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Evaluation of Pelvic Floor Muscle Strength Using Different Measurement Methods in Female with Stress Urinary Incontinence

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Article

Keywords:

Posted Date: March 18th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9003802/v1

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Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at Scientific Reports on October 31st, 2026.
See the published version at https://doi.org/10.1038/s41598-026-78423-3.

Abstract

Bu çalışmanın amacı, stres üriner inkontinansı (SUI) olan kadınlarda pelvik taban kası (PTK) fonksiyonunu değerlendirmek için kullanılan farklı yöntemler arasındaki ilişkiyi, PTK fonksiyonunu dijital palpasyon, transperineal yüzey elektromiyografisi (sEMG) ve intravajinal sEMG kullanarak inceleyerek araştırmaktır. İdrar kaçırma tanısı konulan yirmi beş kadın, aynı muayene uzmanı tarafından sırasıyla dijital palpasyon (Modifiye Oxford Ölçeği, MOS), transperineal sEMG (küçük yüzey elektrotları ile) ve intravajinal sEMG (prob) kullanılarak pelvik taban kaslarının değerlendirilmesine tabi tutuldu. Bulgular, değerlendirilen parametrelerin (Ortalama, Çeyrekler Arası Aralık, MVC) hiçbirinde transperineal sEMG ile MOS arasında veya intravajinal sEMG ile MOS arasında anlamlı bir uyum olmadığını göstermiştir. Benzer şekilde, değerlendirilen tüm parametrelerde transperineal ve intravajinal sEMG yöntemleri arasında da bir uyum gözlenmemiştir. Bu çalışmanın sonuçları, bu üç yöntemin pelvik taban kası (PTK) fonksiyonunun farklı parametrelerini değerlendirdiğini ve PTK fonksiyonunun değerlendirilmesinde birbirlerinin yerine kullanılamayacağını göstermektedir. Anahtar Kelimeler: Pelvik taban kasları, Stres üriner inkontinans, Elektromiyografı, Transperineal, İntravajinal

INTRODUCTION

The integrity of the pelvic floor muscles (PFMs) plays a fundamental role in maintaining urinary and fecal continence, supporting the pelvic organs, and sustaining healthy sexual function. Pelvic floor dysfunction (PFD) is particularly common among parous women. It adversely affects quality of life, including mental health and sexual function. Pelvic floor muscle training is recommended as the first-line conservative treatment for women with urinary incontinence in order to improve or resolve symptoms[1].

Urinary incontinence may be considered an indicator of PFM dysfunction, and determining PFM function through clinical assessment is regarded as important for treatment planning [2].

Stress urinary incontinence (SUI) is defined as involuntary leakage of urine associated with physical activities such as exercise, sneezing, coughing, laughing, or bending [3]. It is a common and multifactorial disorder. Although it significantly affects quality of life (QoL), it may also lead to profound social, emotional, and psychological consequences [4]. It is more prevalent in women; however, relatively few seek medical attention, as many perceive their symptoms to be mild and not worthy of reporting [5].

In the assessment of women with SUI, measuring muscle strength, endurance, and neuromuscular activity is a fundamental requirement [6]. Although no gold standard method exists for evaluating PFM strength and endurance, various assessment tools are available [6]. The most commonly used methods include vaginal manometry, vaginal dynamometry, digital palpation, and electromyography (EMG) [7,8].

Digital vaginal examination is a fundamental clinical method used to assess PFM function; however, the evaluation largely depends on the clinician’s experience. The use of the Modified Oxford Scale (MOS) is

considered to standardize the assessment. Although MOS has been described in some studies as a practical and well-tolerated method [9], its adequacy for scientific research remains controversial [10].

In recent years, electromyography (EMG) has gained attention due to its high reliability and validity demonstrated in other muscle groups [2]. One of the methods used to examine the neuromuscular function of the PFMs is surface electromyography (sEMG). Surface EMG enables the objective assessment of PFM activity in urodynamic studies [11] and is widely used in physiotherapy practice to facilitate motor learning of muscle contraction and relaxation through biofeedback [12].

