Effectiveness of a Kegel protocol on urinary incontinence in female weightlifters

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Summary

Objectives: The aim of this study was to evaluate the incidence and associated factors of urinary incontinence in women who participate in weightlifting sports.
Material and method: The final sample included 22 female athletes aged 18–27. Participants were divided into a control group (n = 6) and two intervention groups based on training frequency: IG1 (≥4 days/week, n = 8) and IG2 (<4 days/week, n = 8). The intervention, based on Kegel exercises performed five times weekly for six weeks. UI impact was assessed pre and post intervention using the ICIQ-LUTSqol questionnaire.
Results: A high prevalence of urinary incontinence (UI) was reported (63.6%), especially during sports activity. In the intervention groups, no statistically significant differences were observed in ICIQ-LUTSqol scores between groups (P = 0.65) or over time (P = 0.47), nor in the group-by-time interaction (P = 0.15). However, a non-significant trend suggested a reduction in ICIQ-LUTSqol scores in IG2 post-intervention. However, a non significant trend suggested a reduction in ICIQ-LUTSqol scores in IG2 post-intervention, although eta 2 was low.
Conclusions: The six-week Kegel intervention had limited impact on UI symptoms among these young female athletes, suggesting that longer interventions and consideration of additional factors may be necessary to achieve significant UI reduction in this population.

Key words:
Urinary incontinence. Pelvic floor. Strength. Women. Sports.

Efectividad de un protocolo de Kegel sobre la incontinencia urinaria en levantadoras de pesas

Resumen

Objetivos: El objetivo de este estudio fue evaluar la incidencia y los factores asociados a la incontinencia urinaria en mujeres que participan en deportes de levantamiento de pesas.
Material y método: La muestra incluyó a 24 deportistas femeninas de entre 18 y 27 años. Las participantes fueron divididas en un grupo de control (n = 6) y dos grupos de intervención basados en la frecuencia de entrenamiento: GI1 (≥4 días/semana, n = 8) y GI2 (<4 días/semana, n = 8). La intervención, se basó en la realización de un protocolo de ejercicios de Kegel realizados cinco veces a la semana durante seis semanas. El impacto de la incontinencia urinaria (IU) se evaluó antes y después de la intervención utilizando el cuestionario ICIQ-LUTSqol.
Resultados: Se reportó una alta prevalencia de IU (63.6 %), especialmente durante la práctica deportiva. En los grupos de intervención, no se observaron diferencias estadísticamente significativas en las puntuaciones del ICIQ-LUTSqol entre los grupos (p = 0.65) o a lo largo del tiempo (p = 0.47), ni en la interacción grupo por tiempo (p = 0.15). Sin embargo, una tendencia no significativa sugirió una reducción en las puntuaciones de ICIQ-LUTSqol en GI2 después de la intervención, aunque eta 2 fue baja.
Conclusiones: La intervención de seis semanas con Kegel tuvo un impacto limitado en los síntomas de IU entre estas jóvenes deportistas, lo que sugiere que pueden ser necesarias intervenciones más largas y la consideración de factores adicionales para lograr una reducción significativa de la IU en esta población.

Palabras clave:
Incontinencia urinaria. Suelo pélvico. Fuerza. Mujeres. Deportes.

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Introduction

Urinary incontinence (UI) is defined by the International Continence Society (ICS) as the involuntary loss of urine[1], which affects a percentage of 15 to 30% of women worldwide, regardless of age[2]. For the urinary continence mechanism to be effective, coordination among the nervous system, bladder, urethra, and pelvic floor is necessary[3]. The main risk factors include family history, as well as aggravating factors such as obesity, experiencing complicated vaginal childbirth[4], and engaging in vigorous physical activity[5]. In this context, the clinical presentation of UI that occurs during physical exertion is referred to as stress urinary incontinence (SUI)[1]. The prevalence of SUI in young women who regularly participate in high-impact sports ranges from 28% to 68%, with even higher rates observed in sports such as gymnastics[6] and hockey[7]. Furthermore, studies among weightlifters and powerlifters have reported a prevalence of SUI between 32% and 50%[8]. Despite these figures, the actual incidence of SUI is believed to be even higher, as many women do not seek treatment due to the feelings of embarrassment it causes[9], which affects their quality of life[10] and athletic performance, potentially leading to abandonment of the sport[11].

