Women. Health. Bull. 2021; 8(3)
Published online 2021 July. **Research Article**

Effect of Aquatic Exercises on Severity of Urinary Incontinence and Estrogen Level in Postmenopausal Women

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Received April 24, 2021; **Revised** May 15, 2021; **Accepted** June 2, 2021

Abstract

Background: Urinary incontinence (UI) is prevalent among women and seriously impairs the quality of life. Urinary incontinence is believed to be associated with a decrease in estrogen and estrogen regeneration improves these signs. We conducted the present study to assess the effects of aquatic exercise on multiple domains of urinary leakage and estradiol level in postmenopausal women.
Methods: In this semi-experimental study, 24 postmenopausal women with UI were selected from October to December 2019 in Arak, Iran. They were randomized into the aquatic exercise (n=12) and control (n=12) groups. Aquatic exercise was carried out at moderate intensity, three days per week for eight weeks in 33–34°C, swimming pool. The control group did not participate in a supervised program. The International Consultation on Incontinence Questionnaire–Short Form (ICIQ-SF) was used to assess urinary incontinence and blood samples were collected 48 hours before and after the last sessions of exercise training. In addition, UI-related practices and the use and modification of daily protection were examined. Estradiol was assessed using enzyme-linked immunosorbent assay (ELISA assay). The data were analyzed utilizing paired t test or Wilcoxon test in SPSS version 21.
Results: The mean age of the subjects was 56.77 years old; 78.6% were married and 58% were overweight. The ICIQ-SF score (P=0.03) as well as severity of urinary incontinence symptoms (P=0.05) in the exercise group improved significantly compared to those in the control group. Furthermore, no significant differences in estradiol level were observed between the groups (P>0.05).
Conclusion: Aquatic exercise was found to be beneficial and improved fitness and severity of urinary incontinence in postmenopausal women although this improvement occurred without changes in estrogen levels.

Keywords: Aquatic exercise, Estradiol, Postmenopausal, Urinary incontinence

How to Cite: Saremi A, Zohrevandian K, Parastesh M, Khaleghi S. Effect of Aquatic Exercises on Severity of Urinary Incontinence and Estrogen Level in Postmenopausal Women. Women. Health. Bull. 2021;8(3):152-160. doi: 10.30476/whb.2021.90934.1117.

1. Introduction

Urinary incontinence is a discontent of involuntary loss of urine. Urinary incontinence is divided as stress incontinence, emergency incontinence, postural incontinence, enuresis, mixed incontinence, persistent incontinence, numb incontinence, and sexual incontinence. The most popular form of involuntary loss of urine owing to exercise training, sneezing or coughing is stress incontinence (1). Urinary incontinence is a usual disorder among women. Urinary leakage is reported at least once a year by 25-45% of women (2). Along with age, the prevalence of urinary incontinence increases from 7% in non-pregnant women aged 20 to 32% in women over 80 (3). Major causes of urinary incontinence in women include age, childbirth, obesity, diabetes, stroke, smoking, depression, dysfunction, strenuous physical activity, estrogen deficiency, and genitourinary surgery (for example, hysterectomy) (4). Urinary incontinence is related to clinical and psychological complications that strongly affect the quality of life; stress urinary incontinence increases following menopause (5). Although the exact mechanism is not clear, it has been suggested that a decrease in estrogen levels in postmenopausal women leads to atrophy of the urogenital system and urinary mucosa and narrowing of the mucosal vascular network in the urethra eventually leads to hypersensitivity and urinary incontinence (6). Several studies have emphasized the role and importance of estrogen in pelvic organ prolapse and incontinence. Therefore, hormone therapy is a recommended procedure for the treatment of urinary incontinence in postmenopausal women (7, 8). However, the results have been contradictory and several complications have been reported in women undergoing hormone therapy. Numerous alternative therapies are currently available and are claimed to provide a range of benefits to postmenopausal women even though in some cases, there is little scientific support for them (8).

