Pelvic floor muscle exercises in the treatment of urinary incontinence in women – a critical review and meta-analysis

Dorota Rabsztyn[1], Magdalena Stania[2]

[1] Student Research Club „Impuls", Department of Biomedical Sciences and Physical Medicine, Academy of Physical Education in Katowice, Poland

[2] Institute of Sport Sciences, Academy of Physical Education in Katowice, Poland

Correspondence to: Dorota Rabsztyn, email: d.rabsztyn@interia.pl

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Abstract

Background: The occurrence of involuntary urine leakage significantly impairs the comfort of patients' life, negatively affects their social relations and deteriorate their health. Preventative treatment, including pelvic floor muscle training, is suggested in the early stages of diagnostic and therapeutic management

Aims: Pelvic floor muscle (PFM) exercises are a preventative treatment method for stress urinary incontinence. The aim of this systematic review and meta-analysis was to determine the treatment effectiveness of pelvic floor muscle training in women with stress urinary incontinence.

Material and methods: Electronic academic databases, PubMed and EbscoHost, were searched. A mean difference (MD) measure with 95% confidence interval (CI) was used to assess the effect size. The pooled effect size of the meta-analysis was calculated for the random effect model. The I^2 test was used to assess heterogeneity. Furthermore, Physiotherapy Evidence Database Scale was used to evaluate the methodological quality of randomized control trials.

Results: A total of 7 articles, out of 135 identified papers, met the inclusion criteria. Meta-analysis revealed significant differences between the PFM training group and the group without active treatment in terms of total vaginal pressure (perineometry) (MD: -3.35; 95% CI: -4.48 to -2.21; p<0.001), urine loss (measured by 1-hour pad test) (MD: -3.35; 95% CI: -4.48 to -2.21; p<0.001), and pelvic floor muscle strength (MD: 1.67; 95% CI: 1.41 to 1.92; p<0.001).

Conclusion: PFM training is an effective form of treatment for stress urinary incontinence in women.

Key words

pelvic floor muscles, urinary incontinence, exercise training.

Introduction

The prevalence of urinary incontinence in women is estimated to be between 25% and 45% [1]. The occurrence of involuntary urine leakage significantly impairs the comfort of patients' life, negatively affects their social relations, leads to the abandonment or restriction of physical activity, and, consequently, to the deterioration of their health.

The direct cause of stress urinary incontinence (SUI) is considered to be pelvic floor muscle weakening [2]. The most important functions of the pelvic floor include supporting the pelvic floor organs and the abdominal cavity (especially in the habitual position), closing the urethral lumen, and participating in the creation of abdominal pressures [3]. The pelvic floor muscles condition the processes of micturition and defecation and stabilize the lumbar spine [4]. The main causes of pelvic floor muscle weakening include childbirth, lowering of the small pelvic organs, obesity, age, involutional changes in the lower urinary tract area associated with aging, hormonal imbalance, and heavy physical work [1, 2]. When the pelvic floor muscles are weakened in women with SUI, the paravesical part of the urethra is displaced beyond the abdominal pressure area, which disturbs the pressure gradient within the lower urinary tract and consequently leads to involuntary discharge of urine during the urine collection phase [5].

According to the International Continence Society (ICS) recommendations, preventative treatment, including pelvic floor muscle training, is suggested in the early stages of diagnostic and therapeutic management [6].

Aim

The aim of this critical review and meta-analysis was to determine the treatment effectiveness of pelvic floor muscle exercises in women with stress urinary incontinence when compared to no form of treatment.

Material and methods

The research question was formulated according to the PICO model based on the updated Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [7]. *Population*: women with stress urinary incontinence; *Intervention*: pelvic floor muscle training (as monotherapy); *Comparator*: no therapy; *Outcomes*: the value of pressure in the vagina (measured with a manometric perineometer) during contraction of any pelvic floor muscle; the amount of urine that has leaked (as measured by a 1-hour pad test); strength and endurance of pelvic floor muscles, assessed using the Oxford scale based on the PERFECT scheme.