To date, there is no conclusive evidence explaining the primary mechanism behind stress urinary incontinence (SUI). The two most studied theories suggest that, on one hand, athletes have strong pelvic floor muscles due to the co-activation of the abdominal muscle during training. On the other hand, it is proposed that repeated increases in intra-abdominal pressure (IAP) may weaken the pelvic floor[12]. Although the detrimental and beneficial effects of exercise dosages on organs and tissues are well documented, the repercussions of exercise intensity on pelvic floor musculature (PFM) require further research to establish specific recommendations regarding its impact on functionality and health in this region[13]. Considering that many continuous and everyday body movements involving the trunk and lower limbs are associated with an increase in intra-abdominal pressure, this translates into an inertial force of the abdominal contents in a cranio-caudal direction, exerting greater pressure on the pelvic floor[14]. When exercise is performed intensely and repeatedly over time, the increase in IAP can negatively affect the supporting structures of the PFM, consequently leading to SUI[1,15]. This condition appears to be particularly common among elite athletes who are regularly exposed to sharp increases in IAP[16], as seen in sports characterized by weightlifting[17].

Sports such as weightlifting, powerlifting, and cross-training require athletes to lift significant amounts of weight as their primary training and competition modality[18]. They are also characterized by performing functional movements that involve lifting maximal or submaximal loads[19]. Some common exercises in these sports, such as the squat, deadlift, bench press, and clean and jerk[20], have a higher likelihood of triggering UI[21]. The movements that present a higher risk of triggering SUI are the squat and the deadlift[22]. In particular, the squat can cause urinary leaks during the concentric phase of the movement, increasing intra-abdominal pressure and, consequently, stress on the pelvic floor[22]. The deadlift, especially in its sumo variant, also presents a higher probability of triggering SUI because its execution is performed in a wider stance compared to the conventional deadlift[23]. This postural difference alters the mechanics of the lift and modifies the activation of the trunk stabilizing muscles and the pelvic floor, which in turn increases intra-abdominal pressure and elevates the risk of SUI during exercise[22]. Additionally, the common use of a belt and/or breath-holding during the concentric phase of the lift, further increases intra-abdominal pressure, generating even more stress on the pelvic floor[14, 24]. Therefore, considering both the load used and the execution of these exercises, it is common for women participating in sports with these characteristics to experience UI[23]. This stress, combined with the muscle fatigue produced in the pelvic floor muscles, can further compromise their ability to maintain continence due to reduced effectiveness during intense activities[7]. Another factor that can trigger SUI, in addition to intensity, is the frequency of exercise performed[13]. In general terms, it is known that a higher frequency of sports practice is associated with a greater prevalence of urinary leaks[25]. Similarly, both training volume and intensity appear to be risk factors to consider in the development of SUI[7].

The pelvic floor plays a crucial role in preventing UI, as it consists of a group of muscles that can contract voluntarily, allowing for strengthening through specific training of the involved musculature. However, when identifying the pelvic floor muscles, many women make the mistake of activating the hip, gluteal, and abdominal muscles instead of focusing on those located in the lower pelvis[26]. To facilitate the learning of voluntary pelvic floor contraction, Kegel exercises have been proposed as an effective alternative. This model of contraction and relaxation exercises has been reported to improve the strength of both these muscles and those of the urethra[27]. Recent studies have demonstrated that regular practice of Kegel exercises can increase pelvic floor muscle strength[28,29], but it has not yet been investigated whether this exercise model is capable of reducing SUI in young women participating in strength sports, highlighting the need for further research in this area.

Therefore, the aim of this study was to determine the effectiveness of a training protocol aimed at improving pelvic floor strength and reducing the incidence of urinary incontinence in women who participate in weightlifting sports.

Material and method

Study design

This study adheres to the principles established in the Declaration of Helsinki for research involving human subjects and was approved by the Ethics Committee from European University of Atlantic (Spain) (ID: CEI13/2024). Employing a quasi-experimental longitudinal design, convenience sampling was used for participant recruitment. All participants reviewed the study information and provided informed consent. Throughout the study, data protection regulations were rigorously followed, ensuring participant anonymity, respecting their rights, and protecting their well-being. The study was conducted in accordance with the SPIRIT guidelines. The SPIRIT checklist was followed to ensure comprehensive and transparent reporting of the trial's design, conduct, analysis, and interpretation[30].

Participants

The study population consisted of women aged 18 to 27 years who regularly practiced strength sports, including powerlifting, weightlifting,

and cross-training. Inclusion criteria for participation in the study were being an adult and having trained in strength sports for at least six months prior to the start of the study. Women who had previously given birth or had previous experience with specific pelvic floor strengthening protocols were excluded.

The sample recruitment was conducted intentionally, selecting women who met the established inclusion criteria. Participants were recruited through specialized gyms focused on powerlifting, weightlifting, and cross training, as well as through social media and sports groups related to these disciplines. A total of 24 participants were obtained.

