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RAFAEL RATTI FENATO

COMPARAÇÃO DA FORÇA DO MÚSCULO GLÚTEO MÉDIO ENTRE OBESOS E CONTROLE EUTRÓFICO: UM ESTUDO TRANSVERSAL

CASCAVEL-PR
MARÇO/2020

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RAFAEL RATTI FENATO

COMPARAÇÃO DA FORÇA DO MÚSCULO GLÚTEO MÉDIO ENTRE OBESOS E CONTROLE EUTRÓFICO: UM ESTUDO TRANSVERSAL

Esta dissertação foi julgada adequada para a obtenção do título de Mestre em Biociências e Saúde e aprovada em sua forma final pelo Orientador e pela Banca Examinadora.

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RESUMO

FENATO, R. R. **Comparação da força da musculatura do glúteo médio entre obesos e controle eutrófico: um estudo transversal**. 165 páginas. Dissertação (Mestrado). Programa de Pós-Graduação em Biociências e Saúde, Centro de Ciências Biológicas e da Saúde, Campus Cascavel, Unioeste, 2020.

Os músculos abdutores do quadril desempenham um importante papel na estabilização da pelve durante a marcha, sendo sua principal função desempenhada pelo músculo glúteo médio. A insuficiência do músculo glúteo médio está associada a alterações biomecânicas e desordens do sistema musculoesquelético. Devido ao excesso de peso e à possível diminuição de massa muscular, manter a função da musculatura abdutora é um desafio enorme para os obesos. No entanto, ainda não é certo se a musculatura dos obesos consegue compensar essas alterações. O objetivo deste estudo foi comparar a força da musculatura do glúteo médio de obesos com indivíduos com peso normal por meio do uso de dinamômetro digital manual. Vinte e cinco obesos (Índice de Massa Corpórea > 35 kg / m^2) participaram do estudo, sendo pareados em sexo, idade e altura com indivíduos de peso normal. A força do músculo glúteo médio foi medida por um único avaliador com o uso de dinamômetro digital manual fixado por cinta no joelho dos indivíduos em decúbito lateral. Foram realizadas três aferições com intervalos de repouso para cada lado, sendo considerado, para análise, apenas o maior valor aferido de cada membro. Calculou-se a diferença entre os pares e avaliou-se o padrão de distribuição dos dados por meio do teste de Shapiro-Wilk ($p < 0,05$), sendo que as matrizes das variáveis foram estandardizadas e analisadas por meio da análise de componentes principais (PCA). Para as variáveis de força (Newtons) do glúteo médio dos dois lados, não foram detectadas diferenças estatísticas entre os grupos ($p > 0,05$). Contudo, ao normalizar as medidas em relação ao peso dos indivíduos (Newtons / quilogramas), foram detectadas diferenças estatísticas nessas duas variáveis entre os grupos ($p < 0,05$). A PCA indica que tanto a força em valores absolutos quanto normalizada pelo peso são reduzidas nos indivíduos obesos. Esses achados sugerem que indivíduos obesos apresentam a mesma força, ou menor (PCA), para moverem maior massa, o que representa uma fraqueza relativa capaz de justificar sua limitação funcional.

Palavras-Chaves: Obesidade. Quadril. Fraqueza muscular.

ABSTRACT

FENATO, R. R. **Comparison of the gluteus medius strength between obese and eutrophic individuals: a cross-sectional study**. 165 páginas. Dissertação (Mestrado). Programa de Pós-Graduação em Biociências e Saúde, Centro de Ciências Biológicas e da Saúde, Campus Cascavel, Unioeste, 2020.

The hip abductor muscles play an important role in stabilizing the pelvis during gait, with its main function being performed by the gluteus medius. Gluteus medius insufficiency is associated with biomechanical alterations and musculoskeletal disorders. Due to being overweight and a possible muscle mass decrease, maintaining the abductor muscular function can be a great challenge for the obese. However, it is still unclear whether the musculature of obese individuals manages to compensate for these alterations. Therefore, the aim of this study was to compare the gluteus medius strength between obese and normal weight individuals using a digital hand-held dynamometer. Twenty-five obese (BMI > 35 kg / m^2) participated in the study, being matched in gender, age, and height with normal weight individuals. The gluteus medius strength was measured by a single examiner using a belt-stabilized hand-held digital dynamometer on the knee of individuals positioned in lateral decubitus. Three measurements were recorded with rest intervals, considering only the highest value measured for each limb for analysis. The difference between pairs was calculated and the data distribution pattern was assessed using the Shapiro-Wilk test ($p < 0.05$), and the matrices of the variables were standardized and analyzed using the principal component analysis (PCA). For the strength variables (Newtons) on both sides, no statistical differences were detected between the groups ($p > 0.05$). However, statistical differences were detected in these variables between the groups ($p < 0.05$) when normalizing the measurements in relation to individuals' weights (Newtons / kilograms). The PCA indicates that both strength in absolute values and normalized by weight are reduced in obese individuals. These findings indicate that obese individuals have the same or lower strength (PCA) to move more mass, which may suggest a relative weakness that induces functional limitation.

Key words: Obesity. Hip. Muscle weakness.

LISTA DE ILUSTRAÇÕES

LISTA DE ABREVIATURAS

IL	- Interleucina
β	- Beta
OECD	- Organization for Economic Cooperation and Development
%	- Porcentagem
DEXA	- Densitometria por dupla emissão de raios-X
IMC	- Índice de Massa Corpórea
kg / m^2	- Quilogramas por metro quadrado
Kg	- Quilogramas
m	- Metros
SUS	- Sistema Único de Saúde
PiB	- Produto interno bruto
PCR	- Proteína C-reativa
MIP	- Proteína inflamatória de macrófago
TNF	- Fator de necrose tumoral
MCM	- Massa corporal magra
GER	- Gasto energético em repouso
GH	- Hormônio do crescimento
º	- Graus
GH	- Hormônio do crescimento
T	- Tensão da força abdutora
a	- Distância do centro de rotação à musculatura abdutora
b	- Distância do centro de rotação à linha de ação de W
W	- Peso corporal
J	- Resultante da força na articulação
HUOP	- Hospital Universitário do Oeste do Paraná
UNIOESTE	- Universidade Estadual do Oeste do Paraná
CRF	- Centro de Reabilitação Física
cm	- Centímetros
ICC	- Coeficiente de correlação intra-classe
PCA	- Análise de componentes principais

SUMÁRIO

1. INTRODUÇÃO

A obesidade é considerada mundialmente um problema de saúde pública. Em muitos países, mais de um terço da população adulta encontra-se obesa e com características de incidência crescente, o que não exclui nem mesmo os países em desenvolvimento, como o Brasil (NG et al., 2014). A obesidade apenas foi entendida como uma doença crônica com consequências patológicas há menos de um século, sendo relacionada ao aumento na taxa de mortalidade apenas a partir do século XX (EKNOYAN, 2006). Considerada como epidemia global, ela sobrecarrega todo o sistema de saúde, principalmente, pela associação com várias outras doenças, em sua maioria, de evolução crônica. Pelo início indolente dessas doenças, algumas complicações, como diabetes, hipertensão e aterosclerose, contribuem para o aumento da morbidade e mortalidade (FIELD et al., 2001).

O efeito da obesidade sobre o organismo pode ser explicado por dois fatores independentes: o aumento na secreção de substâncias derivadas dos adipócitos e o aumento do tecido adiposo (BRAY, 2004). O primeiro é relacionado ao efeito metabólico pela distância dos produtos secretados pelos adipócitos. Um exemplo disso são os ácidos graxos, estocados no fígado e músculos, tendo uma relação importante na determinação da resistência insulínica em obesos. Outra substância, também liberada pelas células de gordura, são as citocinas. A interleucina (IL) 6, uma das principais adipocinas, é capaz de estimular um estado pró-inflamatório crônico característico da adiposidade (BRAY, 2004). O segundo fator é responsável por problemas sociais, como o estigma da obesidade, pela apneia do sono, resultante do depósito de gordura na região parafaríngea e pelo aumento de osteoartrite em articulações de carga devido à hipersolicitação mecânica do aumento de peso (BRAY, 2004).

Nesse contexto, o sistema musculoesquelético também sofre alterações em decorrência da obesidade, o que é explicado pela associação desses mesmos dois fatores desencadeantes, a ação de mediadores secretados pelas células adiposas e a sobrecarga mecânica.

O estado inflamatório constante, produzido pelo aumento da circulação de citocinas pró-inflamatórias, atua tanto na remodelação muscular como na preservação da homeostase articular. A IL-6 e IL-1β, aumentadas em obesos,

exercem influência deletéria sobre o tamanho, estrutura e força do músculo (ERSKINE et al., 2017). Na articulação, as adipocinas contribuem para o início e progressão do processo de degeneração catabólico articular que culmina em artrose (FRANCISCO et al., 2018).

O aumento do peso também produz alterações biomecânicas no corpo, muitas vezes, não compensadas por proporcional aumento de força, que afeta a eficiência na execução de atividades diárias simples, como ficar em pé ou caminhar (TEASDALE et al., 2013). Tukker, Visscher e Picavet (2009), em estudo realizado com autorrelato de problemas ortopédicos, comprovaram a associação da obesidade com artrose, alteração da marcha, dores nas articulações de joelhos e quadris.

Em obesos, as alterações da marcha recebem destaque e, quando entendidas, podem fornecer subsídios para uma melhor compreensão da patogênese da sobrecarga mecânica relacionada ao excesso de peso. Com a melhora da marcha dos obesos, não somente espera-se uma melhora na qualidade de vida, mas também uma diminuição das lesões geradas pelas alterações mecânicas. Lai et al. (2008) descreveram que as desordens da marcha se devem à maior adução do quadril, durante a fase terminal e de pré-balanço, e a um aumento da eversão do tornozelo. Tais modificações da marcha apresentam semelhanças com as alterações encontradas em indivíduos com insuficiência de musculatura glútea média. Pessoas com ruptura completa do tendão dessa musculatura apresentam clinicamente redução da abdução e aumento da rotação externa (HARRASSER et al., 2016). Com isso, a fraqueza da musculatura glútea poderia explicar, ao menos em parte, os distúrbios da marcha e a sobrecarga nas articulações dos membros inferiores e coluna relacionados à obesidade. Esse fato estaria ligado às alterações inflamatórias musculares, o que ocasiona a diminuição de força e sobrecarga de peso não compensada por igual fortalecimento muscular (TOMLINSON et al., 2016).

Embora inúmeros fatores possibilitem a relação de que a obesidade possa desencadear fraqueza no músculo glúteo médio, poucos são os estudos que analisam a correlação entre essas variáveis, não sendo clara a associação entre a população obesa e a fraqueza desse grupo muscular (PACICCO et al., 2019).

2. OBJETIVOS

2.1 Objetivo Geral

Comparar a força do músculo glúteo médio entre obesos e eutróficos.

2.2 Objetivos Específicos

Verificar se a obesidade tem efeito sobre a força do músculo glúteo médio por meio da aferição de força com o uso de dinamômetro manual digital.

Avaliar a correlação entre a força de musculatura glútea e peso corporal.

3. REVISÃO DE LITERATURA

3.1 Obesidade

3.1.1 Dados epidemiológicos

Com os avanços tecnológicos do século XVIII e a conjuntura socioeconômica, após a Segunda Guerra Mundial, ocorreu um aumento no fornecimento de alimentos disponíveis (EKNOYAN, 2006). A abundância e o fácil acesso à comida, combinados com a redução da atividade física, contribuíram para o gradativo aumento da obesidade em todo o mundo (EKNOYAN, 2006). Mas esse fato não está apenas restrito ao passado remoto, pois a prevalência de obesidade dobrou em mais de 70 países nos últimos 40 anos (AFSHIN et al., 2017).

Estima-se que mais da metade da população adulta e aproximadamente uma entre seis crianças do mundo estão acima do peso ideal (OECD, 2017). Aproximadamente 2,1 bilhões de pessoas no mundo encontram-se entre o excesso de peso e a obesidade, sendo que os índices em países em desenvolvimento estão crescendo em níveis semelhantes ao dos Estados Unidos (NG et al., 2014). A prevalência global de obesos chega a mais de 19% da população, sendo considerada, no Brasil, 20.8% (OECD, 2017). Com o aumento de novos casos, a *Organization for Economic Cooperation and Development* (OECD) projetou, para 2030, que 47% da população dos Estados Unidos estará obesa (OECD, 2017). México e Inglaterra também apresentarão índices alarmantes de obesos com 39% e 35%, respectivamente. Os indivíduos mais suscetíveis a desenvolverem obesidade são as mulheres, pessoas com menor escolaridade e baixo nível socioeconômico (OECD, 2017). Em relação às crianças, o excesso de peso, entre os 5 e 19 anos de vida, comparativamente a 1975, demonstrou significante aumento em todo mundo e continua crescendo, especialmente, em países da Ásia (NCD, 2017).

No Brasil, o excesso de peso parece se tornar crescente com aumento da idade (PINHEIRO et al., 2016; PINHO et al., 2011). Pinheiro et al. (2016), em estudo

transversal sobre a prevalência do excesso de peso em mulheres no município de Vitória de Santo Antão, Pernambuco, verificaram que as mulheres acima de 40 anos apresentavam uma frequência de excesso de peso duas vezes maior do que a encontrada em adolescentes. Tal associação positiva pode ser explicada pelo declínio da taxa metabólica basal relacionada ao envelhecimento e à diminuição da atividade física (PINHO et al., 2011). Diversos trabalhos brasileiros demonstram uma tendência a um aumento da distribuição do excesso de peso em populações de baixa renda, em regiões urbanas, com maior prevalência no sexo feminino (BARBOSA et al., 2009; FLORÊNCIO et al., 2001). Marinho et al. (2003) estudaram a incidência de obesidade em 390 famílias de baixa renda, encontrando diferença significativa entre homens e mulheres, com prevalência de 5,6% e 21,6% ($p < 0,05$), respectivamente.

Em pesquisa, realizada pelo Ministério da Saúde, em 2016, em 27 cidades do país, a frequência de adultos obesos encontrada foi de 18,9%, com maior predomínio em mulheres (19,6%) do que em homens (18,1%) (MINISTÉRIO DA SAÚDE, 2017). A frequência de obesidade diminuiu com o aumento da escolaridade. Mais da metade dos entrevistados (53,8%) apresentavam excesso de peso. Ao contrário da obesidade, o peso acima do normal apresentou-se com maior frequência entre homens (57,7%) do que entre mulheres (50,5%) (MINISTÉRIO DA SAÚDE, 2017).

3.1.2 Método diagnóstico

A gênese da obesidade não apresenta uma fácil explicação, uma vez que a obesidade é uma doença multifatorial, caracterizada pelo acúmulo excessivo ou anormal de gordura corporal (WORLD HEALTH ORGANIZATION, 2014). Para realmente saber se existe obesidade, a densitometria por dupla emissão de raios-X (DEXA), um método de alta acurácia, tornou-se referência para a estimativa da composição corporal. Entretanto, exige exposição à radiação, é relativamente caro e de acesso limitado (HEYMSFIELD et al., 2008). Nesse contexto, a bioimpedância tem se mostrado um exame promissor por não ser invasivo, possuir alta acurácia, baixo custo e por ser comumente utilizado para verificar a composição corporal

(KHALIL; MOHKTAR; IBRAHIM, 2014). A bioimpedância basicamente avalia a densidade corporal do indivíduo por meio de uma corrente elétrica de baixa amplitude e alta frequência aplicada sobre ele (KHALIL; MOHKTAR; IBRAHIM, 2014). Dessa forma, consegue informar características relevantes da composição corporal, como porcentagem de gordura, porcentagem de massa magra, nível de hidratação, quantidade óssea e muscular. Estudos recentes não demonstram diferenças significativas no emprego da bioimpedância em relação à DEXA (KRACHLER et al., 2013).

Para o diagnóstico de obesidade em adultos, uma medida amplamente difundida é o Índice de Massa Corpórea (IMC). Quetelet, em 1842, foi o primeiro a sugerir o cálculo do peso em quilogramas, dividido pela altura em metros elevada ao quadrado (QUETELET, 1842). A Organização Mundial da Saúde (OMS) (2014) define o indivíduo obeso quando esse valor é maior ou igual a 30 kg/m^2, de 25 a 29.9 kg/m^2 sobrepeso, entre 18 e 24.9 kg/m^2 eutrófico e IMC abaixo de 17.9 kg/m^2 baixo peso. Dentro do grupo da obesidade, ainda existe a subdivisão em obesidade grau I (IMC entre 30 e 34.9 kg/m^2), grau II (IMC entre 35 e 39.9 kg/m^2) e grau III ou obesidade mórbida (IMC acima de 40 kg/m^2) (WORLD HEALTH ORGANIZATION, 2014).

A utilização desse parâmetro, no decorrer dos anos, propiciou a observação de que outros fatores, como idade, raça e atividade física, poderiam influenciar e confundir a correlação do IMC com a obesidade (HEYMSFIELD et al., 2009). Um exemplo é o reconhecimento pela OMS de que essa classificação pode subestimar a obesidade na população asiática, devendo-se considerar, nesse caso, uma adequação da aferição para um valor preditivo mais confiável (WORLD HEALTH ORGANIZATION, 2004). Com isso, apesar do IMC se correlacionar com a porcentagem de massa gorda, ele apenas apresenta uma estimativa, sendo que, em indivíduos com maior massa muscular, o IMC pode erroneamente classificá-los como obesos (HEYMSFIELD et al., 2009). Pela sua fácil aplicabilidade e isenção de custo, é o exame mais utilizado, em todo o mundo, para identificação da expressão fenotípica da adiposidade em humanos (HEYMSFIELD et al., 2009).

3.2 Sistema muscular

O tecido muscular altera-se em decorrência da adiposidade. De muitas maneiras, a qualidade muscular e seu desempenho são afetados em indivíduos obesos (ROUBENOFF, 2000). A obesidade é capaz de induzir inflamação sistêmica por meio do aumento da circulação de citocinas pró-inflamatórias, atuando na remodelação muscular e alterando suas propriedades. Erskine et al. (2017) sugerem que, em obesos jovens, o aumento de IL-6 e IL-1β exerce uma alteração na ativação neuromuscular, diminuindo o tamanho muscular, sua estrutura e força. Já em indivíduos eutróficos, o nível normal de Proteína inflamatória de macrófago (MIP) 1β parece exercer um importante papel na manutenção do tamanho muscular, estrutura e força. Em idosos, elevações da IL-8 associaram-se com maior ativação neuromuscular, enquanto, inesperadamente, elevações de Fator de necrose tumoral (TNF) α atuaram aumentando massa muscular, arquitetura e força máxima de contração. A IL-8 atua como fator quimiotático dos neutrófilos e, portanto, é pró-inflamatória, sendo associada à obesidade. O que parece é que a atuação dessa citocina depende da idade. Em jovens, atua diminuindo a massa muscular e exerce efeito contrário em idosos (ERSKINE et al., 2017).