Physical activity was suggested by the ancient Greeks for health and peace of mind. Hippocrates (460-370 BC) stated that eating is good for human health as well as exercise (9). According to the Centers of Disease Control and Prevention, regular exercise is conducive to elimination of menopausal side effects including psychological stress, decreased overall quality of life, weight gain, and loss of strength and muscle mass (10). It is recommended that people do at least 150 minutes of aerobic activity or 75 minutes of strenuous activity per week to stay healthy (11). Participating in a long-term exercise program in postmenopausal women has been associated with improved physical and mental health and overall quality of life (12). Therefore, exercise has been suggested as an important intervention in reducing menopausal symptoms. Interestingly, such progresses could be attained even with low-intensity exercise such as walking (10). Choosing a woman's exercise activity based on her ability increases her likelihood of adhering to this treatment (13). While we know a lot about the effects of exercise on a variety of diseases, there are few studies on the interaction between exercise and women's urinary incontinence. Major research has reported the positive effect of pelvic floor muscle exercises on urinary incontinence (8, 14). However, there is evidence that the prevalence of urinary incontinence is high in elite female athletes (1). However, the scientific evidence for the effect of other exercise programs, including moderate-intensity aquatic exercise (a common and desirable form among postmenopausal women) on women's incontinence is very limited. Thus, the current study aimed to assess the effects of aquatic exercise on multiple domains of urinary leakage and estradiol level in postmenopausal women.

2. Methods

This research was a quasi-experimental study (from October to December 2019) conducted as a pre-test-post-test. The study population included women with stress urinary incontinence under the auspices of Arak Health Centers, Iran.

The sample size was calculated using G Power software (15). Based on the changes in estradiol levels before and after exercise intervention, which were respectively 18.3±2.0 and 16.9±2.3 pg/mL (8), the calculated effect size was 0.64. The alpha level and power were set as 0.05 and 0.80, respectively, which indicated a minimum sample size of 22. In order to diminish the imaginable problems in the study methods, such as the probability of sample lose and the increase in the statistical precision, 24 people were included in the research. Therefore, 24 postmenopausal women (age: 56.77±3.5 years and body mass index: 28.13±3.4 kg/m2) living in Arak were purposefully and voluntarily selected. The participants were invited through the announcements in health centers affiliated to Arak University of Medical Sciences, Arak, Iran. Urinary incontinence is caused by any involuntary discharge of urine from the body, which is characterized by wetting the pad or underwear (5). The criterion for this choice was a positive answer to the following questions: Do you have urinary incontinence (spontaneous and uncontrolled urination)? , Do you experience urinary incontinence when exercising, coughing, sneezing, or laughing? Subsequently, the subjects completed the demographic and clinical information form, which included a brief description of their urinary status. This form was completed by three people in one month until the required sample size was achieved. The individuals were identified as having urinary incontinence and were examined by a gynecologist at this stage to confirm the diagnosis of stress urinary incontinence. According to other inclusion and exclusion criteria, 24 patients were then selected as the research sample. The samples were then randomly divided into two groups of aquatic training (n=12) and control (n=12). For this purpose, an outside researcher produced a computer sequence of odds numbers and the woman was assigned to the aquatic training group or the control group according to the order of participation in the research. This randomization was performed following the evaluation of the patient, which was a blind evaluation. The University Ethics Committee approved this study with the code of IR.IAU.B.REC.1398.019. This work was conducted after receiving written consent from the candidates. The participants were women who had been menopausal for at least three years and had not received hormone therapy. To be eligible, women must also be able to exercise and have not previously participated in a regular exercise program. Menopause is determined as the suspension of the menstrual cycle for over one year (7). The exclusion criteria were vasculopathy, diabetes mellitus, genital prolapse, neuropathy, thyroid disease, hyperprolactinemia, intolerance or discomfort during exercise (pain, allergy to water and chlorine or other disorders), and reluctance to continue the study and absence for more than two consecutive practice sessions or three sessions during the study.

