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EFEITO DO TREINAMENTO DE MAT PILATES NA COMPOSIÇÃO CORPORAL E RESPOSTAS HEMODINÂMICAS EM MULHERES NA PÓS MENOPAUSA

JAQUELINE PONTES BATISTA

UBERLÂNDIA

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Tese apresentada ao Programa de Pós-Graduação em Ciências da Saúde da Faculdade de Medicina da Universidade Federal de Uberlândia, como requisito parcial para a obtenção do título de Doutora em Ciências da Saúde.

Área de concentração: Ciências da Saúde.

Orientador: Guilherme Morais Puga

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Presidente da banca (orientador): Prof. Dr. Guilherme Morais Puga

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RESUMO

Introdução: O exercício físico pode proporcionar reduções na pressão arterial (PA) após sua execução, com valores abaixo dos níveis de repouso bem como controlar valores da composição corporal, perfil lipídico e glicêmico. O método Pilates tem sido bastante procurado por mulheres na pós menopausa e não se sabe ao certo as respostas deste método no perfil antropométrico e hemodinâmicas para mulheres hipertensas e normotensas na pós menopausa. **Objetivos:** Verificar o efeito crônico do treinamento de Mat Pilates na composição corporal e respostas hemodinâmica em mulheres hipertensas e normotensas na pós menopausa. **Material e métodos:** Participaram do estudo 47 mulheres na pós menopausa entre 50 e 70 anos (24 mulheres no grupo normotensas e 23 no grupo hipertensas - uso anti-hipertensivo contínuo). Todas as voluntárias participaram durante 12 semanas de treinamento de Mat Pilates e foram submetidos a testes antes e após a intervenção como o de pressão arterial de repouso, a monitorização ambulatorial da pressão arterial (MAPA) e da variabilidade da pressão arterial (VPA). A freqüência cardíaca também foi monitorada e a análise da variabilidade da frequência cardíaca (VFC) realizadas pelos valores do monitor cardíaco. A composição corporal foi medida por bioimpedância, e, amostras de sangue foram coletadas para os níveis de lipídeos, índices de glicose e ácido úrico. Teste de flexibilidade e de força de tronco de contração isométrica em flexão e extensão também foram mensurados pré e pós intervenção. Foi utilizada a ANOVA Two-Way para comparar grupos, tempo e sua interação. **Resultados:** Foi observado reduções na pressão de repouso sistólica (NT: Δ -8 ± 7; HT: Δ -7 ± 8; p <0,01), diastólica (NT: Δ -7 ± 8; HT: Δ -4 ± 7; p <0,01) e pressão arterial média (NT: Δ -7 ± 7; HT: Δ -5 ± 7; p <0,01) após o treinamento em ambos os grupos. A MAPA no tempo de sono na pressão arterial sistólica (NT: Δ -1,14 ± 8,86; HT: Δ -1,14 ± 10,69; p = 0,05), diastólica (NT: Δ -0,93 ± 6,34; HT: Δ 0,43 ± 7,72; p = 0,05) e média (NT: Δ -1,57 ± 8,85; HT: Δ 0,88 ± 8,94; p = 0,01) foi diferente entre os grupos sendo maior nas hipertensas. Na VPA houve um aumento nos índices de SDdn na pressão arterial sistólica (NT: Δ 0,4 ± 4,0; HT: Δ 2,3 ± 3,9; p = 0,02), diastólica (NT: Δ 0,6 ± 2,3; HT: Δ 1,14 ± 2,5; p <0,01) e arterial média (NT: Δ 0,5 ± 3,0; HT: Δ 1,8 ± 3,4; p = 0,01) em relação ao tempo e em ARV em diastólica (NT: Δ 3,1 ± 9,6; HT: Δ 1,1 ± 2,1; p = 0,03) e média (NT: Δ 3,7 ± 11,4; HT: Δ 0,8 ± 1,8; p = 0,05) também foi observado este aumento em ambos os grupos assim como o aumento da VFC no índice pNN50 (NT: Δ 1,6 ± 5,6; HT: Δ 2,0 ± 6,2; p = 0,04) após o treinamento nos dois grupos. Não houve alterações na composição corporal ao longo do tempo ou entre os grupos, mas a circunferência abdominal diminuiu (NT: Δ -2,48 ± 7,09; HT: Δ -0,26 ± 4,77; p <0,01) após o treinamento em ambos os grupos. Os níveis séricos de lipídeos e glicose também não foram diferentes, mas o ácido úrico aumentou (NT: Δ 0,54 ± 0,14; HT: Δ 0,54 ± 0,20; p <0,01) e a hemoglobina HbA1c diminui (NT: Δ -0,28 ± 0,11; HT: Δ -0,47 ± 0,10; p <0,01) em ambos os grupos, sem diferença entre eles. Além disso, a força isométrica de flexão de tronco (NT: Δ 4,76 ± 4,63; HT: Δ 5,87 ± 5,14; p <0,01) e flexibilidade (NT: Δ 4,19 ± 4,33; HT: Δ 2,98 ± 4,79; p <0,01) aumentaram em ambos os grupos, sem diferença entre eles. **Conclusão:** Um programa de 12 semanas de treinamento em Mat Pilates reduz a pressão arterial de repouso e aumenta a variabilidade da pressão arterial e variabilidade da frequência cardíaca em mulheres hipertensas e normotensas na pós menopausa. Além disso, este treinamento melhora a circunferência abdominal, HbA1c, força isométrica de flexão de tronco e flexibilidade em mulheres hipertensas e normotensas na pós menopausa sem alterações nos níveis de lipídeos e glicose e massa magra e gorda dessas voluntárias.

Palavras-chave: Exercício. Pilates. Menopausa. Hipertensão.

ABSTRACT

Background: Physical exercise can provide reductions in blood pressure (BP) after its execution, with values below resting levels as well as control values of body composition, lipid and glycemic profile. The Pilates method has been highly sought after by postmenopausal women and the responses of this method to hypertensive and normotensive postmenopausal women are uncertain. **Aim:** To verify the chronic effect of Mat Pilates training on body composition and hemodynamic responses in hypertensive and normotensive postmenopausal women. **Material and methods:** 47 postmenopausal women between the ages of 50 and 70 participated in the study (24 normotensive women and 23 hypertensive women - continuous antihypertensive use). All volunteers participated during 12 weeks of Mat Pilates training and underwent tests before and after intervention such as resting blood pressure, ambulatory blood pressure monitoring (ABPM), and blood pressure variability (BPV). Heart rate was also monitored and heart rate variability (HRV) analysis performed by cardiac monitor values. Body composition was measured by bioimpedance, and blood samples were collected for lipid, glucose and uric acid levels. Flexural test and trunk strength of isometric contraction in flexion and extension were also measured before and after intervention. Two-Way ANOVA was used to compare groups, time and their interaction. **Results:** There were reductions in systolic resting pressure (NT: Δ -8 ± 7, HT: Δ -7 ± 8, p <0.01), diastolic (NT: Δ -7 ± 8, HT: Δ -4 ± 7; p <0.01) and mean arterial pressure (NT: Δ -7 ± 7, HT: Δ -5 ± 7; p <0.01) after training in both groups. A MAP in sleep time in systolic blood pressure (NT: Δ -1,14 ± 8,86, HT: Δ -1,14 ± 10,69, p = 0,05), diastolic (NT: Δ -0, 93 ± 6.34, HT: Δ 0.43 ± 7.72, p = 0.05) and mean (NT: Δ -1.57 ± 8.85, HT: Δ 0.88 ± 8.94; = 0.01) was different between groups being higher in hypertensive patients. In the VPA there was an increase in the SDdn indices in systolic blood pressure (NT: Δ 0.4 ± 4.0, HT: Δ 2.3 ± 3.9, p = 0.02), diastolic (NT: Δ0, (Mean ± SD) and mean arterial (NT: Δ 0.5 ± 3.0, HT: Δ 1.8 ± 3.4; = 0.01) in relation to time and in ARV in diastolic (NT: Δ 3.1 ± 9.6, HT: Δ 1.1 ± 2.1, p = 0.03) and mean (NT: Δ 3 , HT (Δ 0.8 ± 1.8, p = 0.05), both increases were observed in both groups as well as the increase in HRV in the pNN50 index (NT: Δ 1.6 ± 5.6, HT: Δ 2.0 ± 6.2, p = 0.04) after training in both groups. There were no changes in body composition over time or between groups, but waist circumference decreased (NT: Δ -2.48 ± 7.09; HT: Δ -0.26 ± 4.77, p <0.01) after training in both groups. Serum levels of lipids and glucose were also not different, but uric acid increased (NT: Δ 0.54 ± 0.14, HT: Δ 0.54 ± 0.20, p <0.01) and hemoglobin HbA1c decreases (NT: Δ -0.28 ± 0.11, HT: Δ -0.47 ± 0.10, p <0.01) in both groups, with no difference between them. In addition, the isometric strength of trunk flexion (NT: Δ 4.76 ± 4.63, HT: Δ 5.87 ± 5.14, p <0.01) and flexibility (NT: Δ 4.19 ± 4 , 33; HT: Δ 2.98 ± 4.79, p <0.01) increased in both groups, with no difference between them. **Conclusion:** 12-week training program in Mat Pilates reduces blood pressure at rest and increases blood pressure variability and heart rate variability in hypertensive and normotensive postmenopausal women. In addition, this training improves abdominal circumference, HbA1c, isometric strength of trunk flexion and flexibility in postmenopausal hypertensive and normotensive women without changes in lipid and glucose levels and lean and fat mass of these volunteers.

Keywords: Exercise. Pilates. Menopause. Hypertension.

LISTA DE ILUSTRAÇÕES

LISTA DE TABELAS

LISTA DE ABREVIATURAS E SIGLAS

A1c glycated hemoglobina

ABPM ambulatory blood pressure monitoring

AC abdominal circumference

ACE angiotensin converting enzyme

ARV24average real variability

AT1 angiotensin 1

AUC area under the curve

BM body mass

BMI body mass index

BP blood pressure

BPV blood pressure variability

CVD cardiovascular diseases

DBP diastolic blood pressure

FER flexion extension ratio

FLEX flexibility

FM fat mass

FP fat percentage

GLU glucose

HbA1c glycated hemoglobin

HC hip circumference

HDL High Density Lipoprotein

HF high frequency zone

HR heart rate

HRV heart rate variability

HT hypertensive

LDL Low Density Lipoprotein

LF low frequency zone

LM lean mass

MAP mean arterial blood pressure

MAPA monitorização ambulatorial da pressão arterial

N-HDL No HDL

NT normotensive

PGI2 prostaciclina

pNN50 percentage of pairs of adjacent RR intervals with difference of at least 50 ms and in the frequency domain

RMSSD square root of the mean squared sum of the differences of adjacent RR intervals

SBP systolic blood pressure

SD24 24-hour standard deviation

SDdn mean diurnal and nocturnal deviations weighted for the duration of the daytime and nighttime interval

SDNN standard deviation of all normal RR intervals

SPE subjective perception of effort

TC total cholesterol

TET trunk extension test

TFT trunk flexion test

TRIGL triglycerides

UA uric acid

WC waist circumference

WHR waist hip ratio

SUMÁRIO

1 INTRODUÇÃO

O climatério é o período de transição fisiológica da fase reprodutiva para não reprodutiva na mulher. É dentro deste período que ocorre a falência total da função ovariana em produzir hormônios esteroides e ovulação, acarretando em amenorreia permanente, a qual se denomina de menopausa (WARD; DENERIS, 2018). Assim, o período correspondente na vida da mulher após o evento da menopausa é chamado de período pós-menopausa. O acometimento da falha de produção de hormônios causa alterações no organismo como elevação do peso corporal, mudança nos depósitos de gordura, alterações do perfil lipídico e aparecimento de doenças metabólicas, bem como aumento na incidência de hipertensão arterial e outras doenças cardiovasculares (GRINDLER; SANTORO, 2015; RECKELHOFF; RECKELHOFF, 2001).

A prevalência da hipertensão arterial eleva-se significativamente com a idade, chegando a 80% na população acima de 80 anos**.** Quando se compara a prevalência desta doença entre os gêneros, observa-se que as mulheres, até a menopausa, apresentam menor prevalência na hipertensão arterial e doenças relacionadas em relação aos homens (COYLEWRIGHT; RECKELHOFF; OUYANG, 2008; RECKELHOFF; RECKELHOFF, 2001). Porém, após a menopausa a prevalência nas mulheres torna-se maior que nos homens (WARD; DENERIS, 2018; ZANESCO; ZAROS, 2009). Acredita-se que este aumento ocorra devido a deficiência de estrógeno, redução da massa muscular, à alteração do perfil lipídico, ao ganho de peso e ao sedentarismo dessas mulheres pós menopausadas em relação as pré menopausadas (WARD; DENERIS, 2018). Todas essas alterações no organismo da mulher na pós menopausa levam ao aumento na incidência de hipertensão arterial, dislipidemias, resistência à insulina, diabetes tipo 2, e outras doenças crônicas (COYLEWRIGHT; RECKELHOFF; OUYANG, 2008; RECKELHOFF; RECKELHOFF, 2001). Sendo assim, métodos de prevenção e tratamento das doenças cardiovasculares e metabólicas são de fundamental importância para essa população e o exercício físico é um desses métodos alternativos.

