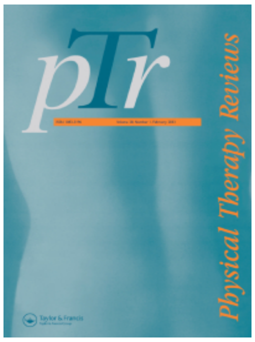

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Pelvic floor muscle activity during coughing and valsalva maneuver in continent women and women with stress urinary incontinence: a systematic review

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ABSTRACT

Background: Pelvic floor muscle (PFM) activation during efforts activities may predispose to urinary loss. However, there is unclear evidence on the behavior of PFM during situations of coughing and Valsalva maneuver.

Objectives: Hence, the present review aimed to evaluate the current evidence on electromyographic (EMG) activity of PFM during coughing and Valsalva maneuver in continent women and women with stress urinary incontinence (SUI).

Methods: The databases EMBASE, PubMed, Science Direct, Scopus and were searched up to August, 2021. Two independent reviewers conducted the selection process based on titles, abstracts, and full-text reading. In addition, studies reporting PFM EMG activity during coughing and/or the Valsalva maneuver with surface EMG were included. The methodological quality of the primary studies was assessed through the checklist proposed by the Joanna Briggs Institute for cross-sectional studies.

Results: Seven cross-sectional studies were included in this review, four of which were on PFM activation of continent women, while the other three compared continent women versus women with SUI. During both Valsalva maneuver and coughing, an increase of PFM EMG activity compared to rest was observed for continent women and women with SUI. Limitations of the present systematic review are that comparison among studies and a meta-analysis were not possible due to heterogeneity of EMG techniques and devices used.

Conclusions: Coughing and Valsalva maneuver lead to an increase in PFM electrical activity compared to rest. This increase was more prominent in women with SUI during Valsalva, with no differences during coughing.

ABBREVIATIONS: BMI: Body Mass Index; EMG: Electromyography; IAP: Intraabdominal pressure; ICC: Intraclass Correlation Coefficient; JBI: Joanna Briggs Institute; mV: milivolts; MVC: Maximal Voluntary Contraction; PFM: Pelvic Floor Muscles; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RMS: Root Mean Square; StArt: State of the Art through Systematic Review; SUI: Stress Urinary Incontinence

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Health evaluation; pelvic floor; muscle contraction; electromyography

Introduction

Stress urinary incontinence (SUI) is defined as any involuntary urine loss that occurs when the bladder pressure exceeded the urethral pressure during increases in intraabdominal pressure (IAP). This incident occurs during activities such as straining, coughing, or sneezing and depicts a reduction of both the active force development and the active stiffness of the pelvic floor tissues [1–3]. During the increase of the IAP, pelvic floor muscles (PFM) contract and give support to the urethra [2] and hence, prevent urinary loss.

PFM can be assessed with different techniques [3], such as ultrasonography [4, 5], vaginal palpation [5], manometry [5], dynamometry [3] and electromyography (EMG) [6, 7]. Literature suggests several situations to be considered when assessing muscle activation and PFM function, such as coughing [8–10], PFM maximal voluntary contraction (MVC) [11], weightbearing positions [11, 12], running [13, 14], jump-landing process [15], Valsalva maneuver [15, 16] and horseback riding [17], among others. The Valsalva maneuver is used to reproduce the increase in the intrabdominal pressure that occurs during straining, even though PFM behave differently during Valsalva and straining [18]. Usually, the Valsalva maneuver is defined as 'a maximal straining effort with forced expiration against a closed glottis [19–21] that results in depression of the bladder base observed using ultrasound [19, 20]'. Valsalva maneuver and coughing, activities

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Table 1. Inclusion and exclusion criteria for studies' analysis by title, abstract and full text.