Academic research databases and literature search strategies

Articles were searched using electronic academic databases: PubMed and EBSCOHost. The following keywords were used: 'urinary stress incontinence', 'stress incontinence', 'genuine stress incontinence', 'pelvic floor muscle training', 'pelvic floor exercises', 'pelvic floor exercise', 'therapy', 'treatment', 'women', 'female', which were combined in different configurations using AND, OR connectors. The bibliography of articles related to this topic was also analysed.

Research eligibility criteria

For this critical review, only randomized controlled trials designed to evaluate the effects of pelvic floor muscle training on symptoms of stress urinary incontinence in women were eligible.

The eligibility criteria were: (1) randomized control trials, (2) full text publication, (3) English or Polish language of publication, (4) studies in which patients in the experimental group received pelvic floor muscle training without any other form of therapy, (5) studies in which patients in the control group did not receive any form of preventive treatment for stress urinary incontinence. Studies that were conducted in women with mixed urinary incontinence were eligible for critical re-

view when patients had predominant symptoms of stress urinary incontinence. Studies in which exercises were conducted in both groups and individually were eligible for the review. Publications in which patients in the experimental group participated in sEMG biofeedback or Pilates exercises were excluded from the review.

Methodological quality assessment of randomized control trials

The Physiotherapy Evidence Database (PEDro) scale was used to assess the methodological quality of randomized control trials [8]. The following categorization of research, depending on the sum of points obtained, was adopted: ≥ 7 – high methodological quality of research, 4-6 points – medium methodological quality of research, ≤ 3 – low methodological quality of research.

Meta-analysis

The meta-analysis was conducted for the following variables: Vaginal pressure value (measured with a manometric perineometer); the amount of involuntarily leaked urine during the 1-hour pad test; strength and endurance of pelvic floor muscles, assessed using the Oxford scale based on the PERFECT scheme. Measure of effect was used to assess the effect size: mean difference (MD). The pooled effect of the meta-analysis was calculated for the random effect model. A 95% confidence interval (CI) was used for all measurements. Heterogeneity analysis of effect size was conducted using the I^2 coefficient, which represents the percentage of true to combined variability: a level of 25% was taken as low heterogeneity, 50% - moderate heterogeneity, 75% - high heterogeneity. In all statistical analyses, a $p < 0.05$ level was taken as statistically significant. STATISTICA (Data Analysis Software System), version 13.3, Suite Plus, was used to perform the meta-analysis procedure.

Results

An initial literature search was conducted based on adopted keywords listing 135 articles published in the PubMed database, and 130 in the EBSCOhost database. Based on the search strategies for randomized controlled trials described previously, 7 articles were ultimately selected for critical review. The results of the literature search and selection based on PRISMA guidelines were graphically presented in **Figure 1**.