Exercise intervention

All the training sessions were performed under the supervision of a hydrotherapist and a researcher in the swimming pool of Arak University. The aquatic training was performed in the pool with a depth range of 0.75 to 1.5 meters and a water temperature of 28°C. The aquatic training program was performed three times a week (non-consecutively) with 40 to 60-minute sessions over a period of two months. Each training session included 10 minutes of stretching exercises to warm up, 20 to 50 minutes of core exercises, and 10 minutes of light stretching exercises in water to cool down. The exercise group underwent interval training programs with the following schedule: 10 exercises in each session; each exercise was performed as three sets of 30 second with 15-second intervals three sessions a week. The intensity of the exercises was controlled based on the Borg scale and the ability of people to speak during the exercises at a moderate level. This training program complies with the recommended exercise guidelines through the American College of Sports Medicine for healthy adults (16). Upper and lower body movements were performed alternately to provide additional healing. The control group was asked to maintain their normal activity during the study and not to participate in any exercise programs.

Measurements

Information about demographic data and risk factors for urinary incontinence in women was recorded through interviews. Weight was measured using a Seca scale with an accuracy of 100 grams and height was measured with a tape measure with an accuracy of 0.1 cm. Body mass index was calculated by dividing weight by height in square meters. The status of urinary incontinence was assessed utilizing the International Short-Form Urinary Incontinence Questionnaire (ICIQ-SF). The validity of the questionnaire was assessed through content validity. For this purpose, a questionnaire was sent to a five-member expert board to obtain their opinions. According to their recommendations, the questionnaire was redrafted. Afterwards, based on their opinions, the questionnaire was revised. Moreover, in a recent study by Hajebrahimi and colleagues, the construct validity of the Persian version of ICIQ-SF was evaluated and confirmed (17). The translation validity of the ICIQ-SF was verified by Mokhlesi and colleagues through forward and backward translation. The objective of this questionnaire is to determine the degree of administrative incontinence and its impact on quality of life (18). Moreover, the reliability of questionnaire was evaluated via the pilot study. To test the internal consistency of the instrument, a pilot study was executed 30 days prior to the study. The findings revealed that the structure and language of the questionnaire could be understood by respondents with different demographic characteristics. On the other hand, Cronbach's alpha coefficient for reliability of knowledge about urinary incontinence was 0.79, which is appropriate. This questionnaire evaluates the frequency of urinary incontinence, the rate of incontinence, and how these parameters affect a person's daily life. These items represent the final quality of life score. An interview form was also used to determine the severity of urinary incontinence including questions about the duration of urinary incontinence symptoms (by year), the use of daily sanitary pads, the number of day and night changes, and sanitary pads.

Estrogen evaluation

In order to measure serum estradiol levels, before and after eight weeks of intervention, 5 cc of fasting blood samples were taken from the anticubital vein of each person's left hand and stored in a -30 °C freezer

Table 1: Baseline participant characteristics by intervention assignment			
Variables	**Exercise group**	**Control group**	**P value**
Age(yr.)	56.42± 3.4	57.13± 3.5	0.18
Weight(kg)	71.22± 6.32	70.46± 5.21	0.32
Body mass index(kg/m2)	28.21± 3.35	28.05± 3.8	0.41
Menopause time(yr.)	5.2± 2.65	5.45± 2.44	0.52
Normal birth(n)	3.11± 1.51	2.75± 1.4	0.31

Data are presented as mean± standard deviation.

after separation. Serum estradiol levels were measured employing a human ELISA kit (DRG Germany) at a sensitivity of 10 pg /mL.

Statistical analyses

Following data collection, SPSS version 22 was used for data analysis. The normality of the data was assessed with the use of the Shapiro-Wilk test. Depending on the data distribution, paired t-test or Wilcoxon test were utilized for intragroup comparison and independent t-test or Mann-Whitney test was used for intergroup comparison. The significance level in all the tests was considered to be less than 0.05.

