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EFFECTIVENESS OF PELVIC FLOOR MUSCLE EXERCISE VERSUS CORE STABILITY EXERCISE IN MANAGING URINARY INCONTINENCE AMONG CERVICAL CANCER PATIENTS

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ABSTRACT

Objective: To compare the effectiveness of pelvic floor muscle exercises (PFME) and core stability exercises (CSE) in reducing urinary incontinence and improving quality of life among women with cervical cancer.

Methods: This is a randomised comparative study. Eighty women with cervical cancer experiencing urinary incontinence were enrolled and randomly allocated into two groups: PFME and CSE. Urinary incontinence severity was assessed using the International Consultation on Incontinence Questionnaire–Urinary Incontinence Short Form (ICIQ–UI SF), and objective urine leakage was measured using the one-hour pad test. Health-related quality of life was evaluated using the EuroQol-5 Dimension-5 Level (EQ-5D-5L). Statistical analysis was conducted using repeated-measures ANOVA and independent t-tests.

Results: Both groups demonstrated improvement in urinary incontinence outcomes. In the PFME group, the mean ICIQ-UI SF score decreased from 13.00 ± 2.48 at baseline to 8.95 ± 1.85 at 8 weeks, while pad test values decreased from 43.9 ± 9.29 g to 37.8 ± 2.56 g. In the CSE group, ICIQ-UI SF scores decreased from 13.50 ± 2.76 to 11.00 ± 2.93 , and pad test values decreased from 38.95 ± 10.91 g to 31.35 ± 5.78 g. Between-group comparison revealed greater improvement in the PFME group. Improvements in health-related quality of life were also observed, particularly in pain/discomfort and anxiety/depression domains.

Conclusion: PFME and CSE enhance urinary incontinence in cervical cancer patients, with pelvic floor training showing better results. Integrating pelvic floor rehabilitation into supportive care can reduce urinary symptoms and enhance quality of life for cervical cancer survivors.

Keywords: Cervical Cancer, Urinary Incontinence, Pelvic Floor Muscle Training, Core Stability Exercises, Quality of Life

INTRODUCTION

Cervical cancer remains one of the most common malignancies affecting women worldwide and continues to impose a substantial public health burden, particularly in low- and middle-income countries [1]. Advances in screening, radiation therapy, and combined chemoradiation have improved survival rates; however, long-term treatment-related morbidities are increasingly recognized [2]. Among these, urinary incontinence (UI) is a common and distressing complication reported in cervical cancer survivors [3].

The International Continence Society defines urinary incontinence as the complaint of any involuntary leakage of urine [4]. The main clinical types include stress urinary incontinence (SUI), urge urinary incontinence, and mixed urinary incontinence [4]. Stress urinary

incontinence, characterized by leakage during activities that increase intra-abdominal pressure such as coughing or exertion, is particularly prevalent in women with pelvic floor dysfunction [5]. In cervical cancer patients, urinary dysfunction may arise from tumor extension, pelvic nerve injury, fibrosis of supporting tissues, radiation-induced cystitis, or surgical disruption of pelvic structures following radical hysterectomy [6–8].

The pelvic floor musculature—including the levator ani complex, endopelvic fascia, and urethral sphincteric system—plays a crucial role in maintaining urinary continence [5, 9]. Damage to these structures during oncologic treatment may reduce urethral closure pressure and impair bladder neck support, leading to urine leakage [9]. Radiotherapy may also induce tissue fibrosis and

neuropathic changes that weaken pelvic floor function [6]. Consequently, urinary incontinence may significantly affect physical functioning, psychological well-being, and overall quality of life among cervical cancer survivors [3, 10].

Pelvic floor muscle training (PFMT) is recommended as first-line conservative management for stress urinary incontinence [11]. PFMT improves pelvic floor muscle strength, endurance, and coordination, thereby enhancing urethral support during increases in intra-abdominal pressure [11, 12]. Additionally, core stability exercises (CSE), which activate the diaphragm, transversus abdominis, multifidus, and pelvic floor muscles, may contribute to continence through coordinated trunk and pelvic muscle function [15, 16].

Assessment of treatment outcomes should include both symptom severity and quality of life. Instruments such as the International Consultation on Incontinence Questionnaire–Urinary Incontinence Short Form (ICIQ–UI SF), the one-hour pad test, and the EuroQol-5 Dimension (EQ-5D-5L) provide comprehensive evaluation of urinary symptoms and patient well-being [17–19]. A multidisciplinary approach involving oncology, physiotherapy, and palliative care teams is essential for optimizing symptom control and improving quality of life in cervical cancer survivors [20].