O estudo dos mecanismos envolvidos na perda de massa muscular, durante a obesidade, realizado por Masgrau et al. (2012), definiu que a obesidade por período prolongado provoca o acúmulo de lipídio em outros tecidos, principalmente, no tecido muscular. Esse acúmulo anormal induz a alterações no metabolismo dos tecidos, como redução da captação de glicose, disfunção mitocondrial e lipotoxicidade (MASGRAU et al., 2012). Esse estudo comparou a evolução da obesidade em duas fases distintas: no ganho de peso inicial e na manutenção tardia da obesidade. Apesar da obesidade aumentar a massa magra a curto prazo, com o passar do tempo, o infiltrado lipídico no músculo esquelético reduz a taxa de síntese de todas as proteínas musculares, particularmente, reduzindo a síntese de proteínas mitocondriais. Quando comparado o peso muscular durante as duas fases da obesidade, não existia diferença, pois, na segunda fase, os músculos apresentavam um aumento no infiltrado de gordura (MASGRAU et al., 2012). Conclui-se que o excesso de gordura tem influência negativa sobre a massa muscular a longo prazo.

3.2.1 Sarcopenia

Com o avanço da idade, a massa e a função do músculo esquelético são diminuídas, condição denominada de sarcopenia (NARICI; MAFFULLI, 2010). Porém, como não há, apenas, uma causa desencadeante da sarcopenia, pode estar relacionada ao declínio da atividade física, inflamação sistêmica crônica e alteração neurológica, como a desenervação das fibras musculares (DEGENS, 2010). Essas condições estão presentes tanto na obesidade quanto na senilidade, podendo se sobrepor e amplificar o dano muscular.

O conceito de obeso sarcopênico, descrito por Roubenoff (2000), sugere que as citocinas pró-inflamatórias, produzidas pela gordura visceral, interferem no metabolismo muscular e, então, desencadeiam um ciclo vicioso que mantém a sarcopenia. Esse aumento nos níveis de citocinas interfere diretamente no metabolismo proteico por seu efeito no equilíbrio do aminoácido muscular e, indiretamente, pela sensibilidade à insulina. O autor propõe que, nos indivíduos com artrite reumatoide, osteoartrose e em idosos, a perda de massa muscular é o maior contribuinte para o aumento de peso, que, por sua vez, atua reforçando a perda de músculo, por meio da diminuição da taxa metabólica de repouso e da atividade física. Esses dois fatores atuam para um desequilíbrio no balanço energético, o que ocasiona o aumento de peso e acúmulo de tecido adiposo. Com o aumento da gordura, ocorre um aumento concomitante nos níveis de leptina e TNF, responsáveis pela resistência periférica à insulina, que diminui o transporte normal de aminoácido para o tecido muscular. Concomitantemente, existe evidência de que a leptina diminui um importante estimulador anabólico, o hormônio de crescimento, e que os níveis elevados de TNF causam efeito catabólico direto no tecido muscular (Figura 1). Esse mecanismo de *feed back* positivo perpetua relação existente entre o acúmulo de gordura e a perda da massa muscular (ROUBENOFF, 2000).

Figura 1. Relação entre a perda de massa magra e adiposidade no obeso sarcopênico. MCM = massa corporal magra; GER = gasto energético em repouso; TNF = fator de necrose tumoral; GH = hormônio do crescimento. Adaptado de Roubenoff (2000).

Schrager et al. (2007) demonstraram que o efeito das citocinas pró-inflamatórias é crucial para o desenvolvimento tanto da obesidade quanto da sarcopenia. Essas duas situações estão associadas a níveis elevados de IL-6, PCR, antagonista do receptor da IL-1 e receptor solúvel da IL-6. A obesidade central parece gerar mais inflamação, contribuindo para o desenvolvimento e progressão da obesidade sarcopênica de forma mais intensa. As alterações inflamatórias, decorrentes do envelhecimento natural, quando associadas com a obesidade, podem agravar ainda mais os efeitos da sarcopenia e gerar repercussões à mobilidade (SCHRAGER et al., 2007).

Nesse sentido, a presença de obesidade associada à sarcopenia tem sido relacionada ao aumento de limitações funcionais e dificuldade para exercer atividades que exijam força. Baumgartner et al. (2004) descrevem a combinação desses dois fatores negativos como uma condição associativa e deletéria para a qualidade de vida do indivíduo com excesso de peso. Seu estudo prospectivo, de acompanhamento de indivíduos idosos por oito anos, sugere que, se a obesidade e sarcopenia apresentam-se concomitantes, existem 2.5 vezes mais chances de ocorrer incapacidade para as atividades cotidianas, quando comparado com o obeso não-sarcopênico ou o sarcopênico não-obeso. A etiologia para esse achado pode estar tanto na diminuição da atividade anabólica da idade quanto no aumento da atividade catabólica da obesidade.

Existe consenso na literatura de que, devido à sobrecarga de peso, os músculos antigravitacionais têm maior força absoluta comparativamente a indivíduos eutróficos (TOMLINSON et al., 2016). Esse pensamento sugere que o aumento da gordura pode atuar como um estimulador para grupos musculares como panturrilha e quadríceps. Porém, mesmo que pareçam ter maior força absoluta, obesos apresentam sempre menor força relativa em músculos antigravitacionais, como o quadríceps (DUVIGNEAUD et al., 2008; MAFFIULETTI et al., 2007). Quando a força muscular é ajustada em relação ao peso, os obesos parecem ser mais fracos. Lafortuna et al. (2005) também corroboram esses dados quando avaliaram a força muscular da extremidade inferior pelo exercício de *leg press*. Comparado com indivíduos de peso normal, os obesos eram mais fortes, porém, quando os valores foram relacionados à massa magra, presente nesses indivíduos, a diferença desapareceu (LAFORTUNA et al.;2005).

Essa fraqueza relativa pode ser a responsável pela redução na mobilidade, adaptações neurais e mudanças na morfologia muscular (TOMLINSON et al., 2016). As evidências na literatura sugerem que existe uma redução na estimulação da força muscular devido a alterações no tamanho do músculo, na sua estrutura e função. A obesidade está associada a limitações funcionais do desempenho muscular e aumento do desenvolvimento de alterações mecânicas, como mobilidade, força, postura e limitações de equilíbrio. Essas alterações são observadas em indivíduos obesos e pioram com o passar do tempo. Sendo assim, adiposidade e idade parecem ter um efeito cumulativo na piora da qualidade muscular (TOMLINSON et al., 2014).

Os mais importantes mecanismos para esse efeito deletério da obesidade sobre o tecido muscular foram descritos por Tomlinson el al. (2016) (Figura 2). O envelhecimento, o sedentarismo, a diminuição nos níveis de atividade física (metabolismo) e alterações alimentares são fatores independentes, porém, cumulativos, que desencadeiam ou aumentam o depósito anormal de tecido adiposo no corpo. Os adipócitos atuam no organismo elevando citocinas pró-inflamatórias e, ao mesmo tempo, diminuindo hormônios anabólicos. Como resultado, tem-se a diminuição da massa magra e de força, o que resulta em limitações funcionais (TOMLINSON et al., 2016).

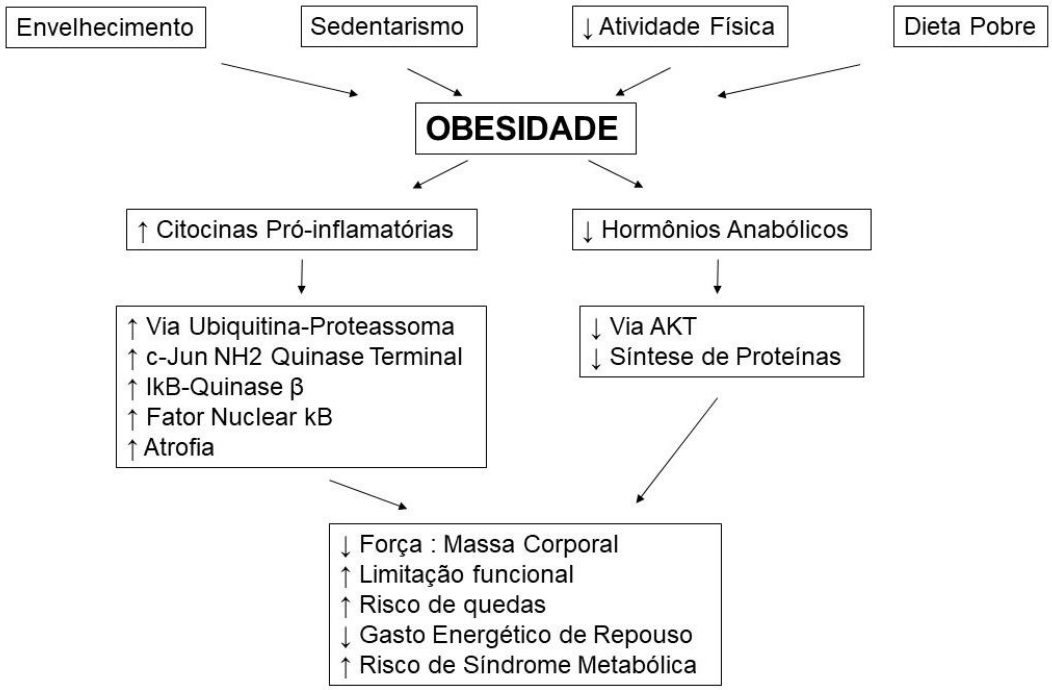

Figura 2. Interação entre obesidade, inflamação e alterações musculares. Adaptado de Tomlinson et al. (2016).

3.3 Doenças ortopédicas

A obesidade também tem um papel importante no adoecimento do sistema osteoarticular. O desequilíbrio inflamatório ou metabólico articular, associado a alterações biomecânicas, contribui para o início e progressão de um processo conhecido como artrite (FRANCISCO et al., 2018). O estado de inflamação crônica leve, causado pelo excesso de peso, é um fator de risco estabelecido para o aumento da incidência de doenças osteoarticulares. Blagojevic et al. (2010), em revisão sistemática e meta-análise, indicaram associação entre o aumento de IMC e a osteoartrose de joelho em adultos idosos. Outros fatores que influenciaram a gonartrose foram lesão prévia em joelho, artrose em mãos, sexo feminino, idade avançada e atividade física de impacto (BLAGOJEVIC et al., 2010). Estudo recente indica que mediadores inflamatórios, como as citocinas derivadas do tecido adiposo, exercem um papel fundamental à ligação da obesidade com a osteoartrite (FRANCISCO et al., 2018). Como a osteoartrite é caracterizada pela degeneração

progressiva da cartilagem articular, o que gera um processo catabólico, a obesidade com alteração mecânica e desequilíbrio inflamatório metabólico pode contribuir fortemente para a progressão dessa doença (FRANCISCO et al., 2018).

Em estudo coorte, Felson et al. (1992) analisaram o IMC de 796 mulheres durante 12 anos. Destas, 68 apresentaram sinais de artrose no joelho. O estudo conclui que alterações no peso afetam o risco de desenvolvimento de gonartrose. Assim, a exemplo, citaram que uma redução de duas unidades do IMC, que representa uma perda de aproximadamente 5,1kg, por um período de 10 anos, diminui o risco relativo para o aparecimento de artrose em quase 50% (odds ratio 0,46; p=0,02) (FELSON et al.; 1992).

Um estudo epidemiológico realizado para correlacionar artrose das mãos com a obesidade concluiu que essas articulações, que não sofrem sobrecarga mecânica em decorrência do peso, têm o risco relativo de artrose quase duas vezes maior para a população obesa, sugerindo como causa a liberação de leptina pelo tecido adiposo, aterosclerose e diabetes (YUSUF et al., 2010). Porém, a relação precisa entre fatores inflamatórios e alterações biomecânicas ainda não está completamente estabelecida para o desencadeamento da artrose.

O que já está bem estabelecido são as influências negativas do excesso de peso sobre as adaptações mecânicas do indivíduo. Mais do que apenas inferirem alterações biomecânicas e articulares relacionadas à obesidade, Fjeldstad et al. (2008) analisaram a influência da obesidade sobre quedas e qualidade de vida. Verificaram uma prevalência maior de quedas e tropeços quando o IMC era maior que 30 kg/m^2 e identificaram que obesos apresentam baixa qualidade de vida relacionada à saúde. Mesmo quando comparados a portadores de outras doenças crônicas, indivíduos acima do peso exibem menores índices de qualidade de vida (JIA; LUBETKIN, 2005).

Em estudo com 4641 mulheres, Arterburn et al. (2012) estudaram a relação entre obesidade, depressão e incapacidade, constatando diminuição da mobilidade, limitações nas tarefas domiciliares e nas atividades de trabalho, quando presente o excesso de peso. Da mesma forma, sobrepeso e obesidade foram relacionados a 5760 dias de ausência no trabalho por 1000 indivíduos/ano. Não obstante à associação com doenças crônicas, alterações dos componentes da musculatura, desequilíbrio das forças biomecânicas e sobrecarga articular, a obesidade também afeta a qualidade de vida (ARTERBURN et al., 2012).

Algumas alterações biomecânicas fundamentais, como a habilidade de equilíbrio do tronco, controle sobre movimentos e capacidade física são relacionadas com a obesidade e parecem ter papel fundamental na baixa qualidade de vida dos obesos (LAI et al., 2008). A estabilidade postural, definida como a capacidade de retornar o corpo ao ponto de equilíbrio quando exposto a uma perturbação, representa uma função primordial para a realização das tarefas de vida diária e está alterada na obesidade (LAI et al., 2008). O aumento no IMC produz instabilidade anteroposterior do tronco em ambos os sexos e instabilidade mediolateral em homens, causando limitação funcional e predispondo a lesões (CAPODAGLIO et al., 2012). Teasdale et al. (2013) confirmaram o efeito deletério do excesso de peso sobre o controle motor e acrescentaram que a perda de peso melhora o equilíbrio do corpo e a precisão de movimentos dos membros superiores ao ortostatismo.

Tukker, Visscher e Picavet (2009) examinaram a associação entre o excesso de peso e problemas relacionados aos membros inferiores, autorrelatados pelos participantes do estudo. Observaram forte correlação entre sobrepeso e obesidade com artrose de quadril ou joelho, dores crônicas em membros inferiores e prejuízo na mobilidade. Descreveram, ainda, que cerca de 25% dos problemas de saúde dos membros inferiores são devido ao excesso de peso (TUKKER, VISSCHER e PICAVET; 2009). Em estudo prospectivo com 10 anos de acompanhamento, Grotle et al. (2008) encontraram associação significativa entre o índice de massa corporal elevado e artrose de joelho e mão.

Existe forte evidência de que o sobrepeso e a obesidade também sejam fatores predisponentes para o desenvolvimento inicial ou para o agravamento de dor crônica lombar (HEUCH et al., 2013). Obesos podem apresentar um aumento de 20% no risco de desenvolverem dor crônica, em particular na região lombar, cervical ou nos ombros (HEUCH et al., 2013). Em contrapartida, a atividade física regular parece ter um efeito protetor contra a dor crônica, compensando em parte o excesso de peso (NILSEN; HOLTERMANN; MORK, 2011).

Das alterações biomecânicas em obesos, a disfunção da marcha recebe destaque. Em estudo com ênfase na análise tridimensional da marcha em obesos, Lai et al. (2008) descreveram as alterações da locomoção desses indivíduos. Dentre as desordens mais importantes, destacaram-se a maior adução do quadril, durante a fase terminal e pré-balanço, e a eversão acentuada do tornozelo (LAI et al., 2008). Tais modificações da marcha apresentam semelhanças com o distúrbio ocasionado

pela fraqueza da musculatura glútea, ou seja, redução da abdução e aumento da rotação externa (HARRASSER et al., 2016).

Há nitidamente um desequilíbrio não compensado, com influência negativa aos parâmetros da marcha (SILVA-HAMU et al., 2013). Manter a força da musculatura glútea pode ser um desafio enorme para esses indivíduos. Tais modificações produzem instabilidade anteroposterior e médio-lateral do tronco, com limitação funcional e predisposição a lesões (CAPODAGLIO et al., 2012; LERNER; BOARD; BROWNING, 2014; ROSSO et al., 2019). Com o avanço da idade, a atrofia muscular do glúteo médio aumenta, o que pode contribuir para quedas e fratura de quadril (CHI et al., 2015).

A alteração inflamatória muscular associada à sobrecarga de peso e fraqueza muscular glútea poderiam explicar os distúrbios da marcha no obeso e a sobrecarga nas articulações de carga e na coluna. Porém, até o momento, nenhuma relação direta entre esses dois fatores foi descrita.

3.4 Musculatura do quadril

A articulação do quadril apresenta uma grande amplitude de movimentação, com capacidade de flexão de 120º, extensão 30º, abdução de 45º a 50º, adução de 20º a 30º, rotação interna 35º e rotação externa 45º (CALLAGHAN; ROSENBERG; RUBASH, 2007). Os músculos dessa articulação apresentam uma configuração particular, cuja ação é totalmente dependente da posição do membro (ZAGHLOUL et al., 2018).

Os flexores primários do quadril são formados pelos músculos iliopsoas, reto femoral e sartório. O músculo glúteo máximo junto com os isquiotibiais atuam como extensores primários. A ação de rotação externa é realizada pelos músculos obturadores interno e externo, gêmeo superior e inferior, quadrado femoral e piriforme (CALLAGHAN; ROSENBERG; RUBASH, 2007). Os músculos, envolvidos na rotação interna do quadril, desempenham essa ação de maneira secundária, uma vez que apresentam outras funções primárias. Os maiores contribuintes são as fibras anteriores do músculo glúteo médio, glúteo mínimo e tensor da fáscia lata (FLACK; NICHOLSON; WOODLEY, 2012). Os músculos adutores do quadril incluem

o adutor curto, adutor longo, adutor magno, pectíneo e grácil. Já a abdução, é realizada predominantemente pelos glúteos médio e mínimo. O músculo tensor da fáscia lata contribui para a abdução apenas quando o quadril se encontra em flexão (CALLAGHAN; ROSENBERG; RUBASH, 2007).

O grupo dos músculos abdutores do quadril, formados pelo glúteo médio, glúteo mínimo e tensor da fáscia lata, desempenham um importante papel na estabilização da pelve durante a marcha (FLACK; NICHOLSON; WOODLEY, 2012). Mediante sua contração, ocorre a manutenção do nível do quadril contralateral no momento do apoio monopodálico. Os músculos glúteo médio e mínimo ainda contribuem para as rotações interna e externa da articulação coxofemoral (FLACK; NICHOLSON; WOODLEY, 2012). De acordo com Correa et al. (2010), os músculos abdutores, juntamente com o iliopsoas e os isquiotibiais, ainda colaboram para o contato normal de forças na articulação do quadril durante a caminhada. Distúrbios, nesse mecanismo intrínseco, podem gerar sobrecarga articular e, consequentemente, artrose (CORREA et al., 2010).