3. Results

In this study, 24 elderly women were randomly selected, 12 in the control group and 12 in the exercise intervention group. There was some sample drop during the study. Accordingly, 12 people in the intervention group and 11 people in the control group completed the study. The participants in the control group had a mean age of 57.13±3.5 years, most of whom were married (78%) and had 10 years of education (71.5%). The average body mass index of the control group was 28.05±3.8 kg/m2 and 57% of them were overweight. The subjects in the intervention group had a mean age of 56.42±4.1 years; most women were married (79.2%) and had seven to nine years of education (61.1%). The average body mass index of the intervention group was

Table 2: Comparison of the risk factors of urinary incontinence in the study groups

	Exercise group			**Control group**		
Risk Factors and Severity Measurements	Pre	Post	P value	Pre	Post	P value
UI time years; Mean ± SD	2.78±0.88	-		3.22±0.75	-	
Activities causing incontinence yes; n(%)						
Coughing	12(100.0)	9(75.0)*	0.02	11(100.0)	11(100.0)	0.89
Sneezing	11(91.66)	10(83.33)	0.21	10(90.90)	11(100.0)	0.56
Laughing	8(66.66)	7(58.33)	0.18	8(72.72)	8(72.72)	0.78
Jumping	6(50.0)	4(33.33)*	0.03	7(63.63)	6(54.54)	0.43
Weight lifting	5(41.66)	3(25.0)*	0.02	3(27.27)	3(27.27)	0.75
Running	3(25.0)	2(16.66)	0.19	4(36.36)	3(27.27)	0.39
Daily protection use number; n(%)						
Always	3(25.0)	1(8.33)*	0.04	2(18.18)	2(18.18)	0.87
Occasionally	4(33.33)	3(25.0)	0.25	4(36.36)	3(27.27)	0.44
Never	5(41.66)	8(66.66)*	0.02	5(45.45)	6(54.54)	0.39
Daily protection changes number; median (IQR)	0.75(2)	0. 5(2)	0.32	1(2)	1(2)	0.79
Nocturnal protection changes number; median (IQR)	1.5(2)	1.5(2)	0.89	0.0(1)	0.5(1)	0.21

Note: Subscript texts represent the units of the variable; for a numerical variable it can be expressed by median and amplitude, or mean and standard deviation, or n and % for categorical variables. IQR=interquartile range; n =absolute frequency; % =relative frequency. The symbol (*) indicates intragroup significant differences (P<0.05).

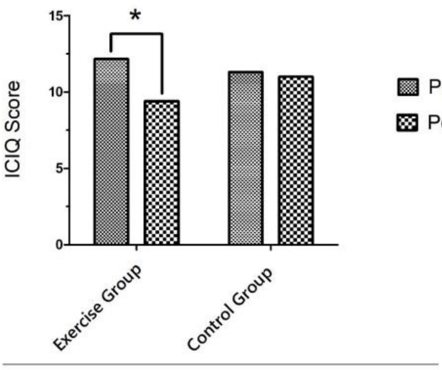

Figure 1: The figure shows the comparison between the pre- and post-values measured using International Consultation on Incontinence Questionnaire–Short time in the exercise and control groups. The symbol (*) indicates intragroup significant differences (P<0.05).

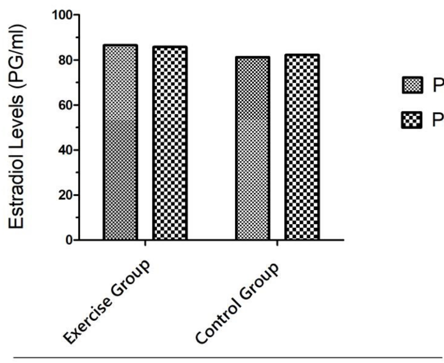

Figure 2: The figure shows comparison between the estradiol levels before and after the aquatic exercise program.

28.21±3.35 kg /m2 and 58% of them were overweight. The duration of menopause was 5.2±2.6 years in the intervention group and 5.45±2.44 years in the control group. The number of normal births was 3.11±1.52 in the intervention group and 2.75±1.4 in the control group (Table 1). In addition to the symptoms of stress incontinence, older women in the control group (57.2%) and the intervention group (54.1%) had urgency-associated urinary incontinence. The training program was well tolerated.

Table 2 compares certain risk factors for the development of administrative incontinence and difficulty measures between the control group and the intervention group before and after the study. The data indicated that at the baseline, both groups were similar in terms of risk factors and severity of measures (P>0.05). After eight weeks of aquatic training, urinary incontinence improved following coughing (P=0.02), jumping (P=0.03), and lifting weights (P=0.02). Moreover, after performing the exercise in the water, the ″always″ (P=0.04) and ″never″ (P=0.02) options for using daily protection were improved (Table 2).

