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Effect of Diaphragmatic Training on Urgency Urinary Incontinence in Post-Menopausal Women

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Abstract:

Background: Urgency urinary incontinence (UUI) is characterized by an uncontrollable loss of urine accompanied by a sudden, intense urge. **Objective:** The aim of this study was to investigate the effect of diaphragmatic breathing exercise on urge urinary incontinence in postmenopausal women. **Methods:**Seventy postmenopausal women complaining from mild or moderate degree of UUI participated in this study. They were randomly distributed into 3 groups unequal in numbers: Group (A) consists of 20 women. They will receive medical treatment in the form of selective anti Muscarinic drugs (5-10 mg) once per day for 12 weeks and instructions including bladder retraining. Group (B) consists of 25 women. They will receive the same treatment in group (A), pelvic floor muscle training (PFMT) and abdominal strengthening 3 sessions/week for 12 weeks. Group (C) consists of 25 women. They will receive the same treatment in group (B), in addition to diaphragmatic training 3 sessions/week for 12 weeks.**Assessment:** Urodynamic investigation used to measure volume at first desire to void, first sensation of bladder filling during cytometry, and maximum bladder capacity for each patient in all groups. Ultrasound assessment used vaginally to assess bladder ascending movement. Incontinence Questionnaire used to assess urinary function. All assessment tools used for each woman in all groups before and after treatment program. **Results**: Regarding bladder ascending movement, there was no significant difference in group A, a decrease in group B, an increase in group C. There was an increase in first sensation and first desire, the maximum bladder capacity and confidence in controlling urine leaks in all groups in favor to group C. **Conclusion**: Diaphragmatic breathing showed a greater increase in bladder ascending movement, first sensation, and desire, and increased bladder capacity.

Keywords:Diaphragmatic Training, Urgency Urinary Incontinence, Post-Menopausal, pelvic floor training

1. Introduction

Urgency urinary incontinence arises from the bladder's failure to store urine effectively. Its exact causes remain unclear but are thought to involve multiple factors including abnormalities in bladder receptors, nerve supply both peripheral and central, pelvic floor muscle (PFM) function, and behavioral aspects (1). Proposed mechanisms for detrusor overactivity, a key contributor to UUI, include decreased neural inhibition, heightened excitatory signals in the urination reflex pathway, and increased sensory input from the bladder that may bypass central controls. Key risk factors for developing UUI in women include age, childbirth history, obesity, neurological conditions, and chronic constipation (2)

UUI poses a substantial health issue for women, restricting daily activities and diminishing life quality. It can lead to additional health concerns, including depression and social withdrawal, and is a key reason for increased dependency in the elderly, often influencing decisions regarding nursing home placements (3).

Also, the repercussions of waking up at night due to urge incontinence can be severe. Without treatment, UUI can significantly deteriorate psychological health, life quality, and physical well-being due to heightened fall risks and a higher likelihood of vaginal and groin infections. Studies have shown that women with UUI are at an increased risk of hip fractures and losing independence (4).

Numerous treatment options exist for managing urinary incontinence in the elderly, with a preference for non-surgical methods as the initial treatment approach. Individualizing treatment is crucial based on patient preferences. Conservative management remains the preferred initial treatment for most cases of urinary incontinence because it does not negatively impact the success of future treatments and typically has minimal side effects (4).

Conservative therapies considered before surgical interventions include pelvic floor muscle training (PFMT), electrical stimulation, biofeedback, magnetic stimulation, and vaginal cones, often. PFMT, in particular, is advised as the primary treatment strategy for women experiencing urinary incontinence (5).

2. Patients and Methods

1.1. Study participants and ethics

Seventy postmenopausal women complaining from mild or moderate degree of UUI participated in this study after signing the consent form. This study extended from August 2022 to March 2024. The study was approved by the Ethical Committee for Human Research at the Faculty of Physical Therapy, Cairo University, Egypt (NO: P.T.REC/012/004600). Also, it has been registered on clinicaltrials.gov with identification no. (NCT06521008).

1.2. Study design

Study design was Pre- test and post- test experimental study. The participants were selected from Outpatient Clinic of Gynecological Department, OM El Masreen General Hospital, Giza. They

were randomly assigned into three equal groups in numbers using a computer-based randomization program by an independent researcher. Group (A) received medical treatment in the form of selective anti Muscarinic drugs (5-10 mg) once per day for 12 weeks and instructions including bladder retraining. Group (B) received the same treatment in group (A), pelvic floor muscle training (PFMT), and abdominal strengthening, three sessions/week for 12 weeks. Group (C) received the same treatment in group (B), in addition to diaphragmatic training three sessions/week for 12 weeks.