3.4.1 Músculo glúteo médio

Para o entendimento aprofundado sobre o papel desses músculos, bem como seu efeito sobre as disfunções articulares e musculares, é primordial o conhecimento de sua estrutura anatômica. O músculo glúteo médio pode ser subdividido em parte anterior, média e posterior, cuja função varia de acordo com o movimento do quadril (SODERBERG; DOSTAL, 1978). Enquanto as fibras anteriores são ativadas com o quadril em flexão e rotação interna, as fibras posteriores funcionam quando o quadril se encontra em extensão e rotação externa (CALLAGHAN; ROSENBERG; RUBASH, 2007). Flack, Nicholson e Woodley (2014) descreveram a morfologia dos abdutores em cadáveres, confirmando três pontos de origem do músculo glúteo (fossa glútea, aponeurose glútea e parte posteroinferior da crista ilíaca) e duas inserções distais do tendão, subdivididas em lateral e posterior. Os autores também determinaram que os fascículos do músculo glúteo mínimo se originavam na fossa glútea, inserindo-se na superfície profunda do tendão distal e na cápsula articular do quadril. O tensor da fáscia lata encontrava-se totalmente encapsulado pela fáscia

lata, não apresentando inserção óssea (Figura 3) (FLACK; NICHOLSON; WOODLEY, 2012).

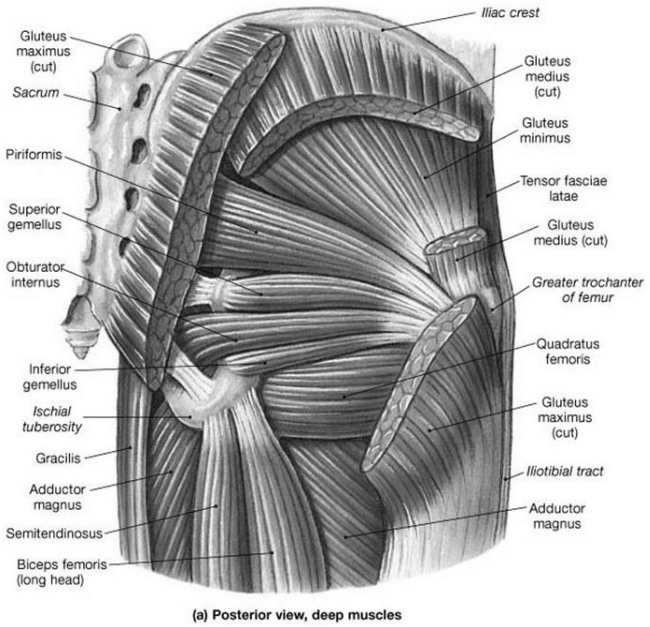

Figura 3. Ilustração com visão posterior de quadril direito. Evidencia-se musculatura abdutora. Adaptado de Brookbush Institute (2019).

Os grupos musculares do quadril contribuem com aproximadamente 95% da força de contato resultante durante a marcha normal (MADETI; RAO; RAO, 2014). O pico máximo da força de contato da articulação do quadril pode chegar a quatro vezes o peso corporal (MADETI; RAO; RAO, 2014), sendo maior quando há distúrbios de marcha (HELLER et al., 2005). Os músculos glúteo médio, glúteo máximo, isquiotibiais e iliopsoas são os principais contribuintes para a força de contato do quadril e impulso para início da marcha (MADETI; RAO; RAO, 2014). O músculo glúteo médio é considerado o principal músculo para os componentes superior e medial dessa força, exercendo um papel relevante como colaboradores no equilíbrio (CORREA et al., 2010). Essa atuação do músculo glúteo médio, como ator primário para o suporte do corpo em pé e também para a progressão da marcha, é confirmada por outros autores, os quais acrescentam que essa importante função muscular estabilizadora permanece constante durante todo o período de marcha (LIU et al., 2008).

3.4.1.1 Equilíbrio na marcha

Esse mecanismo compensatório do músculo glúteo médio é justificado por atuação conjunta na abdução do fêmur, durante a fase de apoio da marcha, realizando a contenção do efeito do momento abdutor criado pelo próprio peso corporal (Figura 4) (CORREA et al., 2010). A força requerida pela musculatura abdutora (*T*) para manter o quadril equilibrado durante o apoio pode ser calculada com a fórmula: *b/a×5W/6,* sendo *a* o momento abdutor, *b* a distância do centro de gravidade para o centro do quadril e *W* o peso corporal (FRANKEL; PUGH, 1984).

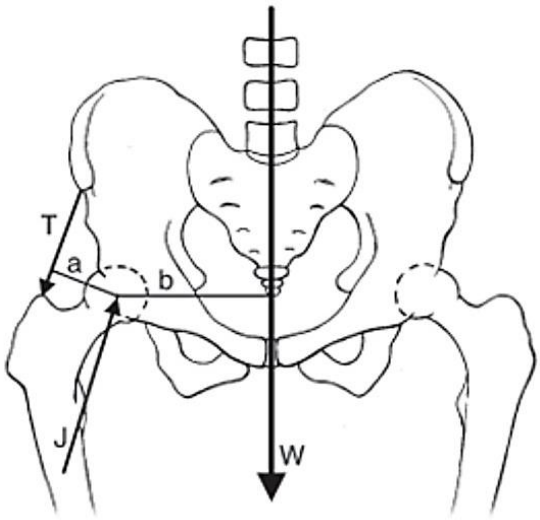

Figura 4. Representação esquemática das relações de força atuantes no quadril direito durante o apoio monopodálico. T = Tensão da força abdutora; a = Distância do centro de rotação à musculatura abdutora; b = Distância do centro de rotação à linha de ação de W; W = Peso corporal; J = Resultante da força na articulação. Fonte: Adaptado de Harrington (2005)

Tomando como base os padrões de um quadril dentro da normalidade, pode-se inferir que *T ~ 2.5W.* Ou seja, a força abdutora é, aproximadamente, 2.5 vezes o peso do indivíduo (FRANKEL; PUGH, 1984). Tal medida é comprovada com estudos *in vivo* (BYRNE; MULHALL; BAKER, 2010).

Portanto, a combinação de força dos abdutores deve ser um múltiplo do peso. Até que esse grupo muscular consiga compensar, gerando tal proporção de força, a marcha será normal e, consequentemente, a sobrecarga articular será neutralizada.

À medida em que ocorrer sobrecarga do peso ou fraqueza muscular, será desencadeada adaptação de descompensação do tronco para equilibrar a fraqueza abdutora, na tentativa de trazer o centro de gravidade do corpo para próximo do centro de rotação do quadril (Figura 5) (CALLAGHAN; ROSENBERG; RUBASH, 2007). Caso isso ocorra, é estabelecida, então, a insuficiência da musculatura glútea, na qual esses indivíduos apresentarão um padrão de marcha patológico, definido como marcha Trendelenburg, bem como redução da força de abdução, tendência à rotação externa e fraqueza para a rotação interna do membro inferior (CALLAGHAN; ROSENBERG; RUBASH, 2007; HARRASSER et al., 2016).

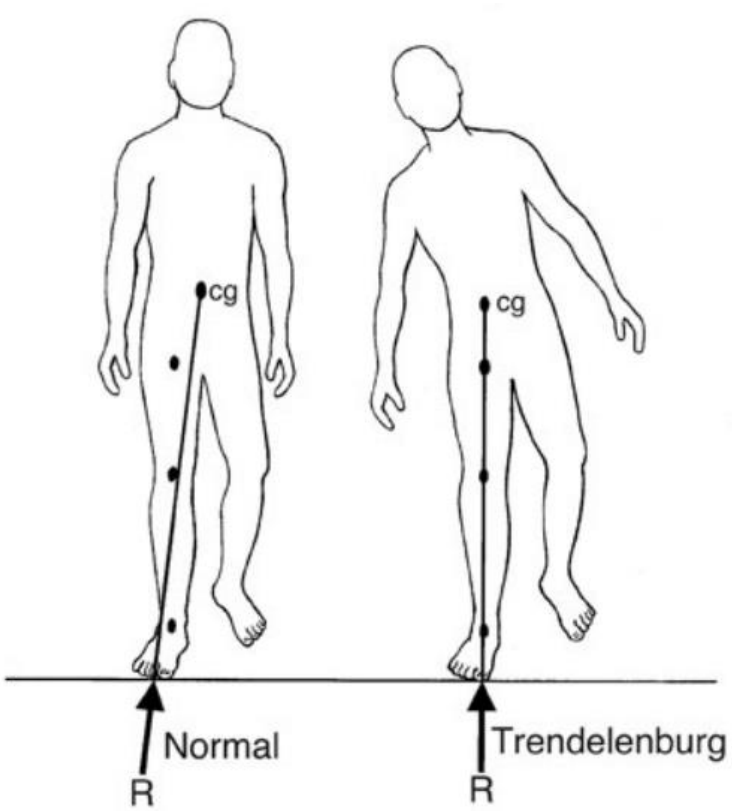

Figura 5. Representação do centro de gravidade durante a sustentação do peso do corpo na marcha normal (à esquerda) com musculatura glútea compensada. Durante a marcha Trendelemburg (à direita), ocorre o desvio lateral do corpo para alterar o centro de gravidade e possibilitar compensação da fraqueza muscular. Fonte: Adaptado de Harrington (2005)

3.4.1.2 Músculo glúteo médio e obesidade

Em estudo de análise de marcha, Lerner, Board e Browning (2014) referem que obesos apresentam maior força absoluta da musculatura glútea e correlacionaram esse aumento de força com o aumento do IMC. Porém, quando normalizaram a força da musculatura glútea pelo peso, não constataram diferença relevante entre os grupos obeso e com peso normal. Ainda, relataram que os indivíduos obesos requeriam maior força do músculo glúteo para uma marcha normal. Tal fato é relevante, uma vez que sugere que obesos necessitam de maior força nesse grupo muscular, tornando-se mais susceptíveis à fadiga (LERNER, BOARD e BROWNING; 2014). Com isso, espera-se que pessoas com excesso de peso apresentem maior força muscular para manter o equilíbrio de tronco adequado enquanto em pé ou durante a marcha.

Para Tallis et al. (2017), a obesidade parece resultar em músculos maiores e de menor qualidade, que possui a mesma força absoluta e potência do que os músculos menores dos indivíduos magros. A análise da ressonância nuclear magnética sugere que os músculos glúteos apresentam aumento de infiltrado de gordura com o aumento do IMC (PACICCO et al., 2019). Embora a obesidade aumente a massa magra a curto prazo, em indivíduos jovens, está claro que, com o passar do tempo, o infiltrado lipídico no músculo esquelético pode reduzir a incorporação de aminoácidos nas proteínas musculares, com diminuição da massa muscular total (MASGRAU et al. 2012; TALLIS et al., 2017). Possivelmente, o efeito da obesidade sobre o tecido muscular, a longo prazo, sobrepõe esse estímulo do peso sobre essa musculatura antigravitacional e culmina na perda muscular com o passar dos anos (SCHRAGER et al., 2007).

3.4.1.3 Insuficiência de musculatura glútea

A insuficiência pura da musculatura glútea, ocorrida após lesão típica com ruptura do tendão, apresenta-se clinicamente com padrão bem definido. Os indivíduos acometidos apresentam redução da força de abdução, Teste

Trendelenburg positivo e tendência à rotação externa do membro, bem como fraqueza na rotação interna (HARRASSER et al., 2016). Provavelmente, a sobrecarga de peso não compensada pelo fortalecimento muscular compensatório ou a fraqueza da musculatura abdutora são responsáveis por quadro clínico semelhante em obesos.

Diversos estudos já correlacionaram as alterações na função do glúteo a danos no sistema musculoesquelético. Cooper et al. (2016), em estudo observacional transversal, analisaram a força desse grupo muscular e diferenciaram indivíduos com e sem lombalgia. Os autores verificaram que o músculo glúteo médio é significativamente mais fraco na presença de dor lombar crônica, o que pode sugerir um papel importante na patogênese dessa doença (COOPER et al.; 2016). Ainda, Bewyer et al. (2009) observaram forte associação entre lombalgia durante a gestação e a debilidade do glúteo médio, sendo que a fraqueza muscular proporciona um aumento de seis a oito vezes na probabilidade de dor lombar gestacional.

A insuficiência abdutora também está presente em problemas na articulação do joelho. Em análise de indivíduos com artrose medial do joelho, Hinman et al. (2010) constataram associação significativa com a fraqueza da musculatura do quadril. Não foi possível estabelecer se a fraqueza precede a osteoartrose ou se ocorre como evolução da doença (HINMAN et al., 2010). Em análise de indivíduos com dor no joelho, Rowe et al. (2007) encontraram força muscular glútea estatisticamente menor na extremidade acometida pela dor no joelho em comparação com o membro normal. Também relacionado ao envolvimento do joelho, Bolgla et al. (2011) demonstraram que mulheres com síndrome dolorosa patelofemoral apresentaram diminuição de força na musculatura do quadril. Tais estudos sugerem atenção à reabilitação do quadril de indivíduos em tratamento de patologias do joelho.

Na articulação do quadril, Sims, Richardson e Brauer (2002) relataram aumento na magnitude de ativação do músculo glúteo em indivíduos com coxartrose, evidenciando disfunção muscular associada à doença, que pode influenciar a evolução natural da artrose e o seu tratamento conservador. Em revisão sistemática, Loureiro, Mills e Barrett (2013) também encontraram fortes evidências de diminuição na potência muscular em membro afetado por artrose de quadril quando comparado com o contralateral ou com indivíduos controle. As maiores reduções de força foram

dos músculos do quadril, flexores e extensores do joelho (LOUREIRO, MILLS e BARRETT; 2013).

Com base em estudos que relacionam o comprometimento da marcha e análise muscular, Inácio et al. (2014) estabeleceram que o risco de queda é afetado pela composição muscular. A musculatura glútea, acompanhada pela fraqueza na abdução do quadril, foi o principal ponto de diferenciação para a queda (INÁCIO et al.; 2014). Nesse sentido, a insuficiência de musculatura glútea deve ser considerada como um fator deletério para a marcha, resultando em sobrecarga ao sistema musculoesquelético e consequente redução para a qualidade de vida.

3.5 Aferição de força muscular

Contudo, aferir a força da musculatura do quadril pode representar uma tarefa difícil. São reportadas diversas limitações quanto à sua execução, especialmente, relacionadas ao acesso restrito a equipamentos de precisão, dificuldades em promover um bom posicionamento do paciente, variações do local de apoio para a colocação do aparelho, possibilidade de movimentação do examinado e inconstância na intensidade do estímulo verbal (BOHANNON, 1997). O teste muscular manual é o método mais utilizado para essa finalidade, uma vez que é fácil, de rápida execução, sem custo e não necessita de equipamentos (CUTHBERT e GOODHEART, 2007). Porém, como esse teste é subjetivo e descritivo, apresenta baixa confiabilidade e, frequentemente, superestima a força mensurada (STARK et al., 2011). O dinamômetro isocinético é considerado o melhor padrão para a avaliação da força e desempenho muscular porque é um método de referência para outros instrumentos que medem a força (STARK et al., 2011). O dinamômetro manual, por sua vez, mede a força de forma objetiva, precisa e sensível (JACKSON et al., 2016), sendo um método validado quando sua estabilização é feita com cinta (MARTINS et al., 2017).

Diante do exposto, postula-se que os músculos glúteos médios de obesos apresentem fraqueza relativa, podendo atuar como desencadeadores ou agravantes de muitas disfunções motoras em indivíduos obesos. Acredita-se que a associação de dois fatores inerentes à obesidade atua como os principais articuladores dessas

disfunções. O primeiro refere-se ao padrão de força e massa muscular, os quais são alterados pelo efeito nocivo da adiposidade sobre sua estrutura. O segundo, associado ao excesso de peso, que sobrecarrega o momento abdutor, deve ser neutralizado por uma força abdutora 2.5 vezes maior que o peso, fato muito improvável de ocorrer.

4. METODOLOGIA

4.1 Tipo de pesquisa

O presente estudo é de natureza observacional, com análise de fenômenos, sem realizar qualquer intervenção que possa influenciar o seu curso natural ou desfecho.

A forma de abordagem da pesquisa é quantitativa, uma vez que trabalhou com variáveis expressas sob a forma de dados numéricos, recursos e técnicas estatísticas para classificá-los e analisá-los. Para o planejamento de ações coletivas, as amostras utilizadas representaram com fidelidade a população de quem foram retiradas, na tentativa de gerar maior precisão e confiabilidade aos resultados alcançados. De acordo com a complexidade da apresentação e da análise dos dados, esta pesquisa pode ser subclassificada como analítica, pois realizou avaliação profunda das informações coletadas na tentativa de explicar o contexto de um fenômeno no âmbito de um grupo.

Quanto ao desenvolvimento no tempo, trata-se de uma pesquisa de aspecto epidemiológico transversal. O estudo da força do glúteo médio, ou seja, dos casos de uma nosologia em grupos diferentes, foi realizado em um determinado local e tempo, sendo estática e essencialmente transversal.

4.2 Campo de estudo

A pesquisa foi realizada no Serviço de Obesidade e Cirurgia Bariátrica do Hospital Universitário do Oeste do Paraná (HUOP), vinculado à UNIOESTE, situado no Município de Cascavel - PR. Os serviços desenvolvidos pelo HUOP são referência regional em alta complexidade em diversas áreas e disponibilizados para

uma população de aproximadamente 2 milhões de habitantes ambulatoriais (UNIOESTE, 2019).

Com equipe multidisciplinar, o atendimento ao paciente obeso conta com assistência de enfermeiro, farmacêutico, endocrinologista, assistente social, fisioterapeuta, cirurgião do aparelho digestivo, psicólogo, dentre outros (UNIOESTE, 2019). O atendimento ambulatorial iniciou em 2013, sendo que, em 2015, adotou-se a forma de atendimento em grupo. As reuniões acontecem uma vez por mês e, durante os encontros, são abordadas estratégias para promover a redução de peso e melhora da qualidade de vida mediante metas coletivas e individuais, troca de experiência, reeducação alimentar e mudança de estilo de vida. Os pacientes são todos oriundos de encaminhamento da 10ª Regional de Saúde, a qual abrange a região oeste do Paraná. Após período de acompanhamento clínico, pode ocorrer a indicação de cirurgia bariátrica ou manutenção do acompanhamento ambulatorial (UNIOESTE, 2019).