O exercício físico desempenha papel muito importante no controle da pressão arterial e dos níveis plasmáticos de colesterol e triglicerídeos. Diversos são os benefícios quando observado os valores da pressão arterial, principalmente pela característica da redução dos valores de repouso da pressão arterial tanto em exercícios físicos crônicos quanto agudo. A magnitude dessa redução da pressão arterial logo após uma sessão de exercício físico é dependente de fatores como intensidade e duração do exercício, grau de comprometimento causado pela patologia em pacientes com doenças cardiovasculares e dos níveis iniciais de pressão arterial antes da realização do exercício físico (DONALD, 2002; HALLIWILL et al., 2013; THOMAS et al., 2017).

A redução da pressão arterial advinda após o exercício físico torna-se uma boa ferramenta para tratamento e prevenção de doenças cardiovasculares, principalmente a hipertensão arterial. Apesar dos exercícios aeróbios serem os mais praticados, o método do Pilates tem sido indicado como uma alternativa de atividade física para mulheres na pós menopausa pelo efeito benéfico na composição corporal dessas mulheres (FOURIE et al., 2013). O método é um programa completo de condicionamento físico e mental, uma técnica dinâmica que visa trabalhar força, alongamento, flexibilidade e equilíbrio, preocupando-se em manter uma boa postura corporal (KLIZIENE et al., 2016).

Apesar de Joseph Pilates, afirmar que os exercícios do método são capazes de fornecer melhorias no sistema cardiovascular, poucos são os estudos que demonstram tais benefícios (FOURIE et al., 2013; MARTINS-MENESES et al., 2015). Estudos indicam que, em indivíduos com níveis mais elevados de pressão arterial, essa redução é maior em comparação com indivíduos normotensos (QUEIROZ et al., 2015). A eficácia do método na flexibilidade, densidade óssea, lombalgia também vem sendo investigada assim como seu benefício em relação à composição corporal, níveis lipídicos, resistência à insulina e outros parâmetros relacionados à aptidão física em mulheres hipertensas e normotensas após a menopausa. Neste grupo, a eficácia do método ainda encontra obscura. Portanto, o objetivo do estudo foi verificar os efeitos do treinamento de Mat Pilates em mulheres hipertensas e normotensas na pós menopausa.

2 FUNDAMENTAÇÃO TEÓRICA

2.1 Hipertensão e Exercício

A hipertensão arterial é uma doença que tem como características os níveis mais levados da pressão de repouso e está frequentemente associado ao risco de eventos cardiovasculares, acidentes cerebrais e doenças renais (THOMAS et al., 2017). A prevelância desta patologia com avanço da idade é mais observada em mulheres do que em homens (GIOSIA et al., 2018).

Como tratamento e prevenção desta doença, estratégias não medicamentosas como por exemplo, o exercício físico vem sendo adotada para regulação dos valores da pressão. Os benefícios da prática de exercício físico podem ser observados tanto de forma crônica, decorrente do treinamento, quanto aguda, pela capacidade de redução da pressão arterial abaixo dos níveis iniciais de repouso após o exercício (DONALD, 2002; GOMES ANUNCIAÇÃO; DOEDERLEIN POLITO, 2011; RECKELHOFF; RECKELHOFF, 2001). Tanto nos exercícios aeróbios quanto resistidos é observado redução dos valores de repouso da pressão arterial após exercício, contribuindo no controle da pressão arterial.

O mecanismo de redução da pressão após realização de exercício físico é denomidado hipotensão pós exercício e pode ser verificado tanto em uma população normotensa e saudáveis quanto nos hipertensos, sendo mais evidentes em indivíduos hipertensos (DONALD, 2002; GOMES ANUNCIAÇÃO; DOEDERLEIN POLITO, 2011). A redução da pressão torna-se mais limitada nas normotensas pois elas já possuem o nível basal de pressão arterial normal o que impede a magnitude da queda pressórica a níveis menores que os basais, por isso a hipotensão pós exercício neste grupo ocorre menos consistente e com menor magnitude que em indivíduos hipertensos. Isto pode ocorrer devido a mecanismos de compensação, tais como o barorreflexo, que são ativados em normotensos, e impedem que o grau de hipotensão pós exercício afete a tolerância ortostática (DONALD, 2002).

Variáveis de treinamento como volume e intensidade do treino também vem sendo investigados para respostas da modulação da redução da pressão arterial. Alguns estudos demonstraram que a intensidade do esforço não influencia na resposta hipotensora pós-exercício (GIOSIA et al., 2018), outras já demonstram a influência desta variável na duração de tal resposta assim como a magnitude ser dependente da duração do exercício (BRITO, DE et al., 2015). Tais modulações ainda são contraditórias devido a diversas intensidades e durações apontadas em exercícios aeróbios e/ou resistidos em diferentes populações

(CORNELISSEN; SMART; SURVEY, 2013; COYLEWRIGHT; RECKELHOFF; OUYANG, 2008). A redução da pressão arterial após exercício, principalmente no aeróbio, começa no primeiro minuto podendo estender-se por algumas horas após sua execução (CORNELISSEN; SMART; SURVEY, 2013).

A monitorização ambulatorial da pressão arterial (MAPA) é uma técnica de análise da pressão arterial a longo prazo, após a intervenção do exercício físico, possibilitando verificar as 24 horas da pressão arterial ao invés de apenas as primeiras horas pós exercício (CORNELISSEN; SMART; SURVEY, 2013; O'BRIEN; ATKINS; STAESSEN, 1995). Esta técnica de mensuração já está incorporada à prática clínica pela efetividade de prognósticos e tratamentos de doenças cardiovasculares (NOBRE, 1998) que nos possibilita visualizar as variações pressóricas durante 24 horas e nos períodos de sono e vigília. Em alguns estudos, verificamos a redução da pressão arterial pós exercício com magnitudes que perduram um período prolongado de 24 horas em sessões agudas e crônicas (HANSEN et al., 2010; MARTINS-MENESES et al., 2015).

Existem diversos mecanismos que buscam sintetizar a diminuição da pressão arterial após qualquer trabalho muscular (GOMES ANUNCIAÇÃO; DOEDERLEIN POLITO, 2011; HALLIWILL et al., 2013; RECKELHOFF; RECKELHOFF, 2001). Um destes mecanismos é a liberação do óxido nítrico no endotélio, que como uma das substâncias vasodilatadoras capazes de diminuir a resistência periférica por várias horas após exercício, sendo este um mecanismo humoral (GIOSIA et al., 2018; HALLIWILL et al., 2013). A formação de NO está ligada ao estímulo por substâncias agonistas como a acetilcolina, bradicinina, adenosina, dentre outras, e também pela forca mecânica exercida pelo fluxo sanguíneo na parede dos vasos - chamada de *shear stress* ou forca de cisalhamento (FRANCIS; BUSCH; CORBIN, 2010; ZANESCO; ANTUNES, 2007)

Além de mecanismos humorais, os centrais também são importantes na redução da pressão após o trabalho muscular, principalmente os que se referem aos ajustes do barorreflexo e na inibição da atividade simpática no sistema nervoso central (CHEN; BONHAM, 2011; HALLIWILL et al., 2013). Os barorreceptores são ativados aumentando à atividade neuronal no núcleo do trato solitário que processa informações como a pressão nos vasos, a freqüência cardíaca, a atividade cardíaca, a composição química do sangue, entre outras. Esse aumento, por sua vez, aumenta a atividade neuronal gaba érgicos na medula ventral lateral caudal resultando na diminuição do disparo dos neurônios na medula rostral ventrolateral e diminuição da atividade do sistema nervoso simpático, que retorna a pressão arterial para o nível de controle normal (CHEN; BONHAM, 2011). Além do controle barorreflexo, o sistema serotonérgico pode também contribuir para a redução da pressão arterial após o exercício físico pela inibição dos receptores de vasopressina no sistema nervoso central e à diminuição de serotonina cerebral (CHEN; BONHAM, 2011; GIOSIA et al., 2018; HALLIWILL et al., 2013). A investigação em diferentes modalidades de exercício faz-se necessário para melhor entendimento dos mecanismos de regulação da pressão.

2.2 Menopausa e Exercício

A menopausa é um marco dentro do período do climatério, período de transição da fase reprodutiva para não reprodutiva da mulher. Este marco é quando há falência parcial ou total da função ovariana em ovular e produzir hormônios esteróides seguido de amenorréia de no mínimo 12 meses. Após todo período desse evento, reconhece-se por pós menopausa (COYLEWRIGHT; RECKELHOFF; OUYANG, 2008; WARD; DENERIS, 2018). Muitas alterações são visualizadas neste período da vida da mulher como alterações no perfil lipídico (GRINDLER; SANTORO, 2015) que potencializa o aumento da adiposidade central e o desenvolvimento da obesidade, considerada um fator de risco cardiovascular independente (WARD; DENERIS, 2018). Muitas destas mudanças são recorrentes a diminuição dos níveis de estrogênio. Este hormônio também é responsável pela modulação da função endotelial (GRINDLER; SANTORO, 2015; WARD; DENERIS, 2018) elevando a produção de óxido nítrico através de receptores específicos no endotélio vascular (BASKURT; ULKER; MEISELMAN, 2011; ZANESCO; ZAROS, 2009) e de prostaciclina (PGI2), que são substâncias vasodilatadoras dependentes do endotélio, por isso considerado um hormônio cardioprotetor. Além disso, parece que os estrogênios podem modular negativamente a síntese de endotelina, que é um potente vasoconstritor (WARD; DENERIS, 2018).

As mulheres, até a menopausa, apresentam menores índices de hipertensão arterial e doenças relacionadas ao coração do que o sexo masculino e após esse período as mulheres passam a ter uma prevalência igual a dos homens (COYLEWRIGHT; RECKELHOFF; OUYANG, 2008) justamente pela falta do estrogênio no período após a menopausa. Além deste fato hormonal, a alteração do perfil lipídico, ganho de peso e sedentarismo nesta fase de vida das mulheres também é mais comum do que em mulheres pré menopausadas (COYLEWRIGHT; RECKELHOFF; OUYANG, 2008; WARD; DENERIS, 2018).

Para sanar todas estas alterações cardiometabólicas, a prática regular de exercícios físicos vem sendo tratada como métodos alternativos de prevenção e tratamento das doenças cardiovasculares (GIOSIA et al., 2018), principalmente da hipertensão arterial que faz-se relevante para a população de mulheres pós menopausadas, além de que a reposição hormonal em mulheres após a menopausa tem se mostrado ineficaz quando utilizados para redução de valores pressóricos arteriais e na prevenção e tratamento de doenças cardiovasculares (GIOSIA et al., 2018).

Através do exercício as mulheres pós menopausadas conseguem reverter quadros clínicos relevantes nesta faixa etária como o aumento do acúmulo de gordura, que pode acarretar a alteração no perfil lipídico, além de reduzir os sintomas climatéricos e melhorar a qualidade de vida dessas mulheres. Há estudos sobre efeito protetor dos exercícios aeróbio e resistido praticado regularmente, contínuo ou intermitente (CORNELISSEN; SMART; SURVEY, 2013) porém pouco se sabe sobre os efeitos nas respostas hemodinâmicas e na composição corporal nessas mulheres com o método Pilates.

O método Pilates foi criado por Joseph Pilates, um estudioso em anatomia e praticante de yoga, ginástica artística, dança e artes marciais. O método surgiu como uma alternativa de reabilitação nos campos de guerra em meados da Primeira Guerra Mundial (KLOUBEC, 2011). O método é a somatória de total coordenação do corpo, mente e espírito para promover um desenvolvimento corporal uniforme com ênfase ao alinhamento postural (CRUZ-FERREIRA et al., 2011). É uma método que trabalha força, flexibilidade, resistência e que para isso utiliza da contração a todo o momento dos músculos do core (LATEY, 2001). Nos dias atuais, o método do exercício Pilates pode ser desenvolvido tanto em solo quanto em aparelhos próprios do método desenvolvido por Joseph (LATEY, 2002).

O método tradicional engloba seis princípios básicos para execução de qualquer exercício, sendo eles: centralização, concentração, controle, precisão, fluidez e respiração (WELLS; KOLT; BIALOCERKOWSKI, 2012). Todos os princípios são trabalhados de forma conjunta e harmoniosa. Em relação a centralização, o trabalho muscular do que é chamado de "*power house*" está em evidência, que são os grupos musculares da região da caixa torácica e do assoalho pélvico. Em todos os movimentos executados durante a prática do Pilates o "*power house*" deve estar ativado (WELLS; KOLT; BIALOCERKOWSKI, 2012). O controle é o princípio responsável pelo alinhamento postural durante os exercícios, juntamente com a concentração, que julga a atenção necessário para o desenvolvimento dos movimentos bem como a precisão, que nada mais é que a acurácia da técnica do exercício.