Although pelvic floor muscle exercises and core stability exercises have been investigated independently, comparative evidence in cervical cancer survivors remains limited. Furthermore, the role of structured rehabilitative interventions within a supportive oncology framework requires further clarification. Therefore, the present prospective randomised comparative study aimed to evaluate and compare the effectiveness of pelvic floor muscle exercises and core stability exercises in reducing urinary incontinence among cervical cancer patients following radiotherapy. The primary objectives were to assess changes in urinary incontinence severity using the International Consultation on Incontinence Questionnaire–Urinary Incontinence Short Form and objective urine leakage using the one-hour pad test. A secondary objective was to evaluate the impact of these interventions on health-related quality of life using the EuroQol-5 Dimension (EQ-5D-5L).

MATERIALS AND METHODS

This randomised comparative study was conducted at the Gujarat Cancer and Research Institute, Ahmedabad. Institutional Ethics Committee approval was obtained prior to study initiation, and written informed consent was secured from all participants.

A total of 80 women diagnosed with cervical cancer and presenting with urinary

incontinence. Participants were randomly allocated into two groups: pelvic floor muscle exercise (PFME) group (n=40) and core stability exercise (CSE) group (n=40). The sample size was calculated based on detecting a clinically meaningful difference in ICIQ-UI SF scores between the two groups. Assuming a standard deviation of 1.0, a minimum detectable difference of 0.95, a two-sided alpha level of 0.05, and a study power of 80%, the required sample size was calculated using the standard formula for comparison of two means. The estimated minimum sample size was 36 participants per group. To account for potential dropouts and to increase statistical robustness, 40 participants were included in each group, resulting in a total sample size of 80 patients.

Women aged 18–65 years with cervical cancer, scoring >5 on the International Consultation on Incontinence Questionnaire–Urinary Incontinence Short Form (ICIQ-UI SF), ECOG performance status ≤ 2 , and ability to understand and perform exercises.

Patients with stage IIIC or IV disease involving the urinary bladder, prior pelvic surgery affecting pelvic floor integrity, neurological or cognitive impairment, mobility limitations, concurrent participation in other trials, or unwillingness to provide consent.

Participants were randomly assigned. Allocation was concealed, and outcome assessors were blinded to group assignment. Both groups received supervised exercise sessions five times per week for eight weeks.

- PFME group: Performed Kegel exercises, rapid contraction (squeeze–release), pelvic floor ball squeeze exercises, and trunk rotation with pelvic floor activation.
- CSE group: Performed abdominal bracing, bracing with heel slides, leg lifts, bridging, standing bracing, and bracing during walking.

All exercises were supervised by a trained physiotherapist to ensure correct technique and adherence.

Primary outcomes included:

1. ICIQ-UI SF score for assessment of urinary incontinence severity and quality-of-life impact.
2. One-hour pad test to objectively quantify urine leakage.

Secondary outcome - EQ-5D-5L used to evaluate health-related quality of life across five domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. An EQ-5D index score and visual analog scale (VAS) score were calculated.

Assessments were conducted at baseline, 4 weeks, and 8 weeks.

Statistical analysis - Data were analysed using SPSS version 26. Continuous

variables were expressed as mean $\pm$ standard deviation. Within-group comparisons were performed using repeated-measures analysis of variance (ANOVA), and between-group differences were analysed using independent t-tests. A P value <0.05 was considered statistically significant.

RESULTS

A total of 80 participants were included in the study, with 40 participants in the Pelvic Floor Muscle Exercise (PFME) group and 40 participants in the Core Stability Exercise (CSE) group.

The mean age of participants in the pelvic floor muscle exercise (PFME) group was 49.25 ± 4.41 years (range, 42–58), whereas the core stability exercise (CSE) group had a mean age of 52.95 ± 4.91 years (range, 42–61). The mean body weight was 53.15 ± 10.37 kg in the PFME group and 51.30 ± 9.38 kg in the CSE group, with an overall range of 40–76 kg.

Among the total study population, hypertension was present in 22 participants (27.5%), diabetes mellitus in 20 (25%), and combined hypertension and diabetes in 12 (15%). Thyroid disorders were reported in 16 participants (20%), asthma in 12 (15%), and chronic obstructive pulmonary disease (COPD) in 6 participants (7.5%). Ten participants (12.5%) reported no associated comorbidities.