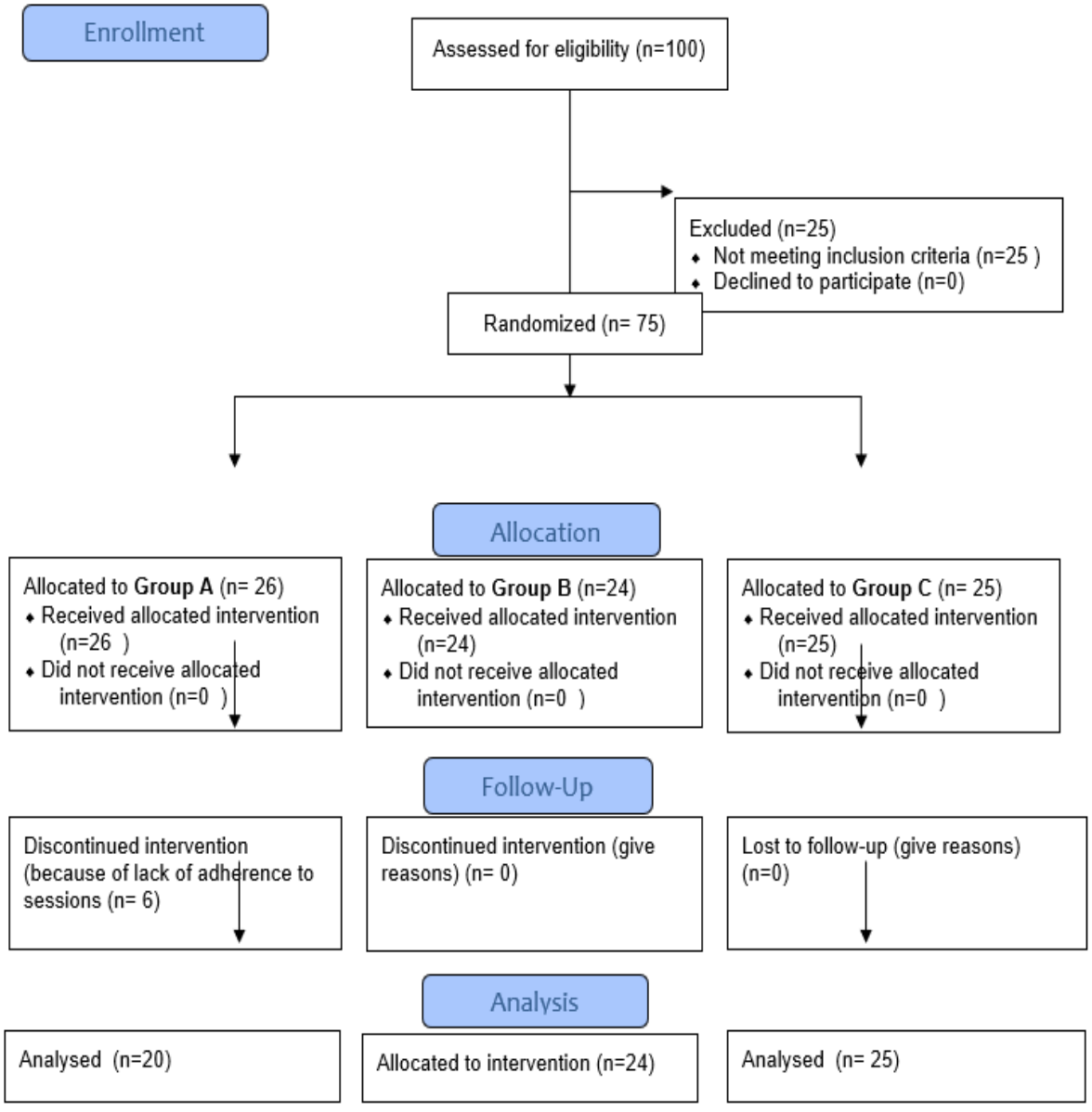

Fig. 1. Flow chart

To be included in the study, subjects were evaluated using the following criteria: patients ages ranged from 50 to 60 years, and their body mass index (BMI) ranged from 25-29.9 Kg/m2. All

patients were multipara and delivered normally. They experienced menopause at least for 3 years. Participants were excluded from this study if they didn't meet the inclusion criteria or if they had dysfunction or associated injuries or any pathological conditions such as pure stress urinary incontinence, genital prolapse, cardiac abnormalities, recurrent urinary tract infections, hypertension, diabetes mellitus, upper motor neuron diseases, previous surgical procedures for gynecological problems or hysterectomy, history of genito-urinary cancer, or previous pelvic irradiation.

2.3. Sample size calculation:

The sample size for this study was calculated using the G*power program 3.1.9 (G power program version 3.1, Heinrich-Heine-University, Düsseldorf, Germany). The effect size for the sample size calculation was depending on the previous studies (Burgio et al., 1998). Sample size calculation based on F tests (MANOVA: Special effects and interactions), Type I error (α) = 0.05, power (1-β error probability) = 0.80, effect size f2 (V) = 0.1437705, and Pillai V = 0.2513975 with a total sample size for 62 participants for 2 independent groups comparison for 5 major variable outcomes. Considering a 10% drop out rate, the appropriate minimum sample size for this study 69 patients.

2.4. Outcome measures:

1. Standard weight/height scale was used to measure weight and height to calculate BMI for each patient in all groups.
2. Transvaginal bladder ultrasonography (6W-3B000218, Model: DC-N2, China) was used to assess bladder ascending movement before and after treatment program for each patient in all groups (6).
3. Urodynamic device (Serial No:CN-0WWVVk-BOZ00-165-0ZXB-A00, Model Dell S2421HN, China) was used to measure volume at first desire to void, first sensation of bladder filling (1st SBF) during cytometry, and maximum bladder capacity (MBC) for each patient in all groups.
4. Urinary Incontinence Questionnaire was used to assess urinary functions for all patients (7).

2.5. Methods:

2.5.1. Assessment procedures

Weight was measured on weight scale on the morning after toilet. Record the weight to the nearest decimal fraction for each woman in all groups. height measured by height Bar. Take the measurement while the woman stands with head, shoulders, buttocks, and heels touching the flat surface (wall). Then, BMI was calculated according to the formula: BMI=weight (kg)/height squared (m2) (8).

Transvaginal ultrasound scans were performed to the patient in the semi crock lying position. Ask the patient not to be in full bladder nor very evacuated the bladder should be in normal state. Using a 5MHz mechanical end-firing probe and the image was visualized on an Ultra mark 4 (ATL). Then ask the patient to do diaphragmatic breathing with pelvic floor contraction. The

bladder dimensions' displacement was then calculated as an average of the three measurements. It was used before and after treatment program for all women (9).