Category	Inclusion criteria	Exclusion criteria
Participants	Continent women and women with SUI	Pregnant women, women in the puerperium period, subjects with prolapse, that underwent gynecological surgery (for prolapse and/or incontinence), women with urgency incontinence, mixed incontinence, fecal or anal incontinence; participants with nervous system dysfunctions, diabetes; studies that included animals, cadaver, children or men; PFM evaluation by anorectal hiatus, studies that involved urodynamic evaluations, invasive EMG.
Interventions	Surface EMG: coughing, Valsalva maneuver.	Invasive (needle, wire) EMG: PFM maximal voluntary contraction, coughing, Valsalva maneuver, jumping, horseback riding.
Comparisons	Continent women and women with SUI	Women with urgency or mixed urinary incontinence
Main Outcomes	EMG: PFM activation pattern and amplitude, onset time, time to peak activity.	Evoked potential action, Motor Unit Action Potential (MUAP).

SUI: Stress Urinary Incontinence; PFM: Pelvic Floor Muscles; EMG: electromyography.

known to increase IAP, may cause different biomechanical responses of the PFM [1, 22].

It is important to assess PFM during different activities to understand how these muscles behave to maintain continence, or during urinary loss. Thus, two systematic reviews have looked into PFM function under different situations. Luginbuehl et al. [23] included studies that have investigated PFM activation and the strength components that may have influenced continence and urinary loss during efforts. They concluded that a high PFM activation and strength components have a positive influence on female urinary continence [23]. Moser et al. [24] investigated PFM electrical activation in women under impact activities, such as jumping, running or coughing. They concluded that impact activities cause involuntary and reflex PFM activity should be further studied. Both reviews did not aim to assess the PFM activity during cough or Valsalva maneuver. Therefore, there is a lack in literature related to the PFM activation during effort activities (cough and Valsalva Maneuver) and the role with urinary symptoms.

Hence, characterizing muscle activation for continent and incontinent women during efforts that may predispose urinary loss is relevant. As such, the aim of the present study was to evaluate the current evidence and understand how PFM of continent women and women with SUI are activated during Valsalva maneuver and coughing.

Methods

Search strategy and eligibility criteria

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [25]. Consulted database included EMBASE, PubMed, Science Direct, Scopus and Web of Science. The search for articles was conducted on October 2019 and updated on August 2021. There was no restriction of time range of publication, language and study design; however, only full text studies were considered. The search strings used in all databases were: (women) AND (evaluation OR assessment OR measurement) AND (EMG OR electromyography) AND (PFM OR 'pelvic floor muscle'). The identified studies were uploaded into State of the Art through Systematic Review (StArt), version 3.4, (Universidade Federal de São Carlos, Brazil). Inclusion and exclusion criteria are described in Table 1, which are based on the PICO (population, intervention, comparison, and outcome) strategy.

Two independent reviewers (RFLM and JBS) performed the selection of potential studies. The selection process was performed in three sequential evaluation phases: (I) selection by title (II) selection by abstract and (III) analysis of the full text in order to determine their inclusion. In case of any disagreements in some of the selection steps between these two reviewers, a third independent reviewer (PD) was consulted to reach a consensus decision.

Methodological quality assessment

Articles included were assessed for methodological quality according to the checklist proposed by The Joanna Briggs Institute (JBI) [26] for analytical cross-sectional studies. The JBI checklist is composed of 8 items, to which reviewers should answer 'Yes' when the criterion was described in the study, 'No' when it was not described, 'Not clear' when the description was incomplete and 'Not Applicable' when the criterion did not apply for the study [26]. The greater the score, the better the methodological quality of the study. The score for each item is zero when the quality criterion is absent (no, unclear, or not applicable) and is scored one if is present. The same reviewers of the previous steps independently analyzed and scored all included studies and reached consensus.

Data extracted referred to participants' characteristics (sample size, age, parity and body mass index), EMG device, EMG electrode type (for both PFM and other muscles assessed in the studies), evaluation protocol, position and task (Valsalva maneuver