Treatment History - At enrolment, 65 participants had received chemotherapy,

radiotherapy, or combined chemoradiotherapy. Radiotherapy was the most common treatment modality, followed by chemotherapy and combined therapy. A small proportion of participants were not undergoing active oncologic treatment at the time of assessment.

Functional Performance Status - Based on Eastern Cooperative Oncology Group (ECOG) performance status, 34 participants (42.5%) were classified as Grade 1 and 46 participants (57.5%) as Grade 2. No participants were categorised as Grade 3 or Grade 4. Demographic data is given in **Table 1**.

Pelvic Floor Muscle Exercise (PFME) Group

At baseline, participants in the PFME group showed moderate urinary incontinence, with a mean ICIQ-UI SF score of 13.00 ± 2.48 and a mean pad test value of 43.9 ± 9.29 grams.

At the 4th-week follow-up, improvements were observed, as reflected by a reduction in the mean ICIQ-UI SF score to 12.10 ± 2.91 and pad test value to 41.25 ± 5.06 grams.

Further improvement was noted at the 8th-week follow-up, with the ICIQ-UI SF score decreasing to 8.95 ± 1.85 and the pad test value to 37.8 ± 2.56 grams.

Repeated measures ANOVA demonstrated a statistically significant reduction in both ICIQ-UI SF scores and pad test values across the three time points (ICIQ-UI SF: $F(2,57) =$

14.21, $P = 0.01$; Pad Test: $F(2,57) = 4.44$, $P = 0.01$). **Table 2** shows ICIQ-UI SF and Pad Test Scores Over Time in PFME Group.

Core Stability Exercise (CSE) Group

Participants in the CSE group demonstrated moderate urinary incontinence at baseline, with a mean ICIQ-UI SF score of 13.50 ± 2.76 and a pad test value of 38.95 ± 10.91 grams.

At the 4th-week assessment, the mean ICIQ-UI SF score reduced to 12.00 ± 2.82 and the pad test value to 35.90 ± 8.57 grams.

By the 8th week, further reductions were observed, with the ICIQ-UI SF score decreasing to 11.00 ± 2.76 and the pad test value to 31.35 ± 5.78 grams.

Repeated measures ANOVA revealed statistically significant improvements in both outcome measures over time (ICIQ-UI SF: $F(2,57) = 3.72$, $P = 0.03$; Pad Test: $F(2,57) = 3.68$, $P = 0.03$). **Table 3** shows ICIQ-UI SF and Pad Test Scores Over Time in CSE Group.

Between-Group Comparison

For the ICIQ-UI SF scores, no statistically significant difference was observed between the pelvic floor muscle exercise (PFME) group and the core stability exercise (CSE) group at baseline, $t(38) = -0.58$, $P = 0.280$, or at the 4th-week follow-up $t(38) = 0.10$, $P = 0.457$. However, at the 8th-week follow-up, a statistically significant difference was observed between the two groups, with the PFME group demonstrating significantly

lower ICIQ-UI SF scores compared to the CSE group, $t(38) = -2.57$, $P = 0.007$.

Similarly, for the 1-hour pad test values, an independent samples t-test revealed no statistically significant difference between the PFME and CSE groups at baseline $t(38) = 1.50$, $P = 0.07$. In contrast, at the 8th-week follow-up, a statistically significant difference in pad test values was observed between the two groups, $t(38) = 4.44$, $P = 0.001$, with the PFME group showing lower urine leakage compared to the CSE group. **Table 4** shows between-Group Comparison of ICIQ-UI SF Scores and Pad Test Values Using Independent t-test.

Description of Urinary Leakage Pattern (ICIQ-UI SF Question 6)

At baseline, responses to Question 6 of the ICIQ-UI SF described the circumstances under which urine leakage occurred among the participants. Urine leakage during coughing or sneezing was reported by 18 out of 80 participants, and leakage during physical activity was also reported by 18 participants, indicating a predominance of stress-related urinary incontinence symptoms. Leakage occurring before reaching the toilet was reported by 8 participants, suggesting urge-related symptoms. 2 participants reported urine leakage during sleep, while 6 participants experienced leakage after voiding. Additionally, 14 participants reported urine leakage for no obvious reason, 8 participants

experienced leakage after getting dressed, and 6 participants reported continuous leakage throughout the day. These findings highlight the varied patterns of urinary incontinence present within the study population. **Table 5** shows pattern of urinary leakage based on ICIQ-UI SF Question 6.