While the inter-session reliability of peak sEMG recorded using intravaginal probes has been reported to be variable [13,14], intra-session reliability has been shown to be higher.

An alternative approach involves the use of adhesive electrodes placed over the perineum, referred to as transperineal sEMG [15,16]. In EMG, the recorded signal reflects the composite electrical output of motor units; because it is easy to apply, low-cost, and noninvasive, it is widely used in both clinical and research settings [13].

A review of studies evaluating PFM strength and the reliability of measurement methods indicates that various assessment tools have been compared [17].

A review of the literature indicates that EMG is widely used in the assessment of PFM strength, and its use is expected to increase with ongoing technological advancements. Although surface electrodes and intravaginal probes have been evaluated separately in terms of measurement reliability, no study has directly examined the relationship between these two methods.

Based on this gap in the literature, the present study aimed to investigate the differences between surface and intravaginal EMG methods in women with stress urinary incontinence and to compare these findings with the MOS.

METHODS

Study Design

Ethical approval was obtained from the Kırşehir Ahi Evran University Ethics Committee (Approval number: 2025-20/267). The cross-sectional study protocol is additionally registered at ClinicalTrials.gov on 21.12.2025 (NCT07320573). It was conducted due to the Helsinki Declaration.Written informed consents were obtained. All measurements were taken at the Obstetrics and Gynecology Polyclinic of Kırşehir Training and Research Hospital. Digital palpation was performed by a gynecologist, and EMG measurements were taken by a physiotherapist experienced in this field. This ensured that blinding was achieved.

Patients

Women aged 30–60 years who had been diagnosed with SUI and who voluntarily agreed to participate were included in the study.

Exclusion criteria were as follows: pregnancy; presence of neurological and/or cognitive disorders; history of previous genitourinary surgery; symptoms of overactive bladder; use of medication for the treatment of incontinence; presence of pelvic organ prolapse (POP); age younger than 30 years or older than 60 years; inability to correctly understand and perform pelvic floor muscle contractions; and refusal to participate in the study.

All participants included in the study were first evaluated by digital palpation. The patient was placed in the lithotomy position. After donning gloves, lubricating gel was applied to the examining fingers (index and middle fingers), which were then gently inserted into the vagina. The patient was instructed to contract her PFMs by squeezing the examiner's fingers and lifting inward within the vaginal canal.

Scoring was performed according to contraction strength as follows: 0 = no contraction; 1 = very weak (flicker); 2 = weak; 3 = moderate (with lift); 4 = good (with lift); and 5 = strong (with lift) [18]. Results were graded according to the Modified Oxford Scale.

For EMG measurements, participants were positioned on an examination table. For assessment with surface electrodes, adhesive surface electrodes were placed at the 3 and 9 o'clock positions of the perineal region while the patient was lying in the supine hook-lying position [19].

Two separate contraction protocols were then administered: five short contractions (2 seconds of contraction followed by 4 seconds of rest) and five long contractions (5 seconds of contraction followed by 10 seconds of rest). A 2-minute rest period was provided between the short and long contraction protocols.

Participants were able to observe their contractions on a monitor and listen to muscle activity through speakers. Surface EMG assessments were performed using a Simplex Pro portable EMG Biofeedback device (NeuroTrac, Wexford, Ireland).

For intravaginal sEMG measurements, participants were again positioned in the supine hook-lying position on the examination table. A vaginal probe with bilateral metal recording surfaces that detect the electrical activity generated during muscle contractions was inserted into the vagina. Ultrasound gel was used for lubrication.

The same contraction protocol applied for the surface electrode assessment was also used with the intravaginal probe, and participants were instructed to perform both short and long contractions. The recorded EMG parameters included the Average value, maximum voluntary contraction (MVC), and the median (IQR) value of PFM activity.

