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**EFFECT OF PILATES AND DYNAMIC NEUROMUSCULAR STABILIZATION  
EXERCISES COMBINED WITH PELVIC FLOOR MUSCLES EXERCISE ON  
URINARY INCONTINENCE IN POST MENOPAUSAL WOMEN OF AHMEDABAD:  
A COMPARATIVE STUDY**

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**ABSTRACT**

**Introduction:** Urinary incontinence (UI), defined by the International Continence Society as the involuntary leakage of urine, is highly prevalent among postmenopausal women. Hormonal decline, pelvic floor muscle weakness, connective tissue alterations, and impaired neuromuscular coordination contribute significantly to its development. UI adversely affects physical functioning, emotional well-being, and social participation, thereby reducing overall quality of life. Pelvic Floor Muscle Exercises (PFME) are considered the first-line conservative management strategy. However, urinary continence depends not only on pelvic floor strength but also on coordinated activation of the diaphragm, abdominal musculature, and pelvic floor muscles. Exercise approaches such as Pilates and Dynamic Neuromuscular Stabilization (DNS), which emphasize core stability, breathing control, and neuromuscular coordination, may enhance the effects of PFME.

**Aim:** To compare the effects of Pilates combined with PFME versus DNS combined with PFME on urinary incontinence in postmenopausal women.

**Methodology:** A randomized comparative study was conducted among 40 postmenopausal women aged 45–65 years with urinary incontinence. Participants were randomly allocated into two groups (n=20 each). Group A received Pilates with PFME, while Group B received DNS with PFME for six weeks (four sessions per week). Outcomes were measured using the King's Health Questionnaire and the one-hour Pad Test, with statistical significance set at  $p < 0.05$ .

**Results and Conclusion:** Both groups showed significant improvements; however, DNS combined with PFME demonstrated comparatively greater reduction in urinary leakage and improvement in quality of life. DNS may therefore provide superior clinical benefits in pelvic floor rehabilitation

**Keywords:** Urinary Incontinence, Postmenopausal Women, Pelvic Floor Muscle Exercise, Pilates, Dynamic Neuromuscular Stabilization, King's Health Questionnaire, Pad Test

## INTRODUCTION

Urinary incontinence (UI) defined by the International Continence Society (ICS) as the involuntary leakage of urine, is a highly prevalent condition that significantly affects women's physical comfort, psychological well-being and social participation [1]. Although not life-threatening, UI represents a major public health concern due to its impact on hygiene, self-esteem, sexual health and overall quality of life [2]. The prevalence increases with age, particularly after menopause, with nearly one in three women experiencing some form of urinary leakage during their lifetime [3]. Epidemiological studies report prevalence rates ranging from 25% to 45% among middle-aged women [4] and Indian data indicate similarly high rates among postmenopausal women [5]. Despite its frequency, UI remains underreported because many women perceive it as a normal consequence of aging and hesitate to seek medical attention [6].

Menopause, defined as the permanent cessation of menstruation for 12 consecutive months [7], is associated with estrogen deficiency, sarcopenia and connective tissue alterations [8, 9]. Declining estrogen levels reduce collagen content, vascular supply and tissue elasticity within pelvic structures, leading to weakening of pelvic floor muscles (PFM) and reduced urethral closure pressure [9]. Continence depends on coordinated function of the levator ani complex, urethral sphincter mechanism and endopelvic fascia [10]. Additionally, the diaphragm, abdominal wall and pelvic floor operate as an integrated pressure-regulating system that maintains intra-abdominal pressure during functional activities such as coughing or lifting [11]. Disruption of muscular strength, connective tissue integrity or neuromuscular coordination may result in stress, urge or mixed urinary incontinence [1, 2].

Pelvic Floor Muscle Training (PFMT) is recommended as first-line conservative management and has demonstrated significant effectiveness in reducing urinary leakage [12]. However, continence depends not only on strength but also on timing and coordination of the lumbopelvic–abdominal system [11]. Exercise approaches such as Pilates and Dynamic Neuromuscular Stabilization (DNS) emphasize core stabilization, breathing control and neuromuscular integration. Pilates promotes controlled activation of pelvic floor muscles with deep abdominal musculature and diaphragm, enhancing trunk stability and pressure regulation [13, 14]. DNS, based on developmental kinesiology principles, focuses on restoring reflex-mediated stabilization and optimizing intra-abdominal pressure distribution through diaphragmatic breathing and integrated core activation [15, 16]. These approaches may provide additional benefits when combined with PFMT.