Figure 1 presents the Pattern of Urinary Leakage Based on ICIQ-UI SF Question 6.

Health-Related Quality of Life (EQ-5D-5L)

Health-related quality of life was assessed using EQ-5D-5L. Improvements were observed in several domains following the intervention.

In the pelvic floor muscle exercise (PFME) group, improvement was noted in the pain/discomfort and anxiety/depression

domains, with a reduction in mean scores from baseline to the 8-week follow-up. The self-care domain also demonstrated mild improvement over time. However, the mobility and usual activities domains showed minimal change across baseline and 8-week assessments.

Similarly, in the core stability exercise (CSE) group, moderate improvement was observed in the pain/discomfort and anxiety/depression domains, while self-care showed slight improvement during follow-up. Comparable to the PFME group, mobility and usual activities domains did not demonstrate substantial improvement over time. Table 5 shows EQ-5D-5L score of both groups.

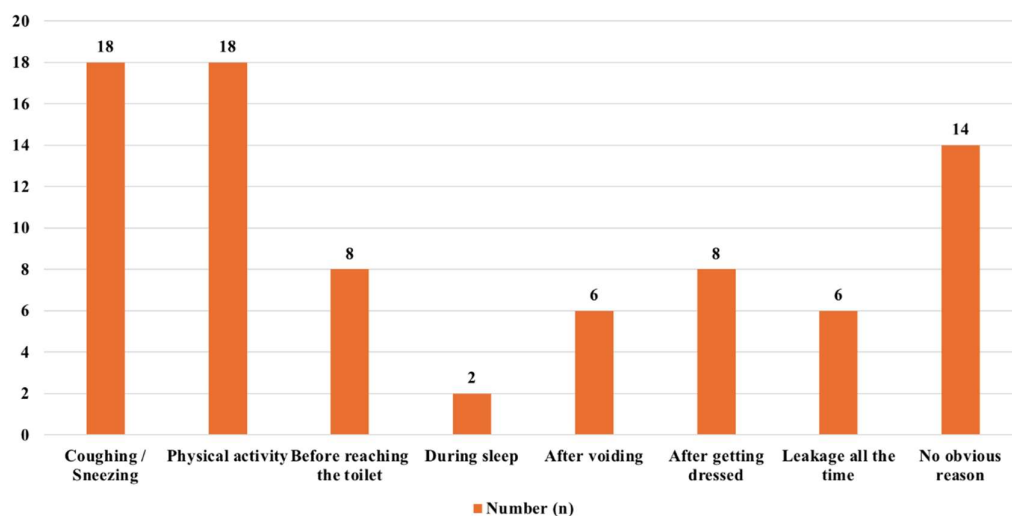


Figure 1: Legend - Pattern of Urinary Leakage Based on ICIQ-UI SF Question 6 (n = 80)

Table 1: Legend

Table 1 – Demographic data		
Variable	PFME Group (n = 40)	CSE Group (n = 40)
Age (years)		
Mean ± Standard deviation	49.25 ± 4.41	52.95 ± 4.91
Range	42 - 61	
40 – 49	22 (55%)	10 (25%)
50 – 59	18 (45%)	28 (70%)
60 – 69	0 (0%)	2 (5%)
Weight (kg)		
Mean ± Standard deviation	53.15 ± 10.37	51.30 ± 9.38
Range	40–76	
Comorbidities [n (%)]		
Hypertension	12 (30%)	10 (25%)
Diabetes Mellitus	12 (30%)	8 (20%)
Hypertension + Diabetes	6 (15%)	6 (15%)
Thyroid disorders	8 (20%)	8 (20%)
Asthma	6 (15%)	6 (15%)
COPD	4 (10%)	2 (5%)
No comorbidity	4 (10%)	6 (15%)
Treatment Status [n (%)]		
Chemotherapy	10 (25%)	10 (25%)
Radiotherapy	16 (40%)	20(50%)
Chemotherapy + Radiotherapy	4 (10%)	8 (20%)
Not on treatment	10 (25%)	2 (5%)
ECOG Performance Status [n (%)]		
Grade 1	18 (45%)	16 (40%)
Grade 2	22 (55%)	24 (60%)

Table 2: ICIQ-UI SF and Pad Test Scores Over Time in PFME Group

Time Point	ICIQ-UI SF (Mean ± SD)	Pad Test (Mean ± SD, g)
Baseline	13.00 ± 2.48	43.9 ± 9.29
4th Week	12.10 ± 2.91	41.25 ± 5.06
8th Week	8.95 ± 1.85	37.8 ± 2.56
P-value	0.01	0.01