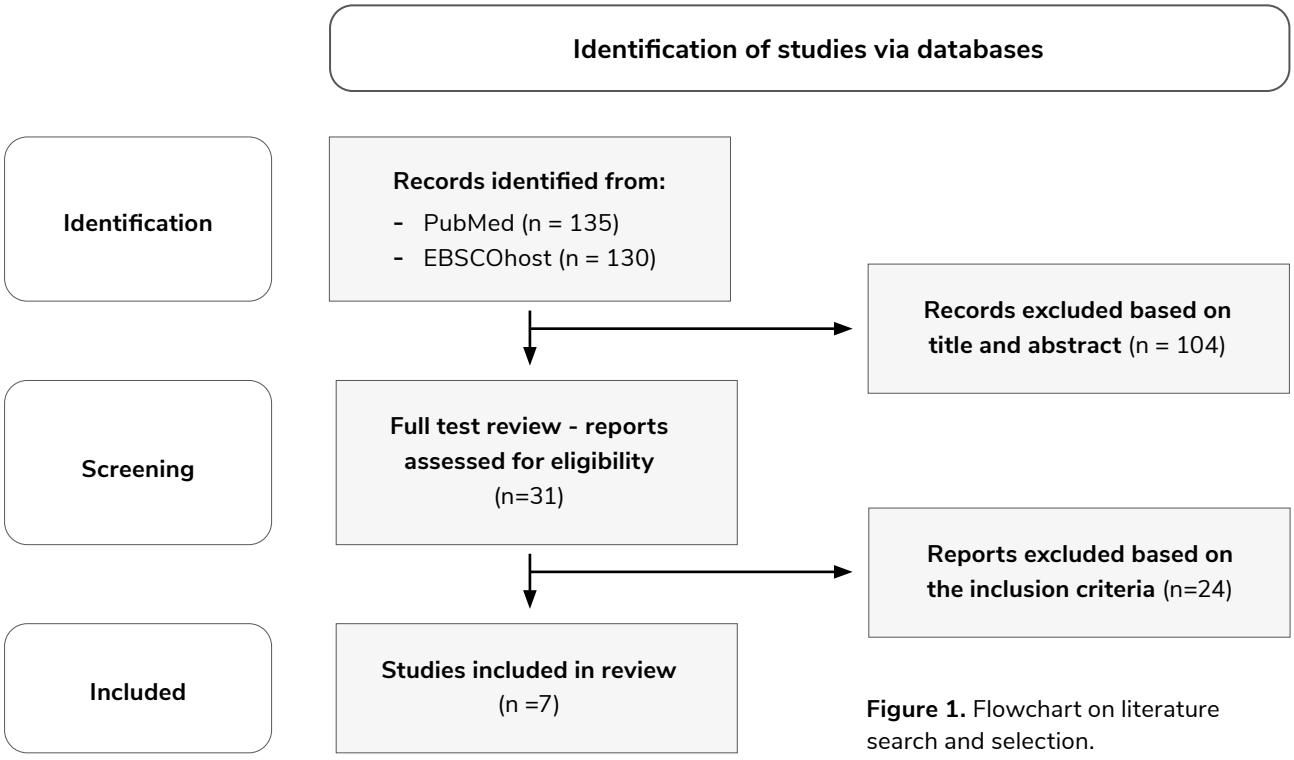

Figure 1. Flowchart on literature search and selection.

One randomized clinical trial was of high methodological quality [9], six others were of moderate quality [10-15] (**Table 1**). The characteristics of the research eligible for review were provided in **Table 2**.

Table 1. Methodological quality of randomized controlled trials on the effectiveness of pelvic floor muscle exercises in the treatment of stress urinary incontinence as assessed by the Physiotherapy Evidence Database (PEDro) scale.

References	Eligibility criteria	Randomization	Blinded allocation	Group homogeneity	Single-blinded	Double-blinded	Triple blinded	>85% of subjects in follow-up	Intra-group analysis	Inter-group analysis	Variability and final estimation	Score
Aksak 2003	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	**8**
Bø 1999	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	**7**
Castro Rodrigo 2008	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	**7**
Celiker Tosun 2015	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	**7**
Marques 2020	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	**7**
Nascimen-to Coreia 2012	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	**5**
Pereira 2010	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	**7**

Table 2. Characteristics of published studies on the effectiveness of pelvic floor muscle exercises in the treatment of stress urinary incontinence.

