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INFLUENCE OF GAME THERAPY ON URINARY INCONTINENCE PATIENTS: A SYSTEMATIC REVIEW

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Abstract

This study performed a systematic review of game therapy effects on urinary incontinence patients. Eleven databases (PubMed, SCOPUS, SciELO, LILACS, Web of Science, EMBASE, Cochrane library, LIVIVO, OpenGrey, OpenThesis, and OATD) were used as research sources. The search was conducted in January 2021 with the following keywords: urinary incontinence, urinary stress incontinence, pelvic floor muscle, pelvic floor training, virtual reality, game therapy, virtual reality exposure, and virtual reality therapy. The review included only clinical studies using game therapy for treating urinary incontinence in women without restrictions on language, year, and publication status. Only three studies fulfilled the eligibility criteria. The extracted data comprised sample characteristics (the number of patients in each study and average age) and treatment characteristics (game type, associated therapies, treatment duration, evaluated objectives, and result-measuring methods). The methodological quality of the articles showed a low risk of bias. One-hour pad test values decreased in all studies, and ICIQ-SF scores reduced in two articles. One study reported treatment adherence (92%), and another showed neuropsychological index improvements. The reduction of urinary symptoms was similar between the group associating game therapy with treatment and the group using only conventional pelvic floor muscle training. Game therapy, as a resource of pelvic floor muscle training, seems beneficial to urinary incontinence, including decreased urinary symptoms, lower one-hour pad test scores, and neuropsychological index improvements.

Keywords: Pelvic floor. Rehabilitation. Urinary incontinence. Virtual reality. Virtual reality exposure therapy.

1. Introduction

Pelvic floor muscles support pelvic structures to allow the coordination between contraction and relaxation, and they are essential to ensure continence through their reflexive contraction associated simultaneously with the closing of the vagina and urethral and anal sphincters (Messelink et al. 2005; Eickmeyer 2017). However, the deterioration of these structures may cause pelvic floor disorders, such as urinary incontinence (Bø 2005). Some factors seem to affect the development of pelvic floor disorders, including age, pregnancy, the number of deliveries, and menopause, among others (Wu et al. 2014).

Urinary incontinence patients lose bladder control, causing unintentional urination (Irwin 2019). This condition is more frequent in women, especially middle-aged ones. Despite being relatively common, urinary incontinence remains underreported because of its embarrassing and stigmatizing perspective, leading patients not to report it to professionals (Bardsley 2016; Irwin 2019). Moreover, urinary incontinence may significantly affect the quality of life (Bardsley 2016; Irwin 2019). Women with urinary incontinence presented high rates of anxiety, depression, and social isolation, potentially worsening the symptoms (Felde et al. 2017; Tyrala-Seweryn et al. 2017; Lim et al. 2018).

Urinary incontinence may be treated differently, such as with medications, surgical interventions, lifestyle changes, and muscle strengthening, and the prevalent urinary incontinence type will determine the appropriate treatment (Irwin 2019). Pelvic floor muscle training is among the more accepted urinary incontinence therapies (evidence level 1 for stress and mixed urinary incontinence) (Abrams et al. 2017). Adherence to a regular exercise program is essential to reach treatment goals (Kim et al. 2011). However, that is challenging because of the difficulty in keeping patients motivated (Elliott et al. 2015). Combining exercises with playful and didactic activities helps increase treatment adherence, improving the condition (Fraser et al. 2014; Elliott et al. 2015). Hence, game therapy (virtual reality) has stood out as an interactive and beneficial experience (Elliott et al. 2015).

Game therapy uses virtual reality to execute pelvic floor exercises (De Bruin et al. 2010). The basic protocol includes abdominopelvic cavity workouts performed with a console and games. Patients play seated on a device, such as the Wii Balance Board™, combining anteversion, retroversion, lateral inclination, and circumference exercises (Botelho et al. 2015). As in conventional pelvic floor muscle training, the main objective is to re-educate the abdominopelvic cavity (Botelho et al. 2015). However, game therapy allows patient interaction in the game environment, potentially increasing exercise adherence and motivation (Botelho et al. 2015).