A transição suave dos movimentos é realizada pela fluidez. Por último, a respiração que é o movimento do ar para dentro e para fora dos pulmões em coordenação com o exercício. Neste princípio vale ressaltar que este processo de coordenação combina-se a fase excêntrica do movimento com a inspiração e a concêntrica com a expiração visando uma maior contração dos músculos da região do "*power house*" (LATEY, 2002). Uma ponderação importante é que enquanto exercício físico entende-se sua execução quanto à carga atribuída as tensões das molas quando executados nos aparelhos e ao peso corporal quando no solo e as repetições preconizadas em apenas dez em cada exercício, pois o criador do método acreditava que era número de repetições suficientes para um trabalho bem executado sem nenhuma perda nos seis princípios (LATEY, 2001).

Quando analisamos as mulheres na pós menopausa verificamos alguns estudos que demonstram a eficácia do Pilates em diversos aspectos. Um grupo de mulheres pós menopausadas na Itália foi submetido ao programa de 12 semanas de treinamento de Pilates no solo e foi verificado o aumento de força muscular de membro superior e abdominal nestas mulheres (BERGAMIN et al., 2015). Em outro estudo, com duração de um ano de intervenção do método também aplicado em mulheres pós menopausadas porém com osteoporose, encontrou-se melhora na qualidade de vida, mas sem melhoras na mobilidade funcional e prevenção de quedas (KÜÇÜKÇAKIR; ALTAN; KORKMAZ, 2013). Melhoras na qualidade de vida, densidade mineral óssea e diminuição de intensidade de dores também foi relatado (ANGIN; ERDEN; CAN, 2015). Melhoras em patologias de coluna (F. HITA-CONTRERAS, A. MARTÍNEZ-AMAT; TO, 2016) e na composição corporal, níveis de glicose e perfil lipídico em mulheres obesas e com sobrepesos e também na pós menopausa (KOCHAN, 2015).

Um estudo analisou as respostas hemodinâmicas no Pilates e encontrou diminuição do duplo produto de repouso, pressão arterial sistólica, diastólica e média em repouso, 24 horas sono e vigília em mulheres entre 30 e 50 anos hipertensas (MARTINS-MENESES et al., 2015). Em outro, mulheres acima de 60 anos foram submetidas a oito semanas de um programa de exercícios de Pilates no solo. E encontrou redução nos valores da pressão arterial sistólica e dos valores de glicose, sem alteração na pressão arterial diastólica, colesterol total e triglicérides (FOURIE MARINDA, GILDENHUYS MAGDA, SHAW INA, SHAW BRANDON, TORIOLA ABEL, 2013). Apesar desses estudos repercutirem diversas variáveis dentro da parte corporal e metabólica, verificamos uma escassez quanto a estudos em mulheres na pós menopausa para o método Pilates.

3 OBJETIVOS

Verificar o efeito crônico do treinamento de Mat Pilates na composição corporal e respostas hemodinâmicas em mulheres hipertensas e normotensas na pós menopausa.

Objetivos específicos

Verificar os efeitos crônicos do treinamento de Mat Pilates tanto nas mulheres na pós menopausa hipertensas quanto nas normotensas:

(na flexibilidade);

(na força de contração isométrica do tronco);

(na relação entre a atividade simpática e parassimpática através da medida da variabilidade da freqüência cardíaca);

(nas medidas da variabilidade da pressão arterial através da pressão ambulatorial durante 24 horas);

(nas medidas de pressão arterial de repouso e ambulatorial durante 24 horas);

(nos valores de perfil lipídico (Colesterol total e frações, e triglicerídeos) e glicemia de repouso).

4 ARTIGO 1

EFFECTS OF MAT PILATES TRAINING ON BODY COMPOSITION, MUSCLE STRENGHT, FASTING BLOOD GLUCOSE AND LIPID PROFILE: COMPARASION BETWEEN NORMOTENSIVE AND HYPERTENSIVE POSTMENOPAUSAL WOMEN

Abstract

The aim of this study was to evaluate the effects of Mat Pilates training on body composition, lipids levels, glucose indexes and muscle strength in hypertensive and normotensive postmenopausal women. Forty-seven postmenopausal women between 50 and 70 yrs. were allocated in hypertensive (n=24) and normotensive (n=23) groups. The Mat Pilates exercises program was performed three times a week for 12 weeks. Before and after the intervention body composition was measured by bioimpedance analysis, blood samples were collected for lipids levels, glucose indexes and uric acid measurements. Trunk flexibly by wells bank test and isometric trunk contraction was measured using a load cell. Two-Way ANOVA was used to compare groups, time and its interaction. There were no changes in body composition over time or between groups, but only abdominal circumference decrease ($p<0.01$) after training in both groups. Lipids and glucose serum levels were not different as well, but Uric acid increases ($p<0.01$) and Hemoglobin HbA1c decreases ($p<0.01$) in both groups without difference between them. In addition, the trunk flexion isometric strength ($p<0.01$) and flexibility ($p<0.01$) increased in both groups without difference between them. These results suggest that 12 weeks of Mat Pilates training improves abdominal circumference, HbA1c, trunk flexion isometric strength and flexibility in both hypertensive and normotensive postmenopausal women without changes in lipids and glucose levels and fat and lean mass.

Keywords: Menopause; Hypertension; Pilates; Exercise; Body Mass; Isometric Strength.

1. Introduction

Postmenopausal women report important clinical symptoms that have a negative impact on the quality of life[1]. Besides the reducing of basal metabolism, concurrently there is a loss of lean muscle mass [2], muscle strength [3] accumulation of body fats [4], dyslipidemia and insulin resistance [5] in this critical period of life. These changes are also associated with increases in sedentary behavior [5,6] leading to elevated risk of chronic diseases development, such as cardiovascular diseases and hypertension [7].

We can consider hypertensive and normotensive women to be divergent as a consequence of biological and behavioral issues. The most important biological factors that protect against high blood pressure in women may include hormones, gene variability and additional biological gender variables [7]. These differences may reflect different anthropometric responses between these two groups since normotensive women appear to be less exposed to cardiovascular risks and to physiological changes that reflect on metabolic profile and body composition.

Drug strategies accompanied by non-medication interventions, such as regular physical activity, are already recommended by the guidelines to improve body composition, lipids and glucose levels and blood pressure control, reducing cardiovascular risk and cardio and metabolic diseases development [5,8,9]. Low-impact exercises such as Mat Pilates have been largely performed by postmenopausal women [10] because this method can work with physical capacities aiming improvements in strength, flexibility and balance, and also improving mental conditioning, since it follows principles such as concentration, precision, fluid movement, breathing, axial alignment and centering [10,11].

The Pilates method, in addition to the basic principles of breathing, works all the time with expiration combined with the concentric phase of the movement and inspiration in the eccentric phase, emphasizing the activation of the stabilizing muscles, especially in the transversus abdominis and all musculature of the abdomen pelvic floor being activated in all exercises performed [11]. In isometric exercises, the breathing count continues to be performed with the activation of the muscles mentioned. The method exercises are performed in all their form with the concern of maintaining proper posture and correct muscle recruitment according to what each exercise requires.

Although previous research has demonstrated the efficacy of Pilate’s method on flexibility [1], bone density [12], balance [13], and chronic low back pain [14], there is still a gap in its benefit regarding body composition, lipids levels, insulin resistance and other related physical fitness parameters in hypertensive women after menopause. Therefore, the aim of this study was to investigate the chronic effect of 12 weeks of Pilates training in anthropometric responses in hypertensive and normotensive postmenopausal women.

2. Methods

2.1. Participants

The sample size was calculated using G Power version 3.1 software, adopting an alpha error of 5%, 80% of power analysis, 0.5 of correlation among repeated measures and a nonsphericity correction of 1, in a F family within-between analysis. Changes in body mass index (BMI) were considered as the main variable of the study, so, using the variations caused by Pilates in this variable in a study with similar intervention and population [15], authors report a "Cohen's d effect size" of -0.44, which was transformed into "effect size F", resulting in an effect size of 0.22 for calculation. Thus, we found a minimum required sample of 44 individuals. Participants in the study were women between the ages of 50 and 70, who were in the post-menopausal period (amenorrhea of at least 12 months). The inclusion criteria were: had no physical limitations that avoid exercise performance in the mat and with their own body weight; no history of stroke or acute myocardial infarction; no renal diseases history; not under use of hormonal therapy; not diabetic; not medicated for the control of dyslipidemias or glycemia and no smokers. All participants were regularly active and signed the Informed Consent Term and allocated in normotensive or hypertensive group. Ethical principles for medical research involving human subjects were used by declaration of Helsinki [16]. The exclusion criteria adopted were: students with 2 consecutive absences and at the end of the training did not have 80% of presence; increase in antihypertensive medication for hypertensive patients; physical activities parallel to our intervention.

2.2. Procedures

The clinical trial study was submitted and approved by the local ethics committee of the Federal University of Uberlândia under the number CAE: 68408116.9.0000.5152 and also to the Clinical Trials (NCT03626792). The Pilates exercises program was performed three times a week for 12 weeks. Initially a familiarization with Pilates exercises and its principle of execution was realized as well as familiarization with the Borg Scale. All volunteers performed anthropometric assessments, isometric strength test of the trunk, flexibility test and food recall and collected blood sample before and after the Mat Pilates training period. The study was not blinded and the tests in the pre and post moments were done with the same evaluators. Post tests occurred after 72 hours of the last training session.

2.3. Training program

The Mat Pilates session was held for 50 minutes of exercises with the first 5 minutes of warm-up, 40 minutes of class and 5 minutes of cooling. There was 45 seconds of rest between one exercise and another. For the practice of the 20 exercises chosen (TABLE 1) through the classic exercises thus classified by the creator of the Joseph Pilates method [11], we use only the mats and alternative devices such as the Swiss ball and the flexible ring. Body weight and force of gravity were used as resistance factors and Borg's subjective effort scale [17] as intensity parameters as used in other studies [1,18]. The exercises were divided into training A and B and the progression of overloading occurred with the increase in intensity by the PSE with the score of 9 to 11 during the warming and cooling and in the main part of the class from 11 to 15. From the first to the third volunteers performed 10 repetitions in each exercise, going to 12 repetitions in the fourth to sixth week and from the seventh to the ninth week there was an increase of load through shin guards and free weights maintaining these same increments in the tenth to twelfth week and increasing to 15 repetitions[11,19]. During the sessions, the volunteers were instructed on breathing and body control during the execution of each exercise. All sessions were supervised by an exercise specialist, with a teaching certification in Pilates methodology of training. The classes were held in the morning and the maximum capacity of each hour was 10 participants.

TABLE 1 HERE

2.4. Anthropometric evaluation

To determine the body composition of the volunteers, the anthropometric measures of height and body mass were collected through the In Body 230 bioimpedance (Seoul, South Korea) device using the instrument's own software for reading. In addition abdominal, waist and hip circumference were also collected by a Filizola inelastic tape. Abdominal circumference was obtained between the ribs and the crest with an inelastic flexible tape measure without compressing the tissues based on the measurement above the umbilical scar. The hip circumference was obtained by placing a flexible and inelastic tape measure around the hip region in the area of greater protuberance, without compressing the skin. The waist circumference was obtained in the lowest curvature located in the trunk also by an inelastic and flexible tape. The body mass index (BMI) was calculated using the measures of weight and height, according to the following BMI = weight (kg) / height^2 (cm). The waist-to-hip ratio was also calculated by the waist value divided by the hip value.

2.5. Isometric trunk contraction test

The volunteers were placed in dorsal decubitus (for trunk flexion test) and in ventral decubitus (for trunk extension test) in a cushioned seat with knees extended, feet resting on the seat and secured with a belt and flexion part of the trunk. A belt was used which covered the upper trunk and was connected to a chain, which was attached to the load cell (Kratos model IK-15). The subjects were held firmly in the position of the test and instructed in the attempt to perform a maximum isometric flexion or isometric extension of the trunk in the sagittal plane for five seconds [20]. In both tests, the volunteers had 2 trials with a 3 minute interval between each to validate the result of higher value. The order definition between the flexion and extension test was defined at random. During all the test the volunteer had a verbal stimulus from the evaluator. This load cell was placed perpendicular to the test bench on the floor and so that the value was viewed by the evaluator in Kgf. The flexion / extension ratio was calculated by the value of the bending force divided by the extension force.