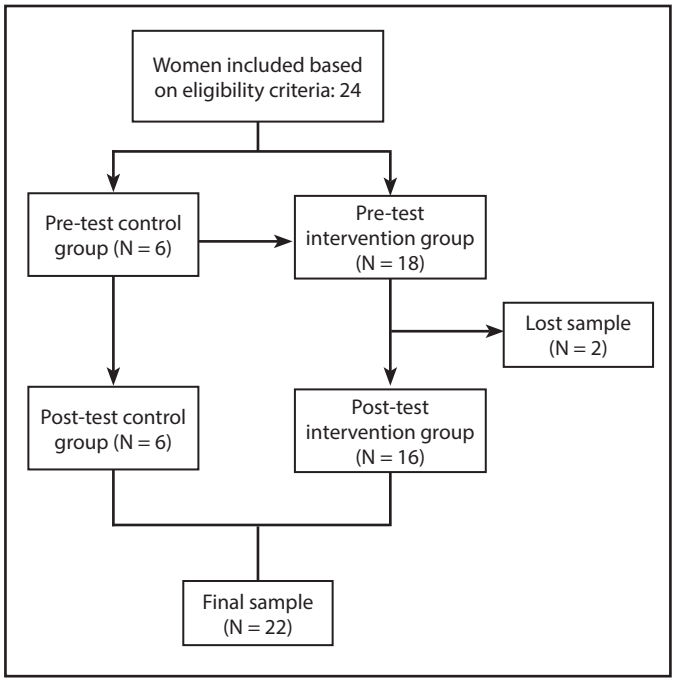
Participants were intentionally grouped into three study groups, considering their usual training frequency and their willingness to undergo the intervention. The first intervention group (IG1) included participants with a weekly training frequency of four days or more (n = 10), while the second intervention group (IG2) consisted of participants with a training frequency of fewer than four days per week (n = 8). The control group (CG) was formed by women who, although training in strength sports with a frequency of four days or more per week, did not undergo the intervention (n = 6). A flow diagram illustrating the selection process of participants is provided in Figure 1. This diagram details the number of participants assessed for eligibility, excluded, and included in the final analysis.

Materials and instruments

The dependent variable of the study was the presence of UI, measured through a questionnaire. The independent variable corresponded to the frequency of strength training in the case of the intervention groups and the implementation of the pelvic floor strengthening protocol through Kegel exercises. The questionnaires, administered via Google Forms (https://docs.google.com/forms/d/1HBOJB9wHlevuR8uOVD4mO8oVPpLbuxTiyKyCmY2lqAs/edit?ts=67211d53) and used for the assessment of the women, included the following.

A questionnaire was designed that encompassed questions in several categories, including demographic information (age, origin, and context of UI occurrence) and sporting information (type of sport practiced, duration of practice in years, and training frequency). Additionally, questions were included about the types of exercises in their training routines (squats or deadlifts) and the presence of UI during these activities. Furthermore, the ICIQ-LUTSqol (International Consultation on Incontinence Questionnaire-Lower Urinary Tract Symptoms Quality of Life) was included, a validated Grade A questionnaire widely used to assess the impact of urinary incontinence on the quality of life in women. This instrument evaluates both the symptoms of the disorder and its impact on the quality of life of affected individuals. It consists of 19 questions, with an overall score ranging from 19 to 76 points, reflecting that a higher score indicates a worse quality of life[31].

Figure 1. Flow Diagram of the Assignment of the Sample to Intervention and Control Groups



This flowchart represents the process of including women in a study based on eligibility criteria.

Procedure

Both experimental groups (IG1 and IG2), prior to their usual strength training or, in the absence of such training, before going to bed, followed a standardized protocol focused on improving pelvic floor strength through the execution of Kegel exercises. This protocol was carried out with a frequency of five sessions per week over a period of six weeks. In each of these sessions, participants in the intervention groups performed three sets of 10 repetitions, maintaining the contraction for 5 seconds, following the recommendations described by[32,33]. The first repetition was performed in a supine position with knees flexed; the second in a seated position; and the third while standing. The control group did not undergo any intervention aimed at improving pelvic floor strength.

Statistical analysis

The statistical analysis was conducted using the Jamovi 2.3.28 statistical software for macOS. First, a descriptive analysis of the categorical variables of the sample was performed. Second, the normality assumption of the data was assessed using the Shapiro-Wilk test. For the main analysis, a repeated measures ANOVA was conducted to evaluate the differences across the multiple time points. The sphericity assumption was tested using Mauchly's test. Effect sizes were calculated using eta squared (η^2). The interpretation of eta squared values follows Cohen's guidelines: 0.01 indicates a small effect, 0.06 indicates a medium effect, and 0.14 or higher indicates a large effect[34]. All statistical tests were two-tailed, and a *P*-value of less than 0.05 was considered statistically significant.