Assessment of treatment effectiveness requires both objective and subjective outcome measures. The one-hour Pad Test, recommended by the ICS, quantifies urinary leakage by measuring pad weight gain during standardized activities [17]. The King's Health Questionnaire (KHQ) is a validated disease-specific instrument that evaluates the impact of UI on quality of life across physical, emotional and social

domains [18]. Together, these tools provide comprehensive evaluation of clinical and patient-reported outcomes in pelvic floor rehabilitation.

## OBJECTIVES

- To study the impact of pilates combined with pelvic floor muscle exercise on urinary incontinence using King's health questionnaire and Pad test in post-menopausal women.
- To study the impact of dynamic neuromuscular stabilization exercise combined with pelvic floor muscle exercise on urinary incontinence using King's health questionnaire and Pad test in post-menopausal women.
- To compare the impact of pilates and dynamic neuromuscular stabilization exercises combined with pelvic floor muscle exercise on urinary incontinence using King's health questionnaire and Pad test in post-menopausal women.

## METHODOLOGY

- Sampling technique – Simple random sampling.
- Sample size – 40 (20 in each group).
- Study population – post-menopausal women.
- Source of data – Sainath hospital, Ahmedabad
- Duration of study – 6 months.
- Intervention duration – 6 weeks, 4 day a week.

- Materials required – Yoga mat, pad, weight machine, ball, stool, assessment form, consent form, pen/pencil, data collection sheet.

### INCLUSION

- Urinary incontinence, including stress, urge or mixed type.
- Adults age between 45-65 years.
- Experiencing at least one urinary incontinence episode per week over the last 3 months.
- Individuals with the cognitive ability to consent and participate in interventions or questionnaires.
- No ongoing invasive treatment or surgeries for urinary incontinence.
- Both prima gravida and multi gravida.
- Stable use of medications unrelated to urinary incontinence that won't affect outcomes.

### EXCLUSION

- History of prior surgical intervention for urinary incontinence.
- Active Urinary tract infection.
- Stroke, multiple sclerosis, diabetes or chronic kidney disease
- Induced menopause
- Use of antimuscarinics drugs affecting urinary function.
- Any abdominal or urogenital surgery in the past 6 month
- Severe anxiety or depression.

### OUTCOME MEASURES

- King's health questionnaire (for assessing impact of urinary incontinence on various dimensions of life).
- Pad test (for measures urine leakage by waiting absorbent pads before and after use during standardized activity).

### INTERVENTIONS

- **FOR PILATES GROUP**

| EXERCISE                  | DESCRIPTION                                                                                                                                                                                                                             | REPETITIONS            | SETS |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------|
| Pilates breathing         | Take slow breaths and pay attention to diaphragm movement.                                                                                                                                                                              | 10 with 10 second hold | 2    |
| Butter fly or hip Opening | Sit with your legs straight in front. Slowly bend your knees and bring your heels toward each other. Stretch only as much as you comfortably can tolerate.                                                                              | 10 with 10 second hold | 2    |
| Pelvic tilt               | In the crook-lying position, perform pelvic tilting movements in both clockwise and counterclockwise directions.                                                                                                                        | 10 with 10 second hold | 2    |
| Shoulder bridge           | In the crook lying position, begin the movement by tightening your core muscles. Then squeeze your gluteal muscles, tilt your pelvis backward, and lift your hips upward. Slowly lower your pelvis and return to the starting position. | 10 with 10 second hold | 2    |
| Wall squat                | Stand with your back supported against a wall. Keep your feet about one foot apart. Tighten your core muscles and slowly bend your knees to squat down as far as you comfortably can, then return to standing.                          | 10 with 10 second hold | 2    |

As you slowly breathe out through pursed lips, softly engage and hold your core muscle while keeping the body still.