Os indivíduos eutróficos foram avaliados no HUOP e no Centro de Reabilitação Física (CRF) da UNIOESTE, Cascavel - PR. O CRF é um órgão prestador de serviços de reabilitação, destinado ao tratamento de pessoas com deficiência física, o qual está vinculado ao Curso de Fisioterapia da UNIOESTE. Sua equipe de trabalho é formada por assistente social, enfermeiro, fisioterapeuta, fonoaudiólogo, ortopedista, psicólogo e terapeuta ocupacional (UNIOESTE, 2018). Os indivíduos eutróficos, avaliados nesses dois locais, eram funcionários das instituições, acompanhantes ou pacientes, que apresentavam os critérios de inclusão e não se enquadravam nos critérios de exclusão, descritos a seguir.

4.3 População e amostra

Para atingir o objetivo proposto, foram avaliados clinicamente e por meio de testes quantitativos a força da musculatura glútea da população obesa em comparação com a população normal. A caracterização da população obesa considerou o grau de obesidade para uma melhor predição de positividade das análises. Baseou-se, como objeto de estudo, na obesidade grau II e III, composta por indivíduos que apresentaram IMC superior a 35 kg/m^2. Para efeito de

comparação com a normalidade, constituiu-se uma população eutrófica, controle, com indivíduos de IMC abaixo de 24,9 kg/m^2.

Para o cálculo do *n* amostral, assumiu-se um tamanho de efeito grande (0,8), em função da homogeneização do grupo de pacientes do Serviço de Obesidade e Cirurgia Bariátrica do HUOP, bem como um erro tipo I, equivalente a 0,05, e um poder de análise em família de testes de distribuição t-Student equivalente a 0,80. A partir desses parâmetros, foi definido um *n* total igual a 54.

A amostragem foi feita por conveniência, após o aceite do termo de consentimento livre e esclarecido. Dois grupos foram formados para o desenvolvimento desta pesquisa. O primeiro, composto por 27 indivíduos obesos em início de acompanhamento ambulatorial no Serviço Obesidade e Cirurgia Bariátrica do HUOP, Cascavel-PR. Esse grupo amostral inclui indivíduos de ambos os sexos, entre 20 e 60 anos, cuja obesidade possui IMC acima de 35 kg/m^2.

O segundo grupo amostral, considerado como grupo controle ou eutrófico, foi formado por 54 indivíduos eutróficos, para que fosse possível o pareamento de sexo, idade e altura. Esses indivíduos foram convidados aleatoriamente a participar do estudo nas estruturas do CRF e do HUOP e apresentavam IMC abaixo de 25 kg/m^2.

4.4 Critérios de exclusão

Todos os sujeitos elegíveis para a pesquisa foram avaliados para critérios de exclusão por meio de história clínica e exame físico direcionado. Foram excluídos os indivíduos que apresentassem gestação, doença ortopédica dos membros inferiores, dor ou sequela no aparelho locomotor, parestesia ou fraqueza em membros inferiores, dor ortostática ou ao caminhar, doença cardíaca ou outra doença com restrição da capacidade funcional.

O exame físico de triagem incluiu avaliação de distúrbio sensitivo, elevação passiva da perna e avaliação de dor articular em quadril, após manobra de flexão e rotação interna, e de joelho, após flexão e extensão.

Indivíduos que apresentaram qualquer alteração com sinais sugestivos de patologia relacionada a comprometimento do aparelho locomotor foram excluídos.

4.5 IMC

Foi realizada mensuração do peso, em quilogramas, e altura, em metros, bem como calculado o IMC, com base na fórmula de Quetelet (EKNOYAN, 2008), o que foi obtido dividindo-se o peso (quilogramas) do indivíduo pela sua altura (metros) elevada ao quadrado.

4.6 Teste muscular de força com dinamômetro

Para a aferição da força muscular, utilizou-se uma maca, coxim abdutor, dinamômetro digital (MICROFET2, Draper, USA) e cinta inelástica de velcro (Figura 6).

Figura 6. Material utilizado para a coleta de força muscular: maca, coxim, dinamômetro digital e cinta inelástica de velcro

O dinamômetro digital manual utilizado apresenta certificado de calibração para erro máximo de 1%, atestado em 27/03/2018 (Anexo 01). As medidas foram registradas em Newtons e tomadas no visor do aparelho (Figura 7).

Figura 7. Visor do aparelho dinamômetro digital microFET2, com medida de duração de força em segundos e de pico de maior força em quilogramas força

Na tentativa de buscar os maiores componentes de força para o músculo glúteo médio, utilizou-se a adaptação da técnica, descrita por Hislop e Montgomery (MIOR, 1985). A adaptação relaciona-se ao local de posicionamento do dinamômetro, localizado a 5 cm proximal à interlinha articular do joelho dos examinados, como proposto por Ireland et al. (2003).

O dinamômetro foi preso à maca com o uso de uma tira inelástica e não se realizou força contra a resistência por parte do examinador. Foi solicitada a aplicação de força máxima contra o aparelho, por meio de estímulo verbal durante 5 segundos. O valor da força era anotado em formulário impresso (Apêndice 01). O dinamômetro era, então, zerado e, após 30 segundos de intervalo para repouso, ocorria nova solicitação de força, até a coleta de 3 medidas. Apenas o maior valor, após as três repetições, foi considerado como válido para o estudo. Após a análise

do músculo glúteo médio direito, os indivíduos eram reposicionados para a análise do lado esquerdo.

4.6.1 Teste de força do músculo glúteo médio

Para analisar a força do músculo glúteo médio, o examinado permaneceu em decúbito lateral, porém, com o quadril em extensão. A pelve foi sustentada em leve inclinação anterior. Entre o joelho e a maca, foi acondicionado um coxim, para que não houvesse adução do membro. O dinamômetro foi posicionado a 5 cm proximal à linha articular do joelho, sendo fixado por uma tira inelástica à maca (Figuras 8 e 9).

Figura 8. Visão posterior do posicionamento para aferição de força do músculo glúteo médio. Indivíduo posicionado em decúbito lateral, coxim entre o joelho e a maca para adução e quadril em extensão. Quadril contralateral mantido em ligeira flexão. Dinamômetro fixado com tira ao redor da maca, posicionado a 5 cm proximal a articulação do joelho, na face lateral da coxa.

Figura 9. Visão superior do posicionamento para aferição de força do músculo glúteo médio. Visualização da flexão do quadril contralateral e extensão do quadril examinado.

Após posicionado o paciente e o aparelho, foi solicitada aplicação de força máxima contra o aparelho, com estímulo verbal de 5 segundos, além de repouso de 30 segundos entre os estímulos, até a coleta de 3 medidas (Anexo 02).

4.7 Análise dos dados

Os dados obtidos foram tabulados no programa Microsoft Excel 2013® a partir do preenchimento de formulário específico da entrevista e do exame físico (Apêndice 01). As variáveis analisadas foram: idade, sexo, peso, altura, IMC, gestação, doença ortopédica dos membros inferiores, dor ou sequela no aparelho locomotor, parestesia ou fraqueza em membros inferiores, dor ortostática ou ao caminhar, doença cardíaca ou outra doença com restrição da capacidade funcional, distúrbio sensitivo, Manobra de Lasegue, manobra de flexão e rotação interna, flexo-

extensão de joelho e as três medidas da força muscular com dinamômetro dos músculos glúteo médio direito e esquerdo.

Para averiguar a confiabilidade de medidas do avaliador, foi realizado o cálculo do coeficiente de correlação intraclasse (ICC). De forma aleatória, foram avaliados seis indivíduos, em um teste piloto, para a análise de força muscular com dinamômetro dos músculos glúteos médios.

Após a avaliação da confiabilidade das medidas, 95 pessoas foram analisadas, das quais 35 obesas e 60 eutróficas. Dessas, 8 indivíduos, pertencentes ao grupo obeso, e 3, aos eutróficos, não se enquadraram nos critérios de seleção para a pesquisa. Pela dificuldade de pareamento, devido à baixa estatura de dois indivíduos obesos, eles foram excluídos (Figura 10).

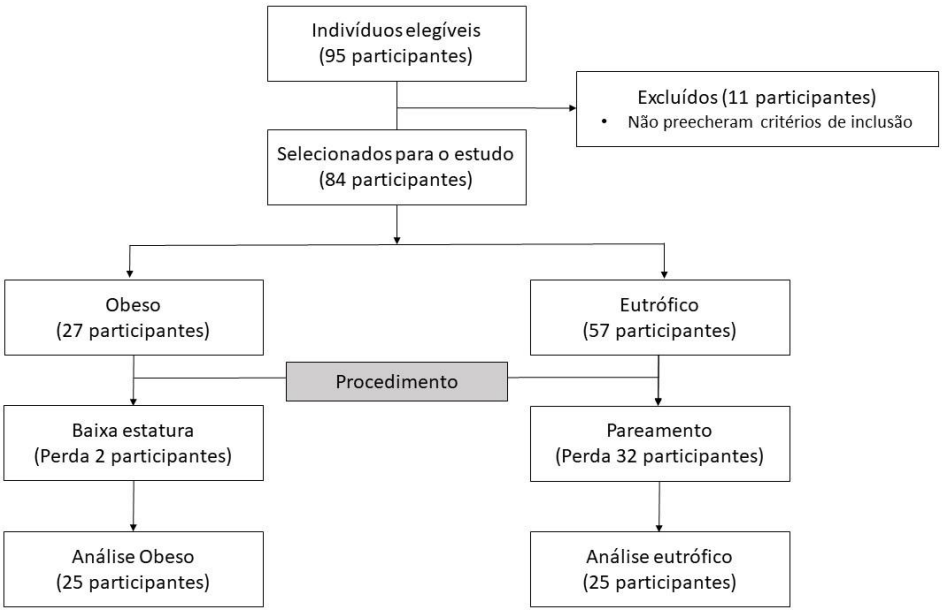

Figura 10. Fluxograma detalhado da composição dos componentes amostrais do estudo

Após tabulação, os dados foram analisados por meio de estatística descritiva e inferencial. Em relação às variáveis quantitativas, foi realizado o cálculo da diferença entre os pares, além de avaliado o padrão de distribuição dos dados por meio do teste de Shapiro-Wilk. Uma vez que todas as variáveis se encontravam em normalidade, a comparação entre os pares foi realizada por meio do teste t para amostras pareadas.

Em seguida, as matrizes das variáveis foram estandardizadas e analisadas por meio de componentes principais (PCA). Na análise de componentes principais,

são determinadas as cargas fatoriais, as quais são definidas como as correlações de cada variável com a composição do fator, sendo o fator uma nova variável descrita pelo conjunto das cargas fatoriais. As cargas fatoriais resultantes dos componentes principais foram avaliadas quanto à sua significância por meio do teste t para amostras independentes. Em todos os testes estatísticos, o nível de significância utilizado foi de 0.05, sendo realizados com o programa computacional R (R Core Team, 2018).

4.8 Aspectos éticos

A presente pesquisa foi submetida e aprovada pelo Comitê de Ética em Pesquisa da UNIOESTE e desenvolvida conforme preconiza a Resolução n. 466/12 do Conselho Nacional de Saúde para Pesquisa em Seres Humanos. Este estudo é recorte de um projeto maior, intitulado “Assistência interdisciplinar ao indivíduo com obesidade da região do oeste do Paraná no Hospital Universitário do Oeste do Paraná/HUOP”, aprovado em julho de 2015 pelo Comitê de Ética em Pesquisa em Seres Humanos da UNIOESTE, sob o número de parecer 1.180.202 (Anexo 03).

O Termo de Consentimento Livre e Esclarecido foi assinado de forma livre e voluntária, sendo assegurado, por princípios éticos, o sigilo acerca das informações obtidas (Apêndice 02).

4.9 Forma de apresentação dos resultados

Os resultados serão apresentados no formato de artigo, submetido ao periódico BMC Musculoskeletal Disorders, cujas normas estão disponíveis em: https://bmcmusculoskeletdisord.biomedcentral.com/submission-guidelines/preparing-your-manuscript/research-article.

ARTIGO CIENTÍFICO 1

Comparison of the gluteus medius strength between obese and eutrophic individuals: a cross-sectional study

Comparison of gluteus medius strength between obese and normal-weight individuals: a cross-sectional study

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Abstract

Background: The hip abductor muscles, primarily the gluteus medius, play an important role in stabilizing the pelvis during gait. Gluteus medius weakness is associated with biomechanical changes and musculoskeletal disorders. Obese individuals can have great difficulty maintaining abductor muscular function due to being overweight and possibly experiencing a decrease in muscle mass. However, it is still unclear whether the musculature of obese individuals can compensate for these changes. Therefore, the aim of this study was to compare gluteus medius strength between obese and normal-weight individuals using a digital hand-held dynamometer.

Methods: Twenty-five obese (BMI > 35 kg/m^2) participants were matched for sex, age, and height with normal-weight individuals. Gluteus medius strength was measured by a single examiner using a belt-stabilized hand-held digital dynamometer placed on the knee of the individuals positioned in lateral decubitus. Three measurements were recorded with rest intervals, and only the highest value measured for each limb was used for analysis. The differences between pairs were calculated, and the normality of the data was assessed using the Shapiro-Wilk test ($p < 0.05$). The matrices of the variables were standardized and analysed using principal component analysis (PCA).

Results: For the strength variables (Newtons) on both sides, no significant differences were detected between the groups ($p > 0.05$). However, significant differences were detected in these variables between the groups ($p < 0.05$) when the measurements were normalized to body weight (Newtons/kilograms). PCA indicated

that both the absolute and normalized values of strength are lower in obese than in normal-weight individuals.

Conclusions: These findings suggest that obese individuals could have the same or less strength (PCA) to move more mass, which may imply a relative weakness that induces functional limitations.

Trial registration: The study was approved by the UNIOESTE Human Research Ethics Committee (#1.180.202) in July 2015.

Keywords: Obesity, Hip, Muscle weakness

Background

Hip abductor muscles play an important role in stabilizing the pelvis during gait, which allows the body to effectively maintain balance and lower limb mobility [1]. This group of muscles includes the gluteus medius, gluteus minimus, and tensor fasciae latae, but the gluteus medius is the main hip abductor muscle [2,3].

The magnitude of force required by the hip abductors to stabilize the pelvis is approximately 2.5 times the individual's body weight [4], as confirmed by *in vivo* studies [5]. Thus, the strength of the abductor muscles together must be higher than the individual's body weight. When there is enough strength to support the individual's body weight, his or her gait pattern is normal, and the joints work properly. If weight overload or muscle weakness occurs, an adaptation of the upper body will be triggered in an attempt to bring the centre of gravity closer to the centre of hip rotation.

Maintaining the strength of the gluteal musculature can be very challenging for obese individuals. When a three-dimensional gait analysis of obese individuals was

performed, larger hip adduction, associated with marked ankle eversion, was observed during the terminal stance and pre-balance phases [6]. These findings are similar to those found in individuals with missing gluteal musculature, which leads to a pathological gait pattern, defined as Trendelenburg gait [7], as well as reduced abduction strength, an external rotation tendency, and internal rotation weakness of the lower limbs [8]. There is clearly an imbalance, which has a negative influence on gait parameters [9]. These changes lead to anteroposterior and mediolateral instability of the upper body and thus functional limitations and a predisposition to injuries [10-12].

Both overweight and obese people still suffer from the metabolic effects of adipose tissue on the muscular system. A decrease in anabolic hormones, such as growth hormones [13], and an increase in proinflammatory cytokines alter muscle metabolism. Both factors affect the amino acid balance, neuromuscular activation, and signalling pathways in the caspase cascade [13-16]. Finally, a decrease in muscle mass establishes a condition called sarcopenic obesity [13], in which the inflammatory cytokines produced by visceral fat are able to alter muscle metabolism and trigger a vicious cycle involving degeneration and a reduction in skeletal muscle quality [17-19].

It is very important to assess gluteus medius strength in obese individuals in clinical practice. Weakness in this muscle is associated with not only biomechanical changes but also musculoskeletal system disorders, such as hip arthrosis, lower back pain, knee arthrosis, and patellofemoral syndrome [20-26].

We conducted this study to compare the strength of the main gait-stabilizing muscle of obese and normal-weight individuals. The aims of this study were to measure the strength of abductor muscles, especially the gluteus medius, using a

digital hand-held dynamometer and to compare two groups of matched individuals: obese and normal-weight individuals.

Methods

The present study is observational, quantitative, analytical, and cross-sectional. The UNIOESTE Human Research Ethics Committee (#1.180.202) approved it in July 2015. The patients provided written formal consent in accordance with the rules of the ethics committee.

Obese individuals who were beginning ambulatory follow-ups at the Obesity and Bariatric Surgery Service in the Western Paraná University Hospital (Cascavel, Paraná, Brazil) were included in the study. These individuals were of both sexes, were aged 20 to 60 years old, had grade II and III obesity, and had a body mass index (BMI) higher than 35 kg/m^2 [27,28]. The exclusion criteria were pregnancy, an orthopaedic disease of the lower limbs, locomotor system pain or sequelae, paresthesia or weakness in the lower limbs, orthostatic or walking pain, heart disease, or other diseases with restricted functional capacity.

For comparison, a group of normal-weight individuals (control group) was recruited, with a BMI below 24.9 kg/m^2, a value considered normal. They were matched with the obese individuals by sex, age and height.

For the calculation of the sample size, a large effect size (0.8) was assumed due to the homogeneity of the group of patients from the Obesity and Bariatric Surgery Service of HUOP, and a type I error equivalent to 0.05 and a power of analysis with Student's t-test of 0.80 were used. Based on these parameters, a total sample size of 54 was needed.

A single examiner evaluated the participants in an attempt to prevent analysis bias between observers from affecting the results. Weight (kilograms, kg) and height (meters, m) were measured.

All subjects eligible for the research were evaluated according to the exclusion criteria by assessing their clinical history and targeted physical examination findings. Individuals with pregnancy, an orthopaedic disease of the lower limbs, pain or sequelae in the locomotor system, self-reported paresthesia or weakness in the lower limbs, orthostatic or walking pain, heart disease or other diseases with restricted functional capacity were excluded.

The physical screening examination included an assessment of sensory disturbances, passive leg elevation and an assessment of hip joint pain after hip flexion and internal rotation and knee flexion and extension. Individuals who exhibited any signs suggestive of a pathology related to the impairment of the locomotor system were excluded.