Results

The study sample, initially consisting of 24 women recruited based on the inclusion criteria, experienced a loss of participants due to a lack of adherence to the intervention protocol. Ultimately, a total of 22

women from four Spanish provinces completed the study and were divided as follows: CG = 6; IG1 = 8; and IG2 = 8.

As detailed in Table 1, the mean age of the participants was 22.4 ± 3.4 years. Participants reported an average of 2.6 ± 1.6 years of experience in strength sports. Notably, 21 women (95.5%) identified powerlifting as their primary strength sport. Regarding UI, 12 women reported experiencing it during physical exercise. Of the total sample, 63.6% (n = 14) indicated using the sumo variation compared to the conventional variation. Furthermore, it was observed that the incidence of UI was higher among those performing the sumo deadlift (27.3%) compared to the conventional deadlift (22.7%).

The scores obtained from the ICIQ-LUTSqol questionnaire were analyzed by combining the scores of both intervention groups (IG1 and IG2) compared to the control group (CG). First, the analysis was conducted considering the interaction of time × group, and no significant interaction was found between the two factors, F (1,20) = 0.25, $P = 0.62$, $\eta^2 = 0.001$. The analysis of variance did not show statistically significant differences between groups, F (1,20) = 0.49, $P = 0.49$, $\eta^2 = 0.02$, indicating that the questionnaire scores were similar in both the intervention and control groups. No significant changes were observed in the questionnaire scores with respect to the time variable (pre *vs*. post), F (1.19) = 0.60, $P = 0.45$, $\eta^2 = 0.002$. The effect sizes of η^2 for comparisons between groups and between time points were small (0.001-0.02). The mean values obtained for each group can be seen in Table 2.

Secondly, the scores obtained from the ICIQ-LUTSqol questionnaire were analyzed considering the three groups: IG1, IG2, and CG. No statistically significant results were found in the interaction analysis of time × group, F (1.19) = 2.06, $P = 0.15$, $\eta^2 = 0.17$. There were no statistically significant differences between groups, F (2.19) = 0.43, $P = 0.65$, $\eta^2 = 0.04$, indicating that the questionnaire scores were similar in both cases, regardless of the frequency of weekly training sessions performed by the women. No significant changes were observed in the questionnaire scores with respect to the time variable (pre vs. post), F (1.19) = 0.52, $P = 0.47$, $\eta^2 = 0.02$. The effect sizes of η^2 for comparisons between groups and between time points were small (0.02-0.17). A non-significant difference in means was observed in IG2, with an average score of 23.5 points in the pre-intervention assessment and 22 points in the post-intervention assessment (Table 2).

Table 1. Descriptive data of the participants.

Variable	N	Mean	SD
Age (years)	22	22.36	3.44
Sport experience (years)	22	2.64	1.59
Residence	**N**	**% of Total**	**% Accumulated**
Salamanca	2	9.1%	9.1%
Santander	14	63.6%	72.7%
Valladolid	4	18.2%	90.9%
Ourense	2	9.1%	100.0%
Sport	**N**	**% of Total**	**% Accumulated**
Powerlifting	21	95.5%	95.5%
Crosstraining	1	4.5%	100.0%
Context of incontinence appearance	**N**	**% of Total**	**% Accumulated**
Never	8	36.4%	36,40%
When performing physical effort/exercise	12	54.5%	90.9%
When coughing or sneezing	1	4.5%	95.5%
When he has finished urinating and is dressed	1	4.5%	100.0%
Dead weight	**N**	**% of Total**	**% Accumulated**
Sumo	14	63.6%	63.6%
Convencional	8	36.4%	100.0%

The table presents demographic and sports-related variables of 22 athletes, including age and years of sports experience, with their respective means and standard deviations (SD). Frequencies and accumulated percentages are shown for residence in different cities (Salamanca, Santander, Valladolid, and Ourense), type of sport practiced (powerlifting and cross-training), context of urinary incontinence occurrence (never, when performing physical effort/exercise, when coughing or sneezing, and after urinating and getting dressed), and type of deadlift (sumo and conventional).
N: sample; SD: Standar desviation.

Table 2. Results for Questionnaire Scores by Group and Pre-Post Measurements (Means).

	Groups	N	Pre test Mean (SD)	Post test Mean (SD)
Score ICIQ-LUTSqol	Intervention Group	16	23.7 (7.26)	23.9 (7.44)
	Control Group	6	21 (5.37)	22.2 (5.53)
	Intervention groups		**Pre test Mean (SD)**	**Post test Mean (SD)**
	Intervention Group 1	8	23.9 (6.71)	25.9 (7.62)
	Intervention Group 2	8	23.5 (8.25)	22 (7.21)
	Control Group	6	21 (5.37)	22.2 (5.53)

The table displays the mean scores and standard deviations (SD) for the ICIQ-LUTSqol questionnaire, comparing pre-test and post-test measurements among different groups. It includes the overall intervention group (n = 16) and control group (n = 6), as well as subgroups within the intervention group based on training frequency: Intervention Group 1 (≥4 days/week, n = 8) and Intervention Group 2 (<4 days/week, n = 8).
N: sample; SD: Standar desviation.