Table 3: ICIQ-UI SF and Pad Test Scores Over Time in CSE Group

Time Point	ICIQ-UI SF (Mean ± SD)	Pad Test (Mean ± SD, g)
Baseline	13.50 ± 2.76	38.95 ± 10.91
4th Week	12.00 ± 2.82	35.90 ± 8.57
8th Week	11.00 ± 2.93	31.35 ± 5.78
P-value	0.03	0.03

Table 4: Between-Group Comparison of ICIQ-UI SF Scores and Pad Test Values Using Independent t-test

Outcome Measure	Time Point	PFME Group (Mean ± SD)	CSE Group (Mean ± SD)	t value	P value
ICIQ-UI SF	Baseline	13.00 ± 2.48	13.50 ± 2.79	- 0.58	0.280
	4th Week	12.10 ± 2.91	12.00 ± 2.82	0.10	0.457
	8th Week	8.95 ± 1.85	11.00 ± 2.93	-2.57	0.007
Pad Test	Baseline	43.9 ± 9.29	38.95 ± 10.91	1.50	0.07
	4th Week	41.25 ± 5.06	35.90 ± 8.57	-2.34	0.012
	8th Week	37.8 ± 2.56	31.35 ± 5.78	4.44	0.001

Table 5: Health-Related Quality of Life (EQ-5D-5L) (Mean ± SD)

Domain	PFM		CSE	
	Baseline	8th week	Baseline	8th week
Mobility	2.4 ± 0.6	2.3 ± 0.5	2.5 ± 0.6	2.4 ± 0.6
Self-care	2.1 ± 0.5	1.6 ± 0.4	2.0 ± 0.5	1.8 ± 0.4
Usual activities	3.0 ± 0.7	2.8 ± 0.6	3.1 ± 0.7	2.9 ± 0.6
Pain/discomfort	3.2 ± 0.8	2.1 ± 0.6	3.1 ± 0.7	2.4 ± 0.6
Anxiety/depression	2.7 ± 0.6	1.9 ± 0.5	2.8 ± 0.6	2.2 ± 0.5

DISCUSSION

Urinary incontinence is a common complication among women treated for cervical cancer and can significantly affect physical functioning, psychological well-being, and overall quality of life [6, 7]. The present prospective randomised comparative study evaluated the effectiveness of pelvic floor muscle exercises (PFME) and core stability exercises (CSE) in reducing urinary incontinence among cervical cancer patients. The results of this study demonstrated that both exercise interventions resulted in significant improvements in urinary incontinence severity and urine leakage over time; however, pelvic floor muscle exercises showed greater improvement compared with core stability exercises.

The results indicated that both intervention programs showed improvement in urinary incontinence. Nevertheless, pelvic floor muscle activities demonstrated a greater benefit than core stability training at the end of the intervention period. These findings show the value of systematic, focused pelvic floor rehabilitation in improving continence and elevating the quality of life for cervical cancer patients.

Several studies have reported that pelvic floor muscle training strengthens pelvic floor musculature, improves urethral control, and enhances neuromuscular

coordination, thereby reducing urinary leakage and improving continence. Dumoulin *et al* (2018) reported that structured pelvic floor muscle training programs represent one of the most effective conservative treatments for stress and mixed urinary incontinence [21]. Similarly, Shankar *et al* (2019) and Rehman *et al* (2017) identified a high prevalence of pelvic floor dysfunction among cervical cancer survivors and emphasized the importance of specialized rehabilitation strategies to address urinary symptoms in this population. The greater improvement observed in the pelvic floor muscle exercise group in the present study is consistent with these findings and may be attributed to the direct strengthening of the levator ani muscles and urethral sphincter mechanisms [22, 23].

The superior improvement observed in the pelvic floor muscle exercise group can be explained by the physiological adaptations associated with targeted pelvic floor training. Participants in the PFME group demonstrated a notable reduction in mean ICIQ-UI SF scores from 13.00 ± 2.48 at baseline to 8.95 ± 2.56 at follow-up, along with a decrease in pad test values from 43.90 ± 9.29 g to 37.80 ± 2.56 g. These results suggest improved urethral support and reduced urine leakage following intervention. Pelvic floor muscle training enhances muscle strength, endurance, and

stiffness, thereby increasing urethral closure pressure and improving stabilisation of the bladder neck during activities that elevate intra-abdominal pressure. Regular training also improves neuromuscular coordination and reflex activation of pelvic floor muscles, reducing stress-related leakage episodes and promoting improved continence control [24].