Gluteus medius strength was measured using a hand-held digital dynamometer (MICROFET2, Draper, USA), which has been shown to have high reliability in test-retest studies [29]. The device was positioned 5 cm proximal to the knee joint line, a technique adapted from the reports of Hislop and Montgomery [30-32]. The participant was positioned on a stretcher in lateral decubitus with a knee pad to avoid adduction, with slightly extended hips and anterior inclination of the pelvis, so that the strength components predominantly related to the gluteus medius could be measured (Fig. 1). The upper limbs remained relaxed to prevent them from affecting the strength test. The dynamometer was attached to the stretcher by using a rigid band, eliminating the need for the examiner to apply a resistance force. The participants were verbally asked to exert a maximum force against the device for 5

seconds, and after a 30-second rest interval, a new trial was performed. Three measurements were made, and only the highest value measured was used for analysis. After the analysis, the participant was repositioned for the measurement of the contralateral gluteus medius. The right side was always tested first.

Statistical analysis

The intraclass correlation coefficient (ICC) was calculated to assess the reproducibility of the evaluator's measurements. A pilot study was performed to evaluate the strength of both the right (RGM) and left (LGM) gluteus medius muscles of six selected individuals. Homogeneity of the measures was observed, with ICC values for the right and left sides equivalent to 0.9675 and 0.9288, respectively.

The data were tabulated in the Microsoft Excel 2013® program. Pairing was performed between groups by similarity in the variables sex, age, and height. The differences between pairs were calculated, and the normality of the data was assessed using the Shapiro-Wilk test. The comparisons between pairs were performed using the paired-samples t-test since all the variables were normally distributed. The statistical tests were performed using the R Core Team program (R Core Team, 2018) with a significance level of 0.05.

Then, matrices of the variables were standardized and analysed using principal component analysis (PCA). With PCA, the factor loads are defined as the correlations of each variable with the factor composition, where the factor is a new variable defined by the set of factor loads. This analysis did not consider the pairings but rather the subdivision of two large groups in an attempt to differentiate them. The factorial loads resulting from the main components were evaluated in terms of statistical significance using the independent-samples t-test.

Results

After the reliability of the measurements was assessed, 95 individuals were examined: 35 obese and 60 normal-weight individuals. Of these, 8 individuals from the obese group and 3 individuals from the control group did not meet the selection criteria and were excluded. Two obese individuals were also excluded due to their short stature, which made it difficult to correlate their findings with the normal-weight individuals. Ultimately, 25 control-obese pairs were formed, matched by gender and similarity in age and height. A total of 32 normal-weight participants were excluded because they could not be paired (Fig. 2).

Fifty individuals, including 4 (8%) males and 46 (92%) females, were included in the analysis, number that do not reach the recommended sample size because of the pairing (Additional supporting files). The variables of sex, age, and height were considered statistically equivalent between the obese and control groups ($p > 0.05$). The weight and BMI variables showed statistically significant differences between pairs ($p < 0.0001$; Table 1).

Table 1. Descriptive data of the pairs regarding age, height, weight, and BMI. P-value corresponding to the paired-samples t-test.

Variable	Group	Minimum	Maximum	Mean	Standard deviation	P-value
Age	Obese	20.000	60.000	43.600	9.785	0.407
	Control	23.000	57.000	42.880	10.647	
Height	Obese	1.500	1.930	1.600	0.091	0.729
	Control	1.480	1.900	1.599	0.090	
Weight	Obese	89.000	165.000	114.600	19.111	<0.0001*
	Control	45.000	80.000	58.068	8.825	
BMI	Obese	36.616	56.008	44.604	5.126	<0.0001*
	Control	17.360	24.948	22.629	2.032	

For the strength (N) of the RGM and LGM, no significant differences were detected between groups ($p > 0.05$). However, when the measurements were normalized to the body weight (N/kg), significant differences were detected in these to variables between groups ($p < 0.05$) (Table 2, Fig. 3).

Table 2. Descriptive results for the absolute strength and strength normalized to body weight of the RGM and LGM. P-value corresponding to the paired-samples t-test.

		Control	Obese	P-value
Strength (N)	RGM	292.0 ± 94.5	256.2 ± 104.2	0.149
	LGM	290.7 ± 76.6	261.1 ± 118.0	0.231
Strength / Weight	RGM	51.5 ± 15.6	22.7 ± 8.0	<0.0001
(N / Kg)	LGM	51.8 ± 15.0	23.1 ± 9.1	<0.0001

Considering only the values normalized by weight among the individuals included in the analysis, the multivariate assessment verified the separation of the two groups: the control and obese groups. In this study, pairing was not considered, only the division of two samples in relation to the force variable was considered to differentiate them. The first main component was defined as the variation in the strength of the RGM and LGM normalized to body weight (in N/kg) (eigenvalue = 3.03; variability =75.67%) and was directly related to the separation of the two groups analysed. The second main component was defined by the absolute muscle forces of the RGM and LGM (in N), which were also directly related (eigenvalue = 0.72; variability = 18.04%; Fig. 4).

The factor loads of the main component 1, which represents the variation in muscle forces in N/kg, showed significant differences between pairs ($t = 5.14$; $p < 0.0001$; Fig. 5a), indicating that the strength values normalized to weight (in N/kg) of the RGM and LGM were higher in the normal-weight individuals. The factor loads of main component 2 also showed significant differences between groups ($t = -8.63$; $p < 0.0001$), indicating that the strength values of the RGM and LGM in N tend to be reduced in obese individuals (Fig. 5b).

Discussion

Measuring the strength of hip muscles can be a difficult task. Several limitations have been reported regarding this task, including limited access to accurate equipment, difficulties in positioning the patient properly, variations in the support area on which the device is placed, the possibility of patient movement, and inconsistency in the verbal stimulus intensity [29]. Manual muscle testing is the most commonly used method for this purpose since it is easy and quick to perform, is free

of charge, and does not require equipment [34]. Nevertheless, this test is subjective and descriptive, so it leads to low reliability and frequently overestimates the actual strength. The isokinetic dynamometer is the gold standard device for assessing muscle strength, with an exact and secure evaluation toll [35]. Because of the cost of an isokinetic testing device and difficulties in routine clinical testing, there is evidence that supports the clinical use of the hand-held dynamometer in routine medical examinations [36]. This device measures strength in an objective, precise and sensitive way [37]. However, the hand-held dynamometer is not without limitations, especially because this method is dependent on external adjustments to improve result validity and reliability [38]. It is a valid method when stabilized by a belt, and although these devices do not yield the same measures as isokinetic dynamometers, the values for hip muscle groups are correlated [39]. Thus, we chose to use a digital dynamometer stabilized by a brace to measure of the strength of the gluteus medius muscle.

The determination of the force required by the abductor muscles to balance the body in a standing position depends on two variables: pelvic anatomy and body weight [27]. In the present study, since individuals were paired in relation to sex, age, and height, it is assumed that there was a similarity in the pelvic anatomy between the pairs. Since the examination was performed by a single examiner, variability in the measurements due to differences in the technique used were not observed. Weight was the only relevant variable that could interfere with the strength data.

In the present study, obese individuals did not present a statistically significant difference in gluteus medius strength compared to nonobese individuals ($p > 0.05$). The absolute strength values were 292.0 N for the RGM and 290.7 N for the LGM in

the control group. In the obese group, the values were 256.2 N and 261.1 N, respectively.

In a literature review, Benfica et al. [28] reported the hip abductor muscle strength values in individuals aged between 50 and 59 years old to be 208.12 N for the dominant limb and 203.27 N for the nondominant limb in women and 305.97 N for the dominant limb and 298.49 N for non-dominant limbs in men. In the present study, this variation in the measurements can be explained by the age differences among the individuals included in the analysis, differences in sex, and differences related to the measurement technique.

The age range of the participants (from 20 to 60 years old) was chosen since it corresponds to an economically active group in whom movement disorders can greatly impact function and work. Additionally, people over 60 years of age may have reduced muscle mass and function [40].

It is worth noting that the study population in the present study consisted predominantly of women (92%) for reasons of convenience and that abductor muscle strength varies between sexes. Women have lower abductor muscle strength, which corresponds to a higher risk of developing musculoskeletal pathologies [41].

In contrast to these findings in our study, some authors suggest that the antigravity muscles of obese individuals generate higher absolute forces [42-45]. Increased muscle strength is described as a beneficial adaptation to obesity, with excess body weight acting as a chronic training stimulus for daily activities [45].

Several studies have reported increased knee extension strength in obese individuals, with values varying from 10 to 30% higher than those of normal-weight individuals [46]. However, gait analyses in obese individuals have shown a shorter stride length with a strategy involving quadriceps overloading and decreased

hamstring activation [6,47]. Due to gait changes, obesity can cause mechanical adaptations that favour the use of the strongest muscles and minimize the use of the weakest ones.

Regarding the gluteus medius, Lerner et al. [11] reported that obese individuals have higher absolute strength during gait and correlated this change with an increased BMI, reflecting the same theory of overload adaptation. These data were not confirmed by the gluteus medius strength analysis performed in the present study since there was no difference in the isometric strength values between the groups tested ($p > 0.05$). An analysis using nuclear magnetic resonance suggested that the gluteal musculature presents an increase in fat infiltrate as the BMI increases [48]. Although obesity increases muscle mass in the short term in young individuals, lipid infiltration in skeletal muscle can reduce the incorporation of amino acids into muscle proteins over time, with a decrease in total muscle mass [17]. It is possible that the long-term effect of obesity on muscle tissue overlaps with this weight stimulus on antigravity muscles and culminates in muscle loss over time [15]. This possibility may justify the findings of our study.

When the gluteus medius strength values were normalized to body weight, there was a significant difference ($p < 0.05$) between groups, which indicates that obese individuals have relative gluteus medius weakness compared to normal-weight individuals. Obesity results in larger and lower quality muscles, which have the same absolute strength and power as smaller muscles in thin individuals [49]. However, obese individuals generally struggle to move their body mass. A lack of strength can culminate in functional adaptations and imbalance, predisposing these individuals to injuries [10,50].

Although some studies have suggested that obese individuals have higher absolute strength, they have less relative strength in some muscles, such as the quadriceps [51,52]. Lafortuna et al. [53] also corroborated these data when they evaluated lower limb muscle strength through a leg-press exercise. Compared with normal-weight individuals, the obese individuals were stronger, but when the values were normalized by muscle mass, this difference disappeared.

When Lerner et al. [11] normalized the strength of the gluteal muscles by weight, there was no relevant difference between the obese and normal-weight groups. Regarding muscle mass, the authors also reported that obese individuals required greater gluteal muscle strength for normal gait. This evidence is relevant since it suggests that obese individuals need stronger gluteal muscles, causing them to be more susceptible to fatigue. Thus, it was expected that overweight individuals have higher muscle strength to maintain balance while standing or walking. This fact was not proven by the results in the present study. When strength was normalized to body weight, the obese individuals had relative weakness in the gluteus medius muscle ($p < 0.05$). It can be concluded that strength alone does not seem to be an adequate parameter for assessing the abductor musculature since more than half of the world's population is overweight and these strength values can be overestimated [54,55].

The gluteal strength of obese individuals is a relevant factor since these two variables, obesity and weakness, are independently associated with musculoskeletal system changes [20-26,56]. Moreover, according to new scientific evidence, muscle strength is inversely and independently associated with all-cause mortality [57]. Some authors even recommend the use of an algorithm to remove the dependence on body size and to more appropriately compare the strength of the hip muscles

across individuals since it cannot be concluded that the force is directly proportional to body weight [58,59].

When the statistical analysis of the factor loads was performed, it was possible to differentiate the two distinct groups for all gluteus medius force variables, regardless of whether they were normalized to body weight. This finding indicates that both the absolute strength values and those related to weight were different, constituting two distinct groups: the obese group and the normal-weight or control group.

The present study has some limitations. First, despite the sample size being close to the recommended value in the sample calculation, we consider that it would be necessary to increase the number of subjects to reduce the effect size of the analysis. Therefore, additional studies are needed to confirm and increase the generalizability of the results found. Second, the study population was predominantly composed of women (92%). Although this limitation did not interfere with the conclusions since the individuals were paired between groups, it would be interesting to increase the number of men since this sex are stronger than women. Activity level between groups should have been another variable and was not reported in this study. Additional studies are needed to prove whether there are morphological and functional changes in obese gluteal muscles that may justify gait imbalances and associations with musculoskeletal disorders.

Conclusions

The findings of the present study suggest that although obese individuals have the same absolute strength of the gluteus medius muscle as eutrophic individuals, when

the strength is normalized as a function of body weight, it is possible to state that obese individuals have such a weaker gluteus medius muscle. Since obesity is an epidemic, as the majority of the world's population is overweight, it is recommended that individuals strengthen the gluteal muscles in relation to their weight, especially since obesity and weakness are independently associated with musculoskeletal system changes.

List of abbreviations

BMI - body mass index

cm – centimetres

ICC – intraclass correlation coefficient

kg - kilograms

LGM - left gluteus medius muscle

m - metres

N - Newtons

N/kg – Newtons per kilogram

PCA - principal component analysis

RGM - right gluteus medius muscle

UNIOESTE – Universidade Estadual do Oeste do Paraná

USA – United States of America

Declarations

Ethics approval and consent to participate

The UNIOESTE (Universidade Estadual do Oeste do Paraná) Human Research Ethics Committee approved the researche in July 2015 by the number 1.180.202.

A written informed consent for publication of the images was obtained.

Consent for publication

All individuals participating in this research signed an informed consent form prior to their inclusion in the study.

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

There were no sources of funding for the reported research.

Authors' contributions

RRF – performed the examination of the individuals and was a major contributor in writing the manuscript.

ACFA – conducted the research and guided the data collection.

ATBG – analyzed and interpreted the individuals data.

All authors read and approved the final manuscript.

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Figures

Fig. 1a

Fig. 1b

Fig. 1. a) Posterior and b) superior view of the position used to measure gluteus medius strength.

Fig. 2

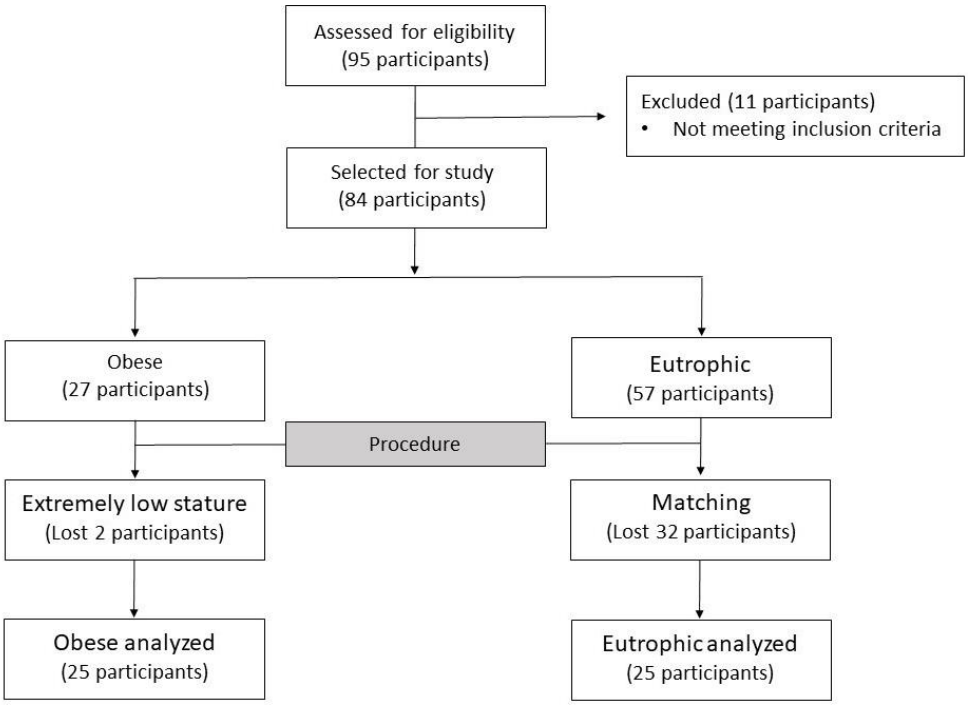

Fig. 2. Diagrams showing a schematic summary of the participants recruited for this study.

Fig. 3

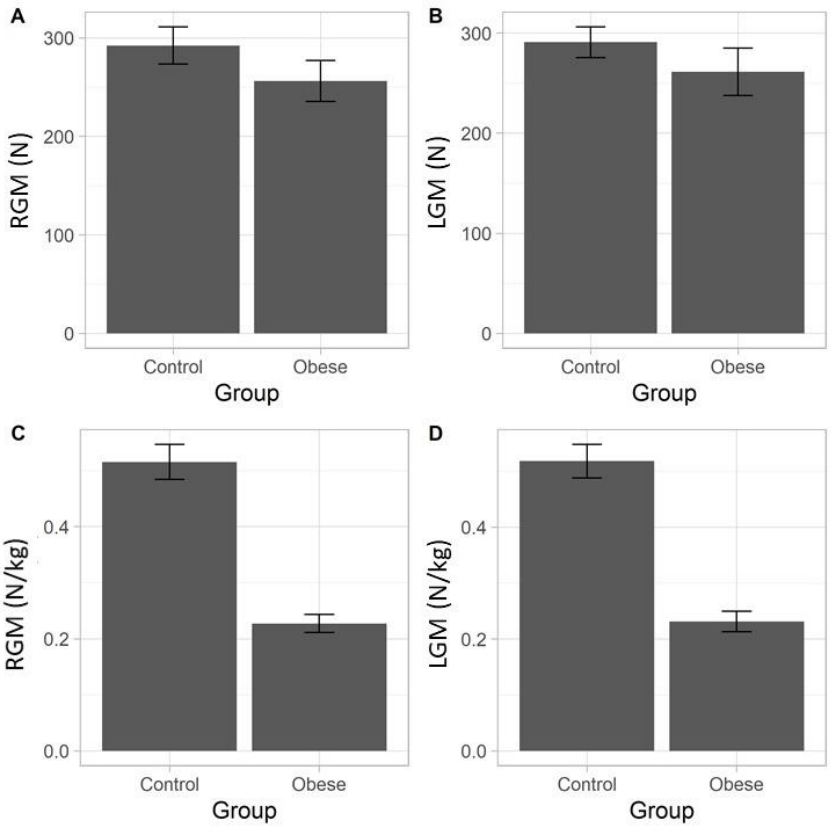

Fig. 3. Comparative graphs showing the difference between the RGM and LGM. Legends: a) RGM in N; b) LGM in N; c) RGM in N/kg; d) LGM in N/kg.