A 10-minute rest period was provided after each measurement. Participants who completed all three assessments were considered to have completed the study protocol.

Statistical Analysis:

The normality of numerical variables was assessed using the Shapiro–Wilk test. The relationship between numerical variables was analyzed using the Spearman rank correlation coefficient. Agreement between measurement methods was evaluated using the intraclass correlation coefficient (ICC).

All statistical analyses were performed using SPSS version 22.0 for Windows. A p value < 0.05 was considered statistically significant. The minimum number of patients required for a statistically significant high level of agreement (ICC=0.90) between the measurements was determined to be 24 (α=0.05, 1-β=0.80). (https://wnarifin.github.io/ssc/ssicc.html)

RESULTS

A total of 25 women diagnosed with SUI were included in the study. The mean age of the participants was 43.8 years (range: 32–59 years). The mean body mass index (BMI) was 24.28 kg/m² (range: 19.03–29.69 kg/m²). The demographic characteristics of the participants are presented in Table 1.

Table 1
Demographic Characteristics and Modified Oxford Scale (MOS) Scores (n = 25)

Age (years)	**Mean ± SD**	**Median (Min-Max)**
	43,8 ± 6,66	**43 (32–59)**
Height (cm)	164 ± 6	164 (147–177)
Weight (kg)	65,36 ± 6,82	66 (52–76)
BKI	24,28 ± 3,06	24,3 (19,03–29,69)
MOS	2,96 ± 0,68	3 (2–4)

“Table 1 **is here”**

Table 2 presents the values obtained from the participants using perineal sEMG (Average, IQR, and MVC), intravaginal sEMG (Average, IQR, and MVC), and the Modified Oxford Scale (MOS).

Table 2
EMG (Perineal Surface Electrode and Intravaginal Probe) Average, IQR, and MVC Values and MOS Scores (n = 25)

	Surface (Perineal Surface Electrode)		**Intravaginal Probe**	
	Mean ± SD	**Median (Min-Max)**	**Mean ± SD**	**Median (Min-Max)**
Avarage 2s	5,72 ± 2,45	5,3 (1,5–11,4)	9,42 ± 5,14	8,3 (3–20,6)
Avarage 5s	5,92 ± 2,53	5,1 (1,7–12)	9,85 ± 5,17	8 (3,8–25,1)
IQR 2s	2,18 ± 1,21	1,9 (0,4–4,8)	4,02 ± 3,09	3,2 (0,6–13,6)
IQR 5s	2,65 ± 1,79	2,3 (0,4–9,2)	4,29 ± 2,38	3,6 (1–10,7)
MVC 2s	53,4 ± 7,21	53,3 (38,9–66,2)	49,98 ± 11,03	51 (26,1–67,6)
MVC 5s	45,51 ± 8,61	47,2 (26,5–61,8)	44,28 ± 9,14	45,2 (24,3–60,7)
	Mean ± SD		**Median (Min-Max)**	
MOS	2,96 ± 0,68		3 (2–4)	

None of the participants were classified as grade 0, 1, or 5 according to the MOS by the examiner. During palpation, all women included in the study were able to voluntarily contract and fully relax their pelvic floor muscles. No participant demonstrated hypertonic pelvic floor muscles.

It was confirmed through observation that none of the women used accessory muscles (such as the gluteal muscles or hip adductors) during the pelvic floor muscle assessment.

“Table 2 **is here”**

The agreement between measurements obtained using the MOS and those obtained through perineal sEMG and intravaginal sEMG was evaluated using the ICC. Table 3 presents the ICC values reflecting the agreement between MOS scores and perineal and intravaginal sEMG measurements.

