexos, divididos em 4 grupos: grupo osteoartrítico de meia idade (GOAM), com idade entre 40 e 50 anos, sedentários e diagnosticados radiograficamente com OA de joelho II ou III, grupo osteoartrítico idoso (GOAI), participantes com 70 anos ou mais, sedentários e diagnosticados radiograficamente com OA de joelho II ou III, grupo controle de meia idade (GCM), participantes com idade entre 40 e 50 anos, sedentários e saudáveis, e grupo controle idoso (GCI), indivíduos com 70 anos ou mais, sedentários e saudáveis.As
avaliações acontecerão no laboratório de análise da função articular (LAFAr) do Departamento de Fisioterapia da Universidade Federal de São Carlos (UFSCar), e os exames de ultrassonografia, tomografia computadorizada e raio-x no Hospital Universitário (HU)/UFSCar.

Objetivo da Pesquisa:
O objetivo primário do estudo será investigar a arquitetura muscular do músculo vasto lateral da coxa, em indivíduos com diferentes faixas etárias, na presença ou não de Osteoartrite de joelho nos graus II e III.

Avaliação dos Riscos e Benefícios:

O pesquisador responsável descreve como riscos "Dor muscular após a avaliação de força, devido ao esforço muscular grande; dor no joelho após os testes funcionais (Short Physical Performance Battery) e teste de força muscular. Entretanto caso isso o participante voluntário será informado quanto ao uso de recursos para diminuir sua dor (gelo ou bolsa com água quente). Caso a dor persista, os pesquisadores responsáveis

realizarão o seu tratamento até que sua dor diminua.Exposição a radiação, durante o exame radiográfico, tomografia computadorizada, densitometria óssea (DXA e ultrassom, entretanto a exposição não deverá trazer prejuízos ao participante, pois os equipamentos utilizados recebem regularmente manutenção e calibração, impedindo a emissão de radiação desnecessária. Além disso, todos os procedimentos que emitem radiação serem executados por profissionais qualificados e especializados na área.Descreve como benefícios:"O participante terá conhecimento da atual condição em relação a: força muscular do quadríceps; capacidade de realizar atividades no dia-a-dia e dor no joelho, por meio de questionários e testes funcionais; presença ou não de desgaste nos joelhos a partir da radiografia;composição corporal, por meio do exame de densitometria óssea (DXA) e de tecido adiposo por meio do exame de tomografia computadorizada da região abdominal e das coxas; percepção da

qualidade de vida e dos sintomas relacionados à OA por meio dos questionários; características estruturais do músculo quadríceps por meio do ultrassom; e nível de atividade física por meio de um sistema de acelerometria. Além disso, os participantes se beneficiarão de orientações e cartilhas de exercícios específicos elaboradas por profissionais habilitados e especializados, incentivando a prática regular de exercício físico. Além disso, todos os participantes da pesquisa serão convidados a participar de palestras explicativas sobre assuntos referentes a osteoartrite de joelho.

Comentários e Considerações sobre a Pesquisa:

Projeto de pesquisa apresenta relevância para a área em questão.Apresenta cronograma adequado de acordo com as recomendações.

Considerações sobre os Termos de apresentação obrigatória:

Faltam informações importantes no TCLE.

Folha de rosto e Carta de aceite do Hospital Universitário adequadas.O Termo de Consentimento Livre e Esclarecido foi apresentado de acordo com a Resolução nº 466 de 2012.

Recomendações:

Nada a declarar.

Conclusões ou Pendências e Lista de Inadequações:

Aprovação do projeto condicionada à inserção no TCLE de informações sobre o fato que o participante não terá ganhos ao aceitar participar da pesquisa e nem terá gastos, nem ao menos com o transporte, o qual será ressarcido todas as vezes que tiver que comparecer a algum local por causa da pesquisa.

Considerações Finais a critério do CEP:

O Comitê de Ética em Pesquisa (CEP) em Seres Humanos recomenda que os pesquisadores responsáveis consultem as normas do CEP e a resolução nº 466 de 2012, disponíveis na página da Plataforma Brasil em caso de dúvidas.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_840084.pdf	17/02/2017 16:26:37		Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_completo_2.pdf	17/02/2017 16:26:10	Jéssica Bianca Aily	Aceito
Declaração de Instituição e Infraestrutura	hospitaluniversitario.pdf	10/01/2017 14:06:10	Jéssica Bianca Aily	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_completo_CEP.pdf	10/01/2017 14:04:01	Jéssica Bianca Aily	Aceito
Folha de Rosto	Jessica.pdf	10/01/2017 13:57:42	Jéssica Bianca Aily	Aceito

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

SAO CARLOS, 10 de Março de 2017

Assinado por:
Priscilla Hortense
(Coordenador)