Discussion

The objective of this study was to evaluate the incidence and associated factors of urinary incontinence in women participating in strength sports, with a particular focus on those practicing powerlifting. We observed that more than half of the athletes studied experienced urinary leakage only during physical exertion, compared to 36.4% who indicated that it never happened to them.

Our results align with the study conducted by Eliasson *et al.*[25], which reported that in a sample of trampoline gymnasts, all athletes experienced urinary leakage during physical exertion (54.5% *vs.* 100%, respectively), and none experienced it during daily activities. The lower percentage of affected women in our participants may be attributed to differences in competitive levels; our athletes were recreational, while the gymnasts were elite international athletes[35]. Consequently, the training demands, in terms of volume, are much higher for the latter[16].

This finding raises an important issue, given the concern that a predominantly young sample presents with urinary leakage, even if it occurs solely during exercise and not in daily life. The presence of incontinence during competition or in the sports practice environment can negatively interfere with athletes' lives, both socially and in terms of performance[36]. A meta-analysis conducted by Teixeira[37] revealed a 36% prevalence of UI in female athletes from various sports, finding that, compared to inactive women, athletes had a 177% higher risk of experiencing UI. This suggests that SUI may be a significant issue among young athletes, who are traditionally associated with good health and physical fitness.

Nearly all participants in our study practice powerlifting. As indicated by Wikander *et al.*[38], female powerlifters primarily experience situations of UI during weightlifting sessions compared to their daily lives, making it crucial to address this issue within this specific context. Current international recommendations suggest performing muscle strengthening exercises at least twice a week, highlighting weightlifting as one of the primary options for this purpose[39]. However, UI can significantly affect the quality of life of women engaging in this activity[40]. In some cases, UI can even lead to the discontinuation of sports participation[41], affecting both recreational athletes and active women.

The powerlifting discipline consists of three movements, including the deadlift[42], and specifically, more than half of the participants perform this exercise in its sumo variant. According to various studies, the sumo deadlift tends to provoke a higher incidence of SUI compared to the conventional deadlift. Our results support this assertion, as we observed that the sumo variant has a higher percentage of SUI compared to the conventional variant, suggesting that women practicing powerlifting, especially in the sumo variant, may be at greater risk of experiencing SUI[22,38].

Despite the six weeks of duration, both the participants in the IG and those in the control group CG did not show significantly lower means in the ICIQ-LUTS Qol questionnaire. These findings are not in line with those reported by Cavkaytar *et al.*[28], who observed a significant improvement in quality of life and a reduction of associated symptoms in middle-aged women with SUI following the implementation of a home-based Kegel exercise protocol. It is important to note that the participants in the aforementioned study performed 10 sets of Kegel exercises daily over eight weeks. This difference in exercise volume, with our participants performing 86% fewer exercises, and the difference in age (40% menopause) may explain the discrepancies observed between the studies. The necessity of conducting these programs for a minimum of eight consecutive weeks was highlighted for them to be effective in improving SUI. Based on the results of our study, we agree with these authors seems six weeks of targeted training are insufficient to yield benefits. Additionally, Abu Raddaha & Nasr[27] emphasized in their study that Kegel exercises are effective in enhancing the strength of the pelvic floor muscles, a crucial aspect for reducing the symptoms of SUI. Regular practice of these exercises contributes to stabilizing urethral support, thereby decreasing urinary leaks during activities that increase abdominal pressure, such as coughing or exercising. Kegel training also positively impacted on the participants' quality of life, with improvements in emotional and social areas often affected by incontinence symptoms.

Moreover, in this regard, our intervention period was guided by recommendations from Soave *et al.*[43], who noted the absence of a standardized protocol for gaining pelvic floor strength but suggested that typical programs should include training several days a week over a period of six to eight weeks. Following this initial phase, and to maintain long-term effects, as is the case with any training program, the recommendations indicate the need to sustain the program over time. Additionally, it is important to note that we did not assess strength in our participants, leaving us unaware of any changes that may have occurred, as well as whether such changes could be responsible for the reduction in incontinence episodes. In this regard, Domoulin *et al.*[44] recommend implementing such programs for more than three months to effectively strengthen the pelvic floor. A recent scoping review, research found a significant lack of evidence supporting the hypothesized mechanisms behind pelvic floor muscle training programs for managing urinary incontinence in women[45].

