Women. Health. Bull. 2020; 7(4)

Published online 2020 October.

Research Article

The Ameliorating Impact of Pilates Training on Anxiety and Body Mass Index in Menopausal Symptoms

Arezu Farzaneh[1], PhD candidate; Maryam Koushkie Jahromi[1]*, PhD; Mohsen Salesi[1], PhD; Robabeh Rostami[1], PhD

[1]Department of Sport Sciences, School of Education and Psychology, Shiraz University, Shiraz, Iran

Corresponding author:* Maryam Koushkie Jahromi, PhD; Department of sport sciences, school of education and psychology, Shiraz University, Eram Sq., Postal code: 71946-84334, Shiraz, Iran. Tel: +98 71 36134666;Fax:** +98 71 36286441; **Email:** koushkie53@yahoo.com

Received July 2, 2020; **Revised** August 20, 2020; **Accepted** September 10, 2020

Abstract

Background: Menopausal symptoms severely affect a woman's lifestyle and health. Lifestyle, including physical activity, is known to be an effective factor on the menopausal-associated symptoms. We conducted the present study to evaluate the effects of an eight-week Pilates training on menopausal-related symptoms, including somatic, psychological and sexual symptoms, body mass index (BMI), and anxiety as possible effective factors on menopausal symptoms.
Methods: This was an experimental study conducted in the summer of 2020. The participants in this study were 27 postmenopausal women (aged 60-65, BMI: 24-30) who participated in the study voluntarily. They were randomly divided into two groups of control (n=12) and exercise (n=15). The subjects in the training group participated in Pilates training for eight weeks, three sessions per week and each session lasted 75 minutes with progressive intensity. BMI was measured and the participants completed anxiety and depression questionnaires (HADS) and menopausal symptoms rating scale (MRS) before and after the exercises. We utilized paired t-test and analysis of co-variance (ANCOVA) to analyze the data.
Results: BMI (P=0.023), anxiety (P<0.001), physical score (P<0.001), psychological score (P=0.001), and the total (P<0.001) score of menopausal symptoms reduced significantly following Pilates training compared to the control group. No significant changes were observed in the sexual symptoms of menopause following Pilates training compared to the control group (P=0.60).
Conclusion: An eight-week Pilates training reduced most of the postmenopausal symptoms (somatic, psychological, and total) as well as potentially aggravating menopausal symptoms, including anxiety and BMI.

Keywords: Exercise, Menopause, Body Mass Index, Anxiety, Postmenopause

How to Cite: Farzaneh A, Koushkie Jahromi M, Salesi M, Rostami R. The Ameliorating Impact of Pilates Training on Anxiety and Body Mass Index in Menopausal Symptoms. Women. Health. Bull. 2020;7(4):46-53. doi: 10.30476/whb.2020.88198.1084.

1. Introduction

Menopause is defined as the last period of menstruation, which follows one year of amenorrhea. Accordingly, menopause is the period following the final menstruation (1). It is a natural process that occurs with normal aging (2). Women spend over a third of their lives in menopause, and due to the effects of menopause on the body's systems, preventative measures are of great importance in reducing the incidence of menopausal symptoms (3). Menopausal age in women depends on their lifestyle and medical history. During this process, middle-aged women between the ages of 40 and 60 experience a variety of menopausal symptoms, including physical symptoms such as night sweats, vaginal dryness, hot flashes, joint pain, and psychological symptoms such as forgetfulness, insomnia, anxiety, and headaches. It strongly affects women's lifestyle and health (4). Several factors are involved in the development and exacerbation of menopausal symptoms, including body composition, menopausal stage, age, and lifestyle (5).

Lifestyle, including physical activity, is known to be an effective factor in the onset of menopausal symptoms. Physical activity is divided into exercise and daily physical activity (6). Regular exercise prevents weight gain, improves body composition, develops strength, and increases the body functional capacity. A review study demonstrated that exercise in postmenopausal women causes optimal changes in their body composition, decreases adipocyte, and increases lean mass (7). Regular exercise in various forms, brisk walking for instance, can reduce weight and body fat, and considering the effect of body composition and obesity on menopausal symptoms, it could reduce menopausal symptoms (8). Walking for four months in postmenopausal women has been observed to reduce anxiety and ultimately, menopausal symptoms (9). However, moderate-intensity aerobic exercises for 12 weeks did not reduce vasomotor symptoms, yet improved quality of sleep, insomnia, and anxiety in middle-aged women with sedentary lifestyle (3). Meanwhile, following 12 weeks of exercise all the indicators of quality of life in postmenopausal women