- **FOR DYNAMIC NEUROMUSCULAR STABILATION EXERCISE**

| PATIENT'S POSITION                                                    | INVESTIGATOR'S POSITION                                                                                    | INSTRUCTIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | REPETITION | SET |
|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----|
| Crook lying                                                           | At the patient's side, palpating the transverse abdominis muscle (medial to anterior superior iliac spine) | Gently tighten pelvic floor muscles, imagine to stop the urine. Keep this contraction while you breathe in and let your abdomen expand against the therapist's fingers. Maintain the expansion as you slowly breathe out, and then continue breathing normally.                                                                                                                                                                                                                                                                                                                                        | 10         | 2   |
| Prone                                                                 | The posterolateral aspect of the abdominal wall below the lower ribs from behind                           | Same as the previous exercise.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 10         | 2   |
| Supine position with lower extremities placed on a stool for support. | Manual palpate the abdominal muscle medial to anterior superior iliac spine                                | Same as the previous exercise.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 10         | 2   |
| Quadruped                                                             | The posterolateral aspect of the abdominal wall below the lower ribs from behind                           | Same as the previous exercise.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 10         | 2   |
| Sagittal plane stabilization combined with hip abduction.             | Manual palpate the abdominal muscle medial to anterior superior iliac spine                                | Instruct the patient to gently contract the pelvic floor muscles, similar to attempting to interrupt the flow of urine. Maintain this contraction during inhalation, allowing the abdomen to expand against the therapist's fingers. Sustain the abdominal expansion during slow exhalation and continue normal breathing without releasing the pelvic floor contraction. While holding this position, ask the patient to abduct one hip by moving the leg sideways, keep the opposite leg in the starting position. Return to the initial position and repeat the movement on the contralateral side. | 10         | 2   |
| Sagittal stabilization with hip flexion                               | Palpate the abdominal muscle medial to anterior superior iliac spine                                       | Gently tighten pelvic floor, image to try to stop the urine. Keep this contraction while you breathe in and let your abdomen expand against the therapist's fingers. Maintain the expansion as you slowly breathe out, then continue breathing normally without relaxing the pelvic floor. While holding this position, lift one leg up by bending the hip (hip flexion), keeping the other leg in the starting position. Lower it back down and repeat the same movement with the other leg.                                                                                                          | 10         | 2   |

### • FOR PELVIC FLOOR MUSCLE EXERCISE

| EXERCISE                                  | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | REPETITION | SETS |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|
| Kegel exercise                            | <ul style="list-style-type: none"> <li>- Lie in the supine position.</li> <li>- Close your eyes and imagine to stop the flow of urine.</li> <li>- Tighten the muscles as much as possible, hold this position for 10 second.</li> <li>- Release the muscles and rest for 10 seconds.</li> </ul>                                                                                                                                                                                                                                                                                          | 10         | 1    |
| Squeeze and release                       | <ul style="list-style-type: none"> <li>- Empty the bladder Sit in a comfortable position.</li> <li>- Squeeze the perineal muscle as quickly as possible and release without attempting to sustain a contraction.</li> <li>- Rest for 10 seconds, repeat movement of squeeze and release.</li> <li>- Repeat the same exercise in lateral (side lying) position.</li> </ul>                                                                                                                                                                                                                | 10         | 1    |
| Pelvic Floor/Inner Thigh Ball Squeeze     | <ul style="list-style-type: none"> <li>- This exercise can be performed with 25-30 cm sized ball.</li> <li>- Lie in a supine position with both knees bent and feet placed flat on the floor.</li> <li>- Place a ball between knees, supporting it so it doesn't slip or fall.</li> <li>- Inhale, relaxing pelvic floor muscles for 5 seconds.</li> <li>- During exhalation gently squeeze the ball.</li> <li>- Place the coccyx bone (tailbone) firmly in contact with the ground.</li> <li>- Contract pelvic floor muscles for 10 seconds and then release the contraction.</li> </ul> | 10         | 1    |
| Lower trunk rotation / Lying hip rotation | <ul style="list-style-type: none"> <li>- Lie in a supine position with both knees bent and feet placed flat on the floor.</li> <li>- Keep the body firmly on the floor.</li> <li>- Gently roll both bended knees over to the right side.</li> <li>- Contract perineal and anal muscles, hold for 10 seconds relax muscle.</li> <li>- Return to the starting position.</li> <li>- Then repeat the same for left side.</li> </ul>                                                                                                                                                          | 10         | 1    |

## STATISTICAL ANALYSIS

Data were analysed using Statistical Package for the Social Sciences (SPSS) version 29.0. Preliminary data entry was performed in Microsoft Excel before transfer to SPSS for analysis. Normality of distribution was assessed using the Shapiro–Wilk test, which confirmed normal distribution; therefore, parametric tests were applied. Descriptive statistics (mean  $\pm$  standard deviation) were calculated for demographic and baseline variables. Between-group comparisons were

conducted using the independent (unpaired) t-test, while within-group (pre–post) comparisons were analysed using the paired t-test. A p-value  $< 0.001$  was considered statistically significant.