Fig. 4

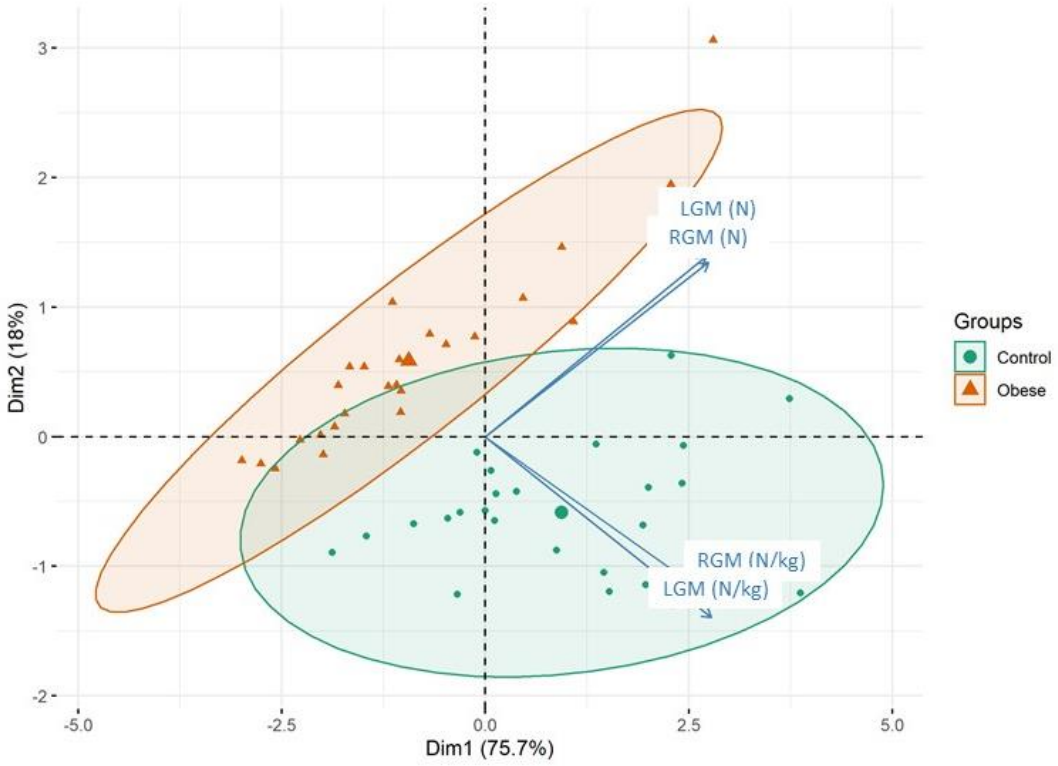

Fig. 4. Ordering diagram of the principal components. Legends: RGM – right gluteus medius strength in N/kg; LGM – left gluteus medius strength in N/kg; RGM N – right gluteus medius strength in N; LGM N – left gluteus medius strength in N. Control (green ellipse) and obese (orange ellipse) groups.

Fig. 5

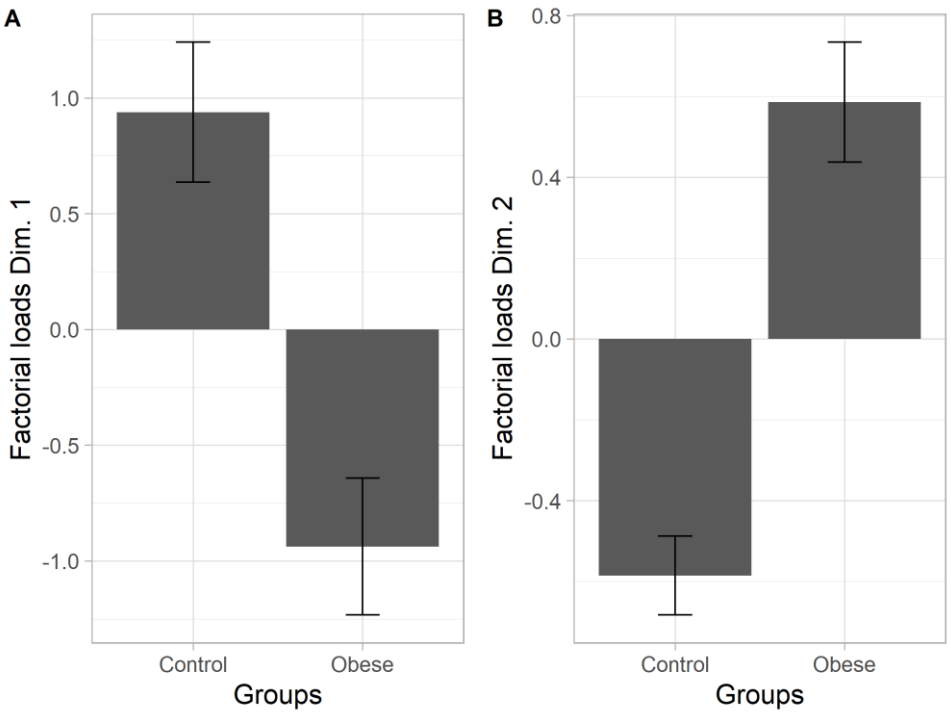

Fig. 5. Means and standard errors of factor loads of the main components for the control and obese groups. Legends: a) first main component; b) second main component.

ANEXO COM NORMAS DO PERIÓDICO

Preparing your manuscript

The information below details the section headings that you should include in your manuscript and what information should be within each section.

Please note that your manuscript must include a 'Declarations' section including all of the subheadings (please see below for more information).

Title page

The title page should:

• present a title that includes, if appropriate, the study design e.g.: "A versus B in the treatment of C: a randomized controlled trial", "X is a risk factor for Y: a case control study", "What is the impact of factor X on subject Y: A systematic review" or for non-clinical or non-research studies a description of what the article reports

• list the full names and institutional addresses for all authors. If a collaboration group should be listed as an author, please list the Group name as an author. If you would like the names of the individual members of the Group to be searchable through their individual PubMed records, please include this information in the “Acknowledgements” section in accordance with the instructions below indicate the corresponding author

Abstract

The Abstract should not exceed 350 words. Please minimize the use of abbreviations and do not cite references in the abstract. Reports of randomized controlled trials

should follow the CONSORT extension for abstracts. The abstract must include the following separate sections:

• Background: the context and purpose of the study

• Methods: how the study was performed and statistical tests used

• Results: the main findings

• Conclusions: brief summary and potential implications

• Trial registration: If your article reports the results of a health care intervention on human participants, it must be registered in an appropriate registry and the registration number and date of registration should be in stated in this section. If it was not registered prospectively (before enrollment of the first participant), you should include the words 'retrospectively registered'. See our editorial policies for more information on trial registration

Keywords

Three to ten keywords representing the main content of the article.

Background

The Background section should explain the background to the study, its aims, a summary of the existing literature and why this study was necessary or its contribution to the field.

Methods

The methods section should include:

• the aim, design and setting of the study

• the characteristics of participants or description of materials

• a clear description of all processes, interventions and comparisons. Generic drug names should generally be used. When proprietary brands are used in research, include the brand names in parentheses

• the type of statistical analysis used, including a power calculation if appropriate

Results

This should include the findings of the study including, if appropriate, results of statistical analysis which must be included either in the text or as tables and figures.

Discussion

This section should discuss the implications of the findings in context of existing research and highlight limitations of the study.

Conclusions

This should state clearly the main conclusions and provide an explanation of the importance and relevance of the study reported.

List of abbreviations

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Supplementary material/private homepage

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Doe, J: Title of preprint. http://www.uni-heidelberg.de/mydata.html (1999). Accessed 25 Dec 1999.

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- Clinical research manuscripts that comply with international and national standards for such work (such as the Declaration of Helsinki or relevant Governmental regulation e.g. the UK's The Medicines for Human Use (Clinical Trials) Regulations).
- Studies which are adequately controlled (be that compared to a placebo or conventional medicine), blinded (where appropriate), randomised and of sufficient statistical power to confidentially and accurately interpret the effect reported. Studies reporting a CAM treatment/technique compared only to another CAM treatment/technique are not sufficient to test the efficacy of the CAM treatment in question. Studies in which a conventional treatment is supplemented with a CAM technique are only valid if compared to the same conventional treatment supplemented with a placebo.
- CAM treatments/techniques tested on animal models and/or human patients: It is unethical for such work, on humans or animals, to have taken place without adequate prior evidence that the treatment/technique shows some potential of being therapeutic. Manuscripts must include evidence that takes the form of objective, measurable data from previously published peer reviewed literature which adheres to scientific principles (for instance in vitro or cellular work). Other forms of evidence are not valid. Manuscripts describing work lacking this evidence will not be considered on ethical grounds.

Consent for publication

For all manuscripts that include details, images, or videos relating to an individual person, written informed consent for the publication of these details must be obtained from that person (or their parent or legal guardian in the case of children under 18). The consent must be for publication of their details under the Creative Commons Attribution License 4.0 (such that they will be freely available on the internet). If the person has died, consent for publication must be obtained from their next of kin. The manuscript must include a statement that written informed consent for publication was obtained.

Authors can use the BMC consent form to obtain consent for publication, or a consent form from their own institution or region if appropriate. The consent form must state that the details/images/videos will be freely available on the internet and may be seen by the general public. The consent form must be made available to the Editor if requested, and will be treated confidentially.

In cases where images are entirely unidentifiable and there are no details on individuals reported within the manuscript, consent for publication of images may not be required. The final decision on whether consent to publish is required lies with the Editor.

Trial registration

BMC supports initiatives to improve reporting of clinical trials. This includes prospective registration of clinical trials in suitable publicly available databases. In line with ICMJE guidelines, BMC requires registration of all clinical trials that are reported in manuscripts submitted to its journals.

The ICMJE uses the World Health Organization (WHO) definition of a clinical trial, which is "any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes". This definition includes phase I to IV trials. The ICMJE defines health-related interventions as "any intervention used to modify a biomedical or health-related outcome" and health-related outcomes as "any biomedical or health-related measures obtained in patients or participants". Authors who are unsure whether their trial needs registering should consult the ICMJE FAQs for further information.

Suitable publicly available registries are those listed on the ICMJE website as well as any of the primary registries that participate in the WHO International Clinical Trials Registry Platform, including the ISRCTN registry, which is administered and published by BMC.

The trial registration number (TRN) and date of registration should be included as the last line of the manuscript abstract.

For clinical trials that have not been registered prospectively, BMC encourages retrospective registration to ensure the complete publication of all results. Further information on retrospective registration is available from the AllTrials campaign, the Public Accounts Committee and the Department of Health.

Many journals published by BMC will consider manuscripts describing retrospectively registered studies. The TRN, date of registration and the words 'retrospectively registered' should be included as the last line of the manuscript abstract.

Registration of systematic reviews

BMC supports the prospective registration of systematic reviews and encourages authors to register their systematic reviews in a suitable registry (such as

PROSPERO). Authors who have registered their systematic review should include the registration number as the last line of the manuscript abstract.

Availability of data and materials

Submission of a manuscript to a BMC journal implies that materials described in the manuscript, including all relevant raw data, will be freely available to any scientist wishing to use them for non-commercial purposes, without breaching participant confidentiality.

For all journals, BMC strongly encourages that all datasets on which the conclusions of the paper rely should be available to readers, and where there is a community established norm for data sharing, BMC mandates data deposition (for data types with required deposition, see below).

We encourage authors to ensure that their datasets are either deposited in publicly available repositories (where available and appropriate) or presented in the main manuscript or additional supporting files, in machine-readable format (such as spreadsheets rather than PDFs) whenever possible. Please see the list of recommended repositories. For several journals, deposition of the data on which the conclusions of the manuscript rely is required. Please check the individual journal's Submission Guidelines for more information.

Support on our data policy for authors and editors can be found at researchdata@springernature.com. This service provides advice on research data policy compliance and on finding research data repositories. It is independent of journal, book and conference proceedings editorial offices and does not advise on specific manuscripts.

Availability of data and materials section

All authors must include an “Availability of Data and Materials” section in their manuscript detailing where the data supporting their findings can be found. Authors who do not wish to share their data must state that data will not be shared, and give the reason.

Availability of data and materials statements can take one of the following forms (or a combination of more than one if required for multiple datasets):

• The datasets generated and/or analysed during the current study are available in the [NAME] repository, [PERSISTENT WEB LINK TO DATASETS]

• The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

• All data generated or analysed during this study are included in this published article [and its supplementary information files].

• The datasets generated and/or analysed during the current study are not publicly available due [REASON WHY DATA ARE NOT PUBLIC] but are available from the corresponding author on reasonable request.

• Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

• The data that support the findings of this study are available from [third party name] but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of [third party name].

• Not applicable. If your manuscript does not contain any data, please state 'Not applicable' in this section.

BMC endorses the Force 11 Data Citation Principles and requires that all publicly available datasets be fully referenced in the reference list with an accession number or unique identifier such as a digital object identifier (DOI).

List of recommended repositories

A list of recommended repositories by subject area and data type can be found on the Springer Nature Recommended Repositories list. If you have questions as to the suitability of a given repository, please contact the helpdesk at researchdata@springernature.com.

Community-established norm of data deposition

Mandatory deposition Suitable repositories

Publication of clinical datasets

For datasets containing clinical data, authors have an ethical and legal responsibility to respect participants' rights to privacy and to protect their identity. Ideally, authors should gain informed consent for publication of the dataset from participants at the point of recruitment to the trial. If this is not possible, authors must demonstrate that publication of such data does not compromise anonymity or confidentiality or breach local data protection laws, for the dataset to be considered for publication. Authors must consider whether the dataset contains any direct or indirect identifiers (see here for further information) and consult their local ethics committee or another appropriate body before submission if there is any possibility that participants will not be fully anonymous. Authors must state in their manuscript on submission whether informed consent was obtained for publication of patient data. If informed consent was not obtained, authors must state the reason for this, and which body was consulted in the preparation of the dataset.

Software and code

Any previously unreported software application or custom code described in the manuscript should be available for testing by reviewers in a way that preserves their anonymity. The manuscript should include a description in the Availability of Data and Materials section of how the reviewers can access the unreported software application or custom code. This section should include a link to the most recent version of your software or code (e.g. GitHub or Sourceforge) as well as a link to the archived version referenced in the manuscript. The software or code should be archived in an appropriate repository with a DOI or other unique identifier. For software in GitHub, we recommend using Zenodo. If published, the software application/tool should be readily available to any scientist wishing to use it for non-commercial purposes, without restrictions (such as the need for a material transfer agreement). If the implementation is not made freely available, then the manuscript should focus clearly on the development of the underlying method and not discuss the tool in any detail.

Standards of reporting

BMC advocates complete and transparent reporting of biomedical and biological research. Please refer to the Minimum standards of reporting checklist when reporting your research (published in BMC Biology). Exact requirements may vary depending on the journal; please refer to the journal's submission guidelines. We also strongly recommend that authors refer to the minimum reporting guidelines for health research hosted by the EQUATOR Network when preparing their manuscript, and FAIRsharing.org for reporting checklists for biological and biomedical research, where applicable. Authors should adhere to these guidelines when drafting their

manuscript, and peer reviewers will be asked to refer to these checklists when evaluating such studies.

Checklists are available for a number of study designs, including:

• Randomized controlled trials (CONSORT) and protocols (SPIRIT)

• Systematic reviews and meta-analyses* (PRISMA) and protocols (PRISMA-P)

• Observational studies (STROBE)

• Case reports (CARE)

• Qualitative research (COREQ)

• Diagnostic/prognostic studies (STARD and TRIPOD)

• Economic evaluations (CHEERS)

• Pre-clinical animal studies (ARRIVE)

*Authors of systematic reviews should also provide a link to an additional file from the ‘methods’ section, which reproduces all details of the search strategy. For an example of how a search strategy should be presented, see the Cochrane Reviewers' Handbook.

Statistical methods

Authors should include full information on the statistical methods and measures used in their research, including justification of the appropriateness of the statistical test used (see the SAMPL guidelines for more information). Reviewers will be asked to check the statistical methods, and the manuscript may be sent for specialist statistical review if considered necessary.

Resource identification

To enable effective tracking of the key resources used to produce the scientific findings reported in the biomedical literature, authors are expected to include a full description of all resources with enough information to allow them to be uniquely identified. In support of the Resource Identification Initiative (RII), we encourage authors to use unique Resource Identifiers (RRIDs) within their manuscript to identify their model organisms, antibodies, or tools.

Cell line authentication

If human cell lines are used, authors are strongly encouraged to include the following information in their manuscript:

• The source of the cell line, including when and from where it was obtained

• Whether the cell line has recently been authenticated and by what method

• Whether the cell line has recently been tested for mycoplasma contamination

Further information is available from the International Cell Line Authentication Committee (ICLAC). We recommend that authors check the NCBI database for misidentification and contamination of human cell lines.

Gene nomenclature

Standardized gene nomenclature should be used throughout. Human gene symbols and names can be found in the HUGO Gene Nomenclature Committee (HGNC) database; requests for new gene symbols should be submitted here and any enquiries about gene nomenclature can be directed here. Alternative gene aliases that are commonly used may also be reported, but should not be used alone in place of the HGNC symbol. Nomenclature committees for other species are listed here.

Reporting of sequence variants

We endorse the recommendations of the Human Variome Project Consortium for describing sequence variants (Human Genome Variation Society) and phenotypes (Human Phenotype Ontology).

We recommend that authors should submit all variants described in a manuscript to the relevant public gene/disease specific database (LSDB): a list is available here. The database URL and the unique identifier should be reported in the manuscript.

Data

To drive the maximum re-use and utility of published research, we expect authors to comply with available field-specific standards for the preparation and recording of data. Please see the BioSharing website for information on field-specific data standards. Authors must comply with best practice in their field for sharing of data, with particular attention to maintaining patient confidentiality.

Authors using unpublished genomic data are expected to abide by the guidelines of the Fort Lauderdale and Toronto agreements. Based on broadly accepted scientific community standards, the key requirement of third parties using genomic data is to contact the owners of unpublished data (i.e. the principal investigator and sequencing centre) prior to undertaking their research, to advise them about their planned analyses.

Describing new taxa

Algal, fungal, and botanical names

Since January 2012, the electronic publication of algal, fungal, and botanical names has been a valid form of publication. Manuscripts containing new taxon names or other nomenclatural acts must follow the guidelines set by the International Code of

Nomenclature for algae, fungi, and plants. Further helpful information by Sandra Knapp et al. is available here.

Authors describing new fungal taxa should register the names with a recognized repository, such as Mycobank, and request a unique digital identifier which should be included in the published article.

Zoological names

Since January 2012, electronic publication of zoological names has been a valid form of publication if certain conditions are met. Manuscripts containing new taxon names or other nomenclatural acts must follow the guidelines set by the International Commission on Zoological Nomenclature. We require the new taxon name and the article it is published in to be registered with ZooBank. The unique identifier provided by ZooBank should be included in the published article. Authors will be able to update ZooBank with the final citation following publication. Further helpful information by Frank-T. Krell is available here.