Copyright© 2020, Women's Health Bulletin. This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (http://creativecommons.org/licenses/by-nc/4.0/) which permits copy and redistribute the material just in noncommercial usages, provided the original work is properly cited.

improved (10). Exercise might improve menopausal symptoms by improving physical and functional parameters, such as body composition or fitness (11). It has been suggested that exercises improving cardiovascular fitness can decrease hot flashes or other menopausal symptoms (12). A type of exercise suggested for the reduction of the harmful effects of menopause on physical function is Pilates (13). Pilates includes easy exercises which increase strength, muscular endurance, and flexibility and improve cognitive function. This sport is safer than other types of exercises, and can be considered as a suitable kind of exercise for elder people (14) . A study has shown that eight weeks of Pilates exercises reduced vasomotor, mental disorders, and physical symptoms in postmenopausal women (15) . Nevertheless, certain indicators such as body composition and anxiety affect menopausal symptoms, which has not been controlled in most of previous studies. In addition, considering the wide variety of Pilates training (in terms of intensity and method of execution), it is not clear which kind affects menopausal symptoms. Moreover, environmental factors such as lifestyle, including nutrition and daily physical activity, which are various in different countries, could be effective on the reducing impact of Pilates on these indicators. Therefore, this study aimed to examine the impact of Mat Pilates training with increasing intensity on the menopause-associated symptoms.

2. Methods

In order to examine the impact of Pilates training on menopausal symptoms and clarify the possible effect of BMI and anxiety on these symptoms, we conducted the present work on postmenopausal women. This research is an applied and experimental study performed by pretest-posttest method with two groups of Pilates training and control. It was conducted in the summer of 2020. The statistical population was postmenopausal women in Isfahan. The statistical samples of the project were purposefully selected based on a call among women aged 60 to 65 years. Initially, the call to participate in the research was distributed in various centers, including the Retirement Center and welfare centers in Isfahan. The exclusion criteria was as the following: history of cardiovascular disease, diabetes, smoking, mental illness including depression, use of antidepressants, getting psychotherapy, use of hormonal drugs (estrogen and progesterone),not participating in the research program including exercises and tests, any unpredicted illness that could affect the hormones or variables, any acute psychological stress or movement problems, and the unwillingness of the subject to continue collaboration was with the researcher. The inclusion criteria included subjects with menopausal history of at least five years and the ability to perform the exercises.

We calculated the sample size using the following formula (16):

$$n_A = \kappa n_B \text{ and } n_B = \left(1+\frac{1}{\kappa}\right)\left(\sigma\frac{z_{1-\alpha/2}+z_{1-\beta}}{\mu_A-\mu_B}\right)^2$$

$$1-\beta = \Phi\left(z - z_{1-\alpha/2}\right) + \Phi\left(-z - z_{1-\alpha/2}\right) \quad , \quad z = \frac{\mu_A-\mu_B}{\sigma\sqrt{\frac{1}{n_A}+\frac{1}{n_B}}}$$

$\kappa = nA/nB$ is the matching ratio;

σ is the standard deviation;

Φ is the standard Normal distribution function;

$\Phi-1$ is the standard Normal quantile function;

α is Type I error;

β is Type II error, meaning $1-\beta$ is power.

According to Chow and colleagues (17), the vasomotor symptoms of the exercise and control groups were predicted as 8.86±5.97 and 17.74±11.47, respectively, and the sample size was estimated to be 13 subjects in each group. Out of 61 volunteers, 35 were selected according to the inclusion criteria. Five women were excluded for different reasons, such as sudden stress or illness, possibly affecting the results of the study. 30 women were randomly divided into the control (n=15) and the exercise (n=15) groups through blocked randomization method. 3 women of the control group were excluded due to not participating in the post tests. Therefore, the final participants considered for the data analysis included 27 people, among which 15 were in the training group and 12 in the control group.

Ahead of the exercises, we measured the participants' height and weight parameters to measure BMI. The participants also completed two questionnaires of anxiety and depression (HADS) (17) and menopause rating scale (MRS) (18) so that we could assess the related symptoms. The method of completing the questionnaires was fully explained to the participants. For controlling the acute effect of the exercises, we remeasured the participants' height and weight 72 hours following the training course and both questionnaires were completed by the participants again.