2.6. Flexibility Test - Sit and Reach Test

The methodology for the flexibility test adopted was the "sit and reach" test and during this test the practitioners performed a projection of the trunk ahead. To achieve this, the assistance of a bank with already determined dimensions (Bank of Wells Instant Pro Sanny model BW 2005 manufactured by American Medical of Brazil Ltda.). Three attempts were made, where the highest value was recorded in centimeters [21].

2.7. Blood Samples Collection and Analysis

Fifteen mL blood samples were collected after an overnight fast, five days before, and 72 h after, the last exercise training session to eliminate the acute effects of the exercise. These samples were placed in EDTA or serum tubes with separator gel and then centrifuged at 3000 rpm for 15 min and stored in small tubes for future analysis. Plasma concentrations of total cholesterol, triglycerides, high density lipoprotein (HDL) and low density lipoprotein (LDL) cholesterol, uric acid and glucose were determined by enzymatic colorimetric methods. The concentration of glycated hemoglobin (HbA1c) was determined by the turbidimetry method. All analyses were performed using an automated system (Cobas Mira, Roche Instruments Inc. Bellport, NY, USA), using commercial kits (Labtest, Minas Gerais, Brazil).

2.8. Statistical analysis

The results were presented in mean ± standard deviation. To verify the normality of the results, a Shapiro-Wilk normality test and the Levene homogeneity were applied. Two-way ANOVA variance analysis for mixed measures was used for variables in relation to time, group and interaction. The effect size adopted was the partial square eta of the interaction between group and time. All analyzes were performed using SPSS statistical software version 21.0. The level of significance was set at $p \leq 0.05$.

3. Results

A database of 806 women enrolled in the program recruited in traditional media (TV, radio and posters) since the year 2015, of which 755 were excluded because they did not meet the inclusion criteria of the study. The allocation in the groups occurred through a contact list of the database by priority of the longest registration time. The remaining 51 participants started the programme that was divided in two groups: 25 women in the normotensive group and 26 in the hypertensive group under antihypertensive drug therapy but one was excluded because they were impeded from exercise to labyrinthitis in normotensive group, and 2 women gave up for personal reasons and 1 lost of follow-up due to increased antihypertensive dosage in hypertensive group. A total of 47 postmenopausal women participated in the study: in two groups: 24 women in the normotensive group and 23 in the hypertensive group (Figure 1). When comparing the characteristics between the normotensive and hypertensive groups, there were no significant differences in the age (NT: 58 ± 5, HT: 58 ± 5 years; $p = 0.88$), years after menopause (NT: 9 ± 7, HT: 9 ± 7 years; $p = 0.96$), resting systolic blood pressure (NT: 118 ± 9, HT: 123 ± 9 mmHg; $p = 0.09$), resting diastolic blood pressure (NT: 76 ± 6, HT: 78 ± 9 mmHg; $p = 0.36$), resting mean arterial pressure (NT: 90 ± 6, HT: 93 ± 8 mmHg; $p = 0.17$) and resting heart rate (NT: 72 ± 10, HT: 72 ± 7 bpm; $p = 0.90$).

FIGURE 1 HERE

Table 2 presents the anthropometric values of the volunteers from both groups analyzed. There was no interaction between group*time in body mass, lean mass, fat mass, fat percentage, body mass index, waist circumference, hip circumference and waist hip ratio. However, there were a reduction in the abdominal circumference between the pre and post values of both normotensive and hypertensive groups.

TABLE 2 HERE

The results of lipids and glucose serum levels demonstrated that there was no interaction between group*time in total cholesterol, High Density Lipoprotein, Low Density Lipoprotein, No HDL, triglycerides and glucose but Uric acid increases and Hemoglobin HbA1c decreases in both groups without difference between them (Table 3).

TABLE 3 HERE

In the isometric contraction test of the trunk (Table 4), the postmenopausal women, both hypertensive and normotensive, presented increased flexural strength of the trunk in relation to the beginning of the intervention. In the extension force and in the relation between flexion and extension no significant results were found regarding time and group. All volunteers also increased flexibility between pre and post-intervention moments in both groups. In none of the tests of trunk isometry nor of flexibility, we found interaction between group and time.

TABLE 4 HERE

4. Discussion

In our study we found a reduction in abdominal circumference and increase muscular strength of flexion of the trunk and flexibility after 12 weeks of Mat Pilates in both normotensive and hypertensive postmenopausal women. However, the exercises were not effective in reducing body weight, lean mass and fat percentage significantly in both groups but it was effective for maintenance of body composition. Lipids and glucose serum levels were not different as well, but uric acid increases and Hemoglobin HbA1c decreases in both groups. In none of the variables was observed interaction between group and time studied.

Pilates has been studied in different populations, but the results in body composition are still controversial. Positive improvements in the percentage of fat and gain of lean mass in women was found [22] as that found reduction in the percentage of body fat and fat mass in the elderly[10]. In the study with combined training group of water aerobics and Pilates was reduced the anthropometric measures[23]. In other study did not see the gain of lean body mass after Pilates training with postmenopausal women [24].

It is important to report that both lean mass gain and fat mass loss depend directly on the energy expenditure that the exercise provides. The food control showed that there was no difference in the caloric intake between the pre and post training moments, demonstrating that the maintenance of the body composition did not suffer dietary interference. Thus, exercise intensity seems to be a variable that corroborates the anthropometric profile of each individual. In this case, the intensity varied between 9 and 15 by PSE seems not to have been enough to promote an increase in caloric expenditure in postmenopausal hypertensive women. Despite not increasing the lean mass, the maintenance of the same is very important for postmenopausal women. In this phase of women's life sarcopenia is quite common and causes a negative impact on the quality of life of these women by directly compromising the activities of daily life [3]. A finding of extreme relevance in our study was the decrease in abdominal circumference that is directly related to cardiovascular risk factors [25], which demonstrates a positive point for our study. It seems that the Pilates method therefore has a great potential in modulating morphological curvatures than the body composition itself.

Another positive improvement was observed in the increase of the trunk flexion strength of these women due to the neural adaptation of the trained method exercises. The movement of trunk flexion occurs mainly through the rectus abdominis muscles, internal oblique, external oblique, transverse abdomen, iliopsoas, sternocleidomastoid and anterior serratus. According to the exercises chosen in this intervention, these muscles were more activated than the muscles responsible for the extension; so, the increase in muscle strength was only visible significantly in the trunk flexion test. The variable of the ratio between the two forces analyzed also did not express significant results, which shows that the difference between the flexion strength and trunk extension was not large proportionally. Eight weeks of training in this method demonstrated that was enough to improve trunk strength and flexibility in postmenopausal women [1]. Other studies have also addressed the improvement of trunk strength with the Pilates method [1,14] and this increase is very important for prevention of chronic back pain.

In addition to the loss of muscle strength, postmenopausal women also suffer from decreased flexibility, a major strength for musculoskeletal disorders [26]. In the study identified flexibility as a determinant of arterial stiffness [27], which is known to be an independent risk factor for cardiovascular disorders, target organ damage and increased risk of mortality [28]. Pilates in our study increased flexibility for both group as well as in other studies [1,29] because of the characteristics of applied training this specific skill.

Postmenopausal abdominal weight gain is associated with the development of an adverse lipid profile, with an increase in low-density lipoprotein cholesterol and a decrease in high-density lipoprotein cholesterol and insulin resistance [5], which contributes to the atherosclerotic process, a component of the potentially fatal metabolic syndrome. In our study we observed maintenance of lean mass and decreased waist circumference although serum lipid and glucose levels were not so different. However, uric acid increased in both groups as well as the concentrations of glycated hemoglonia after training. High concentrations of uric acid (AU) could be interpreted as a protective factor due to a protective antioxidant response against oxidative stress. The antioxidant activity of UA also occurs in the brain, being a protector for several diseases, such as multiple sclerosis and neurodegenerative disease. Higher concentration of UA is associated with a lower risk of developing Parkson's disease and a favorable effect on disease progression [25]. This finding in our study demonstrates the relevance of Mat Pilates as a protective factor for neurodegenerative diseases in this population. Another important fact that praised the method was the reduction of glycated hemoglobin reflecting in lower blood glucose levels during prolonged periods after training in both normotensive and hypertensive patients.

Although the hypertensive patients were more exposed to worsening of the clinical conditions studied [30], all these clinical relevance were not different between the hypertensive and normotensive groups, demonstrating that the behavior of these analyzed variables were more influenced by the hormonal alterations, that is the postmenopausal women that represent the pathophysiological mechanism [5,30]. Postmenopausal women are more likely to develop metabolic syndrome, changes in weight and body fat distribution related to ovarian hormones deficiency lead to insulin resistance and hypertension [6]. It is notable that the results of maintenance in body composition, increase muscle strength and flexibility in the present study, suggest possible benefits of Mat Pilates in postmenopausal women, both hypertensive and normotensive. Thus, these results can not be generalized for women in other phases, for men or with other types of intervention. It is important to emphasize that the answers obtained could have been different if the intervention time was longer and more evaluations to justify some mechanisms studied. It is noteworthy that few studies with the detailed periodization of the Pilates method as in our study, which gives greater reliability in the results and reproducibility in the tests besides the clinical applicability found for the practice of the method for postmenopausal women in order to maintain the practice in normotensive women for the prevention of cardiometabolic diseases and for non-progression of the disease in the case of hypertensive patients.

5. Conclusion

Twelve weeks of Mat Pilates was not able to change lean or fat body masses in postmenopausal hypertensive and normotensive women, but this exercise training was effective in reducing abdominal circumference and increasing muscle strength related to trunk flexion and flexibility of this population. In addition, an increase in uric acid concentration and decrease in glycated hemoglobin was observed. This response occurred in both the hypertensive and normotensive groups demonstrating that the method provides positive and similar responses in both populations.

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Figure 1. Flowchart

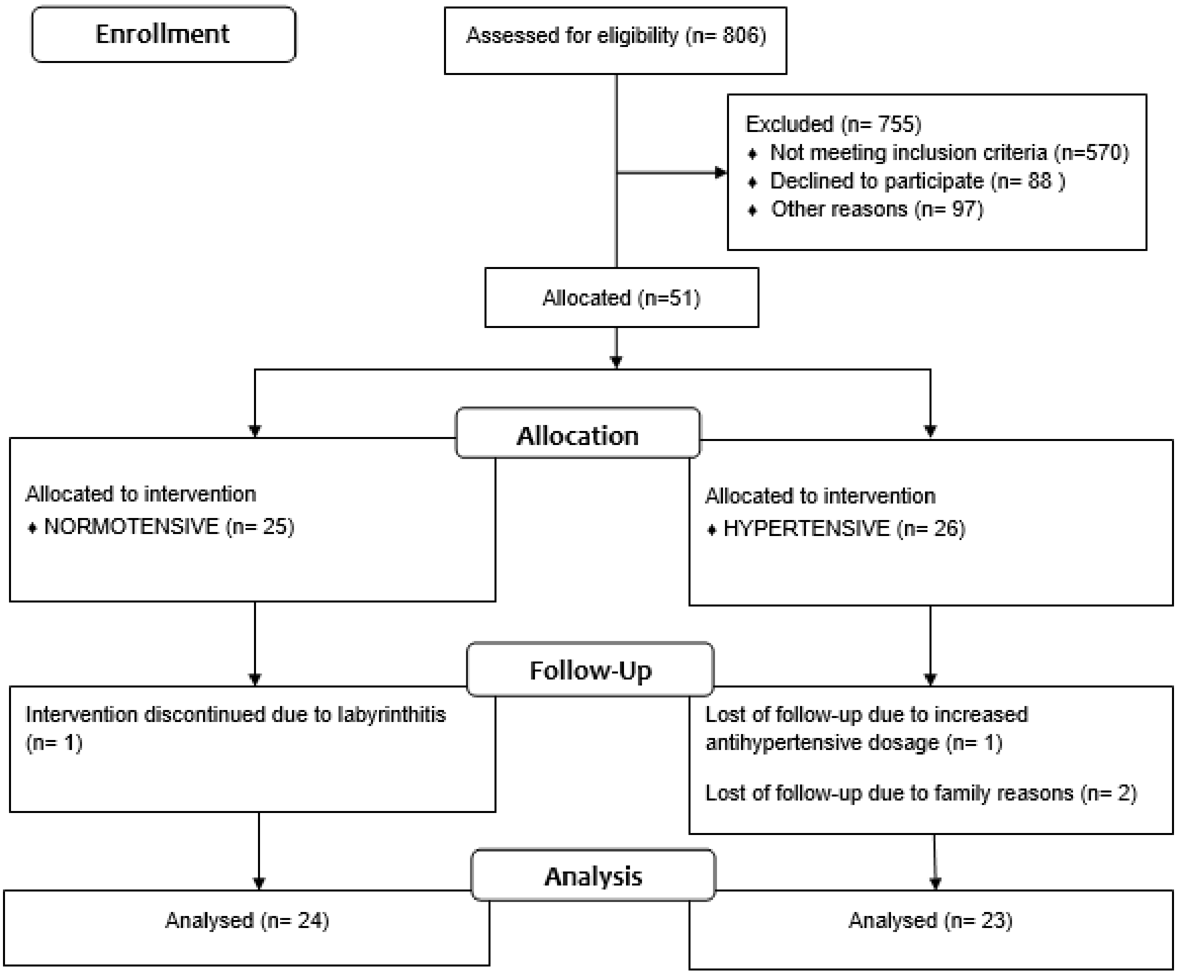

Table 1. Pilates exercise program

Warm up	Exercise	Description
	Roll up	Dorsal decubitus, arms going toward the shoulder line, and from there the head starts to rise and the trunk curls towards the feet.
	Knee folds	Lie on your back with your pelvis in an neutral position, with your knees bent and feet flat. Exhale and tighten your abs to lift your right leg straight up to 90 degrees. Inhale, then exhale and lift your left leg straight up to 90 degrees. Lower your legs to the floor.
	Knee sways	Lying in a dorsal decubitus with a bend in your knees and your feet relaxed flat on the surface.Keep your knees and feet lightly touching and your shoulders flat against the surface as you slowly sway your knees together from side to side.
Training A		
	The one leg stretch	Neutral position lying on back, slowly raise one leg and bend it, forming a 90 ° angle, without leaving the neutral position. Extend the leg forward taking care not to arch your back and raise the other leg extending to which it was folded but without lowering the leg.
	One leg circle (right / left)	Dorsal decubitus, straight legs and circular movements with both legs, one at a time clockwise.
	One leg circle (right / left)	Dorsal decubitus, straight legs and circular movements with both legs, one at a time in the counterclockwise direction
	The shoulder bridge in the ball	Lying face up, bend the knees and place the feet on top of a stability ball.Rest on the