Therefore, considering the need for therapies that value patient participation and promote treatment adherence, this study conducted a systematic literature review of game therapy effects on treating urinary incontinence patients (symptom reduction). We hypothesized that game therapy would benefit these patients, potentially increasing treatment adherence and improving urinary symptoms.

2. Material and Methods

Protocol and registration

This systematic review followed the list of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) recommendations (Page et al. 2021) and the Joanna Briggs Institute (JBI) Manual (Aromataris and Munn 2020). The systematic review protocol was registered in the PROSPERO database under CRD42020175766.

Eligibility criteria and study design

This systematic review aimed to answer the following guiding question: What are the game therapy (Intervention) effects on treating (Outcome) women with urinary incontinence (Population)?

We included only clinical studies using game therapy for treating female urinary incontinence without restrictions on language, year, and publication status (ahead of print). The exclusion criteria were: 1) Studies outside the objective; 2) Review articles, letters to the editor/editorials, personal opinions,

books/book chapters, textbooks, reports, conference abstracts, and patents; 3) Case reports; 4) Studies with healthy patients.

Sources of information and search

The primary study sources were the Embase, LILACS, Medline (via PubMed), SciELO, SCOPUS, Web of Science, LIVIVO, and Cochrane Library databases. OpenThesis, OpenGrey, and OATD partially captured the grey literature. A manual search was also performed in the references of eligible studies. All steps aimed to minimize study selection biases.

The MeSH (Medical Subject Headings), DeCS (Health Sciences Descriptors), and Emtree (Embase Subject Headings) resources selected the keywords. The Boolean operators "AND" and "OR" enhanced the search strategy through several combinations according to the database. Table 1 shows the final search paths for each database. The bibliography was researched in March 2020 and updated in January 2021. The collected results were exported to EndNote Web™ software (Thomson Reuters, Toronto, Canada), and duplicates were removed automatically.

Study selection

A calibration exercise was performed before selecting the studies, in which the reviewers discussed the eligibility criteria and applied them to a sample of 20% of the retrieved studies to determine inter-examiner agreement. After achieving a proper agreement level (Kappa ≥ 0.81) in the first selection phase, two eligibility reviewers (ABLN and CR) methodically analyzed the titles independently. The reviewers were not blind to the names of authors and journals. Titles outside the objective, book chapters, conference abstracts, case reports, and literature reviews were eliminated in this phase. In the second phase, the reviewers (ABLN and CR) read the abstracts independently for the initial application of the exclusion criteria. The results whose titles met the study objectives but did not have abstracts available were fully analyzed in phase three. In the third phase, we obtained the full texts of eligible studies and evaluated them regarding the eligibility criteria. When both reviewers disagreed, a third one (LRP) was consulted for a final decision. The studies rejected in this phase were registered separately, explaining the reasons for exclusion.

Data collection and extraction

The following information was extracted from the eligible studies: study identification (author, year, country, and study design), sample characteristics (the number of patients in each study and average age), treatment characteristics (game type, associated treatments, treatment duration, objectives, and result-measuring methods), and main results. In case of incomplete or insufficient information, the corresponding author was contacted via e-mail. Both reviewers were trained by jointly extracting data from an eligible study to ensure consistency. Reviewer disagreements were solved with discussion until consensus. When this was impossible, a third reviewer (LRP) was consulted for a final decision.

Risk of individual study biases

The risk of bias and individual quality of the selected studies were analyzed with the Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews - Checklist for Analytical Cross-Sectional studies (Moola et al. 2020) and the Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews - Checklist for Randomized Controlled Trials (Barker et al. 2023). Two authors (ABLN and CR) independently assessed each domain regarding their potential risk of bias, according to the PRISMA statement (Page et al. 2021). Any disagreement between the reviewers was solved through discussions on the topics, and when both reviewers disagreed, a third one was consulted for a final decision. The risk of bias was ranked as High when the study reached up to 49% of the "yes" score, Moderate from 50% to 69% of the "yes" score, and Low over 70% of the "yes" score.

Table 1. Strategies for database search.