Training and testing: The training protocol consisted of 8 weeks of Pilates training, with about 60 minutes each session (19). In order to observe the principle of overload in sports training, the intensity of exercise increased gradually with the increase in the number of repetitions. The sets and the type of exercises were controlled with Borg scale (Borg, 1998) and heart rate was measured with smart wristbands. The intensity of these exercises increased gradually during the training period according to the ability of the participants. In the first week, the intensity of exercises was moderate meaning that it was 3- 4 (RPE) according to the Borg scale or 96 beat/min based on the heart rate). In the second to fourth week, the intensity was 4- 6 (RPE) based on the Borg scale or average heart rate 110 beat/min. From the fifth to eighth week, the intensity was 6-7 (RPE) based on the Borg scale or average heart rate of 125 beat/min. To obtain the principle of individualization of the training, we increased the intensity of the training based on the ability of each person individually.

The exercises were designed according to Pilates (2001) acetate instructions. The warm-up included 5 minutes of gentle kinetic and tensile movements of various joints. The main exercises were divided into two parts. The initial part (4 weeks) of Mat exercises and the second part (second 4 weeks) of resistance exercises were added. Before starting the main exercises, we performed two training sessions in order to adapt and familiarize our subjects with the Pilates exercises. (20). Each session was performed with one to three sets and with 8-12 repetitions per set, and the number of repetitions increased progressively. The training intensity increased by changing the type of exercises and the number of repetitions and sets.

The Hospital Anxiety and Depression Scale (HADS): Surveying the tension and melancholy in patients with physical and mental issues is an exceptionally suitable and useful self-report apparatus. This questionnaire incorporates 14 inquiries and comprises two sections, 7 of which measure the anxiety, and the other 7 measure the depression. Each of the questions has four options and is scored 0 to 3 (17). The Persian version of the questionnaire was validated by Montazeri and colleagues, whose validity and reliability was approved (21).

The MRS questionnaire: The MRS questionnaire is globally valuable and is employed for assessing menopausal symptoms. It includes 11 menopause-associated inquiries in three areas: physical (4 questions), mental (4 inquiries), and urogenital (3 inquiries). Physical problems assess symptoms of hot flashes and night sweats, sleeping disorders, heart problems, and muscle and joint pain; psychological inquiries examine depression, nervousness, anxiety, poor memory, and lack of concentration; urogenital inquiries are related to urinary problems and dryness, the decreased sexual desire and satisfaction, and vaginal burning. These inquiries are measured on a 5-point Likert scale. In the research by Heinman and colleagues the content and face validity of this questionnaire was assessed and confirmed, Cronbach's alpha was used for calculating its reliability that was obtained to be above 0.65 for all the dimensions (22). Darsareh and colleagues. approved the validity and reliability of its Persian version (23). Lower scores of each domain or the total score is indicative of less severe symptoms of menopause (18). We utilized SPSS software (version 20) to analyze the data. Due to the normality of the data, paired t-test was used to examine within-group changes. The analysis of covariance was applied for examining the differences between the groups. The significance level throughout the present study was considered at 95% or alpha 0.05.

The participants signed the informed consent prior to their contribution to the study. Primarily, the study was approved by the Local Ethic and Graduate Committee of Shiraz University (no: 993/48/1481) and also Ethic Committee of School of Rehabilitation Science in Shiraz University of Medical Sciences (no: IR.SUMS.REHAB.REC.1399.033).

3. Results

Table 1 represents the demographic information of our subjects. The comparison of the two groups using independent t-test indicated no significant differences between the exercise and control groups before the intervention in terms of BMI (t=0.31, P=75), menopausal age (t=0.25, P=0.80), and menopausal history (t=1.25, P=0.22). Therefore, the two groups were considered homogeneous in the above-mentioned variables.