Urodynamic investigations where the patient is placed supine, and a multi-lumen urodynamic catheter is inserted into the bladder. The catheter is introduced into the bladder with an aseptic technique using local anesthetic lubricant gel. A second catheter is introduced into the rectum or vagina to measure abdominal pressure. The transducers for the fluid-filled system are external and adjusted to the height of the superior border of the symphysis pubis, the approximate anatomical level of the base of the bladder. The three traces displayed on the screen indicate the abdominal pressure, vesical pressure, and the calculated detrusor pressure. The bladder is filled and then the patient is asked to void, with continuous pressure monitoring during filling and emptying. It was also used to measure volume at first desire to void, first sensation of bladder filling (1st SBF) during cytometry, when the patient first becomes aware of the bladder filling and maximum bladder capacity (MBC) (volume at which patients feel they can no longer delay micturition during filling) (10).

Urinary incontinence questionnaire was used to assess urinary functions for each patient in all groups. It consisted of 21 questions: 17 related to urinary leakage problems, 2 related to frequency problems, and 2 related to retention problems. Each patient was instructed carefully about the questionnaire and was given appropriate time to give appropriate answer to each question (11).

2.5.2. Treatment procedures

Each woman in all groups received selective anti muscarinic drugs (5-10mg) once per day for 12 weeks. All patients were taught lifestyle modifications such as pelvic floor muscle training, fluid management, reducing caffeine and other bladder irritants, and managing constipation (12).

Bladder training using consistent incremental voiding schedules to reduce voiding frequency, increase bladder capacity. Patients were instructed to void at predetermined intervals. A voiding interval was determined for each patient based on the longest time interval between voids that was comfortable for her. Over time, the voiding interval was increased at comfortable intervals to a maximum of every 3–4 hours (13).

Pelvic Floor Muscle Training (PFMT) included teaching patients how to control the bladder by contracting the striated skeletal PFM that surrounded the urethra (Anna et al., 2018). Each patient was instructed on how to contract her PFM correctly when she stopped mid-stream urine from a crock lying position. (Newman et al., 2016). For pubo vaginalis muscle, each patient was asked to try to contract as if she controlled her urethral orifice, hold contraction for a count of 10, and relaxed for a count of 10 (3). For pubo rectalis muscle, therapist stood beside the patient and both hands were under the glutei with the tips of the fingers around the anus to feel the contraction of the muscle. She tried to contract as if she controlled bowel action without glutei movement. For the whole muscle, the therapist stood beside the patient with both hands under the glutei and the tips of fingers around the anus; the therapist observed contraction of the pubo vaginalis part through lowering of the lower abdomen. Each patient was asked to try to contract as if she controlled bowel action and urethral orifice, and drew the vagina up. Duration of

contraction and repetitions were increased every session about 10 repetitions. Also, as a graduation, PFMT were performed from sitting on the ball. The training program was 3 sessions/week under supervision for 12 weeks. The total duration was 20 -30 minutes (3).
Static abdominal exercises were performed from crook lying and creeping positions. Abdominal exercises were performed for 15 minutes (14).
Diaphragmatic breathing exercises were performed from comfortable crock lying position. She was asked to take deep inspiration from the nose, make her abdomen like a balloon, and push the therapist's hand up, then expire the air from the mouth with a sigh. She was not allowed to initiate inspiration with accessory muscles and upper chest, nor to force expiration. Also, diaphragmatic breathing from sitting position was performed as patient was asked to sit straight on a chair, lengthening the distance between her navel and sternum and placing her hand at the waistline while performing the same deep inspiration steps. Exercise from each position was repeated for 3-4 times to avoid hyperventilation then, relax for 5 seconds and repeat. The total duration was 5-10 minutes. It was performed 3 time/week for 12 weeks (15).
The combined breathing exercise with PFMT was performed as patient was asked to breathing out as you start your exercise and then time keep doing your pelvic floor exercise as you breathe shallow and soft, not deep. Keep breathing and keep holding pelvic floor muscles as if you can for up to 10 seconds and then relax back to resting breathing normally (16).
Breathing exercise combined with abdominal exercises was performed as each patient was instructed to lie face down and place a small ball under the abdomen. She was asked to inhale until full, then breath out, stiffening all muscles of the abdomen at once, as if bracing against the ball, hold for 3 seconds, then slowly inhale and relax (17).

Sample size calculation

It was calculated using the G*power program 3.1.9 (G power program version 3.1, Heinrich-Heine-University, Düsseldorf, Germany). The effect size for the sample size calculation was depending on the previous studies (Burgio et al., 1998). Sample size calculation based on F tests (MANOVA: Special effects and interactions), Type I error (α) = 0.05, power (1-β error probability) = 0.80, effect size f2 (V) = 0.1437705, and Pillai V = 0.2513975 with a total sample size for 62 participants for 2 independent groups comparison for 5 major variable outcomes. Considering a 10% drop out rate, the appropriate minimum sample size for this study 69 patients.

Statistical analysis

The statistical analysis was conducted by using statistical SPSS Package program version 25 for Windows (SPSS, Inc., Chicago, IL). Quantitative data for clinical general characteristic of postmenopausal women (age, weight, height, and BMI) are expressed as mean and standard deviation. Qualitative data are reported as frequency (percentage) for self-report urinary incontinence questionnaire items. Analysis on variance (ANOVA) test used to compare among group A, group B, and group C for clinical general characteristic of postmenopausal women. Chi-square test used to compare among group A, group B, and group C for self-report urinary

incontinence questionnaire items. All statistical analyses for quantitative and qualitative data were significant at level of probability ($P \leq 0.05$).