Just as we can assert that the training protocol used in our study was insufficient to induce improvements in the overall IG, we also could not demonstrate the efficacy of the six-week Kegel protocol considering the strength training frequency of the women included in the study. However, although our results indicate that none of the groups subjected to the intervention achieved significant improvements in the questionnaire scores, they suggest that women with a training frequency of less than four days per week might benefit from the proposed protocol, based on the means obtained in the ICIQ-LUTSqol. It is important to highlight that several authors have indicated that for a treatment to be considered clinically acceptable in terms of improving patients' quality of life, a change of at least six points on the ICIQ-LUTSqol questionnaire is required[46]. In our study, the reduction observed in the scale was 1.5 points in the group with a training frequency of less than four days, and an increase of 2.4 points in participants with a higher training frequency.

Furthermore, it is important to consider that the factor of weekly training frequency is not the only one that could influence the prevalence of SUI[47,25,26]. In this sense, it is known that more experienced lifters tend to train with heavier loads and greater volume compared to novices[38]. Therefore, while training frequency is a significant risk factor in sports practice concerning the increased prevalence of SUI, other variables of interest should also be taken into account, such as intensity, total volume (number of repetitions x number of sets) of training, accumulated fatigue, and the stage of the season in which the interventions are carried out, which are influenced by factors related to exercise programming[48].

During the phases leading up to a competition, protocols known as "peaking" and "tapering" are implemented, which elevate both the total training load and its intensity[42,49]. Therefore, if these additional factors were considered, rather than just training frequency, clearer relationships could be established between training intensity and the prevalence of SUI, as most women experience leakage during maximum lifts[50].

Therefore, in relation to what has been presented in this work, various practical aspects should be considered when implementing programs aimed primarily at the prevention and management of UI in young athletes. The following key points can be highlighted:

- Education on urinary incontinence: It is essential to inform young female athletes, especially novices in disciplines involving movements like squats, cleans, or snatches, about the potential for experiencing UI during exercise. This awareness can facilitate the

adoption of prevention strategies and improve muscle control, contributing to a reduction in episodes of incontinence during high-intensity training.

- Emotional impact assessment: It is important to evaluate the emotional impact that performing the sumo squat (common in many sports) may have on the athlete. Considering the emotional cost-benefit associated with this exercise can be crucial for the athlete's mental well-being and performance.
- Duration of Kegel exercise programs: While recent studies suggest that a 6-week duration of Kegel exercises is sufficient to observe improvements in UI control among young female athletes, further research is needed that involves longer intervention periods. This would help ascertain the effectiveness of such programs over extended durations and contribute to developing more comprehensive training protocols.

Conclusions

This study highlights the prevalence of exercise-induced urinary incontinence (UI) in young recreational athletes involved in weightlifting sports, emphasizing the need for targeted interventions. Although the six-week Kegel exercise protocol did not produce statistically significant improvements in UI symptoms across the intervention groups, some benefit was observed in participants with lower training frequency. These findings suggest that longer or more tailored interventions may be needed to achieve significant UI reduction in this population. Future research should consider additional factors, such as training intensity and volume, for more comprehensive management strategies.

Conflict of interest

Authors report no conflict of interest.