References	Sample size	Groups	Intervention	Outcome measure	Follow-up	Conclusions
Aksak 2003	50	Group I: exercise PFM Group II: exercises PFM + biofeedback Group III: no therapy	Group I: 5 sec PFM contraction, 10 sec break, 10 series, 3x daily. Contraction time was increased to 10 sec and break to 20 sec, 8 wks. Group II: 3x weekly, 8 wks. Duration of session - 20 min; 40 cycles: 10 sec. contraction, 20 sec. break	perineometry measurement, per vaginam palpation with assessment of PFM strength, pad test, social activity (SAI index) pain level (VAS scale)	- before - after 8-week therapy	Therapeutic superiority of the PFM exercise method with biofeedback in the treatment of SUI in women
Bø 1999	107	Group I: PFM exercises Group II: vaginal electrostimulation Group III: vaginal cones Group IV: no therapy	Group I: 8-12 submax. contractions. PFM, 3x daily, 1x monthly. 45 min. group exercises with physiotherapist. Group II: daily electrostimulation 30 min, 50 Hz, impulse time. 0.2 ms, biphasic symmetrical, intensity 0-120 mA Group III: 20 min. daily, vaginal cones: 20, 40 and 70g.	24-hour pad test, micturition diary, activity indicator	- before - after 6-months therapy	Reduction in symptoms of stress urinary incontinence in each group (I-III). The greatest improvement was obtained in the group using PFM exercises
Castro 2008	118	Group I: PFM exercises Group II: vaginal electrostimulation Group III: vaginal cones Group IV: no therapy	Group I: 45 min of exercise: 10 x 5 sec. contraction + 5 sec. rest; 20 x 2 sec. contraction + 2 sec. rest; 20 x 1 sec. contraction + 1 sec. rest; 5 x 10 sec. contraction + 10 sec. rest; 5 max. contractions with coughing (1 min. break between contractions) Group II: 20 min. electrostimulation, 50 Hz, contraction time 5 sec, rest time 10 sec, pulse time 0.5 ms Group III: 45 min. exercise with 20-100g cones	incontinence test, I-QOL questionnaire, urodynamic testing, micturition diary, PFM strength measurement with Oxford scale	- before - after 6-months therapy	Statistically greater improvement in PFM strength in group I compared to the other groups. All forms of therapy used in group I, II and III are effective in treating SUI in women.
Celiker 2015	124	Group I: PFM exercises Group II: no therapy	Group I: 3x a week (for 2 weeks) 30 min. exercises with physiotherapist on correction of body posture and correct contraction of PFM, 3x a week (for 10 weeks) 30 min. PFM exercises according to the recommendation of The American College of Sports Medicine	assessment of PFM function (PERFECT scale, ultrasound, perineometry measurement), evaluation of complaints related to SUI and MUI	- before - after 12-weeks therapy	12-week PFM training reduced symptoms of SUI and MUI

References	Sample size	Groups	Intervention	Outcome measure	Follow-up	Conclusions
Marques 2020	43	Group I: PFM exercises Group II: PFM exercises, adductor muscles of the hip joint and gluteus maximus and medius muscles	Group I: 10 contractions 5 sec, 15 contractions 3 sec, 20 contractions 2 sec, 20 contractions 1 sec with the same interval between contractions. Then 5 max contractions while attempting to cough. Progression of difficulties by changing the position. Group II: exercises as in group I (40 min.) Group II: exercises as in group I (40 minutes) plus 20 minutes of hip adductor activation exercises and two exercises to activate the gluteus maximus and medius muscles. Progression by adding load (1-3 kg) during concentric exercises of thigh adductors.	Oxford scale assessment, perineometry measurement, 3-day micturition diary, KHQ questionnaire, IQO-L questionnaire	- before - after the 10-week therapy	Statistical analysis showed a significantly higher rate of reduction in UI frequency in group II.
Nascimento- Correia 2012	30	Group I: group PFM exercises Group II: no therapy	Group I: group 1-h PFM exercises x 1 per week. in groups of 8-10 people for 12 weeks. Exercises in supination and sitting positions, progression of difficulty (number of repetitions and/or contraction time)	PFM function assessment (PERFECT scale), PFM strength assessment (modified Oxford scale), ultrasound, KHQ questionnaire, 1-hour pad test, perineometry.	- before - after 12-week therapy	The exercise protocol used in group I reduced the symptoms of SUI by strengthening the PFMs and improving their function.
Pereira 2011	49	Group I: group PFM exercises Group II: individual PFM exercises Group III: no therapy	Group I and II: 2 x wks of 1-h exercise each, for a period of 6 weeks. Group exercises took place in groups of 8-10 women. During one therapy on average about 100 PFM contractions were performed: phase contractions lasting 3 sec. and 6 sec. rest; tonic contractions lasting 5-10 sec. with a break of 10-20 sec.	1-h pad test, KHQ questionnaire, perineometry measurement, PFM (Oxford palpation scale)	- before - after 6 -week therapy	Intergroup analysis showed no statistically significant differences between groups I and II. The therapeutic effect of groups I and II was comparable.