Bacterial names

In accordance with the International Code of Nomenclature of Prokaryotes (ICNP) effective publication of new prokaryotic names in electronic journals is possible. In order to comply with rules of the International Committee on Systematics of Prokaryotes (ICSP) for valid publication authors must submit a copy of the published article in its final form, together with certificates of deposition of the type strain (for unrestricted distribution), in at least two internationally recognized, publicly accessible culture collections located in different countries, to the International Journal of Systematic and Evolutionary Microbiology (IJSEM) editorial office. Following review

by the List Editor, effectively published names that conform to all of the rules of the ICNP will appear on a subsequent Validation List, in the order received, thereby becoming validly published.

Virus names

The proposal of new virus names must follow the guidelines established by the International Committee on Taxonomy of Viruses (ICTV) in the International Code of Virus Classification and Nomenclature. Proposals for new virus taxa should be forwarded to the relevant Study Group of the ICTV for consideration.

Competing interests

BMC requires authors to declare all competing interests in relation to their work. All submitted manuscripts must include a ‘competing interests’ section at the end of the manuscript listing all competing interests (financial and non-financial). Where authors have no competing interests, the statement should read “The author(s) declare(s) that they have no competing interests”. The Editor may ask for further information relating to competing interests.

Editors and reviewers are also required to declare any competing interests and may be excluded from the peer review process if a competing interest exists.

What constitutes a competing interest?

Competing interests may be financial or non-financial. A competing interest exists when the authors’ interpretation of data or presentation of information may be influenced by, or may be perceived to be influenced by, their personal or financial relationship with other people or organizations. Authors should disclose any financial

competing interests but also any non-financial competing interests that may cause them embarrassment if they were to become public after the publication of the manuscript.

Financial competing interests

Financial competing interests include (but are not limited to):

• Receiving reimbursements, fees, funding, or salary from an organization that may in any way gain or lose financially from the publication of the manuscript, either now or in the future.

• Holding stocks or shares in an organization that may in any way gain or lose financially from the publication of the manuscript, either now or in the future.

• Holding, or currently applying for, patents relating to the content of the manuscript.

• Receiving reimbursements, fees, funding, or salary from an organization that holds or has applied for patents relating to the content of the manuscript.

Non-financial competing interests

Non-financial competing interests include (but are not limited to) political, personal, religious, ideological, academic, and intellectual competing interests. If, after reading these guidelines, you are unsure whether you have a competing interest, please contact info@biomedcentral.com.

Commercial organizations

Authors from pharmaceutical companies, or other commercial organizations that sponsor clinical trials, should declare these as competing interests on submission. They should also adhere to the Good Publication Practice guidelines for pharmaceutical companies (GPP3), which are designed to ensure that publications

are produced in a responsible and ethical manner. The guidelines also apply to any companies or individuals that work on industry-sponsored publications, such as freelance writers, contract research organizations and communications companies. BMC will not publish advertorial content.

Authorship

Authorship provides credit for a researcher’s contributions to a study and carries accountability. Authors are expected to fulfil the criteria below (adapted from McNutt et al.,Proceedings of the National Academy of Sciences, Feb 2018, 201715374; DOI: 10.1073/pnas.1715374115; licensed under CC BY 4.0):

Each author is expected to have made substantial contributions to the conception OR design of the work; OR the acquisition, analysis, OR interpretation of data; OR the creation of new software used in the work; OR have drafted the work or substantively revised it AND to have approved the submitted version (and any substantially modified version that involves the author's contribution to the study); AND to have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

Please see individual journal's Submission Guidelines for information on the format for listing author contributions.

Authors wishing to make changes to authorship will be asked to complete our change of authorship form. Please note that changes to authorship cannot be made after acceptance of a manuscript.

Corresponding authors

Corresponding authors are responsible for ensuring that all listed authors have approved the manuscript before submission, including the names and order of authors, and that all authors receive the submission and all substantive correspondence with editors, as well as the full reviews, verifying that all data, figures, materials (including reagents), and code, even those developed or provided by other authors, comply with the transparency and reproducibility standards of both the field and journal.

This responsibility includes but is not limited to: (i) ensuring that original data/original figures/materials/code upon which the submission is based are preserved following best practices in the field so that they are retrievable for reanalysis; (ii) confirming that data/figures/materials/code presentation accurately reflects the original; and (iii) foreseeing and minimizing obstacles to the sharing of data/materials/code described in the work. The corresponding author should be responsible for managing these requirements across the author group and ensuring that the entire author group is fully aware of and in compliance with best practices in the discipline of publication.

To discourage ghost authorship, corresponding authors must reveal as appropriate whether the manuscript benefited from the use of editorial services that, if unacknowledged, might constitute an undisclosed conflict of interest. Examples include use of an editor from an organization that may have a vested interest in slanting the results or reliance on a technical writer at a level that would warrant authorship credit. These situations might variously be addressed by including a statement in the acknowledgments, by describing the effort in the methods section, or by adding an author.

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Corresponding authors should indicate whether any authors on earlier versions have been removed or new authors added and why. It is incumbent on the corresponding author to ensure that all authors (or group/laboratory leaders in large collaborations) have certified the author list and contribution description: that all authors who deserve to be credited on the manuscript are indeed identified, that no authors are listed who do not deserve authorship credit, and that author contributions, where they are provided, are expressed accurately.

Acknowledgements

All contributors who do not meet the criteria for authorship should be listed in an ‘Acknowledgements’ section. Examples of those who might be acknowledged include a person who provided purely technical help or writing assistance, or a department chair who provided only general support.

Third party submissions

All manuscripts must be submitted by an author and may not be submitted by a third party.

Citations

Research articles and non-research articles (e.g. Opinion, Review, and Commentary articles) must cite appropriate and relevant literature in support of the claims made.

Excessive and inappropriate self-citation or coordinated efforts among several authors to collectively self-cite is strongly discouraged.

Authors should consider the following guidelines when preparing their manuscript:

• Any statement in the manuscript that relies on external sources of information (i.e. not the authors' own new ideas or findings or general knowledge) should use a citation.

• Authors should avoid citing derivations of original work. For example, they should cite the original work rather than a review article that cites an original work.

• Authors should ensure that their citations are accurate (i.e. they should ensure the citation supports the statement made in their manuscript and should not misrepresent another work by citing it if it does not support the point the authors wish to make).

• Authors should not cite sources that they have not read.

• Authors should not preferentially cite their own or their friends', peers', or institution's publications.

• Authors should avoid citing work solely from one country.

• Authors should not use an excessive number of citations to support one point.

• Ideally, authors should cite sources that have undergone peer review where possible.

• Authors should not cite advertisements or advertorial material.

Preprint sharing and citation

BMC journals encourage posting of preprints of primary research manuscripts on preprint servers, authors' or institutional websites, and open communications between researchers whether on community preprint servers or preprint commenting platforms. Preprints are defined as an author's version of a research manuscript prior

to formal peer review at a journal, which is deposited on a public server (as described in Preprints for the life sciences. Science 352, 899–901; 2016); preprints may be posted at any time during the peer review process. Posting of preprints is not considered prior publication and will not jeopardize consideration at BMC journals. Manuscripts posted on preprint servers will not be taken into account when determining the advance provided by a study under consideration at a BMCjournal.

Our policy on posting, licensing, citation of preprints and communications with the media about preprints of primary research manuscripts is summarized below.

Authors should disclose details of preprint posting, including DOI and licensing terms, upon submission of the manuscript or at any other point during consideration at a BMC journal. Once the preprint is published, it is the author's responsibility to ensure that the preprint record is updated with a publication reference, including the DOI and a URL link to the published version of the article on the journal website.

Authors may choose any license of their choice for the preprint including Creative Commons licenses. The type of CC-license chosen will affect how the preprint may be shared and reused. More information to help guide licensing choices can be found in these resource documents developed by an ASAPbio licensing taskforce.

Preprints may be cited in the reference list of articles under consideration at BMC journals as shown below:

Babichev, S. A., Ries, J. & Lvovsky, A. I. Quantum scissors: teleportation of single-mode optical states by means of a nonlocal single photon. Preprint at http://arxiv.org/abs/quant-ph/0208066 (2002).

Authors posting preprints are asked to respect our policy on communications with the media. Researchers may respond to requests from the media in response to a preprint or conference presentation by providing explanation or clarification of the

work, or information about its context. In these circumstances, media coverage will not hinder editorial handling of the submission. Researchers should be aware however that such coverage may reduce or pre-empt coverage by other media at the time of publication. We also advise that researchers approached by reporters in response to a preprint make it clear that the paper has not yet undergone peer review, that the findings are provisional and that the conclusions may change.

Information about our self-archiving policies and release of Author's Accepted Manuscript may be found here.

Duplicate publication

Any manuscript submitted to a BMC journal must be original and the manuscript, or substantial parts of it, must not be under consideration by any other journal. In any case where there is the potential for overlap or duplication we require that authors are transparent. Authors should declare any potentially overlapping publications on submission. Any overlapping publications should be cited. Any 'in press' or unpublished manuscript cited, or relevant to the Editor's and reviewers' assessment of the manuscript, should be made available if requested by the Editor. BMC reserves the right to judge potentially overlapping or redundant publications on a case-by-case basis.

In general, the manuscript should not already have been formally published in any journal or in any other citable form. If justified and made clear upon submission, there are exceptions to this rule. Details of these exceptions follow below and are also summarized in table 1.

BMC is a member of CrossCheck's plagiarism detection initiative and takes seriously all cases of publication misconduct. Any suspected cases of covert duplicate

manuscript submission will be handled as outlined in the COPE guidelines and the Editor may contact the authors' institution (see Misconduct policy for more information). BMC endorses the policies of the ICMJE in relation to overlapping publications.

Complete manuscripts

Cochrane systematic reviews

BMC does not currently have a co-publication agreement with the Cochrane Library for its systematic reviews. BMC will therefore only consider publishing novel Cochrane systematic reviews, or updated versions of articles in the Cochrane Library, if they provide substantial new information.

Co-publication in multiple journals

If transparent, and with prior agreement of the relevant journals and under the conditions specified in the ICMJE guidelines, co-publication in multiple journals will be considered at the Editor's discretion.

Health technology assessment

The reports of the NHS Health Technology Assessment (HTA) programme are freely accessible in full online. At the Editor's discretion, some BMC journals will consider full or shortened versions of these articles for peer review.

Preprint servers and author/institutional repositories

Posting a manuscript on a preprint server or an author's personal or institutional website does not constitute previous publication. Please see our preprint sharing and citation policy for further information. Material that has formed part of an academic thesis and been placed in the public domain, as required by the awarding institution, will also be considered by BMC's journals.

BMC encourages self-archiving by authors of manuscripts accepted for publication in its journals.

Translations into English

Authors should comply with the ICMJE guidelines and seek approval from the original publisher to check that they do not breach the copyright terms of the original publication and that the original publisher gives permission for publication of the translation under the Creative Commons Attribution License 4.0.

Incomplete manuscripts

Abridged articles

At the Editor's discretion, some BMC journals will consider manuscripts that are substantially extended versions of articles that have previously been published in another peer-reviewed journal. In such cases the prior publication of an abridged version of the article would therefore not preclude publication, provided the new manuscript represents a substantially novel contribution to the scientific record. If applicable, the authors should seek approval from the original publisher before submitting the extended version of the manuscript.

Abstracts/posters

Prior abstracts of up to 400 words and posters presented at, or published as part of, academic meetings do not preclude consideration for peer review of a full manuscript, as the full manuscript represents a formal advance to the citable scientific record. Published abstracts should be cited. Authors should be aware that many conference proceedings exceed the allowable word limit and constitute a citable form.

Datasets

Making scientific data sets publicly available before associated manuscripts are submitted will not preclude consideration by a BMC journal. Because an increasing number of research funding agencies require that their grant holders share the 'raw data' research outputs, such data sharing is encouraged by BMC, provided appropriate safeguards are in place to protect personal or sensitive information. See the policy on publication of clinical datasets (above) for more information.

Non-research articles

Authors of non-research articles (usually commissioned reviews and commentaries) can include figures and tables that have been previously published in other journals provided they confirm on submission that permission has been obtained from the original publisher (if applicable) and cite the original article. Documentary evidence to support this permission must be made available to the Editor on request.

In order to avoid the potential for self-plagiarism, inadvertently or otherwise, authors agreeing to write commissioned articles should notify the Editor of any recent publications or invitations to write on a similar topic.

Open science

If authors have previously discussed or posted their own data in venues such as blogs, wikis, social networking websites, or online electronic lab notebooks, they are still able to submit their findings to BMC's journals. However, given the rapidly evolving nature of these resources, where discussion of data or manuscripts posted to these venues has subsequently been incorporated into the manuscript, the Editor

will make their own assessment as to whether there may be duplication in the submitted manuscript.

Study protocols

Publication of study protocols reduces the risk of non-publication of research findings and facilitates methodological discussion, and is encouraged by a number of BMC journals. Therefore prior publication of a study protocol before submission of a manuscript reporting the results is not considered duplicate publication.

Summary clinical trial results in public registries

Posting of summary clinical trial results in publicly accessible databases is generally not considered duplicate publication. BMC requires authors of manuscripts reporting clinical trials to have registered their trial in a suitably accessible registry (see our Trial Registration policy for more information). In the US, submission of trial results to ClinicalTrials.gov is a statutory requirement.

Communication of findings prior to publication

BMC journals do not wish to hinder communication among researchers. We support open communications between researchers whether on a recognised community preprint server, through discussions at conferences or on online collaborative sites such as wikis or the author's blog. Neither conference presentations nor posting on recognized preprint servers constitute prior publication.

Researchers may respond to requests from the media in response to a preprint or conference presentation, by providing explanation or clarification of the work, or

information about its context. In these circumstances, media coverage will not hinder editorial handling of the submission.

Researchers should be aware that such coverage may reduce or pre-empt coverage by other media at the time of publication. We also advise that researchers approached by reporters in response to a preprint make it clear that the paper has not yet undergone peer review, that the content is provisional and that the conclusions may change. Authors are expected to keep details of the peer review and editorial processes confidential.

We believe it important that the peer-reviewed and published version of a paper should be publicly available when the work is discussed in the public media, allowing the press to provide informed comment based on this version. For that reason, we strongly discourage the direct soliciting of media coverage to appear ahead of publication of the final version of a paper.

If further clarification is required, please contact the press office by e-mail.

Text recycling

Authors should be aware that replication of text from their own previous publications is text recycling (also referred to as self-plagiarism), and in some cases is considered unacceptable. Where overlap of text with authors' own previous publications is necessary or unavoidable, duplication must always be reported transparently and be properly attributed and compliant with copyright requirements. In collaboration with COPE, BMC has created guidelines for Editors on how to deal with text recycling which provide further detailed information on when text recycling is or is not considered acceptable. If a manuscript contains text that has been published elsewhere, authors should notify the Editor of this on submission.

Peer review

All research articles, and most other article types, published in BMC journals undergo thorough peer review. This usually involves review by two independent peer reviewers. Individual journals may differ in their peer review processes; for example, some journals operate an open and others a closed peer review system. For an individual journal’s peer review policy, please see the journal's 'About' page.

Peer review policy

All submissions to BMC journals are assessed by an Editor, who will decide whether they are suitable for peer review. Where an Editor is on the author list or has any other competing interest regarding a specific manuscript, another member of the Editorial Board will be assigned to assume responsibility for overseeing peer review. Submissions felt to be suitable for consideration will be sent for peer review by appropriate independent experts identified by the Handling Editor. Editors will make a decision based on the reviewers’ reports and authors are sent these reports along with the editorial decision on their manuscript. Authors should note that even in light of one positive report, concerns raised by another reviewer may fundamentally undermine the study and result in the manuscript being rejected.

Open peer review

For journals operating an open peer review process, the reviewers' names are included on the peer review reports. In addition, if the manuscript is published, the named reports are published online alongside the article. All previous versions of the manuscript are also available to readers on request by contacting

info@biomedcentral.com. On rare occasions, information from the pre-publication history may not be available for a specific article.

Authors will be aware of the reviewers' names during the peer review process and vice versa. However, there should not be direct correspondence between authors and reviewers. Any correspondence between the authors and the reviewers during or after the review process should be made through the journal Editors.

Closed peer review

Most journals operate a closed peer review process. Reviewers will be treated anonymously and the pre-publication history of each article will not be made available online.

Peer reviewers

Authors may suggest potential reviewers if they wish; however, whether or not to consider these reviewers is at the Editor's discretion. Authors should not suggest recent collaborators or colleagues who work in the same institution as themselves. Authors who wish to suggest peer reviewers can do so in the cover letter and should provide institutional email addresses where possible, or information which will help the Editor to verify the identity of the reviewer (for example an ORCID or Scopus ID).

Authors may request exclusion of individuals as peer reviewers, but they should explain the reasons in their cover letter on submission. Authors should not exclude too many individuals as this may hinder the peer review process. Please note that the Editor may choose to invite excluded peer reviewers.

Intentionally falsifying information, for example, suggesting reviewers with a false name or email address, will result in rejection of the manuscript and may lead to further investigation in line with our misconduct policy.

Portability of peer review

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CONCLUSÕES

Os achados do nosso estudo sugerem que indivíduos obesos e eutróficos apresentam mesma força absoluta do músculo glúteo médio. Quando normalizada com relação ao peso corporal, a força desse músculo é diferente entre os pares, sendo os obesos mais fracos. Em análise estatística de componentes principais, todas as variáveis de força, seja absoluta ou relacionada com o peso, apresentaram diferença entre os grupos, com valores maiores no grupo eutrófico.

Como a obesidade é uma epidemia e a maior parte da população mundial encontra-se acima do peso ideal, recomenda-se que a força da musculatura glútea seja medida sempre correlacionada com o peso.

Este trabalho apresenta resultados de relevância para a comunidade científica. Nele, consegue-se vislumbrar uma pequena parcela do que o excesso de peso pode causar para a força muscular. Porém, na integridade do seu ser, o obeso é, muitas vezes, mal compreendido por profissionais que isolam suas partes. Não se espera, com este estudo, uma simples visão de que o obeso é uma pessoa com fraqueza muscular do glúteo médio. Mas, sim, o entendimento de que, na heterogenicidade da doença chamada obesidade, o fator muscular também é relevante, desde a prevenção até o tratamento do seu estigma.

O modelo de atendimento à saúde deve estar aberto à inclusão de novas medidas para a abordagem do indivíduo obeso. Enquanto isso não acontecer, a pessoa com excesso de peso nunca será considerada na sua totalidade. Muito além do que um conjunto interdisciplinar de profissionais de saúde para o auxílio ao tratamento, precisa-se de uma nova mentalidade que reconheça a complexidade e a integralidade da problemática que envolve o obeso.