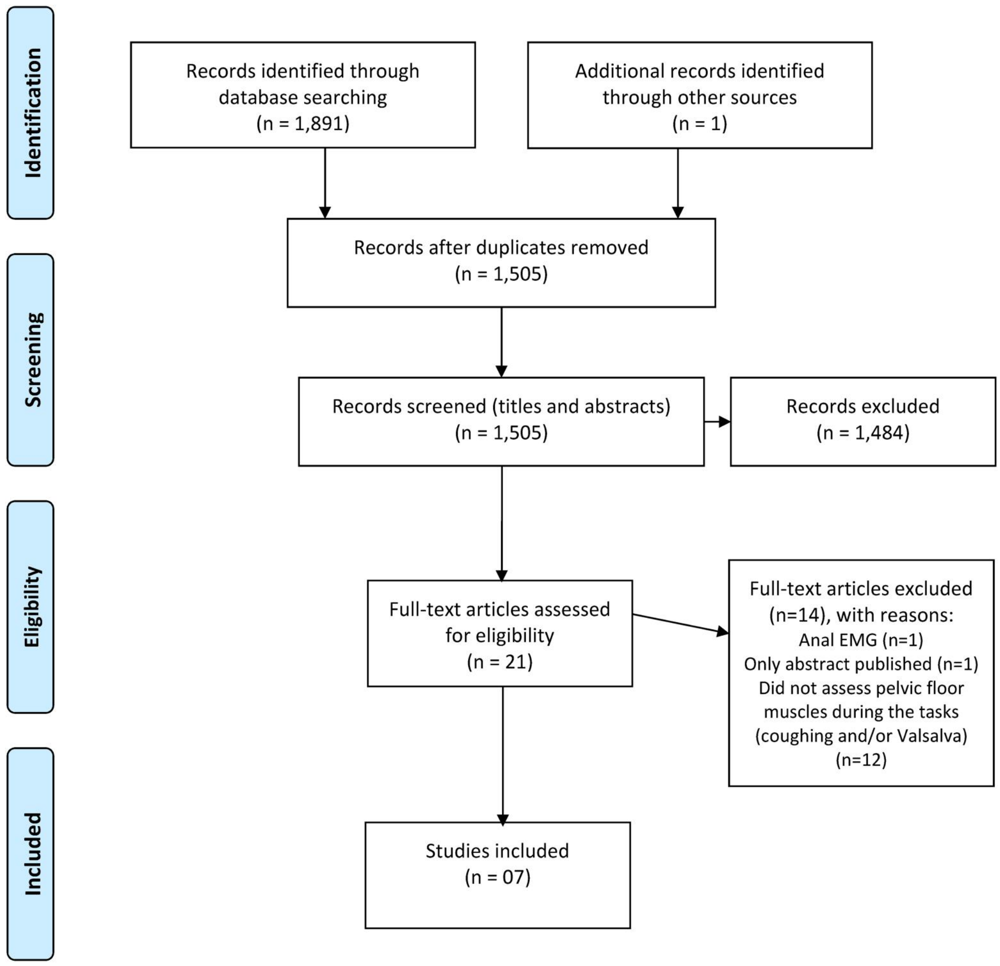

Figure 1. Study's flowchart.

and/or coughing), instruction to the task, main PFM EMG variable(s) evaluated and findings.

Results

The literature review identified 2,101 abstracts. After removal of duplicate studies and application of inclusion and exclusion criteria, seven cross-sectional studies were selected for this systematic review. Figure 1 shows PRISMA flowchart for this review.

Results from the methodological quality assessment of included studies, according to the Joanna Briggs Institute (JBI) criteria, are shown in Table 2. Score ranges from 2 to 6 points.

Participants' characteristics as well as EMG device and electrodes (especially for the PFM assessment) are shown in Table 3. The sample size of the studies ranged from 9 to 102 participants. Surface vaginal EMG was performed either by vaginal probes (Periform™ [10, 11, 19–21], Femiscan™ [9]) or by surface electrodes attached to a probe that was placed intravaginally (Mediwatch UK [18]).

Evaluation protocol, PFM EMG variables analyzed and findings are summarized in Table 4. Positions adopted during those tasks were supine [19–21] and standing [10, 11, 18] or both [9]. In one study [11], standing position was modified by different lumbopelvic positions (neutral, hyperlordosis and hypolordosis). Among PFM EMG variables, amplitude (in mV or in % of PFM maximal voluntary contraction) was included in all studies. Other variables analyzed were onset time [11], time to peak muscle activation [9, 11] and activation pattern for muscle recruitment [20].