For evaluating the effects of Pilates training on menopausal symptoms and the related factors of BMI and anxiety, we employed paired t-test in order to compare the changes in the groups, and ANCOVA test for inter-group comparisons. According to the results of t test in Table 2, following the exercise in the Pilates training group, we observed a significant decrease in BMI (P=0.016), anxiety (P=0.002), and physical (P=0.047), psychological (P=0.01), and the total (P=0.004) symptoms of menopause; meanwhile,

Table 1: Comparison of Demographic characteristics of the participants in the two groups of exercise (n=15) and control (n=12)

	Group	Mean±SD	T	P
Age	Exercise	61.47±1.55	4.5	0.01*
	Control	62±1.44		
BMI (kg/m^2)	Exercise	28±4.oo	0.31	0.75
	Control	26.5±2.75		
Age of menopause	Exercise	49.5±6.10	0.25	0.80
	Control	50±1.70		
History of menopause	Exercise	11.9±6.50	1.25	0.22

BMI: Body mass index, significant, *P<0.05

Table 2: Comparison of the study variables within and between exercise and control groups

Variables		Group	Pre-experiment	Post-experiment	Within group		Between groups		
					t	P	F	P	Eta square
Symptoms of menopause (score)	Physical	Exercise	6.33±2.49	5.06±2.28	2.1	0.047*	18.09	<0.001*	0.43
		Control	6.58±2.46	7.08±2.15	1.31	0.214			
	Psychological	Exercise	6.33±3.47	6.40±2.79	2.71	0.015*	16.06	0.001*	0.40
		Control	8.16±1.11	8.75±0.86	2.54	0.027*			
	Sexual	Exercise	3.93±2.63	3.86±2.53	0.43	0.670	0.27	0.60	0.11
		Control	4.66±1.30	4.91±1.37	1.91	0.082			
	Total	Exercise	16.40±6.99	13.40±5.92	3.49	0.004*	28.01	<0.001*	0.53
		Control	20.75±2.80	19.41±2.90	3.21	0.008*			
BMI (kg/m^2)		Exercise	28.11±3.99	27.70±3.89	2.75	0.016*	5.86	0.023*	0.19
		Control	27.60±4.31	27.61±3.30	02.34	0.039*			
Anxiety (point)		Exercise	9.93±3.53	6.06±3.15	3.68	0.002*	27.90	<0.001	0.54
		Control	10.66±0.98	11.25±1.13	3.02	0.12			

BMI: Body mass index, significant, *P<0.05

no significant differences were found between post-test and pre-test in concerning sexual symptoms (P=0.67) in the exercise group. In the control group, no significant changes were observed in anxiety (P=0.002) and menopausal symptoms, including physical (P=0.214) and sexual symptoms (P=0.082) whereas BMI (P=0.039) and psychological symptoms (P=0.027) increased significantly.

Table 2 represents the results of ANCOVA test regarding the comparison of variables between the two groups. These results revealed that after controlling the effects of pre-test as covariate, significant differences were found between the two groups considering BMI (F=5.86, P=0.023), anxiety (F=27.90, P=0.021), and menopausal symptoms, including physical (F=18.09, P<0.001), psychological (F=16.06, P=0.001) and the total symptoms (F=28.01, P<0.001) after the intervention. However, no significant differences were seen between the two groups concerning sexual symptoms following the intervention (F=0.027, P=0.60).

4. Discussion

The present study implied that an eight-week Pilates training in postmenopausal women resulted in decreased BMI and anxiety, and moderated symptoms of menopause, including physical, psychological and the total symptoms. Yet, we did not observe any significant effects on sexual symptoms in comparison with the control group. Herein, the participants were homogeneous regarding BMI, menopausal age, and menopausal history, which are the effective factors on menopausal indices.

Previous studied have approved the effects of exercise on reducing cardiovascular disease in postmenopausal women and health problems that occur during menopause (24). The present research illustrated that eight weeks of Pilates reduced BMI in older women. The type of breathing in this sport is such that it effectively promotes oxygen transfer, thereby increasing energy and insulin sensitivity; consequently, fat oxidation increases (25), which could reduce the total weight. Coinciding with this research, Moradpour and colleagues (10) reported that physical activity and exercise energy expenditures are associated with the body composition and increased cardiovascular fitness and could reduce menopausal symptoms. In another study, Conceição (26)