Abbreviations: *PFM – pelvic floor muscles*; SAI – *social activity index*; VAS – *Visual Analogue Scale*; I-QOL –*Incontinence Quality of Life*; UI – *urinary incontinence*; SUI – *stress urinary incontinence*; MUI – *mixed urinary incontinence*; KHQ - *King's Health Questionnaire.*

A meta-analysis of the vaginal pressure values (measured with a manometric perineometer) in patients with SUI indicated a statistically significant combined effect of therapy (MD: -3.35; 95% PU: -4.48 to -2.21; p<0.001) in support of pelvic floor muscle training when compared to no preventative treatment (**Figure 2**). Measures of effects from the primary studies included in the meta-analysis have low levels of heterogeneity (I^2=0%, p=0.98) (**Figure 2**).

The amount of urine that leaked during the 1-hour incontinence test was significantly less in women who exercised their pelvic floor muscles when compared to patients who did not receive any treatment (MD: -3.35; 95% CI: -4.48 to -2.21; p<0.001). No significant heterogeneity was found between studies (I^2=0%, p=0.98) (**Figure 3**).

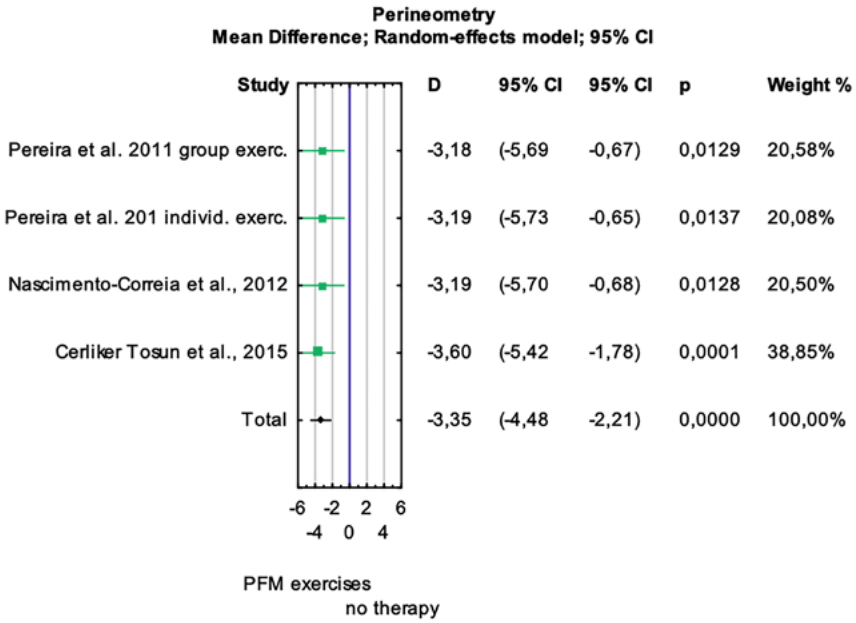

Figure 2. Forest plot for vaginal pressures measured with perineometer results in pelvic floor muscle training and no-treatment groups.