Figure 1 represents that the ICIQ-SF score in the aquatic training group decreased significantly following eight weeks of intervention (P=0.03). These findings indicated the positive effect of aquatic training on reducing the frequency and rate of urinary incontinence and its effect on the quality of life of older women. Additionally, as shown in Figure 2, after eight weeks of intervention, estradiol levels did not change significantly in neither of the groups (P=0.34).

4. Discussion

Overall, our results revealed that participating in an aquatic exercise program significantly reduced the risk of urinary incontinence in women aged 54 to 61 years without any changes in estrogen levels.

Physical activity during menopause and after menopause is of numerous benefits including preventing weight gain, strengthening bones and maintaining muscle mass, and reducing the risk of other diseases (cancer, diabetes, heart disease) (19). Participating in exercise programs has been shown to improve menopausal symptoms including physical, sexual, and psychological difficulties and eventually, the quality of life (20). However, a few studies have been conducted on the effect of physical activity and exercise on incontinence in older women. Previous studies have reported that elite female athletes are more likely to have urinary incontinence (1). This is probably due to the effect of strenuous physical activity on the pelvic floor muscles (21); for example, a recent cross-sectional study showed that following a session of strenuous physical activity, the average voluntary contraction pressure decreased by about 20%, suggesting that such exercise may strain the pelvic floor muscles and increase the risk of urinary incontinence (22). Even though there are several clear studies on the negative effects of strenuous exercise on the symptoms of urinary incontinence (21, 22), little has been done on the effects of moderate-intensity exercise on various physiological aspects of urinary incontinence. In the present study, the ICIQ score significantly decreased in the water-trained group compared to that before the intervention period. On the other hand, this decrease was associated with improved symptoms and risk factors of urinary incontinence in older women. Since this type of exercise is associated with improvements in muscle strength, general health, weight loss, stress relief, and inhibition of pelvic floor prolapse (8, 16), it could apparently be a protective factor against urinary incontinence. In a comprehensive study, Hannestad and co-workers found that women who exercised moderately for 3 hours a week had a 20% lower chance of developing urinary incontinence than sedentary women (23). Consistent with our findings, a prospective study of 6424 women with 40 years of age or older demonstrated that the risk of stress and emergency urinary incontinence was higher in sedentary women than that in active women (24). Recently, certain studies have reported that the association between physical activity and urinary incontinence is stronger in older women. Nonetheless, since marriage is an important risk factor for urinary incontinence in young women, other factors, such as physical activity, may be less important in young women than those in older women (25). Aging and sedentary lifestyle seem to cause a decrease in pelvic floor muscle strength, which is associated with a decrease in urinary control in the elderly people. Studies have shown that strong pelvic floor muscles help reduce the risk of urinary incontinence (3, 14). Therefore, in some studies, the positive effect of pelvic floor muscle strengthening exercises on female incontinence has been studied and confirmed (8, 14); for instance, Virtuoso and colleagues reported that in elderly women, after 12 weeks of pelvic floor muscle strengthening resistance training, the symptoms of urinary incontinence significantly reduced (26). However, there are no clear studies on other forms of exercise, including aquatic exercise, which are preferred by people of this age due to their physical condition and orthopedic problems (including osteoarthritis). Although the positive effects of aquatic exercise on various aspects of elderly women's health, such as improving metabolic indicators, maintaining strength and musculoskeletal mass, quality of life have been confirmed (27), the effect of this exercise on the symptoms of urinary incontinence in women menopause has not been studied.