	shoulders and the upper back while keeping the body in a straight line from the knees to the head. Slowly lower the hips back down to the ground, keeping the ball still.
The Swan dive	Ventral decubitus, palms resting on the floor, elbows extended.Keep the spine extension, triggered abs, buttocks and contractors and shoulders away from the ears as the body swings upward and returns toward the ground.
Abdominal with the ball	Contraction of the abdominal muscle, leave the hip on the floor and support both legs on top of the ball, with the hands resting on the chest, remove the shoulder blades from the floor and return to the starting position.
The Hundred with flex	Lying with the backrest on the mat, head and torso slightly raised, legs raised and arms stretched to the side of the hip without touching the ground. Inhale to raise the head and trunk until reaching the base of the scapula, maintaining control of the body and returning to the initial position. The flex ring should be held between the ankles
Abdominal with the ball (alternating legs)	Abdominal muscle contraction, leave the hips on the floor and support both legs at the top of the ball, with the hands resting behind the neck, withdraw the shoulder blades from the floor going with the right elbow towards the left knee that will leave the ball support and return to the starting position to repeat the exercise with the left elbow toward the right knee.

Training B

The double leg stretch	Neutral position lying on your back, slowly lift your legs and bend them at a 90 ° angle, without leaving the neutral position. Extend your legs forward taking care not to arch but without letting your legs touch the ground.
The Shoulder Bridge	Lying face up, bend the knees and place the feet on the ground.Rest on the shoulders and the upper back while keeping the body in a straight line from the knees to the head. Slowly raise and lower hips back to the floor.
The Shoulder Bridge with one leg (right / left) and flex	Lying straight up, bend your knees and extend one leg toward the ceiling. Rest on the shoulders and upper back, keeping the body straight from the knees to the head. Slowly raise and lower your hip back to the floor. Repeat this movement with the other leg. Hold the flex ring at chest height with your elbows bent at shoulder height and tighten every time your hips are raised.
The shoulder bridge with flex ring	Lying face up, bend the knees and place the feet on the ground.Rest on the shoulders and the upper back while keeping the body in a straight line from the knees to the head. Slowly lower the hips back down to the ground. Position the flex ring between the inner thigh and press every time you lift your hip from the floor
Swimming	Neutral position facing down, raise arms and place forward for a V with shoulders. The lumbar area should be stable, without letting the belly yield towards the floor, but keeping the abdomen contracted. Lift

		both the right arm and the left leg simultaneously at the same height. Lower your right arm and left leg at the same time. Repeat the exercise using the left arm and right leg this time.
	The Swan dive in the ball	Ventral decubitus on top of the ball, palms resting on the floor, elbows extended. Hold the extension of the spine, trigger abs, buttocks, contractors and shoulders away from the ears as the body moves up and returns to the ball.
	The Hundred	Lying with the backrest on the mat, head and torso slightly raised, legs raised and arms stretched to the side of the hip without touching the ground. Inhale to raise the head and trunk until reaching the base of the scapula, maintaining control of the body and returning to the initial position.
	Board	Lean forward, lean on the elbows in the ground aligned with the shoulder. Then raise the hip, keeping only supported by the tip of the feet and the elbows. Exercise has no movement, characterizing isometry.
Cooling Down		
	Spine Stretch	Sitting with the spine straight, legs stretched and open slightly beyond the width of the hips. The arms remain stretched forward, always maintaining the alignment of the shoulder blades. It takes the chin to the chest and rolls the column forward, forming a "C". The chest should pass over the thigh and the inner part of the thighs should be lengthening. Return the

		movement to the starting position
	Cat Stretch	In four supports, with hands under the shoulders, the knees under the hips and the legs apart in the distance of the hips. Pelvis and spine in the neutral position. The head should follow the alignment of the thoracic spine. The movement is to articulate the spine, without misaligning the hands and legs. Tilt posteriorly to the pelvis and round the spine, sequentially joining the coccyx to the head. Maintain the position with the abs contracted and supporting the head with relaxed shoulders. We rejoined the spine sequentially to an extension of the thoracic.
	Roll down	Stand your feet shoulder-width apart. Acoluna must be in a neutral position. Lower the body, rolling it forward, keeping the muscles of the neck and arms totally relaxed. Try touching the shins or feet with your hands. Slowly return to the starting position.

Table 2. Comparison of body mass, lean mass, fat mass, fat percentage, body mass index, waist circumference, hip circumference, abdominal circumference and waist hip ratio between the pre- and post-interventionin the normotensive (NT) and hypertensive (HT) groups.

	Pre	**Post**	Δ	***P***	***P***	***p***	***Parcial η^2***
	Mean ± SD	**Mean ± SD**		**(Groups)**	**(Times)**	**(Groups * Times)**	**Effect Size**
BM (Kg)							
NT	66.8 ± 9.7	66.7 ± 9.7	-0.13 ± 1.81	0.30	0.94	0.54	0.008
HT	69.4 ± 7.9	69.5 ± 7.7	0.16 ± 1.24				
LM (Kg)							
NT	22.5 ± 2.7	22.5 ± 2.7	-0.02 ± 0.52	0.06	0.49	0.31	0.023
HT	22.9 ± 2.7	22.8 ± 2.5	-0.12 ± 0.89				
FM (Kg)							
NT	25.4 ± 6.9	25.4 ± 6.9	0.01 ± 1.58	0.66	0.49	0.65	0.005
HT	27.3 ± 7.3	27.7 ± 6.8	0.38 ± 1.90				
FP (%)							
NT	37.5 ± 5.7	37.6 ± 5.4	0.10 ± 1.49	0.29	0.44	0.47	0.012
HT	38.8 ± 7.6	39.4 ± 6.8	0.58 ± 2.79				
BMI (kg/m²)							
NT	26.6 ± 3.3	26.5 ± 3.4	-0.05 ± 0.72	0.39	0.29	0.47	0.012
HT	27.5 ± 3.9	27.6 ± 3.9	0.06 ± 0.50				
WC (cm)							
NT	81.5 ± 8.3	80.6 ± 6.3	-0.83 ± 4.66	0.35	0.91	0.55	0.008
HT	86.0 ± 7.4	84.2 ± 6.9	-1.76 ± 4.14				
HP (cm)							
NT	103.2 ± 9.1	101.7 ± 8.6	-1.55 ± 4.37	0.05	0.50	0.48	0.011
HT	104.3 ± 6.8	102.5 ± 7.1	-1.81 ± 3.49				
AC (cm)							
NT	92.6 ± 8.0	90.2 ± 7.8	-2.48 ± 7.09	0.66	< 0.01	0.82	0.001
HT	93.0 ± 8.5	92.7 ± 6.7	-0.26 ± 4.77				
WHR							
NT	0.8 ± 0.1	0.8 ± 0.1	0.00 ± 0.04	0.50	0.12	0.22	0.034
HT	0.82 ± 0.1	0.8 ± 0.05	0.00 ± 0.03				

NT: normotensive; HT: hypertensive; BM: body mass; LM: lean mass; FM: fat mass; FP: fat percentage; BMI: body mass index; WC: waist circumference; HC: hip circumference; AC: abdominal circumference; WHR: waist hip ratio.

Table 3. Comparison of lipid profile, uric acid, glucose and glycated hemoglobina between the pre- and post-interventionin the normotensive (NT) and hypertensive (HT) groups.

	Pre Mean ± SE	Post Mean ± SE	Δ	*p* (Groups)	*p* (Times)	*P* (Groups*Times)	*Parcial η²* Effect Size
TC (mg/dL)							
NT	229.54 ± 7.78	225.38 ± 8.39	-4.17 ± 6.22	0.07	0.41	1.00	0.000
HT	212.09 ± 7.67	207.87 ± 6.45	-4.22 ± 7.89				
HDL (mg/dL)							
NT	60.92 ± 2.11	61.79 ± 2.35	0.88 ± 0.96	0.50	0.85	0.25	0.030
HT	59.78 ± 2.32	58.57 ± 2.64	-1.22 ± 1.52				
LDL (mg/dL)							
NT	144.58 ± 7.78	138.08 ± 7.72	-6.50 ± 5.25	0.08	0.24	0.76	0.002
HT	127.48 ± 6.56	123.70 ± 5.95	-3.78 ± 7.00				
N-HDL (mg/dL)							
NT	168.63 ± 8.74	163.58 ± 8.89	-5.04 ± 5.79	0.15	0.42	0.84	0.001
HT	152.30 ± 7.67	149.30 ± 7.44	-3.00 ± 7.97				
TRIGL. (mg/dL)							
NT	125.71 ± 11.83	138.50 ± 13.11	12.79 ± 7.14	0.26	0.63	0.31	0.023
HT	181.57 ± 45.94	146.04 ± 18.40	-35.52 ± 47.93				
UA (mg/dL)							
NT	4.00 ± 0.16	4.54 ± 0.13	0.54 ± 0.14	0.40	<0.01	0.98	0.000
HT	4.21 ± 0.28	4.75 ± 0.19	0.54 ± 0.20				
GLU (mg/dL)							
NT	92.92 ± 2.10	93.21 ± 1.67	0.29 ± 1.94	0.20	0.13	0.08	0.066
HT	98.26 ± 2.01	94.17 ± 1.92	-4.09 ± 1.49				
HbA1c (%)							
NT	5.51 ± 0.07	5.23 ± 0.09	-0.28 ± 0.11	0.65	<0.01	0.20	0.036
HT	5.65 ± 0.05	5.18 ± 0.12	-0.47 ± 0.10				

NT: normotensive; HT: hypertensive; TC: total cholesterol; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein; N-HDL: No HDL; TRIGL: triglycerides; UA: uric acid; GLU: glucose and A1c: glycated hemoglobina.

Table 4. Comparison of flexion and extension strength trunk, flexion extension ratio and flexibility between the pre- and post-interventionin the normotensive (NT) and hypertensive (HT) groups.

	Pre	**Post**	Δ	***P***	***p***	***P***	***Parcial Ƞ²***
	Mean ± SD	**Mean ± SD**		**(Groups)**	**(Times)**	**(Groups * Times)**	**Effect Size**
TFT (kgf)							
NT	8.2 ± 4.4	12.9 ± 4.5	4.76 ± 4.63	0.93	< 0.01	0.44	0.13
HT	7.7 ± 5.4	13.6 ± 6.4	5.87 ± 5.14				
TET (kgf)							
NT	13.7 ± 7.8	14.2 ± 7.1	0.46 ± 7.28	0.56	0.13	0.31	0.23
HT	11.5 ± 8.4	13.9 ± 8.7	2.38 ± 5.33				
FER							
NT	1.0 ± 1.8	1.2 ± 0.7	0.12 ± 1.41	0.83	0.22	0.61	0.006
HT	0.9 ± 0.7	1.2 ± 0.6	1.76 ± 1.02				
FLEX(cm)							
NT	22.5 ± 7.7	26.7 ± 9.3	4.19 ± 4.33	0.35	< 0.01	0.37	0.18
HT	20.8 ± 8.9	23.8 ± 9.4	2.98 ± 4.79				

NT: normotensive; HT: hypertensive; TFT: trunk flexion test; TET: trunk extension test; FER: flexion extension ratio; FLEX: flexibility.