PFM was evaluated during coughing in three studies, two of which in standing position [10, 11] and the other in both standing and supine positions [9]. During coughing, an increase of PFM EMG activity was observed in continent women [10, 11] compared with rest [10, 11] and women with SUI [9].

Valsalva maneuver was measured by five of the seven studies included in this systematic review; two of them assessed women in standing position [11, 18] and three assessed women in supine position [19–21]. All of them showed an increase in PFM EMG activity compared to rest, and this increase was higher for women with SUI [20].

Discussion

The present review evaluated the current evidence and understood how PFM of continent women and

Table 2. Joanna Briggs Institute Methodological Quality Assessment.

Study ID (First author, year)	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropriate statistical analysis used?	Total score
(Baessler et al. 2017)	NC	NC	No	No	Yes	No	NC	Yes	2
(Capson et al. 2011)	Yes	Yes	No	Yes	NA	NA	NC	Yes	4
(Junginger et al. 2010)	NC	No	No	Yes	NA	NA	NC	Yes	2
(Luginbuehl et al. 2016)	Yes	NC	Yes	Yes	NA	NA	NC	Yes	4
(Madill et al. 2010)	Yes	No	No	Yes	Yes	No	NC	Yes	4
(Thompson et al. 2006a)	Yes	No	NC	Yes	NA	NA	NC	Yes	3
(Thompson et al. 2006b)	Yes	Yes	NC	Yes	Yes	Yes	NC	Yes	6

Scoring was based on the answers (Yes = 1 point; No, NC or NA = 0 point). NC: Not clear; NA: Not applicable.

Table 3. Characteristics of the participants and EMG device used in the studies included.

First author (year)	Sample size (*n*) Continent status	Age (years) Mean (SD)	Age range	Parity	BMI (kg/m^2) Mean (SD)	EMG device/Electrodes
Capson et al. (2011)	16 continent	27.1 (5.5)	22–41	0	22.8 (1.6)	Delsys™ Bagnoli-8/surface EMG: vaginal probe Periform™ (PFM bilaterally) and bipolar electrodes for rectus abdominis, external oblique, internal oblique and erector spinae
Junginger et al. (2010)	9 continent	42	32–59	Range: 0–2	24.2	Power 1401 (CED/UK)/PFM: vaginal probe Periform™; abdominal muscle EMG: combination of surface and intramuscular (fine wire) EMG on the right side (transversus abdominis, rectus abdominis, obliquus internus abdominis and obliquus externus abdominis)
Luginbuehl et al. (2016)	11 continent	28.8 (2.3)	20–35	0	21.2 (2)	TeleMyo 2400 G2 (Noraxon)/PFM: vaginal probe Periform™.
Thompson et al. (2006a)	13 continent	37 (9)	20–55	Median: 1 Range: 0–3	21 (2)	Two octopus Cable Telemetric systems (Bortec Electronics, Calgary, Canada) and Medilec amplifier (Oxford Instruments)/ surface EMG: vaginal probe Periform™ (PFM)
Baessler et al. (2017)	17 continent	33	21–52	Median: 2 Range: 0–3	23	TeleMyo (Noraxon)/Surface EMG (Disposable Vaginal Surface electrode, Mediwatch, UK; attached to a sponge)
	85 UI	48	28–83	Median: 1 Range: 0–8	24	
Madill et al. (2010)	8 continent	51.6 (6.2)	35–60	Mean: 1.9	25 (3.7)	Delsys™ Bagnoli-16/Surface EMG: vaginal probe Femiscan™ (PFM) and surface electrodes from rectus abdominis
	16 8 UI	52.3 (7)	35–60	Mean: 2.4	27.1 (5.1)	
	Severe UI	53.5 (6)	35–60	Mean: 2.4	27.4 (5.4)	
Thompson et al. (2006b)	13 continent	37 (7)	20–55	Median: 0	21 (2)	Two octopus Cable Telemetric systems (Bortec Electronics, Calgary, Canada) and Medilec amplifier (Oxford Instruments)/surface EMG: vaginal probe Periform™ (PFM)
	UI = 13	38 (7)	20–55	Median: 2	22 (2)	

BMI = Body Mass Index; EMG = Electromyography; PFM = Pelvic Floor Muscles; SD = Standard Deviation; UI = Urinary Incontinence.

women with SUI activated during Valsalva maneuver and cough. This review suggests that coughing and Valsalva maneuver lead to increased PFM EMG activity in both continent women and women with SUI compared to rest. Women with SUI could have a delay in PFM activation, indicating that the onset time of PFM is an important factor for urinary continence maintenance.