Table 3
Intraclass Correlation Coefficients (ICC) Between Surface sEMG and Intravaginal sEMG Values and MOS Measurements

	Surface sEMG			**Intravaginal sEMG (Probe)**		
	ICC	**Min – Max (%95 GA)**	**p**	**ICC**	**Min – Max (%95 GA)**	**p**
Avarage 2s	0,135	-0,963 0,619	0,363	0,181	-0,859 0,639	0,314
Avarage 5s	0,221	-0,767 0,657	0,272	0,233	-0,741 0,662	0,261
IQR2s	0,090	-1,066 0,599	0,410	0,143	-0,946 0,622	0,355
IQR5s	0,454	-0,239 0,759	0,073	0,360	-0,452 0,718	0,140
MVC 2s	-0,094	-1,483 0,518	0,586	0,036	-1,188 0,575	0,465
MVC 5s	-0,098	-1,492 0,516	0,590	0,025	-1,213 0,570	0,476
* Statistically significant at $p < 0.05$; intraclass correlation coefficient (ICC).						

No significant association was found between MOS scores and any of the perineal or intravaginal sEMG parameters (Average 2 s, Average 5 s, IQR 2 s, IQR 5 s, MVC 2 s, MVC 5 s) ($p > 0.05$).

“Table 3 **is here”**

The agreement between perineal sEMG and intravaginal sEMG measurements was also evaluated using the ICC. Table 4 presents the ICC values reflecting the agreement between perineal and intravaginal sEMG measurements. No significant association was found between perineal sEMG and intravaginal sEMG for any of the evaluated parameters (Average 2 s, Average 5 s, IQR 2 s, IQR 5 s, MVC 2 s, MVC 5 s) ($p > 0.05$).

Table 4
Intraclass Correlation Coefficients (ICC) Between Perineal sEMG and Intravaginal sEMG Measurements

Avarage 2s	**ICC**	**Min - Max (%95 GA)**		**p**
	0,365	**-0,440**	**0,720**	**0,136**
Avarage 5s	0,378	-0,412	0,726	0,126
IQR2s	-0,152	-1,615	0,492	0,634
IQR5s	0,307	-0573	0,694	0,188
MVC 2s	-0,324	-2,005	0,417	0,752
MVC 5s	0,210	-0,793	0,652	0,284
* Statistically significant at p < 0.05; intraclass correlation coefficient (ICC).				

“Table 4 **is here”**

DISCUSSION

In this study, the relationship between the MOS, transperineal surface sEMG, and intravaginal sEMG measurements was comparatively examined in 25 women diagnosed with SUI. The findings demonstrated no significant agreement between MOS and transperineal sEMG, nor between MOS and intravaginal sEMG, for any of the evaluated parameters (Average 2 s, Average 5 s, IQR 2 s, IQR 5 s, MVC 2 s, MVC 5 s).

Similarly, no agreement was observed between transperineal and intravaginal sEMG methods across all assessed parameters. These results suggest that the methods used to evaluate PFM function are not interchangeable.

In women with PFD, the assessment of PFM function is complicated by anatomical alterations [20] and neuromuscular abnormalities [21]. Although the reliability of vaginal palpation [7], manometry, dynamometry [22], and sEMG [23] has been investigated in the literature, comparative data between these methods remain limited.

In sEMG measurements recorded using intravaginal probes, inter-session reliability has been reported to be variable, whereas intra-session reliability appears to be higher [13]. In the study by Glazer et al. [23], the 1–4 month interval between measurements constituted a significant limitation in terms of standardization. Kasaeian et al. [2] reported a positive association between vaginal pressure, manual muscle testing, and EMG data in women with SUI and overactive bladder.

However, the absence of a correlation between MOS scores and sEMG parameters in the present study suggests that the assessment tools may measure different physiological components of PFM function.

Anatomical factors may also influence measurement outcomes. It has been demonstrated that levator hiatus (LH) width affects measurement results, with individuals who have a smaller LH exhibiting higher perineometric values [24]. Similarly, probe shape and surface area have been reported to influence test–retest reliability [13]. This may represent one of the factors explaining the lack of agreement between intravaginal sEMG and MOS observed in the present study.