## RESULT

Baseline characteristics were comparable between the two groups. There were no statistically significant differences in age, baseline King's Health Questionnaire (KHQ) scores, or baseline one-hour Pad Test values ( $p > 0.05$ ), confirming homogeneity prior to intervention

|  | Group             | Baseline KHQ (Mean with SD) | Post-intervention KHQ (Mean with SD) | Mean Difference KHQ | Baseline Pad Test (ml) | Post-intervention Pad Test (ml) | Mean Difference Pad Test | P-value |
|--|-------------------|-----------------------------|--------------------------------------|---------------------|------------------------|---------------------------------|--------------------------|---------|
|  | Pilates with PFME | 58.05 $\pm$ 1.88            | 51.9 $\pm$ 2.40                      | 6.15                | 48.68 $\pm$ 2.09       | 39.42 $\pm$ 3.20                | 9.26                     | <0.001  |
|  | DNS with PFME     | 58 $\pm$ 2.08               | 47.9 $\pm$ 2.73                      | 10.1                | 48.32 $\pm$ 2.45       | 35.06 $\pm$ 3.35                | 13.27                    | <0.001  |

### Baseline Characteristics of Participants

| Variable               | Pilates with PFME (n = 20) | DNS with PFME (n = 20) | p-value |
|------------------------|----------------------------|------------------------|---------|
| Age (years)            | 55.40 $\pm$ 5.27           | 57.15 $\pm$ 6.59       | >0.05   |
| Baseline KHQ score     | 58.05 $\pm$ 1.88           | 58.00 $\pm$ 2.08       | >0.05   |
| Baseline Pad test (ml) | 48.68 $\pm$ 2.09           | 48.32 $\pm$ 2.45       | >0.05   |

### Within-Group Comparison of KHQ Scores and Pad Test Values

Within-group analysis demonstrated statistically significant improvements in both groups following the six-week intervention ( $p < 0.001$ ). In the Pilates with PFME group, mean KHQ scores decreased from 58.05  $\pm$  1.88 to 51.90  $\pm$  2.40, with a mean reduction of 6.15 points. Similarly, Pad Test values decreased from 48.68  $\pm$  2.09

ml to 39.42  $\pm$  3.20 ml, reflecting a mean reduction of 9.26 ml.

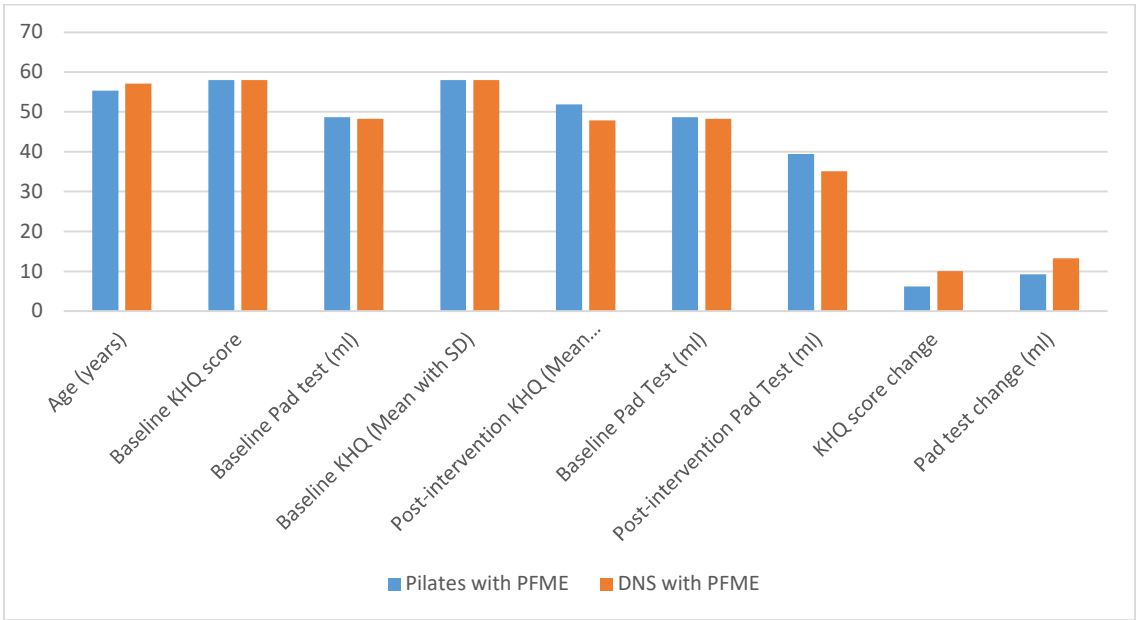
In the DNS with PFME group, greater improvements were observed. Mean KHQ scores decreased from 58.00  $\pm$  2.08 to 47.90  $\pm$  2.73, with a mean reduction of 10.10 points. Pad Test values decreased from 48.32  $\pm$  2.45 ml to 35.06  $\pm$  3.35 ml, showing a mean reduction of 13.27 ml