3. RESULTS

In the current study, a total of 70 postmenopausal women suffering from urgency urinary incontinence were participated and distributed randomly into three unequal groups. The results of clinical general characteristics data for postmenopausal women (Table 1) showed that no significant differences (P>0.05) in mean values of women age (P=0.352), weight (P=0.052), height (P=0.622), and BMI (P=0.103) among groups A, B, and C.

Table 1. Clinical general characteristic of postmenopausal women among groups

Items	Groups (Mean ±SD)			P-value
	Group A (n=20)	Group B (n=25)	Group C (n=25)	
Age (years)	58.25 ±2.48	58.72 ±2.74	57.64 ±2.61	0.352
Weight (kg)	74.30 ±4.52	75.12 ±4.92	77.76 ±3.46	0.052
Height (cm)	158.80 ±2.80	159.52 ±3.02	160.12 ±6.41	0.622
BMI (kg/cm^2)	29.10 ±1.21	29.22 ±1.37	29.81 ±1.01	0.103

Quantitative variables data are reported as mean ±standard deviation P-value: probability value P-value<0.05: non-significant

Statistical comparison test for urine leaks frequency before getting to the toilet (Table 2) within each group showed there were significant decreases (P<0.05) in urine leaks frequency within group A (P=0.010), group B (P=0.0001), and group C (P=0.0001) after treatment. Statistical comparison test for urine leaks frequency before getting to the toilet (Table 2) among groups (A, B & C) indicated that there was no significant difference (P=0.916) in the urine leaks frequency before getting to the toilet among groups before treatment. However, there was a significant difference (P=0.0001) among groups after treatment. Pairwise comparisons (Table 2) showed that there was a significant decrease in the urine leaks frequency before getting to the toilet between group A and group B (P=0.027), in favor of group B, between group A and group C (P=0.0001) in favor of group C, and group B and group C (P=0.003) in favor of group C.

Table 2. Comparison of urine leaks frequency before getting to the toilet (Q1) before and after treatment for groups (A, B & C)

Q1	Group A (n=20)		Group B (n=25)		Group C (n=25)	
	Before-treatment	After-treatment	Before-treatment	After-treatment	Before-treatment	After-treatment
Very loose	0 (0.0%)	6 (30.0%)	0 (0.0%)	10 (40.0%)	0 (0.0%)	22 (88.0%)
Moderately loose	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (20.0%)	0 (0.0%)	0 (0.0%)
Slightly loose	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (8.0%)	0 (0.0%)	0 (0.0%)
Neither tight nor loose	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Slightly tight	17 (85.0%)	14 (70.0%)	22 (88%)	8 (32.0%)	21 (84.0%)	3 (12.0%)
Moderately tight	3 (15.0%)	0 (0.0%)	3 (12.0%)	0 (0.0%)	4 (16.0%)	0 (0.0%)
Very tight	0 (0.0%)	6 (30.0%)	0 (0.0%)	10 (40.0%)	0 (0.0%)	22 (88.0%)
Within group	Group A		Group B		Group C	
P-value	0.010*		0.0001*		0.0001*	
Among groups	Pre-treatment				Post-treatment	
P-value	0.916				0.0001*	
Pairwise comparisons	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
P-value	0.027*		0.0001*		0.003*	

Data are expressed as frequency (percentage); P-value: probability value; * Significant (P<0.05)

Statistical comparison test for urine leaks quantity before getting to the toilet (Table 3) within each group showed there were significant decreases (P<0.05) in the urine leaks quantity before getting to the toilet within group A (P=0.008), group B (P=0.0001), and group C (P=0.0001) after treatment. Statistical comparison test for urine leaks quantity before getting to the toilet (Table 3) among groups (A, B & C) indicated that there was no significant difference (P=0.401) in urine leaks quantity before getting to the toilet among groups before treatment; however, there was significant differences (P=0.0001) among groups after treatment. Pairwise comparisons (Table 3) showed that there were significant decreases in the urine leaks quantity before getting to the toilet between group A and group B (P=0.001), in favor of group B, and between group A and group C (P=0.0001) in favor of group C. However, there was no significant difference (P=0.082) between group B and group C.

Statistical comparison test for urine leaks effect on life (Table 4) within each group showed there were no significant differences (P>0.05) in the urine leaks effect on life within group A (P=0.189), but there were significant decreases within group B (P=0.0001) and group C (P=0.0001) after treatment. Statistical comparison test for urine leaks effect on life (Table 4) among groups (A, B & C) indicated that there was no significant difference (P=0.911) in the urine leaks effect on life among groups before treatment; however, there was significant differences (P=0.0001) among groups after treatment. Pairwise comparisons (Table 4) showed that there were significant decreases in the urine leaks effect on life between group A and group B (P=0.030), in favor of group B, and between group A and group C (P=0.0001), in favor of group C, as well as between group B and group C (P=0.001), in favor of group C.