Database	Search strategy (January 2021)
PubMed http://www.ncbi.nlm.nih.gov/pubmed	("Urinary Incontinence"[All Fields] OR "Urinary Stress Incontinence"[All Fields] OR "Pelvic Floor"[All Fields] OR "Pelvic Floor Muscle"[All Fields] OR "Pelvic Floor Training"[All Fields] OR "Pelvic muscle"[All fields]) AND ("Virtual reality"[All fields] OR "gametherapy"[All Fields] OR "Virtual Reality exposure"[All Fields] OR "videogame"[All Fields] OR "Virtual Reality Exposure Therapy"[All Fields] OR "Virtual Reality Therapy"[All Fields] OR "Virtual Reality Immersion Therapy"[All Fields] OR "Video Games"[All Fields])
Scopus www.scopus.com	("Urinary Incontinence" OR "Urinary Stress Incontinence" OR "Pelvic Floor" OR "Pelvic Floor Muscle" OR "Pelvic Floor Training" OR "Pelvic muscle") AND ("Virtual reality" OR "gametherapy" OR "Virtual Reality exposure" OR "videogame" OR "Virtual Reality Exposure Therapy")
SciELO http://www.scielo.org/	"pelvic muscle" AND "Virtual reality" "Urinary incontinence" AND "Virtual reality" "Pelvic muscle" AND "videogame" "Pelvic Floor Training" AND "Virtual reality"
LILACS http://lilacs.bvsalud.org/	tw:("pelvic muscle" AND "Virtual reality") AND (instance:"regional") AND (db:("LILACS")) tw:("Urinary incontinence" AND "Virtual reality") AND (instance:"regional") AND (db:("LILACS")) tw:("Pelvic muscle" AND "videogame") AND (instance:"regional") AND (db:("LILACS")) tw:("Pelvic floor" AND "virtual reality") AND (instance:"regional") AND (db:("LILACS"))
Web of Science http://apps.webofknowledge.com/	(("Urinary Incontinence" OR "Urinary Stress Incontinence" OR "Pelvic Floor" OR "Pelvic Floor Muscle" OR "Pelvic Floor Training") AND ("Virtual reality" OR "gametherapy" OR "Virtual Reality exposure" OR "videogame" OR "Virtual Reality Exposure Therapy"))
Embase http://www.embase.com	('urinary incontinence'/exp OR 'urinary incontinence' OR 'urinary stress incontinence'/exp OR 'urinary stress incontinence' OR 'pelvic floor'/exp OR 'pelvic floor' OR 'pelvic floor muscle'/exp OR 'pelvic floor muscle' OR 'pelvic floor training'/exp OR 'pelvic floor training') AND ('virtual reality'/exp OR 'virtual reality' OR 'gametherapy' OR 'virtual reality exposure' OR 'videogame'/exp OR 'videogame' OR 'virtual reality exposure therapy'/exp OR 'virtual reality exposure therapy')
Cochrane Library https://www.cochranelibrary.com/	("Urinary Incontinence" OR "Urinary Stress Incontinence" OR "Pelvic Floor" OR "Pelvic Floor Muscle" OR "Pelvic Floor Training") AND ("Virtual reality" OR "gametherapy" OR "Virtual Reality exposure" OR "videogame" OR "Virtual Reality Exposure Therapy")
LIVIVO https://www.livivo.de/	(Urinary Incontinence OR Urinary Stress Incontinence OR Pelvic Floor OR Pelvic Floor Muscle OR Pelvic Floor Training) AND (Virtual reality OR gametherapy OR Virtual Reality exposure OR videogame OR Virtual Reality Exposure Therapy)
OpenGrey http://www.opengrey.eu/	("Urinary Incontinence" OR "Urinary Stress Incontinence" OR "Pelvic Floor" OR "Pelvic Floor Muscle" OR "Pelvic Floor Training") AND ("Virtual reality")
OpenThesis http://www.openthesis.org/	("Urinary Incontinence" OR "Urinary Stress Incontinence" OR "Pelvic Floor" OR "Pelvic Floor Muscle" OR "Pelvic Floor Training") AND ("Virtual reality")
OATD https://oatd.org/	("Urinary Incontinence" OR "Urinary Stress Incontinence" OR "Pelvic Floor" OR "Pelvic Floor Muscle" OR "Pelvic Floor Training") AND ("Virtual reality")

Summary of findings

The findings of eligible studies were described according to questionnaire mean results to verify urinary incontinence symptoms at pre- and post-intervention with game therapy in each group (control and intervention).