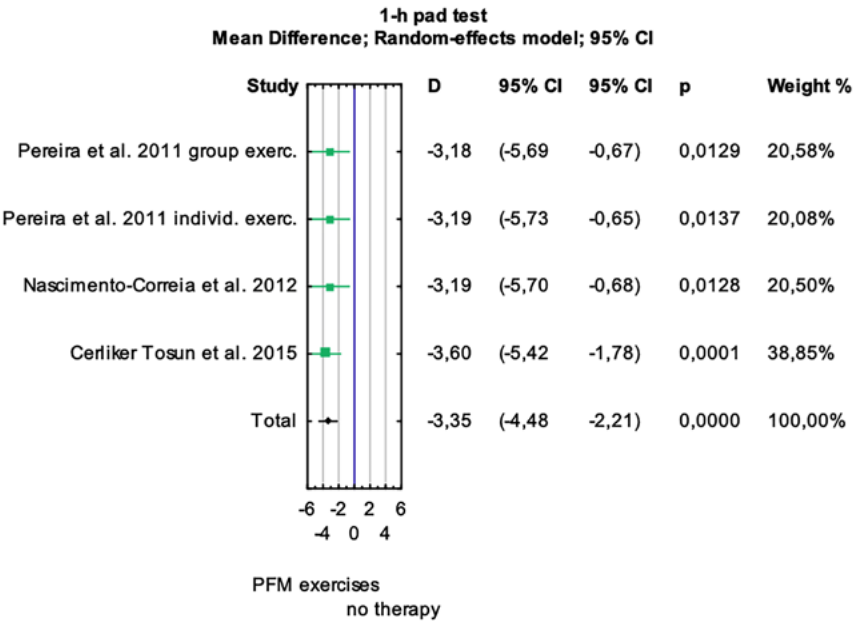

Figure 3. Forest plot for the amount of involuntarily leaked urine measured by the 1-hour pad test results in the pelvic floor muscle training and no-treatment groups.

Pelvic floor muscle strength (as maximal free contraction), assessed using the Oxford scale based on the PERFECT scheme, was significantly greater in women who exercised pelvic floor muscles when compared to women in the control group (MD: 1.67; 95% CI: 1.41 to 1.92; p<0.001), with low heterogeneity of the primary studies included in the meta-analysis (I^2=0%, p=0.71) (**Figure 4**).

Pelvic floor muscle endurance, as expressed by the time to sustain the maximum contraction, was significantly greater in women with stress urinary incontinence from the experimental groups when compared to women from the control groups (MD: 6.54; 95% CI: 0.33 to 12.74; p=0.03). No significant heterogeneity was found between studies (I^2=73.16%, p=0.053) (**Figure 5**).

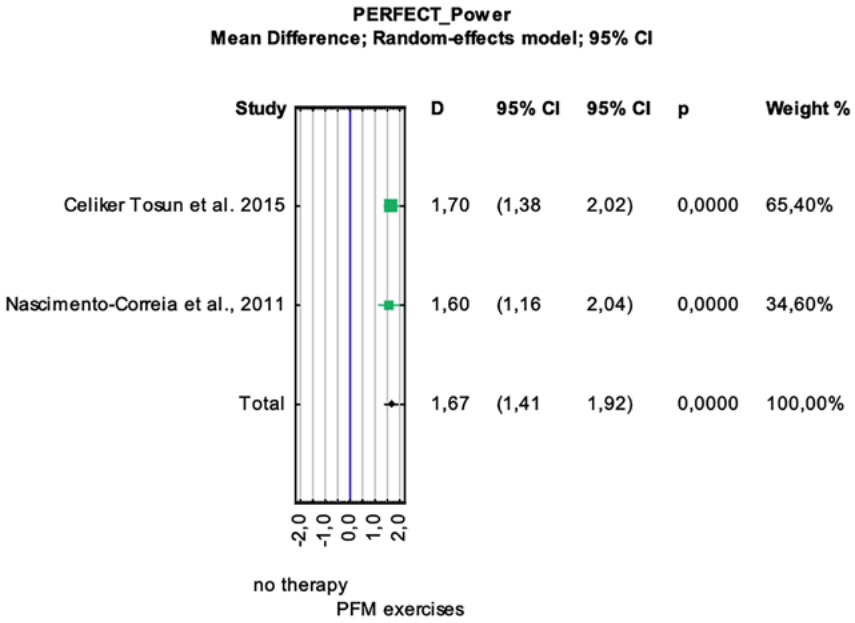

Figure 4. Forest plot for pelvic floor muscle strength (as maximum free contraction) based on the Oxford scale results in the pelvic floor muscle training and no-treatment groups.