Botelho et al. [25] reported a strong correlation between intravaginal sEMG and vaginal palpation in women without PFD. However, in women with PFD, it has been suggested that neuromuscular transmission impairments may result in high sEMG activity despite low force output [26].

In this context, sEMG is considered to reflect neuromuscular activity rather than serving as a direct indicator of muscle strength, and therefore may not correspond directly with force measurements [23]. Our findings support this perspective.

One of the most important methodological issues in transperineal and intravaginal sEMG measurements is cross-talk. The ability of electrodes to detect signals not only from the target muscle but also from adjacent muscles (such as the obturator internus, hip adductors, gluteal muscles, and transversus abdominis) may reduce measurement accuracy [11]. Auchincloss and McLean [13] demonstrated cross-talk originating from the hip adductors in surface EMG by comparing it with fine-wire EMG. Similarly, Navarro Brazález et al. [14] reported a low correlation between transperineal sEMG and PFM strength.

In the present study, the absence of agreement between transperineal and intravaginal sEMG methods may be attributable to differences in electrode configuration and cross-talk effects.

Technical limitations may also influence measurement outcomes. The inability to adjust electrode placement of intravaginal probes according to individual vaginal morphology [27], the potential for probe diameter to alter muscle length [28], and sensitivity to motion artifacts [13] may all affect the recorded measurements. In transperineal sEMG, attenuation of the signal by the soft tissue between the skin and the target muscle represents an additional important limitation [29].

In MOS assessment, combining the occlusion and elevation components into a single ordinal score may limit measurement sensitivity [30]. Inter-rater reliability has been reported to be moderate [17], and discriminative ability appears to decrease particularly in higher score categories [8]. Koenig and Radlinger [31] also reported a weak association between MOS and transcutaneous EMG. These findings are consistent with the results of the present study.

Although some studies in the literature argue that cross-talk is negligible, many researchers consider it a significant issue affecting measurement validity [11,32]. In accordance with the SENIAM recommendations,

the use of small electrode surfaces and short inter-electrode distances is important for minimizing cross-talk. However, it is well recognized that these standards cannot always be strictly maintained in clinical practice.

Clinical and Methodological Implications

The findings of this study suggest that the MOS, transperineal sEMG, and intravaginal sEMG assess different components of PFM function and should not be used interchangeably. While MOS primarily provides a clinical and subjective evaluation of muscle strength, sEMG reflects neuromuscular activity. However, sEMG measurements should also be interpreted with caution due to potential influences of electrode configuration, anatomical variability, and cross-talk.

Limitations and Future Research

The relatively small sample size and the inclusion of only women diagnosed with SUI limit the generalizability of the findings. In addition, no comparison was made with a reference method such as fine-wire EMG, which may be considered a more definitive assessment tool.

Future studies should include larger samples encompassing different subgroups of PFD and employ comparative study designs using standardized electrode configurations and reference measurement methods.

Declarations

Acknowledgements

The authors would like to thank the participants who volunteered in this study.

Data availability

The datasets generated during and/or analysed during the current study are not publicly available due to personal privace but are available from the corresponding author on reasonable request.

Author Contributions

E. B. D.: Conceptualization (lead); methodology (lead); supervision (lead); project administration (lead); resources (lead), Writing – original draft (lead);

S. S. D.: Conceptualization (equal); methodology (equal); project administration (equal); Supervision (equal); validation (lead); investigation (lead).

Conflict of Interest

The authors report no conflict of interest.

Funding

The authors did not receive support from any organization for the submitted work.

Compliance With Ethical Standards

Ethical approval: Ethical approval was obtained from the Kırşehir Ahi Evran University Ethics Committee (Approval number: 2025-20/267). The study protocol is additionally registered at ClinicalTrials.gov on 21.12.2025 (NCT07320573). It was conducted due to the Helsinki Declaration. Written informed consents were obtained.

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