An increase in the PFM EMG activity during the Valsalva maneuver was reported in all studies. Baessler et al. (2017) [18] observed that at the beginning of the Valsalva maneuver, most women (continent and with SUI) increased PFM EMG activity (71% and 76%, respectively). Similarly, Thompson et al. [20] compared continents and women with SUI and reported a higher activity of PFM EMG during the Valsalva maneuver in

Table 4. Characteristics related to the evaluation protocol, PFM EMG variable and findings of the studies included in the review.

First author (year)	Evaluation protocol			PFM EMG variables assessed	Findings
	Position	Task	Instruction for the task		
Capson et al. (2011)	Standing position with different lumbopelvic postures (habitual, hyperlordosis and hypolordosis) and supine position	Coughing and Valsalva Maneuver	Coughing: Missing. Valsalva: Missing	Amplitude (mV), onset time (ms, only for coughing) and time to peak muscle activity (ms); PFM EMG assessments were performed bilaterally (right and left PFM)	Coughing in habitual lumbopelvic position was the task that produced the greatest PFM activation (∼0.18 mV) compared to MVC (∼0.075 mV) and the Valsalva maneuver (∼0.07 mV). Habitual position produced greater muscle activation than hypo or hyperlordosis in all tasks assessed for all muscles assessed. Regarding PFM in the habitual lumbopelvic position, mean activation was ∼0.065 mV for the right PFM and ∼0.06 mV for the left PFM (no differences between sides) compared to ∼0.045 mV (hypolordosis) and ∼0.05 mV (hyperlordosis).
Junginger et al. (2010)	Supine	Valsalva maneuver	Instructed to take a relaxed breath in and out, relax PFM and performed maneuver without breathing; Participants were instructed to forced expiration against the closed glottis with an effort equivalent to 2 on the modified Borg scale.	Amplitude (% MVC EMG)	The Valsalva maneuver was the task that most increased intraabdominal pressure (∼1.59 cmH_2O); during maximal Valsalva maneuver, PFM were strongly activated (∼28% of the MVC); however, PFM were more active during maximal PFM and obliquus externus abdominis contraction than during the Valsalva maneuver.
Luginbuehl et al. (2016)	Standing position	Coughing	Stand relaxed, with feet hip-width apart, hips and knees minimally bent) and not perform any voluntary contraction of PFM. Performed 3 coughs of maximal expulsion effort (through peak-flow-meter) after a maximal inspiration	Amplitude (% MVC EMG)	At rest, mean PFM EMG was ∼25% EMG. When participants received the instruction to cough, the PFM activity increased to ∼35% in the pre-activity anticipatory regulation; at the moment of coughing, PFM activity increased ∼48%, reaching 52.2% in the long-latency response, characterizing the reflex activity during a stretch-shortening cycle.
Thompson et al. (2006a)	Supine	Valsalva maneuver	Participants were instructed to performed a maximal straining effort, with forced expiration against a closed glottis that resulted in depression of the bladder base observed using ultrasound	Amplitude (% MVC EMG)	Compared to rest (∼13% MVC), the Valsalva maneuver corresponded to an increase of ∼29%MVC; this value is still lower than PFM oriented contraction (∼82% MVC).
Baessler et al. (2017)	Standing position	Valsalva Maneuver	Relax PFM and strain or push as if defecating	Amplitude (–)	PFM relaxation was observed in 2.4% (2/85) of women with SUI and in none of the 17 continent women. Increased PFM EMG activity was observed in 76% of women with SUI and 71% of continent women.

(*continued*)

Table 4. Continued.