On the other hand, atrophy of the vagina and surrounding tissues and symptoms, such as dryness, itching, and pain during intercourse, which occur in postmenopausal women, support the belief that urinary tract dysfunction is attributed to estrogen deficiency (28). Therefore, lower urinary tract symptoms (recurrence and incontinence) are thought to indicate estrogen deficiency and restoring normal estrogen levels improve these symptoms (29). Nevertheless, there are conflicting results regarding the effect of hormone therapy on improving the symptoms of urinary incontinence (7, 8). Some studies have suggested that exercise, as a potential intervention strategy, plays a pivotal role in controlling and preventing menopausal complications, such as osteoporosis and muscle atrophy, by altering the levels of anabolic hormones, specifically estrogen (19, 20). Contrary to this belief, in the present study, eight weeks of exercise in water had no significant effects on estradiol levels. In this regard, Razzak and co-workers showed that 12 weeks of exercise is associated with improved estradiol levels in postmenopausal women and that anaerobic exercise is more effective than aerobic exercise (30). On the other hand, in certain studies (31), such as the present paper, no changes have been reported in estrogen levels after exercise in postmenopausal women. Thus, it seems that the fat burning effects of exercise play an important role in the estrogen response because in exercises that reduce fat mass, estrogen levels decrease while no changes in fat mass has been associated with the changes in estrogen levels. Hence, it seems that in the present study, the intensity and duration required for weight loss and subsequent increase in estradiol levels were not provided. In fact, in the present study, no changes were observed in estradiol levels along with the improvement of incontinence symptoms and the ICIQ-SF score, indicating that the positive effects of exercise in water may occur independently of the changes in estrogen levels. Although aquatic exercise has long been an effective treatment, there is little scientific evidence in this regard. The benefits of water exercise include increased aerobic capacity, increased muscle strength and endurance, increased joint range of motion, reduced muscle fatigue and joint pain, reduced risk of cardiovascular disease, and improved mental disorders, such as stress, anxiety, and depression (27, 31, 32). In the present study, the improvement observed in urinary incontinence in women after eight weeks of exercise in water was probably owing to the mechanisms like the improvement in psychological stress and increase in muscle strength and endurance (including in the core and pelvic floor muscles), which requires further study in this area. Herein, we encountered several significant limitations. Urodynamic evaluation is the best way to determine the type of urinary incontinence; meanwhile, this bias decreases by using the ICIQ-SF questionnaire, which detects the frequency and intensity of signs. Clinically, this tool is easier and cheaper to use than urodynamic examination. Another limitation was the small number of samples; thus, it could be recommended to conduct further studies with larger sample sizes and longer time periods to achieve more accurate results.

5. Conclusion

The findings of the present study revealed that a period of aquatic exercise, independent of the changes in estradiol levels, could have positive effects on the symptoms of urinary incontinence in postmenopausal women. In fact, the present study, with an interdisciplinary approach to specialists in sports science, physiotherapy and obstetrics, provided a short-term treatment procedure for elderly women with urinary incontinence.

Acknowledgment: This research is part of a thesis in Exercises Physiology Department of Arak University conducted by Ms. Samira Khaleghi. The researchers would like to thank all the individuals who participated in the research.

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

Conflict of interests: None declared.

Ethical considerations: The study was approved by the University Ethics Committee with the code of IR.IAU.B.REC.1398.019 and the research was conducted after receiving written informed consent from the participants.