5 ARTIGO 2

MAT PILATES TRAINING REDUCES BLOOD PRESSURE IN HYPERTENSIVE AND NORMOTENSIVE POSTMENOPAUSAL WOMEN: A CONTROLLED CLINICAL TRIAL STUDY

ABSTRACT

Background: Cardiovascular diseases (CVD) are more prevalent in postmenopausal women, and physical exercise is a good strategy for treatment and prevention. The aim of this study was to evaluate the effects of a programme of Mat Pilates exercises on resting and ambulatory blood pressure monitoring (ABPM), blood pressure variability (BPV) and heart rate variability (HRV) in hypertensive postmenopausal women.
Methods: Using a clinical trial, 47 postmenopausal women between 50 and 70 years old (24 women in the normotensive group and 23 in the hypertensive group- continuous antihypertensive use. All volunteers participated for 12 weeks of Mat Pilates training and were submitted for pre and post test and before and after the intervention resting blood pressure was measured by automatic monitor, ABPM for were performed during the 24 hours and BPV was analyzed through the measurements obtained from ABPM. Two-Way ANOVA was used to compare groups, time and its interaction. The heart rate was monitored by a heart rate monitor and HRV analyzes were performed.
Results: The main results were reductions on resting systolic ($p< 0.01$), diastolic ($p< 0.01$) and mean blood pressure ($p< 0.01$) after training in both grups. ABPM in sleep time on systolic ($p = 0.05$), diastolic ($p = 0.05$) and mean arterial pressure ($p = 0.01$) was different between groups. In BPV an increase in SDdn indices on systolic ($p =0.02$), diastolic ($p < 0.01$) and mean arterial pressure ($p = 0.01$) in relation with time and in ARV in diastolic ($p = 0.03$) and mean ($p= 0.05$) was observed in both groups. The HRV increase in pNN50 indices ($p = 0.04$) after training in both groups.
Conclusions: A programme of 12 weeks of Mat Pilates training reduce resting blood pressure and increase variability blood pressure and heart rate variability in hypertensive and normotensive postmenopausal women.

1. Introduction

The prevalence of arterial hypertension increases significantly with age, and when the prevalence of this disease between the genders is compared, it is observed that women after menopause are higher than men (Giosia et al., 2018; Whelton et al., 2018). It is believed that this increase occurs due to estrogen deficiency, reduced muscle mass, altered lipid profile, weight gain and the sedentary lifestyle of postmenopausal women compared to premenopausal women (Ward and Deneris, 2018). In addition to the increased incidence of hypertension, all these changes in the body of postmenopausal women also increase the incidence of dyslipidemia, insulin resistance, type 2 diabetes, and other chronic diseases (Cornelissen et al., 2013; Giosia et al., 2018).

Reduction of resting blood pressure values with both chronic and acute exercise plays a very important role in controlling blood pressure and plasma levels of cholesterol and triglycerides (Halliwill et al., 2013). The measurement of resting blood pressure has a time limit, while ambulatory blood pressure monitoring can visualize blood pressure variations over 24 hours and divide into sleep and wake (Parati et al., 2013). Evidences that hypertensive individuals with high blood pressure variability present an increased risk of mortality (Hansen et al., 2010) . Heart rate variability also proves to be a good marker for studying heart health mainly because it is a measure of autonomic activity (Heffernan et al., 2006; Task Force of the European Society, 1996).

Although aerobic exercise is the most practiced, the pilates method has been indicated as an alternative of physical activity for postmenopausal women because of the beneficial effect on various physical abilities of these women (Fourie et al., 2013; Martins-meneses et al., 2015). The method is a complete program of physical and mental conditioning, a dynamic technique that aims to work strength, stretching, flexibility and balance, worrying about maintaining a good body posture (Martins-meneses et al., 2015)

A number of studies have shown that the method Pilates exercises are capable of providing improvements in the cardiovascular system (Fourie Marinda, Gildenhuys Magda, Shaw Ina, Shaw Brandon, Toriola Abel, 2013; Martins-meneses et al., 2015), mainly because it involves exercises with isometry and the expiration junction in the concentric phase of all movement (Gil et al., 2011; Olher et al., 2013), collaborating with an obscure gap in the literature on this type of exercise in hypertensive and normotensive postmenopausal women. Studies indicate that in individuals with higher levels of blood pressure, these reduction is higher compared to normotensive individuals (Queiroz et al., 2015). Therefore, the objective of the study was to verify the effects of the mat Pilates training to better understand the responses of these hypertensive and normotensive postmenopausal women in the cardiovascular responses after training of the mat Pilates method.

2. Methods

2.1. Participants

Participated in the study postmenopausal women (amenorrhea of at least 12 months), aged between 50 and 70 years, who did not present a history of stroke or acute myocardial infarction, renal pathologies, who did not use hormonal therapy, were not smokers, not diabetic; not medicated for the control of dyslipidemias or glycemia and who presented medical certificate releasing the physical activity and that they had no physical limitations that impeded the performance of physical exercises practiced in the soil and with own body weight were considered eligible in the study. All the participants were allocated in the normotensive group or in the hypertensive group (continuous antihypertensive use). The sample size was calculated using G Power version 3.1 software, adopting an alpha error of 5%, 80% of power analysis, 0.5 of correlation among repeated measures and a nonsphericity correction of 1, in a F family within-between analysis. The changes in SBP were considered as the main variable of the study, so, using the variations caused by Pilates in this variable in a study with similar intervention and population (Fourie Marinda, Gildenhuys Magda, Shaw Ina, Shaw Brandon, Toriola Abel, 2013), we found a “Cohen’s d” of 0.42, which was transformed into “effect size F”, resulting in an effect size of 0.21. Thus, we found a minimum required sample of 48 individuals. All participants were regularly active and signed the Free and Informed Consent Term and Ethical principles for medical research involving human subjects were used by declaration of Helsinki (Medical and Wma, 2008). The exclusion criteria adopted were: students with 2 consecutive absences and at the end of the training did not have 80% of presence; increase in antihypertensive medication for hypertensive patients; physical activities parallel to our intervention.

2.2. Procedures

The study was sent and approved by the local ethics committee of the Federal University of Uberlândia under the number CAE: 68408116.9.0000.5152 and also to the Clinical Trials (NCT03626792). The Pilates workout program was performed three times a week for 12 weeks. Initially a familiarization with the principles of concentration, precision, fluid movement, breathing, axial alignment and centering required by the method was performed as well as familiarization with the Borg Scale. All volunteers were submitted to the collection of the blood pressure at rest and for 24 hours through ambulatory blood pressure monitoring (ABPM), in addition to heart rate monitoring and anthropometric evaluation. All of these assessments were collected before and after the Pilates training period. The study was not blinded and the tests in the pre and post moments were done with the same evaluators. Post tests occurred after 72 hours of the last training session.

2.3. Training program

Both groups of volunteers participated in a training program with Pilates physical exercises on the ground with frequency of three times weekly on non-consecutive days over a period of 12 weeks. The Mat Pilates session was held for 50 minutes of exercises with the first 5 minutes of warm-up, 40 minutes of class and 5 minutes of cooling. There was 45 seconds of rest between one exercise and another. For practice we use only mats and alternative devices such as the Swiss ball and the flexible ring, as well as body weight and the force of gravity as resistance factors. As in other studies, (Junior et al., 2016; Lee et al., 2016) we used Borg's subjective perception (Borg, 1982) of effort for intensity parameters. The 20 exercises (TABLE 1) were chosen through the classic exercises thus classified by the creator of the Joseph Pilates method (Martins-meneses et al., 2015). The exercises were divided into training A and B and the progression of overloading occurred with the increase in intensity by the PSE with the score of 9 to 11 during the warming and cooling and in the main part of the class from 11 to 15. From the first to the third week volunteers performed 10 repetitions in each exercise, going to 12 repetitions in the fourth to sixth week and from the seventh to the ninth week there was an increase of load through shin guards and free weights maintaining these same increments in the tenth to twelfth week and increasing to 15 repetitions. During the sessions, the volunteers were instructed on the correct breathing, besides the corporal control during the execution of each exercise monitored by the teacher trained and with Pilates course and 2 instructors. The classes were held in the morning and the maximum capacity of each hour was 10 participants.

TABLE 1 HERE

2.4. Resting and ambulatory blood pressure monitoring

Resting blood pressure (BP) and resting heart rate (HR) were monitored in the pre and post-training moments in both groups of volunteers, using OMRON HEM-7113 automatic monitor the validated and calibrated (Topouchian et al., 2011). At each measurement moment, three pressure and frequency measurements were performed and the mean value was considered for analysis in 3 non-consecutive days. The resting measure was performed with the volunteers in the seated position for twenty minutes in a quiet and quiet environment, with restriction of conversations and of crossing the legs and always in the morning shift.

In addition to the resting BP measurements, ambulatory blood pressure monitoring (ABPM) were performed during the 24 hours with the Dyna Map + - Cardius device, also validated and calibrated (O'Brien et al., 1995). Values well above or below the measurements were discarded by the device software itself, removing the outliers values. On the day of ABPM, the volunteers were instructed not to drink coffee and to record all their meals as well as the medication schedules (in the case of hypertensives) in the daily record. The device was always placed in the morning and taken out the same time the next test.

2.5. Variability of Blood Pressure

The variability of outpatient PA was analyzed through the measurements obtained from ABPM and considered three different indices (Hansen et al., 2010): 24-hour standard deviation (SD) weighted by the time interval between consecutive readings (SD_{24}); the mean diurnal and nocturnal deviations weighted for the duration of the daytime and nighttime interval (SDdn) and the average real variability (ARV_{24}), that averages the absolute differences of measurements and consecutive counts for the order in which the BP measurements are obtained.

2.6. Heart Rate Variability

The heart rate was monitored by the POLAR® RS800cx heart rate monitor (recording frequency: 1000Hz) for 20 minutes at rest (sitting position and spontaneous breathing, in morning). After the measurement, the data were transmitted to a computer via Polar Pro trainer 5® software (Kempele, Finland). Before the HRV analyzes were performed, the data series were visually assessed by an experienced assessor and the points considered artifacts were removed and replaced by the mean of the 3 RR intervals (Interval between adjacent electrocardiographic R deflections) that precede and succeed it. If more than 2% of the data were considered invalid the data series was discarded (Task Force of the European Society, 1996).

HRV analyzes were performed using Kubios® HRV 3.1.0 software (Kuopio, Finland), which was validated for such analysis (Ranta-aho et al., 2013) and was segmented into time and frequency domains (Task Force of the European Society, 1996). The analysis of the data was made by two domains: in the time domain: (1) RMSSD: square root of the mean squared sum of the differences of adjacent RR intervals; 2) SDNN: standard deviation of all normal RR intervals and 3) pNN50: percentage of pairs of adjacent RR intervals with difference of at least 50 ms and in the frequency domain: the high (HF) and low (LF) frequency zones were calculated from the integral of the power density curve of the spectrum in their respective standard zones (LF: 0.04-0.15Hz; HF: 0.15-0.4Hz; ms2). LF and HF were expressed in normalized units (nu), representing the relative contribution of each component to the total power.

2.7. Statistical analysis

The results were presented in mean ± standard deviation. To verify the normality of the results, a Shapiro-Wilk normality test and the Levene homogeneity were applied. The area under the curve (AUC) was calculated by the trapezoidal method (integral calculation) to evaluate the behavior of the variables by time using the Graph Pad Prism software version 4. When analyzed the variables in relation to time, group and interaction, the two way ANOVA for mixed measurements was used. For comparison of the characterization data of the sample of each group, test t Student was used. All analyzes were performed using SPSS statistical software version 21.0. The level of significance was set at $p \leq 0.05$.

3. Results

The program recruited from traditional media (TV, radio and posters) and a database with 806 women was consulted and 755 were excluded because they did not meet the inclusion criteria of the study. The remaining 51 participants started the programme. . The allocation in the groups occurred through a contact list of the database by priority of the longest registration time. There was divided in two groups: 25 women in the normotensive group and 26 in the hypertensive group under antihypertensive drug therapy. For the criteria of exclusion, one was excluded because they were impeded from exercise to labyrinthitis in normotensive group, and two women gave up for personal reasons and one lost of follow-up due to increased antihypertensive dosage. A total of 47 postmenopausal women participated in the study: 24 women in the normotensive group and 23 in the hypertensive group When comparing the anthropometric characteristics between the normotensive and hypertensive groups, we observed that there were no significant differences (Table 2).

TABLE 2 HERE

Table 3 shows the resting blood pressure and heart rate values of both groups. Systolic, diastolic and mean blood pressure values decreased in relation to the pre and post intervention moments in both normotensive and hypertensive women. There was no interaction between group and time for these variables. Analyzing the heart rate we verified a maintenance of the values and no difference between the groups.