The standardized mean difference for each group was calculated by subtracting post- and pre-intervention means. Thus, negative standardized mean differences indicated that mean urinary symptoms were lower post-intervention than pre-intervention.

3. Results

Study selection

The first phase of study selection yielded 227 results distributed in eleven electronic databases, including the grey literature. After removing duplicates, 106 results remained for title and abstract analyses. Only eight studies were eligible for the full-text analysis after applying the eligibility criteria to the titles and abstracts. The references of the eight potentially eligible studies were carefully assessed, but no article was added. After reading the full text, three studies were selected for the qualitative analysis. Figure 1 reproduces the search, identification, inclusion, and exclusion of articles.

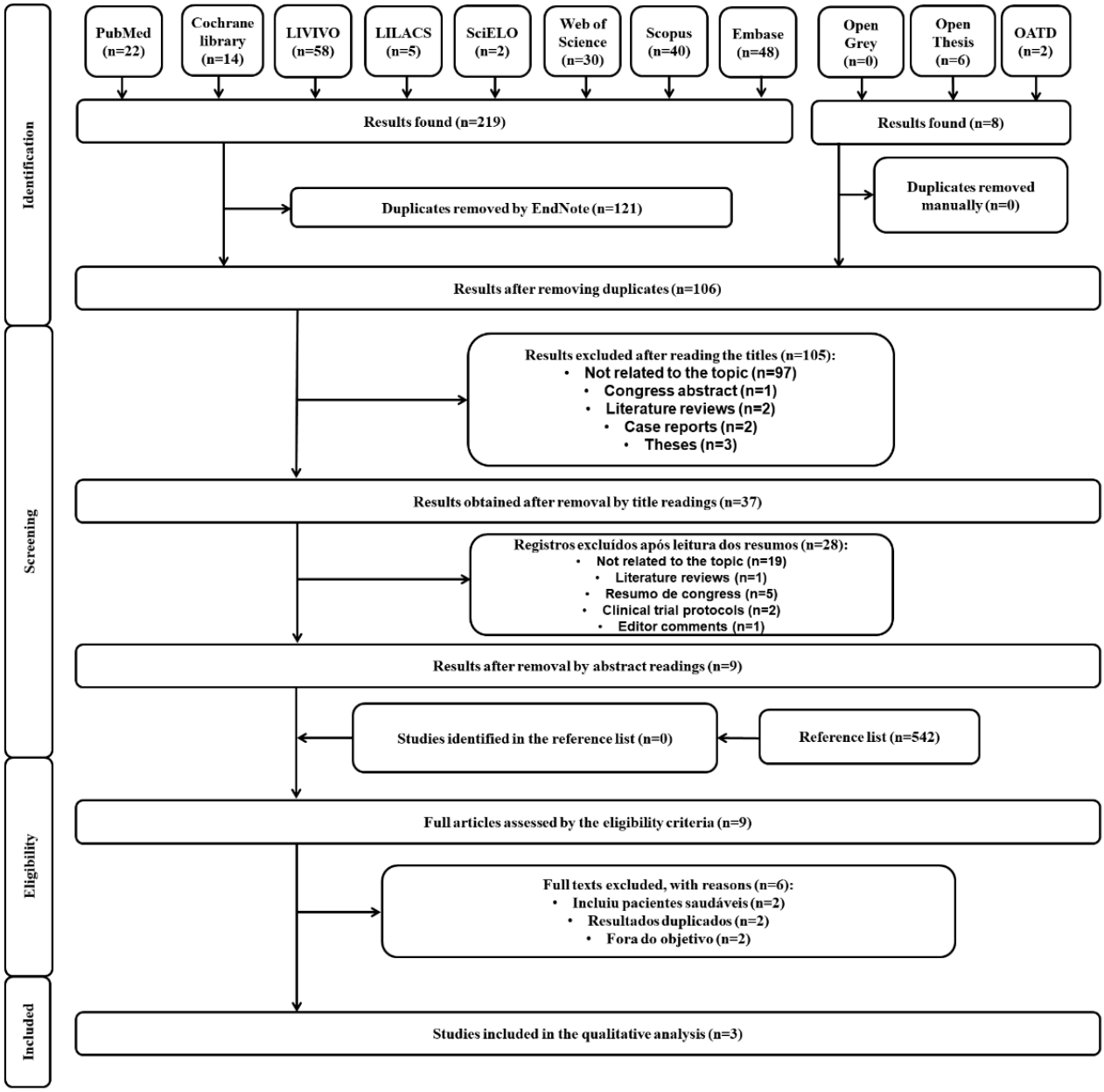

Figure 1. Flowchart of search, identification, inclusion, and exclusion of studies, adapted from PRISMA.

Characteristics of eligible studies

The studies were published between 2014 and 2018 and performed in Canada and Brazil (Fraser et al. 2014; Elliott et al. 2015; Bezerra 2018). Two studies had a quasi-experimental design (Fraser et al. 2014; Elliott et al. 2015), and one was a randomized clinical trial (Bezerra 2018). The final sample included 80 women with urinary incontinence, and the average age of participants was between 52 and 65 years. The game types were StepMania and the Wii Fit Plus™ (Fraser et al. 2014; Elliott et al. 2015; Bezerra 2018).

Two studies performed game therapy associated with pelvic muscle training exercises (Fraser et al. 2014; Elliott et al. 2015). Treatment lasted between eight and 12 months.

The eligible studies assessed game therapy effects on different urinary incontinence aspects: impact on executive functions, dual-task walking, urinary incontinence symptoms, quality of life, treatment satisfaction, and the amount of urinary loss (Fraser et al. 2014; Elliott et al. 2015; Bezerra 2018). Table 2 shows the characteristics of each eligible study.

Risk of individual study biases