	Evaluation protocol				
First author (year)	Position	Task	Instruction for the task	PFM EMG variables assessed	Findings
Madill et al. (2010)	Supine and standing position	Coughing	Deep breath following by a cough of maximal expulsion effort with the mouth sealed over the peak flow meter mouthpiece and meter in vertical	Amplitude (mV), timing (in ms) to peak EMG amplitude related to peak posterior vaginal wall pressure (measured by air charged pressure sensors mounted on the vaginal probe)	Regarding amplitude, no differences were found among groups during coughing in different positions (∼0.05 mV in each situation). Regarding timing of PFM activity related to peak posterior vaginal wall pressure, continent women contracted PFM simultaneously with the peak posterior vaginal wall pressure; women with mild SUI this happened only for the supine assessment, while for the standing position assessment, PFM peaked ∼183 ms before peak posterior vaginal wall pressure. For women with moderate to severe SUI, PFM EMG peaked before the posterior vaginal wall pressure in both assessments (supine/; ∼408ms; standing position ∼245 ms).
Thompson et al. (2006b)	Supine	Valsalva Maneuver	Participants were instructed to performed a maximal straining effort, with forced expiration against a closed glottis that resulted in depression of the bladder base observed using ultrasound	Amplitude (%MVC EMG)	Symptomatic women presented more PFM activation (∼45%MVC) at rest than the asymptomatic group (∼30%MVC). Even though both groups reached 100%MVC during the Valsalva maneuver, the symptomatic group presented significantly lower PFM power, which implies in less muscle activation.

EMG: electromyography; MVC: Maximal Voluntary Contraction; ms: milliseconds, mV: millivolt; PFM: Pelvic Floor Muscles; SUI: Stress Urinary Incontinence; – data not presented.

comparison to rest in the women with SUI. Nonetheless, the latter does not mean that women with SUI may have higher muscle strength because the EMG does not directly assess muscle force output [27].

Even though the Valsalva maneuver is not performed alone during daily life activities, executing this maneuver may help understand how PFM would behave in situations during which there is an increase in IAP, for example, when carrying a heavy object. As such, the definition of the Valsalva maneuver should be clear and consistent with the original definition ('forceful expiration against closed nostrils and mouth in order to increase intrathoracic pressure that is transmitted through the open glottis to the oronasopharyngeal cavity, and thus opens eustachian tubes and inflates the middle ear' [28]). Four out of the five studies that used the Valsalva maneuver defined the maneuver as 'effort of forced expiration against the closed glottis' [18–21], with subtle differences between them. Only one study [18] instructed participants to performed Valsalva maneuver 'as if they were defecating', which would impact how the PFM would be activated, given the differences between straining and Valsalva maneuver on PFM action [18].

During coughing, an increased PFM EMG activity was observed in all studies, with no differences between continent women and women with SUI [9]. Of the three studies that evaluated PFM EMG activity during coughing, two have used a peak flow meter and a nasal plug, along with instruction on how to keep a tight seal around the mouthpiece with the lips [9, 10]. Results from two studies included in the present systematic review have shown that PFM activity increases during coughing compared with rest [10] and to other tasks such as the Valsalva maneuver [11]. Continent women reached the peak of PFM EMG activity and the peak of posterior vaginal wall pressure simultaneously in both standing and supine positions [9]. Women with SUI presented an early PFM EMG peak activity relative to peak posterior vaginal wall pressure, which may mean that PFM were not able to generate the amout of force output needed to maintain continence during peak posterior vaginal wall pressure. Dysfunctional preactivation of the PFM reflex response contributes to the physiopathology of SUI [29]. Capson et al. [11] suggest that coughing may be a useful approach to initiate PFM strengthening in women with difficulties of activating their PFM voluntarily. However, Luginbuehl et al. [10] found poor reliability of PFM activity time interval during coughing, and suggest that data on PFM activation during coughing be interpreted with caution.

Studies have used supine and standing positions to evaluate participants. Supine position does not reflect a functional position while the Valsalva maneuver performed in standing position is more reflective of daily life activities [18]. For continent women, the lumbopelvic posture influences the PFM muscle activation, and the neutral posture is the one in which women reached the greatest PFM EMG amplitude [11]. The authors suggest that PFM training must be performed in the neutral lumbopelvic posture; nonetheless, those results cannot be generalized for women with SUI, given that the study was performed exclusively with continent women [11].