Table 3. Comparison of urine leaks quantity before getting to the toilet (Q2) before and after treatment for groups (A, B & C)

Q2	Group A (n=20)		Group B (n=25)		Group C (n=25)	
	Before-treatment	After-treatment	Before-treatment	After-treatment	Before-treatment	After-treatment
A few drops	0 (0.0%)	6 (30.0%)	0 (0.0%)	20 (80%)	0 (0.0%)	24 (96.0%)
Enough to make underpants/pads wet	20 (100%)	14 (70.0%)	24 (96.0%)	5 (20.0%)	25 (100%)	1 (4.0%)
Enough to wet outer clothes	0 (0.0%)	0 (0.0%)	1 (4.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Urine runs down legs onto floor	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Within group	Group A		Group B		Group C	
P-value	0.008*		0.0001*		0.0001*	
Among groups	Pre-treatment			Post-treatment		
P-value	0.401			0.0001*		
Pairwise comparisons	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
P-value	0.001*		0.0001*		0.082	

Data are expressed as frequency (percentage); P-value: probability value; * Significant (P<0.05)

Table 4. Comparison of urine leaks effect on life (Q3) before and after treatment for groups (A, B & C)

Q3	Group A (n=20)		Group B (n=25)		Group C (n=25)	
	Before-treatment	After-treatment	Before-treatment	After-treatment	Before-treatment	After-treatment
Does not interfere with my life	0 (0.0%)	0 (0.0%)	0 (0.0%)	8 (32.0%)	0 (0.0%)	23 (92.0%)
Minor inconvenience	0 (0.0%)	3 (15.0%)	0 (0.0%)	5 (20.0%)	0 (0.0%)	2 (8.0%)
Slight problem	5 (25.0%)	5 (25.0%)	6 (24.0%)	4 (16.0%)	5 (20.0%)	0 (0.0%)
Moderate problem	15 (75.0%)	12 (60.0%)	19 (76.0%)	8 (32.0%)	20 (80%)	0 (0.0%)
Within group	Group A		Group B		Group C	
P-value	0.189		0.0001*		0.0001*	
Among groups	Pre-treatment			Post-treatment		
P-value	0.911			0.0001*		
Pairwise comparisons	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
P-value	0.030*		0.0001*		0.001*	

Data are expressed as frequency (percentage); P-value: probability value; * Significant (P<0.05)

Statistical comparison test for urine leaks effect on sex life (Table 5) within each group showed there were significant decreases (P<0.05) in the urine leaks effect on sex life within group A (P=0.017), group B (P=0.0001), and group C (P=0.0001). Statistical comparison test for urine leaks effect on sex life (Table 5) among groups (A, B & C) indicated that there was no significant difference (P=0.908) in urine leaks effect on sex life among groups before treatment; however, there was significant difference (P=0.0001) among groups after treatment. Pairwise comparisons (Table 5) showed that there were significant decreases in the urine leaks effect on sex life between group A and group B (P=0.009), in favor of group B, and between group A and

group C (P=0.0001), in favor of group C, as well as between group B and group C (P=0.001), in favor of group C.

Table 5. Comparison of urine leaks effect on sex life (Q4) before and after treatment for groups (A, B & C)

Q4	Group A (n=20)		Group B (n=25)		Group C (n=25)	
	Before-treatment	After-treatment	Before-treatment	After-treatment	Before-treatment	After-treatment
Has not affected my sex life	0 (0.0%)	0 (0.0%)	0 (0.0%)	10 (40.0%)	0 (0.0%)	23 (92.0%)
A little	0 (0.0%)	6 (30.0%)	1 (4.0%)	7 (28.0%)	1 (4.0%)	2 (8.0%)
Somewhat	16 (80.0%)	13 (65.0%)	19 (76.0%)	7 (28.0%)	18 (72.0%)	0 (0.0%)
A great deal	4 (20.0%)	1 (5.0%)	5 (20.0%)	1 (4.0%)	6 (24.0%)	0 (0.0%)
Within group	Group A		Group B		Group C	
P-value	0.017*		0.0001*		0.0001*	
Among groups	Pre-treatment			Post-treatment		
P-value	0.908			0.0001*		
Pairwise comparisons	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
P-value	0.009*		0.0001*		0.001*	

Data are expressed as frequency (percentage); P-value: probability value; * Significant (P<0.05)

Statistical comparison test for level of confidence in controlling ability of urine leaks (Table 6) within each group showed there were significant increases in the level of confidence in controlling ability of urine leaks within group A (P=0.046), group B (P=0.0001), and group C (P=0.0001) after treatment. Statistical comparison test for level of confidence in controlling ability of urine leaks (Table 6) among groups (A, B & C) indicated that there was no significant difference (P=0.988P) in the level of confidence in controlling ability of urine leaks among groups before treatment; however, there were significant differences (P=0.0001) among groups after treatment. Pairwise comparisons (Table 6) showed that there were significant increases in the level of confidence in controlling ability of urine leaks between group A and group B (P=0.009), in favor of group B, and between group A and group C (P=0.0001) in favor of group C. However, there was no significant difference between group B and group C (P=0.066) after treatment.

Statistical comparison test for level of confidence in controlling ability of urine leaks (Table 7) within each group showed there were no significant differences (P=0.188) in the degree of controlling urine leakage within group A. However, there were significant increases in the degree of controlling urine leakage within group B (P=0.004) and group C (P=0.0001) after treatment. Statistical comparison test for level of confidence in controlling ability of urine leaks (Table 7) among groups (A, B & C) indicated that there was no significant difference (P=0.995) in degree of controlling urine leakage among groups before treatment, however there was significant difference (P=0.0001) among groups after treatment. Pairwise comparisons (Table 7) showed that there were significant increases in the degree of controlling urine leakage between group A and group C (P=0.0001), in favor of group C, and between group B and group C (P=0.0001) in

favor of group C. However, there was no significant difference (P=0.160) between group A and group B.