suggested that 16 weeks of weight training improved menopausal symptoms reducing metabolic syndrome, lowering blood glucose, improving body composition and muscle strength in postmenopausal women. In another study on 2399 women aged 46-55, those who had regular physical activity had higher quality of life scores compared to inactive ones. Furthermore, it has been found that women with normal BMI had lower physical symptoms of menopause than inactive women (27). In another study, on 225 middle-aged women, all the three subscales of menopausal symptoms were higher in women with BMI higher than normal score compared to those with normal BMI (26). BMI classification, specifically provided for the Asian populations than international classification was more closely correlated with the menopausal symptoms (28). Inconsistent with the present study, one study showed that weight reduction in obese women could not diminish hot flashes as one of menopausal symptoms (29) while the findings of another research exhibited that higher BMI or higher fat mass might be associated with different effects on menopausal symptoms at different stages of menopause (30). However, given that body composition is a risk factor for the development of menopausal symptoms, a decrease in BMI can be pivotal in reducing the severity of these symptoms. The expansion of the adipose tissues stimulates secretion of inflammatory factors, such as tumor necrosis factor α and interleukin 6, and diminishes adiponectin, disposing to a pro-inflammatory state and oxidative stress. The expanded amount of interleukin 6 stimulates secretion of C-reactive protein (31). Moreover, adipocyte hypertrophy, through physical reasons triggers the rupture of the cells which induce an inflammatory reaction (32). Additionally, there is a relationship between inflammation and hot flashes (33). Therefore, reducing obesity could reduce menopausal symptoms mediating by inflammation reduction.

The present study indicated that eight weeks of Pilates training resulted in a significant reduction in anxiety and menopausal symptoms in older women. Previous findings have shown that women without a history of depression and anxiety are at a higher risk of depression and anxiety during menopause and post menopause than premenopausal stage (34). A strong predictive association has been found between somatic anxiety and the risk of menopausal hot flashes; thus, anxiety treatment has been proposed as a potential target in clinical management of premenopausal women (35). Therefore, another effective factor for reducing the impact of Pilates on menopausal symptoms might be reducing anxiety. Physical activity is one of the best and most effective ways to reduce the rate of cognitive and physical decline and all the malignancies in postmenopausal women due to its multiple health benefits (36). Among various exercises, Pilates improves physical and mental performance, particularly in older women. This type of exercise has been found to be suitable and beneficial for all ages regardless of their abilities (12). Consistent with the present study, a study showed that eight weeks of Pilates exercises improved depression and anxiety, sleeping quality, and fatigue severity in older women aged 60 to 70 (37). Another study examined the effect of 12 weeks of Pilates exercises on people aged 60 to 70. A health chart was used to measure the health, which indicated an improvement in physical, social, mental, and emotional health following the exercise program (38). Another study demonstrated that both aerobic and weight training exercise improved menopausal symptoms in postmenopausal women. Meanwhile, in the group of resistance exercises, no significant changes were observed in the sexual subscale in the post-test, which was consistent with the results of the present study. However, in the group of aerobic exercises, all the subscales indicated a significant decrease (39). The intensity and other characteristics of exercise might be effective on its impact on menopausal symptoms. Dąbrowska and colleagues (40) reported that the severity symptoms of menopause is lower in women with high and moderate levels of physical activity compared to that in inactive women. However, in women with low physical activity, physical and sexual symptoms of menopause were higher than those in women with high or moderate physical activity. Considering that in the present study, the intensity of Pilates training increased progressively, its intensity could be sufficient to induce the ameliorating effects on menopausal symptoms.

The limitations of this study included the small sample size, individual differences (including hormonal differences), physical and psychological conditions before the test, which may affect the test results. Sleeping quality and memory loss are other psychological symptoms of menopause that are suggested to be evaluated further in future researches. Moreover, considering the effect of cardiovascular fitness on menopausal symptoms (10), we suggest that in future researches, the effect of Pilates exercises on cardiovascular fitness and menopausal symptoms be investigated.

5. Conclusion

Eight weeks of Pilates exercises moderated

menopausal symptoms and reduced BMI and anxiety in postmenopausal women. Since obesity and anxiety are among the factors contributing to the severity of menopausal symptoms, in the present paper, Pilates exercises might have reduced menopausal symptoms by affecting these two variables. Due to the hormonal effects on anxiety and stress, future studies are recommended for further clarifications.

Acknowledgements

This paper was a part of the results of a PhD thesis on the effects of Pilates training in postmenopausal women. We greatly appreciate all the participants in the study.

Ethical Approval: The Ethics Review Board of Shiraz University of Medical Sciences approved the present study with the following number: IR.SUMS.REHAB.REC.1399.033).

Funding: This study received no grant from any institution/company/university.

Conflicts of interest: None to declare.