In spite of being currently used to assess PFM, there are several concerns involving EMG, especially for this particular muscle group. One issue is the kind of electrode used, as it may influence results [30]. Intramuscular EMG presents the advantage of being more specific than surface EMG, but it only reflects the activity of the muscle fiber the needle is inserted into, missing the observation of muscle performance as a whole [19, 21]. On the other hand, surface EMG vaginal probes may generate crosstalk by capturing muscle electrical activity from adjacent muscles [31]. There is still a lack in literature to define the muscles 'crosstalk', leading to conclusions based on insufficient evidence. Auchincloss and McLean [32] have analyzed between-trial and between-day reliability of vaginal probes (Periform^{TM} and Femiscan^{TM}), and have shown that Periform^{TM} has a good to high (intraclass correlation coefficient [ICC]$_{(3,1)}$ between 0.80 and 0.98) between-trial reliability, while Femiscan has shown fair to high (ICC$_{(3,1)}$ between 0.58 and 0.98) between-trial reliability. However, between-day reliability was generally poor for both probes (ICC $_{(3,1)}$ between 0.08 and 0.84). Moreover, there is no previous recommendation related to the correct position of the EMG vaginal probe into the participants' vaginal canal, although its known that the higher activity of the PFM during a voluntary contraction assessed by a manometer can be found at the 3.5 cm into the vaginal canal [33]. In addition, one systematic review [30] concluded that, due to several factors (probe geometry, detection surface and inadequate electrode setting), the probes used to collect PFM EMG activity capture crosstalk and generate movement artifact, which affects PFM EMG signal quality.

Normalizing surface EMG data turns comparable between studies [34], and diminishes the influence of intrinsic and extrinsic factors on data analysis and interpretation [35]. Normalizing data may seem an essential step to decrease the influence of electrodes and probes on the data collected. The most studies included in the present review extracted the

Root Mean Square (RMS) from EMG signals, RMS is often used to infer the degree of muscle activation [36]. Six out of seven studies included in the review have normalized signals using PFM MVC, exception Madill et al. [9], that subtracted the lowest RMS value from the highest EMG peak value. One recent study [7] has investigated different normalization methods for PFM, and found excellent reproducibility of EMG normalization with peak RMS in PFM assessment during 3 MVC and crunch tasks. Good reproducibility was also found for cough and Valsalva activities, considering the peak and mean of RMS, respectively [7].

The present study presents several limitations. First, studies vary in methodological quality, with scores ranging from 2 [18, 21] to 6 [20]. A comparison among studies could not be performed due to studies' heterogeneity, lack of standardization of task performances (coughing and Valsalva maneuver, including description of the tasks and verbal instructions given to the participants), difference in data presentation (for amplitude, some studies have shown raw numbers in mV, while other used data as %MVC), use of different devices, especially vaginal probes, and lack of data normalization. Data normalization turns comparison among different subjects and muscles viable by decreasing interindividual variability [37].

There are some important considerations when designing a PFM rehabilitation program, such as correct verbal instructions to use, positions that are more functional and simulate situations of urinary leakage (for example, standing position) and the ability to contract voluntary the PFM. The inclusion of provocative tasks (such as coughing and Valsalva) could be a form of stimulation the reflex contraction of PFM. Also, more positions and tasks that occur in daily life activities (such as heavy lifting, climbing stairs and standing up a seated position) could be assessed and used as rehabilitation positions to perform PFM training. Nonetheless, all results from PFM EMG should be carefully interpreted, as the literature points that the vaginal probes available to assess PFM function may have a great interference of crosstalk and noises, which may impact data quality and validity. Future studies should focus on improving PFM EMG data collection and develop a system that would be valid and reliable for assessing PFM during daily life activities.

Conclusion

Coughing and the Valsalva maneuver led to an increase in PFM electrical activity compared to rest. This increase was more prominent in women with SUI during Valsalva. Nonetheless, EMG data on PFM should be carefully interpreted, given the high variability on electrodes, vagina probes, and normalization techniques.

Authors' contributions

All authors have read and approved the manuscript.

Disclosure statement

No potential conflict of interest was reported by the authors.

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