Table 6. Comparison of level of confidence in controlling ability of urine leaks (Q5) before and after treatment for groups (A, B & C)

Q5	Group A (n=20)		Group B (n=25)		Group C (n=25)	
	Before-treatment	After-treatment	Before-treatment	After-treatment	Before-treatment	After-treatment
Complete confidence	0 (0.0%)	6 (30.0%)	0 (0.0%)	18 (72.0%)	0 (0.0%)	23 (92.0%)
Moderate confidence	14 (70.0%)	8 (40.0%)	17 (68.0%)	7 (28.0%)	18 (72.0%)	2 (8.0%)
Little confidence	3 (15.0%)	4 (20.0%)	3 (12.0%)	0 (0.0%)	3 (12.0%)	0 (0.0%)
No confidence	3 (15.0%)	2 (10.0%)	5 (20.0%)	0 (0.0%)	4 (16.0%)	0 (0.0%)
Within group	Group A		Group B		Group C	
P-value	0.046*		0.0001*		0.0001*	
Among groups	Pre-treatment				Post-treatment	
P-value	0.988				0.0001*	
Pairwise comparisons	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
P-value	0.009*		0.0001*		0.066	

Data are expressed as frequency (percentage); P-value: probability value; * Significant (P<0.05)

Table 7. Comparison of degree of controlling urine leakage (Q6) before and after treatment for groups (A, B & C)

Q6	Group A (n=20)		Group B (n=25)		Group C (n=25)	
	Before-treatment	After-treatment	Before-treatment	After-treatment	Before-treatment	After-treatment
0 (no control)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
1	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
2	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
3	4 (20.0%)	1 (5.0%)	5 (20.0%)	0 (0.0%)	5 (20.0%)	0 (0.0%)
4	12 (60.0%)	10 (50.0%)	16 (64.0%)	11 (44.0%)	14 (56.0%)	0 (0.0%)
5	3 (15.0%)	4 (20.0%)	3 (12.0%)	2 (8.0%)	4 (16.0%)	1 (4.0%)
6	1 (5.0%)	5 (25.0%)	1 (4.0%)	7 (28.0%)	2 (8.0%)	0 (0.0%)
7	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (20.0%)	0 (0.0%)	4 (16.0%)
8	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	13 (52.0%)
9	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (28.0%)
10 (full control)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Within group	Group A		Group B		Group C	
P-value	0.188		0.004*		0.0001*	
Among groups	Pre-treatment				Post-treatment	
P-value	0.995				0.0001*	
Pairwise comparisons	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
P-value	0.160		0.0001*		0.0001*	

Data are expressed as frequency (percentage); P-value: probability value; * Significant (P<0.05)

Statistical comparison test for frequency of daytime urination (Table 8) within each group showed there were no significant differences (P=0.256) in the frequency of daytime urination

within group A. However, there were significant decreases within group B (P=0.001) and group C (P=0.0001) after treatment. Statistical comparison test for frequency of daytime urination (Table 8) among groups (A, B & C) indicated that there was no significant difference (P=0.656) in frequency of daytime urination among groups before treatment; however, there was significant differences (P=0.0001) among groups after treatment. Pairwise comparisons (Table 8) showed that there were significant decreases in the frequency of daytime urination between group A and group B (P=0.001), in favor of group B, and between group A and group C (P=0.0001) in favor of group C, as well as between group B and group C (P=0.002), in favor of group C.

Table 8. Comparison of frequency of daytime urination (Q7) before and after treatment for groups (A, B & C)

Q7	Group A (n=20)		Group B (n=25)		Group C (n=25)	
	Before-treatment	After-treatment	Before-treatment	After-treatment	Before-treatment	After-treatment
1 – 4 times per day	0 (0.0%)	0 (0.0%)	1 (4.0%)	13 (52.0%)	0 (0.0%)	24 (96.0%)
5 – 8 times per day	14 (70.0%)	17 (85.0%)	18 (72.0%)	9 (36.0%)	20 (80.0%)	1 (4.0%)
9 – 12 times per day	6 (30.0%)	3 (15.0%)	6 (24.0%)	3 (12.0%)	5 (20.0%)	0 (0.0%)
≥13 times per day	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Within group	Group A		Group B		Group C	
P-value	0.256		0.001*		0.0001*	
Among groups	Pre-treatment			Post-treatment		
P-value	0.656			0.0001*		
Pairwise comparisons	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
P-value	0.001*		0.0001*		0.002*	

Data are expressed as frequency (percentage); P-value: probability value; * Significant (P<0.05)

Statistical comparison test for frequency of night time urination (Table 9) within each group showed there were no significant differences (P=0.122) in the frequency of nighttime urination within group A; however, there were significant decreases within group B (P=0.008) and group C (P=0.0001). Statistical comparison test for frequency of night time urination (Table 9) among groups (A, B & C) indicated that that there was no significant difference (P=0.886) in frequency of nighttime urination among groups before treatment; however, there were significant differences (P=0.010) among groups after treatment. Pairwise comparisons (Table 9) showed that there were significant decreases in the frequency of nighttime urination between group A and group C (P=0.004), in favor of group C, and between group B and group C (P=0.017) in favor of group C. However, there was no significant difference (P=0.238) in frequency of nighttime urination between group A and group B.