References

1. Harlow SD, Gass M, Hall JE, Lobo R, Maki P, Rebar RW, et al. Executive summary of the Stages of Reproductive Aging Workshop + 10: addressing the unfinished agenda of staging reproductive aging. J Clin Endocrinol Metab. 2012 ;97 (4):1159-68. doi: 10.1210/jc.2011-3362. Epub 2012 Feb 16. PubMed PMID: 22344196; PubMed Central PMCID: PMC3319184.
2. Yu CH, Kor CT, Weng SC, Chang CC, Chen CP, Wu CL. Symptomatic menopausal transition and risk of subsequent stroke. PeerJ. 2019 ;7:e7964. doi: 10.7717/peerj.7964. PubMed PMID: 31687279; PubMed Central PMCID: PMC6825412..
3. Lee B, Im EO, Chee W. Psychometric evaluation of the Midlife Women's Symptom Index in multiethnic groups. West J Nurs Res. 2010 ;32 (8):1091-111. doi: 10.1177/0193945910362066. PubMed PMID: 20606074; PubMed Central PMCID: PMC3037418.
4. Matsuura Y, Matsuzaki K, Yasui T. Menopausal Symptoms in Japanese Nurses: Differences between Smokers and Non-Smokers. Health. 2020;12 (5):85-474. doi: 10.4236/health.2020.125037.
5. Sternfeld B, Guthrie KA, Ensrud KE, LaCroix AZ, Larson JC, Dunn AL, et al. Efficacy of exercise for menopausal symptoms: a randomized controlled trial. Menopause. 2014 ;21 (4):330-8. doi: 10.1097/GME.0b013e31829e4089. PubMed PMID: 23899828; PubMed Central PMCID: PMC3858421.
6. Montgomery G, Abt G, Dobson C, Smith T, Evans W, Ditroilo M. The mechanical loading and muscle activation of four common exercises used in osteoporosis prevention for early postmenopausal women. J Electromyogr Kinesiol. 2019 ;44:124-131. doi: 10.1016/j.jelekin.2018.12.004. PubMed PMID: 30611015.
7. Aragão FR, Abrantes CG, Gabriel RE, Sousa MF, Castelo-Branco C, Moreira MH. Effects of a 12-month multi-component exercise program on the body composition of postmenopausal women. Climacteric. 2014 ;17 (2):155-63. doi: 10.3109/13697137.2013.819328. PubMed PMID: 23826753.
8. Bernard P, Ninot G, Bernard PL, Picot MC, Jaussent A, Tallon G, et al. Effects of a six-month walking intervention on depression in inactive post-menopausal women: a randomized controlled trial. Aging Ment Health. 2015;19 (6):485-92. doi: 10.1080/13607863.2014.948806. PubMed PMID: 25133492.
9. Dąbrowska J, Dąbrowska-Galas M, Rutkowska M, Michalski BA. Twelve-week exercise training and the quality of life in menopausal women - clinical trial. Prz Menopauzalny. 2016 ;15 (1):20-5. doi: 10.5114/pm.2016.58769. PubMed PMID: 27095954; PubMed Central PMCID: PMC4828504.
10. Morardpour F, Koushkie Jahromi M, Fooladchang M, Rezaei R, Sayar Khorasani MR. Association between physical activity, cardiorespiratory fitness, and body composition with menopausal symptoms in early postmenopausal women. Menopause. 2020 ;27 (2):230-237. doi: 10.1097/GME.0000000000001441. PubMed PMID: 31999652.
11. Bailey TG, Cable NT, Aziz N, Dobson R, Sprung VS, Low DA, et al. Exercise training reduces the frequency of menopausal hot flushes by improving thermoregulatory control. Menopause. 2016 ;23 (7):708-18. doi: 10.1097/GME.0000000000000625. PubMed PMID: 27163520.
12. Montero-Fernández N, Serra-Rexach JA. Role of exercise on sarcopenia in the elderly. Eur J Phys Rehabil Med. 2013 ;49 (1):131-43. PubMed PMID: 23575207.
13. Kloubec JA. Pilates for improvement of muscle endurance, flexibility, balance, and posture. J Strength Cond Res. 2010 ;24 (3):661-7. doi: 10.1519/JSC.0b013e3181c277a6. PubMed PMID: 20145572.
14. Wells C, Kolt GS, Bialocerkowski A. Defining