Core stability exercises have also gained attention in recent years for their potential role in improving pelvic floor function through neuromuscular coordination and intra-abdominal pressure regulation. Kou *et al* (2025) reported that combining core stabilisation with pelvic floor muscle training promotes synergistic activation of the transversus abdominis, diaphragm, and pelvic floor muscles, thereby improving urethral support and continence mechanisms [25]. Similarly, Nipa *et al* (2022) found that combined pelvic floor and core stability training significantly reduced urinary incontinence severity by enhancing trunk stability and pelvic floor activation patterns [26]. In the present study, participants in the core stability exercise group also showed gradual improvement, with ICIQ-UI SF scores decreasing from 13.50 ± 2.76 at baseline to 11.00 ± 2.93 at follow-up and pad test values decreasing from 38.95 ± 10.91 g to 31.35 ± 5.78 g, indicating clinically meaningful improvement.

Objective measurement using the one-hour pad test also revealed a significant reduction in urine leakage following both exercise interventions. Participants in the PFME group demonstrated a reduction in mean pad weight from 43.9 ± 9.29 g at baseline to 37.80 ± 2.56 g, whereas those in the core stability exercise group showed a decrease from 38.95 ± 10.91 g to 31.35 ± 5.78 g. Zanetti *et al* (2007) similarly reported that women undergoing supervised pelvic floor muscle training demonstrated substantial reductions in pad test values, highlighting the effectiveness of structured and supervised rehabilitation programs for urinary continence management [27].

Analysis of urinary leakage patterns using Question 6 of the ICIQ-UI SF revealed that the majority of participants experienced leakage during activities that increased intra-abdominal pressure, such as coughing, sneezing, and physical exertion. These findings indicate a predominance of stress urinary incontinence among cervical cancer survivors. A smaller proportion of participants reported leakage before reaching the toilet or leakage without a clear trigger, suggesting the presence of urge or mixed urinary incontinence. These findings suggest that urinary dysfunction following cervical cancer treatment may arise from multiple factors, including pelvic floor muscle weakness, neurological injury, and

structural alterations resulting from cancer therapy.

Health-related quality of life assessed using the EuroQol-5 Dimension 5 Level (EQ-5D-5L) showed improvement in several domains after the intervention. Both pelvic floor muscle exercise and core stability exercise groups demonstrated notable improvement in pain/discomfort and anxiety/depression, indicating better physical comfort and psychological well-being with reduction in urinary symptoms. Mild improvement was also observed in self-care, suggesting better independence in personal activities. However, minimal changes were noted in mobility and usual activities, possibly due to cancer-related fatigue and reduced endurance. Overall, structured exercise-based rehabilitation improved certain aspects of quality of life in cervical cancer patients with urinary incontinence.

Overall, the findings of this study indicate that both pelvic floor muscle exercises and core stability exercises contribute to improvement in urinary incontinence symptoms among cervical cancer patients. However, pelvic floor muscle training resulted in greater improvements in symptom severity, objective urine leakage, and functional continence outcomes. Early identification of urinary dysfunction and timely physiotherapy intervention may help

prevent long-term complications, improve quality of life, and enhance functional independence in this population. Therefore, pelvic floor muscle training should be considered a key conservative strategy in the multidisciplinary rehabilitation of women with cervical cancer.

CONCLUSION

This study demonstrates that both pelvic floor muscle exercises and core stability exercises reduce urinary incontinence symptoms in women with cervical cancer. However, pelvic floor muscle training showed greater improvement in symptom severity, urine leakage, and functional continence. Significant reductions in ICIQ-UI SF scores and pad test values indicate improved pelvic floor strength, coordination, and urethral support. These findings emphasize the importance of structured pelvic floor rehabilitation in supportive care for cervical cancer survivors. Early physiotherapy intervention may reduce urinary complications and improve quality of life. Pelvic floor muscle training should be considered an essential conservative strategy in the multidisciplinary management of cervical cancer-related urinary incontinence.

Limitations - The sample size was relatively small and limited to a single tertiary care center. The duration of follow-up was limited to eight weeks, and long-term

outcomes of the interventions were not evaluated. Additionally, variations in cancer treatment status among participants may have influenced urinary symptoms and functional recovery.

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