References

1. Goldstick O, Constantini N. Urinary incontinence in physically active women and female athletes. Br J Sports Med. 2014;48(4):296-8. doi: 10.1136/bjsports-2012-091880. PubMed PMID: 23687004.
2. Almousa S, Bandin van Loon A. The prevalence of urinary incontinence in nulliparous adolescent and middle-aged women and the associated risk factors: A systematic review. Maturitas. 2018;107:78-83. doi: 10.1016/j.maturitas.2017.10.003. PubMed PMID: 29169586.
3. Padmanabhan P, Dmochowski R. Urinary incontinence in women: a comprehensive review of the pathophysiology, diagnosis and treatment. Minerva Ginecol. 2014;66(5):469-78. PubMed PMID: 25078140.
4. Milsom I, Gyhagen M. The prevalence of urinary incontinence. Climacteric. 2019;22(3):217-222. doi: 10.1080/13697137.2018.1543263. PubMed PMID: 30572737.
5. Bedretdinova D, Fritel X, Panjo H, Ringa V. Prevalence of Female Urinary Incontinence in the General Population According to Different Definitions and Study Designs. Eur Urol. 2016;69(2):256-64. doi: 10.1016/j.eururo.2015.07.043. PubMed PMID: 26259998.
6. Yan W, Li X, Sun S, Xiang Y, Zhou Y, Zeng X, et al. Risk factors for female pelvic organ prolapse and urinary incontinence. Zhong Nan Da Xue Xue Bao Yi Xue Ban. 2018;43(12):1345-1350. doi: 10.11817/j.issn.1672-7347.2018.12.010. PubMed PMID: 30643051.
7. Weinstein MM. Hormone therapy and urinary incontinence. Menopause. 2012;19(3):255-6. doi: 10.1097/gme.0b013e31824e9bb0. PubMed PMID: 22367730.
8. McTiernan A, Tworoger SS, Ulrich CM, Yasui Y, Irwin ML, Rajan KB, et al. Effect of exercise on serum estrogens in postmenopausal women: a 12-month randomized clinical trial. Cancer Res. 2004;64(8):2923-8. doi: 10.1158/0008-5472.can-03-3393. PubMed PMID: 15087413.
9. Chlebowski RT. Nutrition and physical activity influence on breast cancer incidence and outcome. Breast. 2013;22:S30–7. doi: 10.1016/j.breast.2013.07.006. PubMed PMID: 24074789.
10. Stojanovskaa L, Apostolopoulosa V, Polmanb R, Borkolesb E. To exercise, or, not to exercise, during menopause and beyond. Maturitas. 2014;77(4):318-23. doi: 10.1016/j.maturitas.2014.01.006. PubMed PMID: 24548848.
11. Riebe D, Franklin BA, Thompson PD, Garber CE, Whitfield GP, et al. Updating ACSM's recommendations for exercise preparticipation health screening. Med Sci Sports Exerc. 2015;47(11):2473-9. doi: 10.1249/MSS.0000000000000664. PubMed PMID: 26473759.