Table 9. Comparison of frequency of night time urination (Q8) before and after treatment for groups (A, B&C)

Q8	Group A (n=20)		Group B (n=25)		Group C (n=25)	
	Before-treatment	After-treatment	Before-treatment	After-treatment	Before-treatment	After-treatment
Do not urinate at night	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (8.0%)	0 (0.0%)	2 (8.0%)
1 time per night	4 (20.0%)	10 (50%)	5 (20.0%)	14 (56.0%)	6 (24.0%)	22 (88.0%)
2 times per night	14 (70.0%)	8 (40%)	17 (68.0%)	9 (36.0%)	18 (72.0%)	1 (4.0%)
3 times per night	2 (10.0%)	2 (10%)	3 (12.0%)	0 (0.0%)	1 (4.0%)	0 (0.0%)
4 or more times per night	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Within group	Group A		Group B		Group C	
P-value	0.122		0.008*		0.0001*	
Among groups	Pre-treatment			Post-treatment		
P-value	0.886			0.010*		
Pairwise comparisons	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
P-value	0.238		0.004*		0.017*	

Data are expressed as frequency (percentage); P-value: probability value; * Significant (P<0.05)

Statistical comparison test for duration of delaying urination from the first time of feeling urge (Table 10) within each group showed that there were no significant differences (P=0.270) in the duration of delaying urination from the first time of feeling urge within group A; however, there were significant increases within group B (P=0.030) and group C (P=0.0001). Statistical comparison test for duration of delaying urination from the first time of feeling urge (Table 10) among groups (A, B & C) indicated that there was no significant difference (P=0.977) in the duration of delaying urination from the first time of feeling urge among groups before treatment; however, there were significant differences (P=0.0001) among groups after treatment. Pairwise comparisons (Table 10) showed that there were significant increases in the duration of delaying urination from the first time of feeling urge between group A and group C (P=0.0001), in favor of group C, and between group B and group C (P=0.0001), in favor of group C. However, there was no significant difference (P=0.210) between group A and group B.

Statistical comparison test for ability to change urine stream (Table 11) within each group showed that there were significant increases in the ability to change urine stream within group A (P=0.025), group B (P=0.029), and group C (P=0.0001) after treatment. Statistical comparison test for ability to change urine stream (Table 11) among groups (A, B & C) indicated there was no significant difference (P=0.986) in ability to change urine stream among groups before treatment; however, there were significant differences (P=0.0001) among groups after treatment. Pairwise comparisons (Table 11) showed that there were significant increases in the ability to change urine stream between group A and group C (P=0.0001), in favor of group C, and between group B and group C (P=0.0001), in favor of group C. However, there was no significant difference between group A and group B (P=0.077).

Table 10. Comparison of duration of delaying urination from the first time of feeling urge (Q9) before and after treatment for groups (A, B&C)

Q9	Group A (n=20)		Group B (n=25)		Group C (n=25)	
	Before-treatment	After-treatment	Before-treatment	After-treatment	Before-treatment	After-treatment
1 or more hours	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	20 (80.0%)
30 minutes	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (20.0%)	0 (0.0%)	5 (20.0%)
15 minutes	2 (10.0%)	6 (30.0%)	3 (12.0%)	6 (24.0%)	4 (16.0%)	0 (0.0%)
less than 10 minutes	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (4.0%)	0 (0.0%)	0 (0.0%)
1–2 minutes	3 (15.0%)	3 (15.0%)	3 (12.0%)	4 (16.0%)	3 (12.0%)	0 (0.0%)
Cannot delay urination	15 (75.0%)	11 (55.0%)	19 (76.0%)	9 (36.0%)	18 (72.0%)	0 (0.0%)
Within group	Group A		Group B		Group C	
P-value	0.270		0.030*		0.0001*	
Among groups	Pre-treatment				Post-treatment	
P-value	0.977				0.0001*	
Pairwise comparisons	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
P-value	0.210		0.0001*		0.0001*	

Data are expressed as frequency (percentage); P-value: probability value; * Significant (P<0.05)

Table 11. Comparison of ability to change urine stream (Q10) before and after treatment for groups (A, B&C)

Q10	Group A (n=20)		Group B (n=25)		Group C (n=25)	
	Before-treatment	After-treatment	Before-treatment	After-treatment	Before-treatment	After-treatment
Stop urine flow completely	0 (0.0%)	7 (35.0%)	0 (0.0%)	5 (20.0%)	0 (0.0%)	17 (68.0%)
Maintain a change to the urine stream	1 (5.0%)	0 (0.0%)	2 (8.0%)	4 (16.0%)	2 (8.0%)	8 (32.0%)
Partially deflect or change the urine stream	5 (25.0%)	2 (10.0%)	5 (20.0%)	7 (28.0%)	6 (24.0%)	0 (0.0%)
Unable to deflect, change, or slow urine stream	14 (70.0%)	11 (55.0%)	18 (72.0%)	9 (36.0%)	17 (68.0%)	0 (0.0%)
Within group	Group A		Group B		Group C	
P-value	0.022*		0.029*		0.0001*	
Among groups	Pre-treatment				Post-treatment	
P-value	0.986				0.0001*	
Pairwise comparisons	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
P-value	0.077		0.0001*		0.0001*	

Data are expressed as frequency (percentage); P-value: probability value; * Significant (P<0.05)

4. Discussion:

The purpose of this study was to determine the effect of diaphragmatic breathing exercise on UUI in postmenopausal women. The participants were divided into three groups: Group A, which received medical treatment with anti-muscarinic drugs (5-10 mg) once per day for 12 weeks; Group B, which received the same treatment as Group A along with PFMT and

abdominal strengthening exercises three times per week for 12 weeks; and Group C, which received the same treatment as Group B in addition to diaphragmatic breathing training.

The results of this study concluded that Group A showed no significant change in bladder ascending movement. However, there was an increase in first sensation and first desire, the maximum bladder capacity and confidence in controlling urine leaks. There were significant decreases in the frequency and quantity of urine leaks, urine leaks effect on sex life. The degree of controlling urine leakage did not change significantly, nor did the frequency of daytime or nighttime urination.

Group B showed a significant decrease in bladder ascending movement, increased first sensation and desire, and increased maximum bladder capacity. It also reduced urine leak frequency and quantity, reduced their impact on life and sex life, and increased confidence in controlling leaks.