TABLE 3 HERE

Table 4 presents the values of SBP, DBP and MBP in 24-hour, sleep and wake analysis. In sleep time, we found difference between the groups in systolic, diastolic and mean pressures being these values smaller in the normotensives. We did not observe interaction between group and time for the ABPM values. For the other variables, the values were maintained in relation to the time and there was no difference between the groups

TABLE 4 HERE

The area below the curve did not indicated an interaction between group and time in the systolic (pre: 2753.00 ± 235.12; post: 2762.17 ± 201.63 mmHg for NT and pre: 2885.57 ± 278.95; post: 2854.22 ± 178.82 mmHG for HT; p = 0.07; p= 0.68) and diastolic pressures (pre: 1666.33 ± 130.64; post: 1652.46 ± 121.75 mmHg for NT and pre: 1724.65 ± 190.78; post: 1739.13 ± 197.73 mmHg for HT; p = 0.11; p = 0.98). There was no interaction between group and time for the area below the curve in systolic (p= 0.46) and diastolic pressure (p = 0.39) (Figure 1).

FIGURE 1 HERE

In the blood pressure variability there was an increase in SDdn indices in relation to the pre and post-intervention moment in systolic, diastolic and mean pressures, and in ARV in diastolic and mean pressures. There was no interaction between group and time for the variability of blood pressure in any of the indices (Table 5). The maintenance of the values at the SD24 index was found but there was no difference between the groups.

TABLE 5 HERE

Table 6 demonstrates the significant increase in heart rate variability in pNN50 relative to the pre and post intervention time in both group. For pNN50 there was no interaction between group and time. In the SDNN, RMSSD, LF and HF indices there was no interaction between group and time.

TABLE 6 HERE

4. Discussion

The aim of our study was to evaluate the chronic effects of Mat Pilates exercises on resting its variability as well as resting heart rate and its variability in hypertensive and normotensive postmenopausal women. The main results were reductions on resting blood pressure in both groups, in ABPM difference between the groups in sleep time with an increase in hypertensives, an increase in SDdn indices and in ARV in diastolic and mean pressures in BPV in relation with time in both groups. In the HRV, an increase in the PNN50 values was observed in the pre- and post-intervention moments in the hypertensive and normotensive groups.

Analyzing the resting blood pressure, we observed in our study that there was a reduction not only in the resting blood pressure of hypertensive women but also of normotensive women. Some studies have demonstrated that in normotensive individuals, the reduction of blood pressure occurs in a less consistent manner, and with lower magnitude than in individual hypertensive (Donald, 2002; Halliwill et al., 2013). One possible explanation for our findings is the effectiveness of the Pilates. It seems that exercises with work focused on controlled breathing and isometric movements are good predictors for the improvement of the resting profile of blood pressure, which was performed in both hypertensive and normotensive individuals (Gil et al., 2011; Martins-meneses et al., 2015; Olher et al., 2013).

Some physiological explanations for BP reductions can be hypothesize: the bioavailability of substances such as nitric oxide, which is an important hemodynamic and metabolic regulator and that helps in physiological processes during exercise mainly in the relaxation of the smooth muscle (Baskurt et al., 2011), a decrease in peripheral vascular resistance (Melo et al., 2018), which may also be related to thermoregulation mechanisms, a reduction of sympathetic activity, baroreflex activity and reduction of cardiac output mainly due to a decrease in systolic volume (Gomes Anunciação and Doederlein Polito, 2011). Analyzed some mechanisms, the increase of the pNN50 index in heart rate variability demonstrates an autonomic parasympathetic predominance which may explain the reduction of resting blood pressure (Drenjancevic et al., 2014). The maintenance of other variables of heart rate variability was also a good indicator of the prevention of cardiac comorbidities, since the lower the variability, the greater the risk of cardiac complications. In the same line, the maintenance of the heart rate was also visualized in both groups, demonstrating a good response of these women to the cardiovascular adaptation of the exercise, which, due to the more resistance characteristics, did not contemplate the improvement of the reduction of the response of this variable but which was able to maintain even in the similar baseline values after training.

When we verified the pressure of these volunteers throughout the 24 hours, we observed that the blood pressure values did not change significantly, maybe for the type of exercises that does not focus on aerobic fitness work in the same proportion as resistance to be able to increase the amplitude of pressure reduction over the 24 hours. In the sleep interval these values were higher in the hypertensive group when compared to the normotensive values. This finding is explained by the pathophysiology of the disease as a function of the circadian cycle (Coylewright et al., 2008; De Brito et al., 2015).

In this study, we did not find a reduction of BPV regardless of the method used (SD24, SDdn and ARV). Systolic BPV can be divided into low, medium or high when related to the risk of cardiovascular events in hypertensive patients (Mena et al., 2005). It is considered values medium when SD24 values are between 12.0 and 15.2 mmHg and ARV are between 8.3 and 9.8 mmHg. In evaluating the BPV, we observed that in the SD24, ambulatory SBP remained in the mean score (NT: pre: 12.2 ± 2.2; post: 12.0 ± 2.0 mmHg, HT: pre: 12.3 ± 2.6; post: 12.8 ± 2.6 mmHg) while the ARV was unable to maintain between the considered mean values. Thus, Mat Pilates was not able to reduce BPV, but by maintaining the systolic pressure in SD24 we reduced the risk of mortality and the morbidity due to cardiovascular diseases in the study population (Zawadzki et al., 2016).

It is notable that, despite the dissonant results for BP resting and ABPM on the present study, the results suggest possible benefits of Mat Pilates training in hypertensive and normotensive postmenopausal women. This benefit in both groups is due to the variation of the blood pressure of the hypertensive and normotensive individuals, although the basal level is different. Moreover, this reduction behavior in both groups implies maintaining the disease for hypertensive patients with the control of this pressure and for preventing the installation of hypertension in the normotensive patients. Being that, the practice of Mat Pilates exercises seems to guarantee the reduction of BP resting and consequently decrease the risks of morbidity and mortality. Thus, this result cannot be generalized for women in other phases, for men or with other types of intervention.

5. Conclusions

In hypertensive and normotensive postmenopausal women the practice of Mat Pilates exercise reduces resting blood pressure and maintains 24-hours outpatient pressure and resting heart rate. In contrast, in sleep time, ABPM were different between the groups with an increase in hypertensive group. The blood pressure variability increases in SDdn indices and in ARV in diastolic and mean pressures as the PNN50 values in the HRV in both groups. The other variables in the indices of variability of blood pressure and heart rate were the maintenance of the values in study.

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Table 1. Pilates exercise program

Warm up	Exercise	Description
	Roll up	Dorsal decubitus, arms going toward the shoulder line, and from there the head starts to rise and the trunk curls towards the feet.
	Knee folds	Lie on your back with your pelvis in an neutral position, with your knees bent and feet flat. Exhale and tighten your abs to lift your right leg straight up to 90 degrees. Inhale, then exhale and lift your left leg straight up to 90 degrees. Lower your legs to the floor.
	Knee sways	Lying in a dorsal decubitus with a bend in your knees and your feet relaxed flat on the surface.Keep your knees and feet lightly touching and your shoulders flat against the surface as you slowly sway your knees together from side to side.
Training A		
	The one leg stretch	Neutral position lying on back, slowly raise one leg and bend it, forming a 90 ° angle, without leaving the neutral position. Extend the leg forward taking care not to arch your back and raise the other leg extending to which it was folded but without lowering the leg.
	One leg circle (right / left)	Dorsal decubitus, straight legs and circular movements with both legs, one at a time clockwise.
	One leg circle (right / left)	Dorsal decubitus, straight legs and circular movements with both legs, one at a time in the counterclockwise direction
	The shoulder bridge in the ball	Lying face up, bend the knees and place the feet on top of a stability ball.Rest on the

	shoulders and the upper back while keeping the body in a straight line from the knees to the head. Slowly lower the hips back down to the ground, keeping the ball still.
The Swan dive	Ventral decubitus, palms resting on the floor, elbows extended.Keep the spine extension, triggered abs, buttocks and contractors and shoulders away from the ears as the body swings upward and returns toward the ground.
Abdominal with the ball	Contraction of the abdominal muscle, leave the hip on the floor and support both legs on top of the ball, with the hands resting on the chest, remove the shoulder blades from the floor and return to the starting position.
The Hundred with flex	Lying with the backrest on the mat, head and torso slightly raised, legs raised and arms stretched to the side of the hip without touching the ground. Inhale to raise the head and trunk until reaching the base of the scapula, maintaining control of the body and returning to the initial position. The flex ring should be held between the ankles
Abdominal with the ball (alternating legs)	Abdominal muscle contraction, leave the hips on the floor and support both legs at the top of the ball, with the hands resting behind the neck, withdraw the shoulder blades from the floor going with the right elbow towards the left knee that will leave the ball support and return to the starting position to repeat the exercise with the left elbow toward the right knee.

Training B

The double leg stretch	Neutral position lying on your back, slowly lift your legs and bend them at a 90 ° angle, without leaving the neutral position. Extend your legs forward taking care not to arch but without letting your legs touch the ground.
The Shoulder Bridge	Lying face up, bend the knees and place the feet on the ground.Rest on the shoulders and the upper back while keeping the body in a straight line from the knees to the head. Slowly raise and lower hips back to the floor.
The Shoulder Bridge with one leg (right / left) and flex	Lying straight up, bend your knees and extend one leg toward the ceiling. Rest on the shoulders and upper back, keeping the body straight from the knees to the head. Slowly raise and lower your hip back to the floor. Repeat this movement with the other leg. Hold the flex ring at chest height with your elbows bent at shoulder height and tighten every time your hips are raised.
The shoulder bridge with flex ring	Lying face up, bend the knees and place the feet on the ground.Rest on the shoulders and the upper back while keeping the body in a straight line from the knees to the head. Slowly lower the hips back down to the ground. Position the flex ring between the inner thigh and press every time you lift your hip from the floor
Swimming	Neutral position facing down, raise arms and place forward for a V with shoulders. The lumbar area should be stable, without letting the belly yield towards the floor, but keeping the abdomen contracted. Lift

		both the right arm and the left leg simultaneously at the same height. Lower your right arm and left leg at the same time. Repeat the exercise using the left arm and right leg this time.
	The Swan dive in the ball	Ventral decubitus on top of the ball, palms resting on the floor, elbows extended. Hold the extension of the spine, trigger abs, buttocks, contractors and shoulders away from the ears as the body moves up and returns to the ball.
	The Hundred	Lying with the backrest on the mat, head and torso slightly raised, legs raised and arms stretched to the side of the hip without touching the ground. Inhale to raise the head and trunk until reaching the base of the scapula, maintaining control of the body and returning to the initial position.
	Board	Lean forward, lean on the elbows in the ground aligned with the shoulder. Then raise the hip, keeping only supported by the tip of the feet and the elbows. Exercise has no movement, characterizing isometry.
Cooling		
	Spine Stretch	Sitting with the spine straight, legs stretched and open slightly beyond the width of the hips. The arms remain stretched forward, always maintaining the alignment of the shoulder blades. It takes the chin to the chest and rolls the column forward, forming a "C". The chest should pass over the thigh and the inner part of the thighs should be lengthening. Return the

		movement to the starting position
	Cat Stretch	In four supports, with hands under the shoulders, the knees under the hips and the legs apart in the distance of the hips. Pelvis and spine in the neutral position. The head should follow the alignment of the thoracic spine. The movement is to articulate the spine, without misaligning the hands and legs. Tilt posteriorly to the pelvis and round the spine, sequentially joining the coccyx to the head. Maintain the position with the abs contracted and supporting the head with relaxed shoulders. We rejoined the spine sequentially to an extension of the thoracic.
	Roll down	Stand your feet shoulder-width apart. Acoluna must be in a neutral position. Lower the body, rolling it forward, keeping the muscles of the neck and arms totally relaxed. Try touching the shins or feet with your hands. Slowly return to the starting position.

Table 2. Comparison between the normotensive (NT) and hypertensive (HT) groups and medications from the hypertension group.

	NT (n=24)	HT(n=23)	
	Mean ± SD	**Mean ± SD**	**(*p*)**
Age (years)	58 ± 4	58 ± 5	0.88
Menopause (years)	9 ± 7	9 ± 6	0.96
Height (m)	1.6 ± 0.1	1.6 ± 0.1	0.64
Body mass (Kg)	67 ± 10	69 ± 8	0.31
Body mass index (kg/m²)	27 ± 3	27 ± 4	0.31
SBP (mmHg)	118 ± 9	123 ± 9	0.09
DBP (mmHg)	76 ± 6	78 ± 9	0.36
MAP (mmHg)	90 ± 6	93 ± 8	0.17
HR (bpm)	72 ± 10	72 ± 7	0.90
Medications		**(n)**	**(%)**
Monotherapy			
ACE inhibitors		4	17.4
AT1 receiver blockers		6	26.1
Thiazide diuretics		2	8.7
Associations with thiazide diuretics			
ACE inhibitors		1	4.4
AT1 receiver blockers		10	43.5

NT: normotensive; HT: hypertensive; SBP: systolic blood pressure; DBP: diastolic blood pressure; MAP: mean arterial blood pressure; HR: heart rate; ACE: angiotensin converting enzyme; AT1: angiotensin 1.