### Between-Group Comparison

| Outcome Measure      | Pilates + PFME (Mean ± SD) | DNS + PFME (Mean ± SD) | p-value |
|----------------------|----------------------------|------------------------|---------|
| KHQ score change     | 6.15 ± 1.31                | 10.10 ± 2.15           | >0.001  |
| Pad test change (ml) | 9.26 ± 1.93                | 13.27 ± 2.30           | >0.001  |

Between-group comparison revealed a statistically significant difference in the magnitude of improvement, favoring the DNS with PFME group for both KHQ score change and Pad Test reduction ( $p < 0.001$ ).

Overall, while both interventions were effective in reducing urinary leakage and improving quality of life, DNS combined with PFME demonstrated comparatively greater clinical improvement.



DISCUSSION

Urinary incontinence (UI) is highly prevalent among postmenopausal women and significantly impairs quality of life [1-3]. Indian studies report prevalence rates of 20–43%, with many cases remaining underreported [5, 6]. Estrogen deficiency, sarcopenia and connective tissue weakening during menopause reduce urethral closure pressure and pelvic floor support, contributing to continence dysfunction [7-9]. Structural integrity of the urethral

support system and coordinated activation of the diaphragm, abdominal wall and pelvic floor are essential for maintaining continence [10, 11]. Pelvic Floor Muscle Training (PFMT) is the recommended first-line conservative management and improves urethral support and muscle strength [12]. However, continence also depends on neuromuscular coordination and intra-abdominal pressure regulation. Pilates enhances voluntary core activation and trunk stability [13, 14], whereas Dynamic

Neuromuscular Stabilization (DNS) emphasizes reflex-mediated stabilization and optimized pressure distribution [15]. Both intervention groups in the present study showed statistically significant improvement in urinary leakage and quality of life after six weeks ( $p < 0.001$ ), measured using the one-hour Pad Test and King's Health Questionnaire [17, 18]. Between-group analysis demonstrated greater improvement in the DNS combined with PFME group, suggesting that reflex-based neuromuscular integration may provide additional benefit beyond voluntary strengthening alone [11, 15]. These findings support integrated lumbopelvic rehabilitation in managing postmenopausal urinary incontinence.

## CONCLUSION

The study titled “Effect of Pilates and Dynamic Neuromuscular Stabilization Exercises Combined with Pelvic Floor Muscles Exercise on Urinary Incontinence in Post Menopausal Women of Ahmedabad: A Comparative Study” concludes that both Pilates with PFME and DNS with PFME are current reduces UI which improves QOL in postmenopausal lady. Both groups showed noteworthy enhancement in KHQ marks and Pad test values after six weeks of intervention. However, the DNS with PFME group demonstrated significantly greater improvement compared to the Pilates with PFME group in both subjective (quality of

life) and objective (urine leakage) measures. Therefore, while both interventions are beneficial conservative treatment options, DNS combined with PFME appears comparatively more real in managing UI among postmenopausal women.

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## DISCLOSURE STATEMENT

The authors declare no conflict of interest.

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