Pilates exercise: a systematic review. Complement Ther Med. 2012 ;20 (4):253-62. doi: 10.1016/j.ctim.2012.02.005. PubMed PMID: 22579438.
15. Lee H, Caguicla JM, Park S, Kwak DJ, Won DY, Park Y, et al. Effects of 8-week Pilates exercise program on menopausal symptoms and lumbar strength and flexibility in postmenopausal women. J Exerc Rehabil. 2016 ;12 (3):247-51. doi: 10.12965/jer.1632630.315. PubMed PMID: 27419122; PubMed Central PMCID: PMC4934971.
16. Chow S, Shao J, Wang H. Sample Size Calculations in Clinical Research. 2nd Ed. Chapman & Hall/CRC Biostatistics Series. page 58. 2008.
17. Lin CY, Pakpour AH. Using Hospital Anxiety and Depression Scale (HADS) on patients with epilepsy: Confirmatory factor analysis and Rasch models. Seizure. 2017 ;45:42-46. doi: 10.1016/j.seizure.2016.11.019. PubMed PMID: 27915110.
18. Jahangiry L, Parviz R, Mirghafourvand M, Khazaee-Pool M, Ponnet K. The psychometric properties of the Persian menopause rating scale. BMC Womens Health. 2020 ;20 (1):172. doi: 10.1186/s12905-020-01027-0. PubMed PMID: 32787824; PubMed Central PMCID: PMC7424665.
19. Vieira ND, Testa D, Ruas PC, Salvini TF, Catai AM, de Melo RC. The effects of 12 weeks Pilates-inspired exercise training on functional performance in older women: A randomized clinical trial. J Bodyw Mov Ther. 2017 ;21 (2):251-258. doi: 10.1016/j.jbmt.2016.06.010. Erratum in: J Bodyw Mov Ther. 2017 ;21 (3):747. PubMed PMID: 28532866.
20. Campos de Oliveira L, Gonçalves de Oliveira R, Pires-Oliveira DA. Effects of Pilates on muscle strength, postural balance and quality of life of older adults: a randomized, controlled, clinical trial. J Phys Ther Sci. 2015 ;27 (3):871-6. doi: 10.1589/jpts.27.871. PubMed PMID: 25931749; PubMed Central PMCID: PMC4395733.
21. Montazeri A, Vahdaninia M, Ebrahimi M, Jarvandi S. The Hospital Anxiety and Depression Scale (HADS): translation and validation study of the Iranian version. Health Qual Life Outcomes. 2003 28;1:14. doi: 10.1186/1477-7525-1-14. PubMed PMID: 12816545; PubMed Central PMCID: PMC161819.
22. Heinemann LA, Potthoff P, Schneider HP. International versions of the Menopause Rating Scale (MRS). Health Qual Life Outcomes. 2003;1:28. doi: 10.1186/1477-7525-1-28. PubMed PMID: 12914663; PubMed Central PMCID: PMC183844.
23. Darsareh F, Taavoni S, Joolaee S, Haghani H. Effect of aromatherapy massage on menopausal symptoms: a randomized placebo-controlled clinical trial. Menopause. 2012 ;19 (9):995-9. doi: 10.1097/gme.0b013e318248ea16. PubMed PMID: 22549173.
24. Ghorbani M, Azhari S, Esmaily HA, GhanbariHashemabadi BA. Investigation of the relationship between personality characteristics and vasomotor symptoms in menopausal women. Iran J Nurs Midwifery Res. 2016;21 (4):441-7. doi: 10.4103/1735-9066.185618. PubMed PMID: 27563331; PubMed Central PMCID: PMC4979271.
25. Rossouw JE, Anderson GL, Prentice RL, LaCroix AZ, Kooperberg C, Stefanick ML, et al. Risks and benefits of estrogen plus progestin in healthy postmenopausal women: principal results From the Women's Health Initiative randomized controlled trial. JAMA. 2002 ;288 (3):321-33. doi: 10.1001/jama.288.3.321. PubMed PMID: 12117397.
26. Conceição MS, Bonganha V, Vechin FC, Berton RP, Lixandrão ME, Nogueira FR, et al. Sixteen weeks of resistance training can decrease the risk of metabolic syndrome in healthy postmenopausal women. Clin Interv Aging. 2013;8:1221-8. doi: 10.2147/CIA.S44245. PubMed PMID: 24072967; PubMed Central PMCID: PMC3783540.
27. Thakur M, Kaur M, Sinha AK. Association of menopausal symptoms as assessed from Greene Climacteric scale with body mass index and osteoporosis among rural women of North India. Anthropol Anz. 2019 ;76 (4):293-304. doi: 10.1127/anthranz/2019/0940. PubMed PMID: 31033995.
28. Chang SJ, Chee W, Im EO. Effects of the body mass index on menopausal symptoms among Asian American midlife women using two different classification systems. J Obstet Gynecol Neonatal Nurs. 2014;43 (1):84-96. doi: 10.1111/1552-6909.12261. PubMed PMID: 24355039.
29. Gallicchio L, Miller SR, Kiefer J, Greene T, Zacur HA, Flaws JA. The Associations Between Body Mass Index, Smoking, and Alcohol Intake with Ovarian Volume in Midlife Women. J Womens Health (Larchmt). 2016 ;25 (4):409-15. doi: 10.1089/jwh.2015.5360. PubMed PMID: 26667258; PubMed Central PMCID: PMC4834464.
30. Fernández-Alonso AM, Cuadros JL, Chedraui P, Mendoza M, Cuadros AM, Pérez-López FR. Obesity is related to increased menopausal symptoms among Spanish women. Menopause Int. 2010 ;16 (3):105-10. doi: 10.1258/mi.2010.010029. PubMed PMID: 20956684.
31. Ellulu MS, Patimah I, Khaza'ai H, Rahmat A, Abed Y. Obesity and inflammation: the linking mechanism and the complications. Arch Med Sci. 2017 ;13 (4):851-863. doi: 10.5114/aoms.2016.58928.