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APÊNDICE 01 – INSTRUMENTO DE COLETA DE DADOS

unioeste
Universidade Estadual do Oeste do Paraná

Nome: _____

Idade:_____ anos Sexo: ☐ M ☐ F

Peso:_____kg Altura:_____m IMC:_____

☐	Exclusão	Gestação;
		Doença ortopédica dos membros inferiores;
		Dor ou sequela no aparelho locomotor;
		Parestesia ou fraqueza em membros inferiores;
		Dor ortostática ou ao caminhar;
		Doença cardíaca;
		Outra doença com restrição da capacidade funcional.
☐	Exame físico	Distúrbio sensitivo;
		Elevação passiva da perna;
		Dor articular em quadril;
		Dor articular em joelho.

Teste Muscular de Força com Dinamômetro

M TENSOR FL D			
M GLÚTEO MÉD D			
M TENSOR FL E			
M GLÚTEO MÉD E			
M GLÚTEO MÁX D			
M GLÚTEO MÁX E			

APÊNDICE 02 – TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO - TCLE

unioeste
Universidade Estadual do Oeste do Paraná
Pró-Reitoria de Pesquisa e Pós-Graduação
Comitê de Ética em Pesquisa – CEP

Aprovado na
CONEP em 04/08/20

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO - TCLE

Título do Projeto: Assistência interdisciplinar ao indivíduo com obesidade da região oeste do Paraná no Hospital Universitário do Oeste do Paraná/HUOP

Pesquisador responsável: Allan César Faria Araújo

Convidamos você a participar de uma pesquisa que tem o objetivo de implantar um serviço de atendimento ao indivíduo com obesidade grave, que oferece assistência diagnóstica e terapêutica especializada, multidisciplinar e interdisciplinar, com condições técnicas, instalações físicas, equipamentos e recursos humanos adequados ao atendimento e prevenção a essa população. Esperamos, com este estudo, incentivá-lo à hábitos saudáveis de vida, bem como à prática orientada de atividade física, reeducação alimentar, assistência farmacêutica, de enfermagem, apoio psicoterápico e social, além de orientações sobre os diversos tipos de tratamento para a obesidade, incluindo os tipos de cirurgias, indicando-as àqueles que apresentarem necessidade. Para tanto, você foi encaminhado pela 10ª Regional de Saúde e será acompanhado por uma equipe multi/interdisciplinar, por tempo indeterminado, de acordo com sua necessidade, seja clínico ou cirúrgico. Cada área técnica utilizará fichas de entrevista e acompanhamento próprias, de acordo com protocolo do estudo, abordando assuntos que subsidiarão os atendimentos e orientações aos sujeitos.
Durante a execução do projeto os riscos a que você estará exposto estão relacionados aos possíveis desconfortos ou constrangimentos a algum questionamento. Caso você tenha indicação de fazer cirurgia, o médico lhe apresentará um outro termo de consentimento, com mais informações; e o procedimento só ocorrerá com a sua concordância. Sua identidade não será divulgada e seus dados serão tratados de maneira sigilosa, sendo utilizados apenas para fins científicos. Você também não pagará nem receberá para participar do estudo, **TENDO O COMPROMISSO DE NÃO FALTAR ÀS REUNIÕES AGENDADAS**. Além disso, você poderá cancelar sua participação na pesquisa a qualquer momento. No caso de dúvidas ou da necessidade de relatar algum acontecimento, você pode contatar os pesquisadores pelos telefones mencionados acima ou no Comitê de Ética pelo número 3220-3272.

Declaro estar ciente do exposto e desejo participar do projeto participar da pesquisa.

_____

(Assinatura)

_____

_____

(Nome do sujeito de pesquisa)

Eu, _____, declaro que forneci todas as informações do projeto ao participante

(Nome do pesquisador)

e/ou responsável.

Contato: 3321.5166 ou 3321.5214 - falar com Daniela ou Dalas (Serviço de Assistência Social)

Cascavel, _____ de _____ de _____.

ANEXO 01 – GARANTIA DE CALIBRAÇÃO DE APARELHO DINAMÔMETRO DIGITAL MICROFET II UTILIZADO NA PESQUISA

HOGGAN
SCIENTIFIC, LLC

3653 West 1987 South, Bldg 7
Salt Lake City, UT 84104
Tel: 800-678-7888 801-572-6500

TRACEABLE REFERENCES

REFERENCE	WORK STATION	CALIBRATION ID
HS	DO466	JD566

MODEL #: MICROFET SERIAL#: 1F126W

PRODUCT SPECIFICATION

CAPACITY 300 LBS
CONDITION NEW

WEIGHT TESTS	
APPLIED WEIGHT	TEST#1
10 LBS	10.0
20 LBS	20.0
30 LBS	30.1
40 LBS	40.1
50 LBS	50.0
60 LBS	60.0

WEIGHT TESTS	
APPLIED WEIGHT	TEST #1
70 LBS	70.0
80 LBS	80.1
90 LBS	90.1
100 LBS	100.0
110 LBS	110.0
120 LBS	120.1

WEIGHT TESTS	
APPLIED WEIGHT	TEST #1
130 LBS	130.1
140 LBS	140.0
150 LBS	150.4
200 LBS	200.6
247 LBS	246.8
305 LBS	305.0

This unit passes calibration requirements within the allowed limit of +/- 1% as established by HS

Calibrated: Doug Olde DATE: 03/27/2018

ANEXO 02 – TABULAÇÃO DAS VARIÁVEIS

Grupo	Sexo	Altura	Peso	Idade	TFL D	TFL E	GMED D	GMED E	GMAX D	GMAX E
Obeso	F	1,53	103	60	21,1	12,9	12,2	14,4	7,9	7,3
Obeso	F	1,54	105,1	51	27,8	22,8	10,8	22,5	15,3	9,9
Obeso	F	1,56	119,3	54	27,3	27,3	26	25,7	24	18,4
Obeso	F	1,54	96,4	52	31,5	36,5	37,1	38,8	22,8	21,1
Obeso	F	1,59	112,8	24	31,2	33,6	37,5	34,1	27,5	21,9
Obeso	F	1,74	165	39	25,2	27,2	25,6	29,8	15,7	21,1
Obeso	M	1,93	162	32	57,1	58,3	56,6	58,6	47,6	41,7
Obeso	F	1,56	102,3	36	32,2	23,9	26,8	22,6	16	18
Obeso	M	1,66	120,5	49	41,6	43,8	42,9	55,8	28,6	24,4
Obeso	F	1,64	137,5	20	26,3	22,2	24	21	22,5	17,2
Obeso	F	1,59	108,5	56	33,5	34,7	32,8	29,9	22,4	16,4
Obeso	F	1,52	129,4	41	24,3	23,8	22,6	24,2	13,8	10,7
Obeso	F	1,50	93,30	47	21,9	30,2	19	28,8	4,8	5,1
Obeso	F	1,63	106,5	39	31,1	26,3	26,9	22,4	15,1	11,2
Obeso	F	1,54	93,6	51	11,3	20,9	10,2	17,8	6,8	11,2
Obeso	F	1,59	128,9	35	26,9	28,1	19,5	22,7	13,3	9,1
Obeso	F	1,55	89	41	14,9	17,4	17,1	17,5	8,4	10,3

Obeso	F	1,66	108	47	18,8	22,2	27,4	20,8	12	10,9
Obeso	F	1,57	101,7	56	18,8	22	19,8	18,7	11,6	11,6
Obeso	F	1,45	90,4	39	34,1	39,3	37,8	39,1	20,9	26,7
Obeso	F	1,66	117,1	53	18,7	10,2	15,2	9,3	5,8	4,1
Obeso	F	1,46	120	36	22,3	19,2	17,6	20,5	15	9,6
Obeso	F	1,56	123	41	35,6	37,7	36,9	43,5	30,8	19,9
Obeso	F	1,66	100,9	42	22,4	24,4	23,4	12,6	22	14,9
Obeso	F	1,53	106,3	41	14,8	14,5	22,3	18,4	19,8	12,4
Obeso	F	1,63	122,5	40	31,2	22,7	31,2	26,2	20,3	14,7
Obeso	F	1,53	112,4	43	43,3	32,2	29	29,6	25,1	18,8
Controle	F	1,56	57	30	29,9	25,4	28,9	25,2	20,8	22,6
Controle	F	1,58	60	51	32	38,2	28,4	38,2	25,2	26,4
Controle	F	1,55	62	45	34,4	41,8	37,1	40,7	20,7	21,6
Controle	F	1,58	60	54	40	36,3	39	35,7	16,8	15
Controle	F	1,56	68	53	28,2	36,7	31,2	34	21,9	16,9
Controle	F	1,53	49	44	26,9	32,4	24,9	27,3	22,9	22,7
Controle	F	1,59	78	33	26,3	27,1	37,1	38,8	29	25,7
Controle	F	1,5	59,5	55	32,4	39,3	34,1	34,2	12,5	11,6
Control	F	1,66	68	42	22,2	33,3	29,5	35,8	20,9	21,8

e										
Control e	F	1,55	59	39	22,6	25,2	23,9	25	22,9	21
Control e	F	1,7	65	57	40	42,4	42,1	37,1	25	23,7
Control e	F	1,64	62	23	28,6	26,8	26,1	26,1	20,4	21,2
Control e	F	1,51	62	50	20	22,8	23,3	21,3	16,1	15,4
Control e	F	1,59	53	26	26,4	27,5	27,3	29,4	16,6	15,1
Control e	F	1,61	45	24	13,3	13,2	24,4	27,4	7,2	16,8
Control e	F	1,55	52	41	27,6	27,1	25,2	28,8	22	22,5
Control e	F	1,74	72	25	26,4	25,2	23,3	28,7	17,1	18,1
Control e	F	1,63	57	30	24,2	34,2	23,7	23,1	19,2	16,8
Control e	F	1,55	59,1	49	27,5	23,9	25,7	23,1	13,2	13,9
Control e	F	1,58	62	35	37,1	26,3	32,3	29,3	18,1	21,2
Control e	F	1,61	51,2	42	11,5	13,2	18,8	15,1	7,3	11,1
Control e	F	1,65	79	49	32,4	30	27,6	27,1	11,6	16,2
Control e	F	1,69	64,5	34	17,9	21,3	20,2	25,9	13,7	15,4
Control e	F	1,57	63,6	23	14,1	12,9	12,1	11,4	8	9,4
Control e	F	1,56	75,4	50	7,8	6	9,1	7,8	7	6,1

Controle	F	1,64	57,4	50	24,4	23	17,1	17,4	9,1	14,2
Controle	F	1,62	65,7	47	27,7	28,4	23,5	24,7	21,5	22,2
Controle	F	1,6	57	22	23,6	34,4	25,3	35,3	18,3	19,5
Controle	F	1,7	63,9	26	18,2	17,2	16,1	21,5	18,1	14,9
Controle	F	1,59	48,3	56	32,7	37,4	36,1	45	21,8	27,4
Controle	F	1,73	86,3	22	27,7	31	28,9	28,9	19,1	14,6
Controle	F	1,52	66,8	46	24,9	33,2	25,3	25,6	18,1	14,4
Controle	F	1,54	63	49	33,8	32,8	24,3	23,9	22,7	26,6
Controle	M	1,66	68,3	44	45,8	56,4	44,6	39,6	35,6	38,8
Controle	F	1,7	80	39	46,6	40,1	43,9	43,1	26,8	27,5
Controle	F	1,63	45	24	24,7	27,1	22	24,6	23,2	23,8
Controle	F	1,64	66	24	38,4	36,8	35,6	32,9	25,3	22,2
Controle	F	1,61	58	25	36,9	33,2	26,3	33,5	30,8	28,8
Controle	F	1,67	69	24	25,3	34	25,6	26,2	20,5	21,5
Controle	F	1,62	48,9	24	20,7	24,4	17,4	23,4	26,2	26,8
Controle	F	1,82	90,5	35	36,4	51	38,8	46,2	33,3	35,7
Control	F	1,7	62,4	24	19,1	18,1	18,3	17,1	15,4	14,3

e										
Controle	F	1,5	47	54	29,8	28	24,4	31,1	19	16,4
Controle	F	1,53	55	54	31,7	35,6	30,4	32,7	18,6	19,7
Controle	F	1,65	68	28	31,2	27,5	29,9	33	24	17,1
Controle	F	1,65	67	37	22,2	26,8	22,3	27,3	20,4	17,3
Controle	F	1,62	86	51	25,4	24,1	20	23,7	11,8	11,3
Controle	F	1,65	56	27	25,3	30,7	32,4	30,2	33,1	29,8
Controle	F	1,55	55	39	17,7	20,2	9,1	13,4	8,4	11,6
Controle	M	1,86	86	46	43,1	48,6	42,4	42,3	57,6	37
Controle	F	1,65	65,6	42	30,6	35,6	29,9	42,3	26,1	25,4
Controle	F	1,44	50,3	56	25	29,1	33	31,4	9,6	15,6
Controle	F	1,61	66	39	19,5	14,6	16	15,9	3,3	3,6
Controle	M	1,76	77,2	34	37,2	55,7	45,3	63,3	30,7	33,4
Controle	M	1,58	64	48	38,9	48,5	44,3	42,7	23,5	22,2
Controle	F	1,53	58,4	57	32,2	19,5	25,9	25,7	23,5	16,4
Controle	F	1,63	68	39	29,8	31,7	38,7	40,4	28,3	25,8
Controle	F	1,5	48	50	30,3	27,3	31,4	32,6	15,5	13,9

Control e	F	1,48	46	46	29,4	31,5	33,8	31,8	12,7	11,9
Control e	M	1,9	80	29	44	51,6	43,5	41,7	37	36,8

ANEXO 03 – PARECER DO COMITÊ DE ÉTICA EM PESQUISA COM SERES HUMANOS

UNIVERSIDADE ESTADUAL DO OESTE DO PARANÁ/

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Assistência interdisciplinar ao indivíduo com obesidade da região oeste do Paraná no Hospital Universitário do Oeste do Paraná/HUOP
Pesquisador: Allan Cezar Faria Araújo
Área Temática:
Versão: 2

CAAE: 44732515.0.0000.0107
Instituição Proponente: Universidade Estadual do Oeste do Paraná
Patrocinador Principal: Financiamento Próprio hospital universitário do este do Paraná

DADOS DO PARECER

Número do Parecer: 1.180.202

Data da Relatoria: 30/07/2015

Apresentação do Projeto:

Projeto de Pesquisa apresentado trata-se de um estudo longitudinal retrospectivo e prospectivo que será realizado mediante coleta de dados de indivíduos com idade acima dos 18 anos que fazem parte de um programa multidisciplinar direcionado a pessoas que apresentam diagnóstico de obesidade. Esse Programa é realizado parte no Hospital Universitário do Oeste do Paraná (HUOP) e parte no Centro de Reabilitação Física (CRF) da UNIOESTE. Um dos objetivos da pesquisa é utilizar os dados coletados por essa equipe para fazer estudos de casos dos pacientes.

Objetivo da Pesquisa:

Objetivo Primário:
Implantar um serviço de assistência de alta complexidade ao indivíduo com obesidade, que ofereça assistência diagnóstica e terapêutica especializada,

multidisciplinar e interdisciplinar, com condições técnicas, instalações físicas, equipamentos e recursos humanos adequados ao atendimento e prevenção aos indivíduos com obesidade da região oeste do Paraná.

Objetivos Secundários:

- Atender usuários obesos do SUS em nível ambulatorial nas áreas multiprofissionais da saúde; - Realizar vigilância alimentar e nutricional da população adstrita com vistas à - estratificação de risco para o cuidado do sobrepeso e da obesidade; - Realizar ações de promoção da saúde

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eprevenção do sobrepeso e da obesidade com ênfase nas ações de promoção da alimentação adequada e saudável e da atividade física; - Apoiar o autocuidado para manutenção e recuperação do peso saudável; Prestar apoio matricial às equipes de saúde para assistência ao indivíduo com obesidade; - Prestar assistência ambulatorial especializada multiprofissional aos indivíduos adultos com obesidade de acordo com as demandas encaminhadas por meio da regulação; - Realizar exames complementares ao diagnóstico e tratamento da obesidade, de acordo com os protocolos específicos; - Prestar assistência terapêutica multiprofissional pré-operatória aos usuários com indicação de realização de procedimento cirúrgico para tratamento da obesidade; - Avaliar e organizar o acesso dos casos com indicação ao procedimento cirúrgico para tratamento da obesidade, de acordo com o estabelecido nas diretrizes vigentes; -

Realizar tratamento cirúrgico da obesidade de acordo com o estabelecido nas diretrizes vigentes; - Garantir assistência terapêutica multiprofissional e interdisciplinar pós-operatória aos usuários que realizaram procedimento cirúrgico para tratamento da obesidade. - Realizar atividades em grupo com os usuários do ambulatório; Fazer estudo de caso dos usuários em atendimento; -Formar agentes multiplicadores para a prevenção da obesidade.

Avaliação dos Riscos e Benefícios:

Riscos:

Os riscos são os mesmos de outras cirurgias abdominais. Por essa razão, deve ser feita em hospital com estrutura adequada e por médicos habilitados que pratiquem os procedimentos regulamentados pelo Conselho Federal de Medicina (CFM). Embora muito raramente, a cirurgia pode gerar complicações, como infecções, tromboembolismo (entupimento de vasos sanguíneos), deiscências (separações) de suturas, fístulas (desprendimento de grampos), obstrução intestinal, hérnia no local do corte, abscessos (infecções internas) e pneumonia. Além disso, sintomas gastrointestinais podem aparecer após a refeição. Os pacientes predispostos a esses efeitos colaterais devem observar certos cuidados, como reduzir o consumo de carboidratos, comer mais vezes ao dia – pequenas quantidades –, e evitar a ingestão de líquidos durante as refeições. A assistência pós-operatória no tratamento cirúrgico da obesidade deve garantir a continuidade do tratamento por equipe multiprofissional até no mínimo por 18 meses e após anualmente.

Benefícios:

Os usuários atendidos pelo ambulatório de obesidade serão instruídos quanto a hábitos de vida saudáveis, com incentivo à prática orientada de atividade física, reeducação alimentar, assistência farmacêutica, apoio psicoterápico e social, bem como orientações sobre os diversos tipos de tratamento para obesidade, incluindo os tipos de cirurgias. Os benefícios da cirurgia bariátrica são

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perda de peso, remissão das doenças associadas à obesidade (como diabetes e hipertensão), diminuição do risco de mortalidade, aumento da longevidade e melhoria na qualidade de vida.

Comentários e Considerações sobre a Pesquisa:

De relevância para a área da Saúde.

Considerações sobre os Termos de apresentação obrigatória:

Apresenta todos os Termos de apresentação obrigatória.

Recomendações:

Sem recomendações.

Conclusões ou Pendências e Lista de Inadequações:

Sem pendências.

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

Considerações Finais a critério do CEP:

As solicitações feitas foram atendidas pelo pesquisador.

CASCAVEL, 11 de Agosto de 2015