Group C showed a greater increase in bladder ascending movement, increased first sensation, desire, and maximum bladder capacity. It also reduced urination frequencies and delayed urination from the first urge. Group C showed a greater increase in bladder ascending movement, increased first sensation and desire, and increased maximum bladder capacity.

The results of our study indicate that antimuscarinic drugs play a significant role in managing UUI by reducing involuntary bladder contractions and increasing bladder capacity.

A meta-analysis by Chapple et al. (2005) highlighted the efficacy and safety of antimuscarinic treatments for overactive bladder (OAB). The duration of treatment across the included studies varied, generally ranging from 4 to 12 weeks. This analysis concluded that antimuscarinic agents significantly reduced micturition frequency and urgency episodes while improving continence. Adverse events were typically mild to moderate, with dry mouth being the most commonly reported side effect. This comprehensive evaluation provided robust evidence supporting the use of antimuscarinics as effective treatments for OAB (18).

In accordance with our findings, Yamada et al. (2018) investigated the fundamental and clinical aspects of antimuscarinic agents used for treating overactive bladder (OAB). Their study concluded that antimuscarinic agents are the initial drug therapy introduced for OAB and possess the most extensive dataset available. The research indicated that newer antimuscarinic agents, which are highly selective for the bladder, can potentially reduce or prevent systemic side effects like dry mouth and cognitive dysfunction during OAB treatment (19).

Our results came in contradiction with a study by Burgio et al. (1998) in a randomized controlled trial, who compared the effectiveness of biofeedback-assisted behavioral treatment, drug treatment (oxybutynin chloride), and a placebo for urge urinary incontinence in older women. The study included 197 women aged 55 to 92 years and spanned 8 weeks. The results demonstrated that behavioral treatment significantly reduced incontinence episodes by 80.7%, outperforming drug treatment, which had a 68.5% reduction, and placebo, which had a 39.4% reduction. This contradiction may be due different age range and BMI of women (20).

Regarding Pelvic floor muscle training, study results indicate that PFMT and abdominal exercises significantly improve various aspects of bladder control and reduce UUI symptoms in

postmenopausal women. These exercises contribute to strengthening the pelvic floor muscles, stabilizing the bladder,

A systematic review by Bo et al. (2020) supported our results, the review assessed the effectiveness of PFMT in alleviating symptoms of OAB in women. The review analyzed eleven randomized controlled trials, highlighting significant heterogeneity in PFMT protocols, outcome measures, and follow-up periods. Despite these differences, the qualitative analysis demonstrated that PFMT resulted in a significant reduction in OAB symptoms in several studies, particularly in terms of urinary frequency and urgency urinary incontinence (21).

Our study is consistent with the previous studies as a study by Bertotto et al. (2017) who explored the efficacy of combining pelvic floor muscle exercises with electro-myographic biofeedback in postmenopausal women with stress urinary incontinence. Their findings demonstrated significant improvements in muscle strength, myoelectric activity, and pre-contraction, leading to better quality of life outcomes. The study underscored the added benefits of biofeedback to standard pelvic floor muscle exercises (22).

Another study by Aparicio et al. (2020) who investigated the effects of adding postural instructions to an abdominopelvic exercise program for women with stress urinary incontinence. The study found that this combined approach led to significant improvements in urinary incontinence symptoms, reduced the impact of incontinence on daily life, and enhanced overall quality of life. The inclusion of postural instructions appeared to offer additional benefits beyond those achieved with abdominopelvic exercise alone (23).

This outcome is contrary to Bø and Haakstad (2011) who evaluated the effectiveness of PFMT instructed in a general fitness class for pregnant women. The study found no significant differences in urinary incontinence outcomes between the exercise group and the control group, suggesting that PFMT might not be effective when not individually instructed and monitored. This difference can be attributed to the different sample size as pregnant women were included (24).

Regarding Diaphragmatic breathing, our study demonstrates that diaphragmatic breathing, when combined with anti-muscarinic drugs, PFMT, and abdominal exercises, leads to superior outcomes in terms of bladder stabilization, increased bladder capacity, and reduced frequency and quantity of urine leaks. Participants also reported improved quality of life, greater confidence, and better control over urine leakage.

These results confirmed that of Mohamed et al. (2023), who conducted a study to evaluate the combined effects of deep breathing and Kegel exercises on stress urinary incontinence among elderly women. This quasi-experimental study involved 60 elderly women who participated in an 8-week program that included both deep breathing and Kegel exercises. The results demonstrated significant improvements in urinary incontinence symptoms, with participants experiencing reduced frequency of urine leakage and improved control over urination. The combination of deep breathing and Kegel exercises helped to enhance pelvic floor muscle strength and relaxation, thereby reducing the incidence of stress urinary incontinence in the elderly population (25).

Consistent with the literature, Tang et al. (2022) investigated in a 16-week intervention the effect of combining Rumba dance and breathing training. It was found to significantly reduce urine leakage, increase vaginal resting pressure, and improve pelvic floor muscle strength and endurance among sedentary, postmenopausal women with mild-to-moderate stress urinary incontinence. Participants also reported enhanced quality of life, suggesting that this engaging form of physical activity could be an effective therapeutic option for managing urinary incontinence (26).

Our study has some limitations. Firstly, the small follow-up periods. In addition, this study sample may not fully represent the diversity of women experiencing urinary incontinence (e.g., different age groups, ethnicities, or severity levels).

5. Conclusion

Diaphragmatic breathing showed a greater increase in bladder ascending movement, first sensation, and desire, and increased bladder capacity.

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Patient consent statement:

Prior to the start of data collection, all participants provided their written, informed consent.

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