Bibliography

1. Haylen BT, Ridder D, Freeman RM, Swift SE, Berghmans B, Lee J, Monga A, *et al.* An International Urogynecological Association /International Continence Society joint report on the terminology for female pelvic floor dysfunction. *Neurourol Urodyn.* 2010;29(1):4-20.
2. Ptak M, Ciećwież S, Brodowska A, Starczewski A, Nawrocka-Rutkowska J, Diaz-Mohedo E, *et al.* The effect of pelvic floor muscles exercise on quality of life in women with stress urinary incontinence and its relationship with vaginal deliveries: a randomized trial. *BioMed Res. Int.* 2019;2019:5321864 .
3. Marques SAA, da Silveira SRB, Pássaro AC, Haddad JM, Baracat EC, Ferreira EAG. Effect of pelvic floor and hip muscle strengthening in the treatment of stress urinary incontinence: a randomized clinical trial. *Arch Gynecol Obstet.* 2020;302(6):1505-12.
4. Rodriguez-Mias NL, Martinez-Franco E, Aguado J, Sánchez E, Amat-Tardiu L. Pelvic organ prolapse and stress urinary incontinence, do they share the same risk factors? *Eur J Obstet Gynecol Reprod Biol.* 2015;190:52-7.
5. Mannella P, Palla G, Bellini M, Simoncini T. The female pelvic floor through midlife and aging. *Maturitas.* 2013;76:230-34.
6. Cabrera-Guerra M. La incontinencia urinaria en la mujer deportista de élite. *Rev Iberoam de Fisioter Kinesiol.* 2006;9(2):78-89.
7. Dornowski M, Makar P, Sawicki P, Wilczyńska D, Vereshchaka I, Ossowski Z. Effects of low- vs high-volume swimming training on pelvic floor muscle activity in women. *Biology of Sport.* 2019;36(1):95-9.
8. Skaug KL, Engh ME, Frawley H, Bo K. Prevalence of pelvic floor dysfunction, bother, and risk factors and knowledge of the pelvic floor muscles in Norwegian male and female powerlifters and olympic weightlifters. *J Strength Cond Res.* 2022;36(10):2800-7.
9. Zanetti MRD, Castro RDA, Rotta AL, Santos PDD, Sartori M, Girão MJBC. Impact of supervised physiotherapeutic pelvic floor exercises for treating female stress urinary incontinence. *Sao Paolo Med J.* 2007;125(5):265-9.
10. Wikander L, Kirshbaum MN, Waheed N, Gahreman DE. Urinary incontinence in competitive women powerlifters: a cross-sectional survey. *Sports Med Open*. 2021;7:1–11.
11. Eliasson K, Larsson T, Mattsson E. Prevalence of stress incontinence in nulliparous elite trampolinists. *Scand J Med Sci Sports.* 2002;12(2):106-10.
12. Bø K. Exercise and pelvic floor dysfunction in female elite athletes. In: Mountjoy ML (ed). *Handbook of sports medicine and science: the female athlete.* Hoboken, NJ: John Wiley & Sons Inc; 2014.p.76-85.
13. Alves JO, Da Luz ST, Brandão S, Da Luz CM, Jorge RN, Da Roza T. Urinary incontinence in physically active young women: prevalence and related factors. *Int J Sports Med.* 2017;38(12):937-41.
14. Bø K, Berghmans B, Morkved S, Van Kampen M. *Evidence based physical therapy for the pelvic floor: bridgings Science and clinical practice.* 1st ed. Philadelphia, PA: Elsevier Ltd; 2007.
15. Martan A, Masata J, Petri E, Svabík K, Drahorádová P, Voigt R, *et al*. Weak VLPP and MUCP correlation and their relationship with objective and subjective measures of severity of urinary incontinence. *Int Urogynecol J Pelvic Floor Dysfunct.* 2007;18(3):267-71.
16. Da Roza T, Brandao S, Mascarenhas T, Jorge RN, Duarte JA. Volume of training and the ranking level are associated with the leakage of urine in young female trampolinists. *Clin J Sport Med.* 2015;25(3):270-5.
17. Gerten KA, Richter HE, Wheeler TL 2nd, Pair LS, Burgio KL, Redden DT, *et al*. Intraabdominal pressure changes associated with lifting: implications for postoperative activity restrictions. *Am J Obstet Gynecol.* 2008;198(3):306.e1-306.e5.
18. Keogh JW, Winwood PW. The epidemiology of injuries across the weight-training sports. *Sports Med.* 2017;47(3):479-501.
19. NSCA-National Strength & Conditioning Association (Ed.). *Essentials of strength training and conditioning.* 4th ed. Champaign, IL. Human Kinetics; 2021.
20. Tourner A. (Ed.). *Routledge handbook of strength and conditioning: sport-specific programming for high performance*. Londres. Routledge; 2018.
21. Wikander L, Kirshbaum MN, Waheed N, Gahreman DE. Urinary incontinence in competitive women powerlifters: a cross-sectional survey. *Sports Med Open.* 2021;7(1):3.
22. Wikander L, Kirshbaum MN, Waheed N, Gahreman DE. Urinary incontinence in competitive women weightlifters. *J Strength Cond Res.* 2022;36:3130-5.
23. de Araujo MP, Sartori MGF, Girão MJBC. Athletic incontinence: proposal of a new term for a new woman. *Rev Bras Ginecol Obstet.* 2017;39:441-2.
24. Hackett DA, Chow CM. The valsalva maneuver: its effect on intra-abdominal pressure and safety issues during resistance exercise. *J Strength Cond Res.* 2013;27:2218-27.
25. Eliasson K, LarssonT, Mattsson E. Prevalence of stress incontinence in nulliparous elite trampolinists. *Scand J of Med Sci Sports.* 2002;12:106-10.
26. Bø K. Pelvic floor muscle training is effective in treatment of female stress urinary incontinence, but how does it work? *Int Urogynecol J.* 2004;15:82–8.
27. Abu-Raddaha AH, Nasr EH. Kegel exercise training program among women with urinary incontinence. *Healthcare.* 2022;10(12):2359.
28. Cavkaytar S, Kokanali MK, Topcu HO, Aksakal OS, Doğanay M. Effect of home-based Kegel exercises on quality of life in women with stress and mixed urinary incontinence. *J Obstet Gynaecol.* 2015;35:407-10.
29. Mostafa Abd El-Aty, E, EL-Ghareap Hassan M. Effect of Kegel exercise training program on improving quality of life among women with urinary incontinence. *Egypt J Health Care.* 2021;12(2):946–64.
30. Chan AW, Tetzlaff JM, Altman DG, Laupacis A, Gøtzsche PC, Krleža-Jeric K *et al.* Spirit 2013 statement: defining standard protocol items for clinical trials. A*nn Intern Med.* 2013;158:200-7.
31. Kelleher CJ, Cardozo LD, Khullar V, Salvatore S. A new questionnaire to assess the quality of life of urinary incontinent women. *BJOG.* 1997;104:1374–9.
32. Soave I, Scarani S, Mallozzi M, Nobili F, Marci R, Caserta D. Pelvic floor muscle training for prevention and treatment of urinary incontinence during pregnancy and after childbirth and its effect on urinary system and supportive structures assessed by objective measurement techniques. *Arch Gynecol Obstet.* 2019;299.
33. Cho ST, Kim KH. Pelvic floor muscle exercise and training for coping with urinary incontinence. *J Exerc Rehabil.* 2021;17:379–87.
34. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ. Lawrence Erlbaum Associates; 1988.
35. McKay AK, Stellingwerff T, Smith ES, Martin DT, Mujika I, Goosey-Tolfrey VL, *et al*. Defining training and performance caliber: a participant classification framework. *Int J Sports Physiol Perform.* 2021;17:317-31.