Table 3. Comparison of resting blood pressure and heart rate of resting between the pre- and post-interventionin the normotensive (NT) and hypertensive (HT) groups.

	Pre Mean ± SD	Post Mean ± SD	Δ	*p* (Groups)	*P* (Times)	*P* (Groups * Times)
SBP (mmHg)						
NT	118 ± 9	110 ± 11	-8 ± 7	0.06	< 0.01	0.62
HT	123 ± 9	116 ± 8	-7 ± 8			
DBP (mmHg)						
NT	76 ± 6	69 ± 7	-7 ± 8	0.11	< 0.01	0.27
HT	78 ± 9	74 ± 9	-4 ± 7			
MBP (mmHg)						
NT	90 ± 6	83 ± 8	-7 ± 7	0.06	< 0.01	0.34
HT	93 ± 9	88 ± 8	-5 ± 7			
HR (bpm)						
NT	72 ± 10	70 ± 9	-2 ± 6	0.92	0.21	0.67
HT	72 ± 7	71 ± 10	-1 ± 11			

NT: normotensive; HT: hypertensive; SBP: systolic blood pressure; DBP: diastolic blood pressure; MBP: mean blood pressure; HR: heart rate.

Table 4. Comparison of ambulatory blood pressure measurements (ABPM) between the pre- and post-intervention in the normotensive (NT) and hypertensive (HT) groups.

	Pre Mean ± SD	Post Mean ± SD	Δ	*P* (Groups)	*p* (Times)	*p* (Groups * Times)
24 hours						
SBP (mmHg)						
NT	115 ± 10	116 ± 8	0.98 ± 7.90	0.10	0.90	0.42
HT	120 ± 12	120 ± 8	- 0.95 ± 7.66			
DBP (mmHg)						
NT	70 ± 5	70 ± 5	- 0.05 ± 4.54	0.16	0.56	0.41
HT	72 ± 8	73 ± 9	0.93 ± 5.10			
MBP (mmHg)						
NT	88 ± 7	88 ± 5	- 0.26 ± 7.21	0.05	0.56	0.46
HT	91 ± 8	92 ± 8	1.25 ± 7.09			
Sleep						
SBP (mmHg)						
NT	108 ± 11	107 ± 10	- 1.14 ± 8.86	0.05	0.42	0.96
HT	114 ± 13	113 ± 9	-1.14 ± 10.69			
DBP (mmHg)						
NT	63 ± 7	62 ± 6	- 0.93 ± 6.34	0.05	0.85	0.51
HT	66 ± 9	67 ± 8	0.43 ± 7.72			
MBP (mmHg)						
NT	81 ± 8	79 ± 7	- 1.57 ± 8.85	0.01	0.82	0.37
HT	85 ± 9	86 ± 8	0.88 ± 8.94			
Vigil						
SBP (mmHg)						
NT	118 ± 10	119 ± 8	1.07 ± 7.96	0.35	0.42	0.17
HT	123 ± 12	119 ± 15	-3.58 ± 14.16			
DBP (mmHg)						
NT	72 ± 5	72 ± 5	- 0.16 ± 4.76	0.20	0.62	0.32
HT	74 ± 8	75 ± 9	1.17 ± 5.53			
MBP (mmHg)						
NT	90 ± 7	90 ± 5	- 0,30 ± 7.19	0.30	0.66	0.80
HT	93 ± 8	92 ± 14	-0.95 ± 12.95			

NT: normotensive; HT: hypertensive; SBP: systolic blood pressure; DBP: diastolic blood pressure; MBP: mean blood pressure.

Table 5. Comparison of data of blood pressure variability through the indices 24-hour standard deviation (SD 24) , the mean diurnal and nocturnal deviations weighted for the duration of the daytime and nighttime interval (SDdn) and the average real variability (ARV24) between the pre- and post-interventionin the normotensive (NT) and hypertensive (HT) groups.

	Pre	Post	Δ	*p*	*p*	*P*
	Mean ± SD	**Mean ± SD**		**(Groups)**	**(Times)**	**(Groups * Times)**
SD24						
SBP (mmH)						
NT	12.2 ± 2.2	12.0 ± 2.0	-0.2 ± 2.7	0.40	0.68	0.38
HT	12.3 ± 2.6	12.8 ± 2.6	0.5 ± 2.7			
DBP (mmHg)						
NT	9.3 ± 1.6	9.4 ± 1.7	0.1 ± 2.0	0.60	0.15	0.32
HT	9.2 ± 1.6	9.9 ± 1.7	0.7 ± 1.8			
MBP (mmHg)						
NT	9.5 ± 1.8	9.3 ± 1.5	-0.1 ± 2.0	0.63	0.69	0.38
HT	9.4 ± 1.9	9.8 ± 1.8	0.4 ± 1.9			
SDdn						
SBP (mmHg)						
NT	12.3 ± 3.4	12.6 ± 3.1	0.4 ± 4.0	0.09	0.02	0.11
HT	12.5 ± 2.6	14.8 ± 3.3	2.3 ± 3.9			
DBP (mmHg)						
NT	8.9 ± 1.9	9.4 ± 2.1	0.6 ± 2.3	0.15	< 0.01	0.24
HT	9.2 ± 1.8	10.6 ± 2.4	1.4 ± 2.5			
MBP (mmHg)						
NT	9.3 ± 2.6	9.8 ± 2.5	0.5 ± 3.0	0.14	0.01	0.18
HT	9.5 ± 2.4	11.3 ± 2.6	1.8 ± 3.4			
ARV						
SBP (mmHg)						
NT	6.4 ± 14.2	10.4 ± 2.6	4.0 ± 13.7	0.13	0.07	0.25
HT	10.3 ± 2.1	11.2 ± 2.6	0.9 ± 2.8			
DBP (mmHg)						
NT	4.9 ± 9.8	8.0 ± 2.1	3.1 ± 9.6	0.14	0.03	0.26
HT	7.5 ± 1.4	8.5 ± 2.4	1.1 ± 2.1			
MBP (mmHg)						
NT	4.0 ± 11.9	7.7 ± 2.0	3.7 ± 11.4	0.13	0.05	0.21
HT	7.4 ± 1.6	8.2 ± 1.9	0.8 ± 1.8			

NT: normotensive; HT: hypertensive; SBP: systolic blood pressure; DBP: diastolic blood pressure; MBP: mean blood pressure; 24-hour standard deviation (SD 24) , the mean diurnal and nocturnal deviations weighted for the duration of the daytime and nighttime interval (SDdn); the average real variability (ARV24).

Table 6. Comparison of values of heart rate variability in the time domain (SDDN, RMSSD, pNN50) and the frequency domain (LF and HF) between the pre- and post-interventionin the normotensive (NT) and hypertensive (HT) groups.

	Pre	**Post**	Δ	***p***	***P***	***P***
	Mean ± SD	**Mean ± SD**		**(Groups)**	**(Times)**	**(Groups * Times)**
SDNN (ms)						
NT	25.3 ± 13.0	26.3 ± 11.3	1.0 ± 8.2	0.97	0.45	0.22
HT	28.0 ± 22.9	24.0 ± 13.9	- 4.0 ± 17.9			
RMSSD (ms)						
NT	21.4 ± 13.8	23.2 ± 15.0	1.9 ± 12.5	0.75	0.74	0.51
HT	24.2 ± 22.6	23.6 ± 20.1	- 0.6 ± 13.4			
pNN50 (%)						
NT	4.4 ± 9.4	6.0 ± 12.5	1.6 ± 5.6	0.97	0.04	0.79
HT	4.3 ± 7.6	6.3 ± 11.4	2.0 ± 6.2			
LF (nu)						
NT	71.1 ± 15.0	67.2 ± 18.6	- 4.0 ± 16.3	0.20	0.08	0.73
HT	65.8 ± 18.7	59.8 ± 24.5	-5.9 ± 22.2			
HF (nu)						
NT	28.8 ± 15.0	32.8 ± 18.6	4.0 ± 16.3	0.20	0.08	0.73
HT	34.1 ± 18.6	40.1 ± 24.4	6.0 ± 22.2			

NT: normotensive; HT: hypertensive; SDNN: standard deviation of all normal RR intervals; RMSSD: square root of the mean squared sum of the differences of adjacent RR intervals; pNN50: percentage of pairs of adjacent RR intervals with difference of at least 50 ms; LF: area normalized low frequency; HF: area normalized high frequency.

Figure 1. ABPM - Ambulatory blood pressure monitoring in 24 hours.

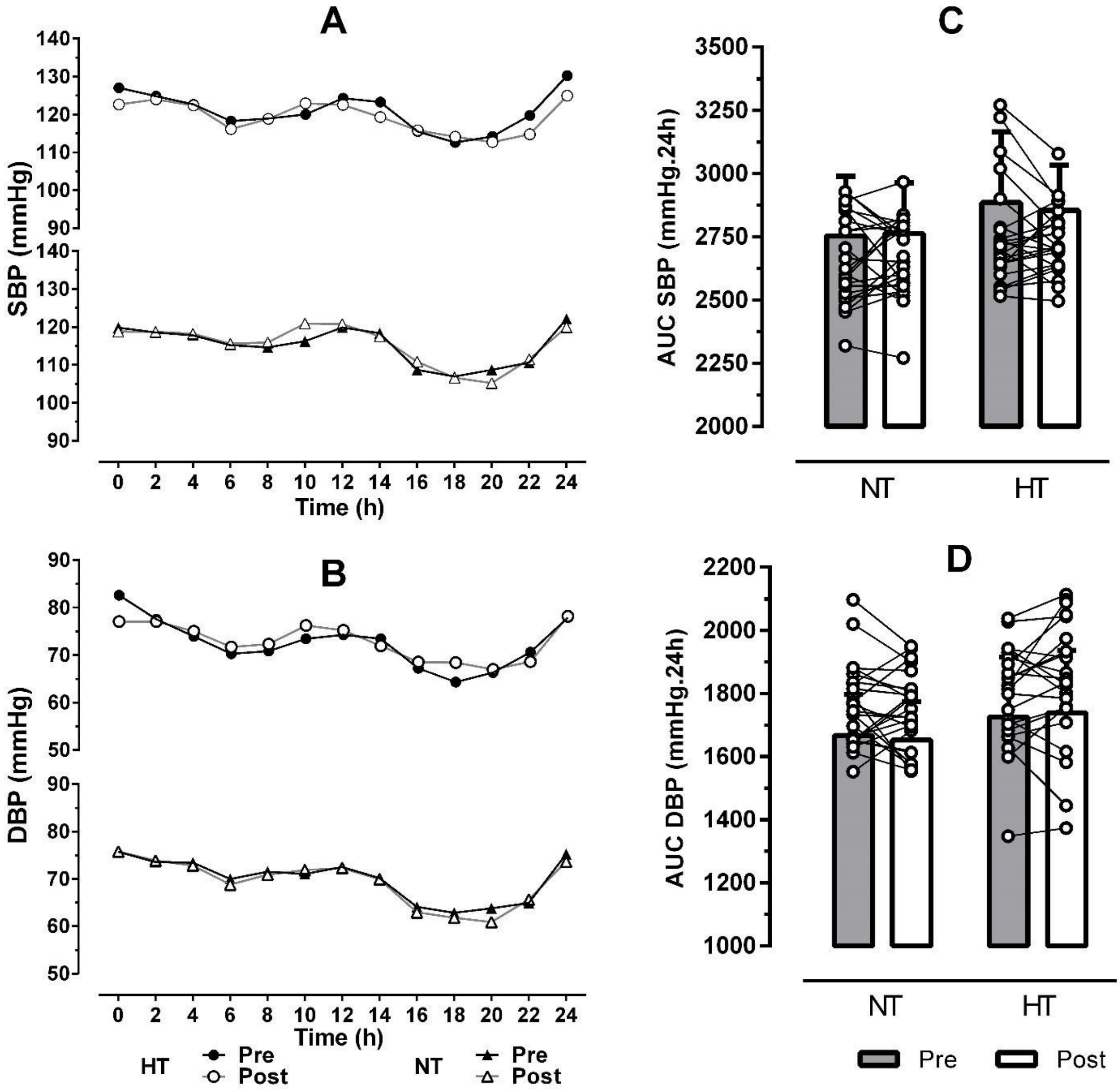

Figure 1. SDB - Systolic Blood pressure (A) DBP - Diastolic Blood pressure (B); AUC SBP -Area under the curve for Systolic Blood pressure (C); AUC DBP - (D) Area under the curve for Diastolic Blood pressure.

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