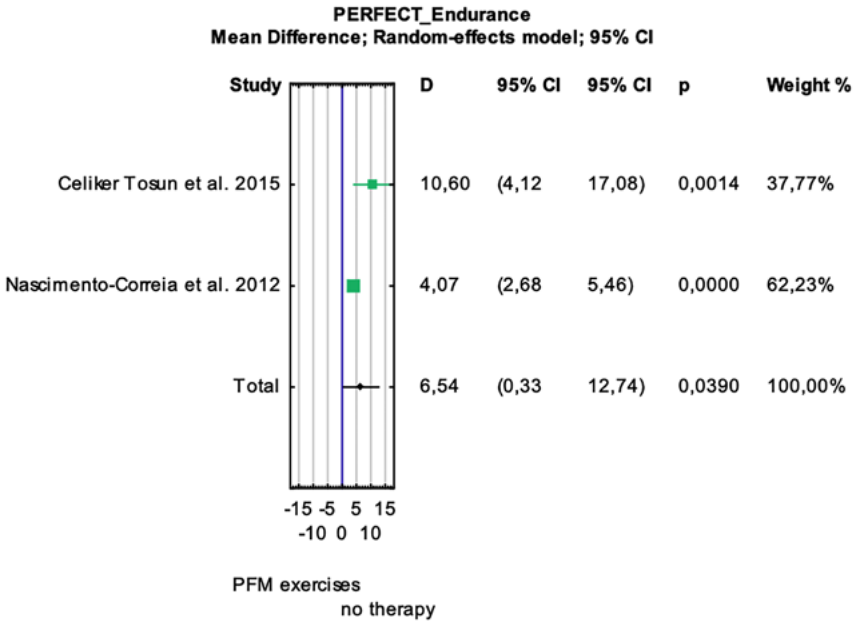

Figure 5. Forest plot for pelvic floor muscle endurance based on the Oxford scale results in pelvic floor muscle training and no-treatment groups.

Discussion

Statistical analysis revealed that the combined effect on change in vaginal pressure, amount of urine that leaked during 24-hour period, and pelvic floor muscle strength (as assessed by the Oxford scale) was statistically significant ($p<0.05$) when comparing pelvic floor muscle exercise-based therapy with no preventative treatment in patients with SUI. Heterogeneity analysis of effect size revealed a low level of heterogeneity for all three variables; hence a strong conclusion can be made that pelvic floor muscle exercises increase vaginal pressure and pelvic floor muscle strength, leading to a reduction in involuntary urinary discharge.

Kegel exercises are the basis of Urogynecological Physiotherapy. The analysis revealed that 14.5% of women did not know what Kegel exercises were, while 85.5% of them have heard of this improvement method [16]. When exercising the pelvic floor muscles, it is important to tighten them in an isolated method without simultaneously activating the abdominal muscles, femur muscles, and gluteal muscles [17].

However, the underlying methodology of pelvic floor muscle training has not been yet systematized [18]. The differences between the conducted studies mainly concern the duration of contraction and relaxation of the pelvic floor muscles, the number of contractions, the adopted exercise position, and the duration of training (Table II). A recent meta-analysis [19] showed that regardless of the training protocols used, pelvic floor muscle exercises significantly reduce urine leakage in the pad test in women with SUI. However, the best treatment results were obtained when the training program lasted from 6 to 12 weeks and included more than 3 exercise sessions per week of < 45 min duration. Another critical review confirmed higher treatment effectiveness of pelvic floor muscle training conducted under the supervision of a qualified physiotherapist when compared to training with occasional medical supervision [20].

The pelvic floor muscles are approximately 70% composed of red, slow-contracting fibres in which oxidative metabolism predominates; the remaining 30% of fibres are white, fast-contracting that work mainly under anaerobic conditions [21]. Therefore, it is important to choose a training technique for the pelvic floor muscles that engages both types of muscle fibres. PFM exercises should target multiple aspects: improving sensorimotor performance, increasing both maximal contractile force, and muscle endurance - the ability to maintain a prolonged contraction without the signs of fatigue. Treatment also should aim to improve contraction velocity and coordination skills, such as alternating activity and relaxation of the PFM [3].

Conclusions

Pelvic floor muscle exercises are an effective form of therapy for women with SUI. Pelvic floor muscle training increases pelvic floor muscle strength and intravaginal pressure, leading to less involuntary urine discharge.

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