36. Almousa S, Moser H, Kitsoulis G, Almousa N, Tzovaras H, Kastani D. The prevalence of urine incontinence in nulliparous female athletes: a systematic review. *Physiotherapy.* 2015;101:58.
37. Teixeira RV, Colla C, Sbruzzi G, Mallmann A, Paiva LL. Prevalence of urinary incontinence in female athletes: a systematic review with meta-analysis. *Int Urogynecol J.* 2018;29:1717-25.
38. Wikander L, Cross D, Gahreman DE. Prevalence of urinary incontinence in women powerlifters: a pilot study. *Int Urogynecol J.* 2019;30(12):2031-9.
39. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, *et al.* World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med.* 2020;54:1451-62.
40. Hunskaar S, Vinsnes A. The quality of life in women with urinary incontinence as measured by the sickness impact profile. *J Am Geriatr Soc.* 1991;39:378-82.
41. Caetano AS, Gomes Cunha Fernandes Tavares MdC, Baena de Moraes Lopes MH. Urinary incontinence and physical activity practice. *Rev Bras Med Esporte.* 2007;13.
42. Travis SK, Mujika I, Gentles JA, Stone MH, Bazyler CD. Tapering and peaking maximal strength for powerlifting performance: a review. *Sports*. 2020;8(9):125.
43. Soave I, Scarani S, Mallozzi M, Nobili F, Marci R, Caserta D. Pelvic floor muscle training for prevention and treatment of urinary incontinence during pregnancy and after childbirth and its effect on urinary system and supportive structures assessed by objective measurement techniques. *Arch Gynecol Obste*t. 2019;299:609-23.
44. Dumoulin C, Cacciari LP, Hay-Smith CEJC. Pelvic floor muscle training versus no treatment, or inactive control treatments, for urinary incontinence in women. *Cochrane Database Syst Rev.* 2018;10.
45. Sheng Y, Carpenter JS, Ashton-Miller JA, Miller JM. Mechanisms of pelvic floor muscle training for managing urinary incontinence in women: a scoping review. *BMC Women's Health.* 2022;22:161.
46. Lim R, Liong ML, Lim KK, Leong WS, Yuen KH. The minimum clinically important difference of the international consultation on incontinence questionnaires ICIQ-UI SF and ICIQ-LUTSqol. *Urology*. 2019;133:91-5.
47. Santesteban López L. *Influencia del deporte de impacto en la disfunción del suelo pélvico en la mujer activa*. Tesis de maestría, Universidad Pública de Navarra. 2014.
48. Bushman BA. Developing the P for progression in a FITT-VP exercise prescription. *ACSM's Health Fit J.* 2018;22:6-9.
49. Pritchard HJ, Barnes MJ, Stewart RJ, Keogh JW, McGuigan MR. Higher versus lower-intensity strength-training taper: effects on neuromuscular performance. *Int J Sports Physiol Perform.* 2019;14(4):458-63.
50. Maggioni-Torres MI. *La prevalencia de la incontinencia urinaria de esfuerzo en mujeres practicantes de deportes de fuerza*. Universidad Europea de Madrid. 2022.