PubMed PMID: 28721154; PubMed Central PMCID: PMC5507106.
32. Monteiro R, Azevedo I. Chronic inflammation in obesity and the metabolic syndrome. Mediators Inflamm. 2010;2010:289645. doi: 10.1155/2010/289645. PubMed PMID: 20706689; PubMed Central PMCID: PMC2913796.
33. Yasui T, Uemura H, Tomita J, Miyatani Y, Yamada M, Kuwahara A, et al. Association of interleukin-8 with hot flashes in premenopausal, perimenopausal, and postmenopausal women and bilateral oophorectomized women. J Clin Endocrinol Metab. 2006 ;91 (12):4805-8. doi: 10.1210/jc.2006-1100. PubMed PMID: 17018658.
34. Mulhall S, Andel R, Anstey KJ. Variation in symptoms of depression and anxiety in midlife women by menopausal status. Maturitas. 2018 ;108:7-12. doi: 10.1016/j.maturitas.2017.11.005. PubMed PMID: 29290217.
35. Freeman EW, Sammel MD. Anxiety as a risk factor for menopausal hot flashes: evidence from the Penn Ovarian Aging cohort. Menopause. 2016 ;23 (9):942-9. doi: 10.1097/GME.0000000000000662. PubMed PMID: 27433864; PubMed Central PMCID: PMC4993654.
36. Anderson D, Seib C, Rasmussen L. Can physical activity prevent physical and cognitive decline in postmenopausal women? A systematic review of the literature. Maturitas. 2014 ;79 (1):14-33. doi: 10.1016/j.maturitas.2014.06.010. PubMed PMID: 25008420.
37. Aibar-Almazán A, Hita-Contreras F, Cruz-Díaz D, de la Torre-Cruz M, Jiménez-García JD, Martínez-Amat A. Effects of Pilates training on sleep quality, anxiety, depression and fatigue in postmenopausal women: A randomized controlled trial. Maturitas. 2019 ;124:62-67. doi: 10.1016/j.maturitas.2019.03.019. PubMed PMID: 31097181.
38. Roh SY. The effect of 12-week Pilates exercises on wellness in the elderly. J Exerc Rehabil. 2016 Apr 26;12 (2):119-23. doi: 10.12965/jer.1632590.295. PubMed PMID: 27162774; PubMed Central PMCID: PMC4849491.
39. Ağıl A, Abıke F, Daşkapan A, Alaca R, Tüzün H. Short-term exercise approaches on menopausal symptoms, psychological health, and quality of life in postmenopausal women. Obstet Gynecol Int. 2010;2010:274261. doi: 10.1155/2010/274261. PubMed PMID: 20814541; PubMed Central PMCID: PMC2931380.
40. Dąbrowska-Galas M, Dąbrowska J, Ptaszkowski K, Plinta R. High Physical Activity Level May Reduce Menopausal Symptoms. Medicina (Kaunas). 2019 ;55 (8):466. doi: 10.3390/medicina55080466. PubMed PMID: 31405242; PubMed Central PMCID: PMC6722698.