12. Villaverde-Gutiérrez C, Araújo E, Cruz F, Roa JM, Barbosa W, Ruíz-Villaverde G. Quality of life of rural menopausal women in response to a customized exercise programme. J Adv Nurs. 2006;54(1):11–9. doi: 10.1111/j.1365-2648. 2006. 03784.x. PubMed PMID: 16553686.
13. Galbreath M, Campbell B, LaBounty P, Bunn J, Dove J, Harvey T, et al. Effects of adherence to a higher protein diet on weight loss, markers of health, and functional capacity in older women participating in a resistance-based exercise program. Nutrients. 2018;10(8):1070. doi: 10.3390/nu10081070. PubMed PMID: 30103509; PubMed Central PMCID: PMC6115985.
14. Radzimińska A, Strączyńska A, We`ber-Rajek M, Styczyńska H, Strojek K, Piekorz Z. The impact of pelvic floor muscle training on the quality of life of women with urinary incontinence: a systematic literature review. Clin Interv Aging. 2018;13:957-965. doi: 10.2147/CIA.S160057. PubMed PMID: 29844662; PubMed Central PMCID: PMC5962309.
15. Dupont WD, Plummer Jr WD. Power and sample size calculations. A review and computer program. Control Clin Trials. 1990;11(2):116-28. doi: 10.1016/0197-2456(90)90005-m. PubMed PMID: 2161310.
16. Da Silva LA, Tortelli L, Motta J, Menguer L, Mariano S, Tasca G, et al. Effects of aquatic exercise on mental health, functional autonomy and oxidative stress in depressed elderly individuals: A randomized clinical trial. Clinics. 2019;74:e322. doi: 10.6061/clinics/2019/e322. PubMed PMID: 31271585; PubMed Central PMCID: PMC6585867.
17. Hajebrahimi S, Nourizadeh D, Hamedani R, Pezeshki MZ. Validity and reliability of the International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form and its correlation with urodynamic findings. Urol J. 2012;9(4):685-90. PubMed PMID: 23235974.
18. Mokhlesi SS, Karimian N, Ebadi A, Khoshnejad F, Dabiri F. Psychometric properties of the questionnaire for urinary incontinence diagnosis of married women of Qom city in 2015. JRUMS. 2017;15(10): 955-966. Persian.
19. Dugan SA, Gabriel KP, Lange-Maia BS, Karvonen-Gutierrez C. Physical activity and physical function: moving and aging. Obstet Gynecol Clin North Am. 2018;45(4):723-736. doi: 10.1016/j.ogc.2018.07.009. PubMed PMID: 30401553.
20. Dąbrowska-Galas M, Dąbrowska J, Ptaszkowski K, Plinta R. High physical activity level may reduce menopausal symptoms. Medicina. 2019;55(8):466. doi: 10.3390/medicina55080466. PubMed PMID: 31405242; PubMed Central PMCID: PMC6722698.
21. Hagovska M, Švihra J, Buková A, Dračková D, Švihrová V. Prevalence and risk of sport types to stress urinary incontinence in sportswomen: A cross-sectional study. Neurourol Urodyn. 2018;37(6):1957-1964. doi: 10.1002/nau.23538. PubMed PMID: 29464810.
22. Ree ML, Nygaard I, Bø K. Muscular fatigue in the pelvic floor muscles after strenuous physical activity. Acta Obste Gynecol Scand. 2007;86(7):870-6. doi: 10.1080/00016340701417281. PubMed PMID: 17611834.
23. Hannestad YS, Rortveit G, Daltveit AK, Hunskaar S. Are smoking and other lifestyle factors associated with female urinary incontinence? The Norwegian EPINCONT Study. BJOG. 2003;110(3):247-54. PubMed PMID: 12628262.
24. Dallosso HM, McGrother CW, Matthews RJ, Donaldson MMK, Leicestershire MRC Incontinence Study Group. The association of diet and other lifestyle factors with overactive bladder and stress incontinence: a longitudinal study in women. BJU Int. 2003;92(1):69-77. doi: 10.1046/j.1464-410x.2003.04271.x. PubMed PMID: 12823386.
25. Danforth KN, Shah AD, Townsend MK, Lifford KL, Curhan GC, Resnick NM, et al. Physical activity and urinary incontinence among healthy, older women. Obstet Gynecol. 2007;109(3):721-7. doi: 10.1097/01.AOG.0000255973.92450.24. PubMed PMID: 17329526.
26. Virtuoso JF, Menezes EC, Mazo GZ. Effect of weight training with pelvic floor muscle training in elderly women with urinary incontinence. Res Q Exerc Sport. 2019;90(2):141-50. doi: 10.1080/02701367.2019.1571674. PubMed PMID: 30945991.
27. Colado JC, Triplett NT, Tella V, Saucedo P, Abellán J. Effects of aquatic resistance training on health and fitness in postmenopausal women.

Eur J Appl Physiol. 2009;106(1):113-22. doi: 10.1007/s00421-009-0996-7. PMID: 19205723.

28. Cody JD, Jacobs ML, Richardson K, Moehrer B, Hextall A. Oestrogen therapy for urinary incontinence in post-menopausal women. Cochrane Database Syst Rev. 2012;10(10):CD001405. doi: 10.1002/14651858.CD001405.pub3. PubMed PMID: 23076892; PubMed Central PMCID: PMC7086391.
29. Hirai K, Tsuda H. Estrogen and urinary incontinence. Int J Urol. 2009;16(1):45-8. doi: 10.1111/j.1442-2042.2008.02164.x. PubMed PMID: 19120525.
30. Razzak ZA, Khan AA, Farooqui SI. Effect of aerobic and anaerobic exercise on estrogen level, fat mass, and muscle mass among postmenopausal osteoporotic females. Int J Health Sci. 2019;13(4):10-16. PubMed PMID: 31341450; PubMed Central PMCID: PMC6619462.
31. Ketabipoor SM, Koushkie Jahromi M. Effect of aerobic exercise in water on serum estrogen and C-reactive protien and body mass index level in obese and normal weight postmenopausal women. Womens Health Bull. 2015;2(3):e25048. doi: 10.17795/WHB-25048.
32. Silva MR, Alberton CL, Portella EG, Nunes GN, Martin DG, Pinto SS. Water-based aerobic and combined training in elderly women: Effects on functional capacity and quality of life. Exp Gerontol. 2018;106:54-60. doi: 10.1016/j.exger.2018. 02.018. PubMed PMID: 29476803.