All studies presented a low risk of bias or high methodological quality (Fraser et al. 2014; Elliott et al. 2015; Bezerra 2018). Cross-sectional studies (Table 3) showed the only methodological limitation in the lack of clarity regarding the identification and strategies to handle confounding factors (Fraser et al. 2014; Elliott et al. 2015). The main methodological limitation of the randomized clinical trial (Table 4) was related to blinding (Bezerra 2018).

Specific findings of eligible studies

Table 5 shows a summary of the main findings of eligible studies. All included articles performed the one-hour pad test (Fraser et al. 2014; Elliott et al. 2015; Bezerra 2018). All authors found a significant decrease in urinary loss after game therapy. One study did not verify differences in urinary loss reduction by the one-hour pad test compared with game therapy and pelvic floor muscle training (Bezerra 2018).

Two eligible studies assessed the International Consultation on Incontinence Questionnaire - short form (ICIQ-SF). The patients presented mean indices between 11.13 and 15.62 before treatment (Elliott et al. 2015; Bezerra 2018). After treatment, response means varied between 5.00 and 8.12, indicating a significant reduction. Moreover, one study found that game therapy and pelvic floor muscle training effectively decreased response indices to the ICIQ-SF without differences (Bezerra 2018).

One study verified a significant improvement in neuropsychological indices and the dual-task after treatment, while another observed better quality of life and treatment satisfaction (Fraser et al. 2014; Elliott et al. 201;). Lastly, Bezerra (2018) also used manometry to assess the pressure produced by the pelvic floor before and after treatment. That study found a significant improvement in pelvic floor muscle pressure in groups treated with game therapy and pelvic floor strengthening without differences.

Figure 2 shows the calculation of the standardized mean difference between post- and pre-intervention for each group. Bezerra (2018) showed that the standardized mean difference was comparable between the control and intervention groups for the pad test and ICIQ-SF. In turn, Elliott et al. (2015) did not include a control group, but the standardized mean difference of the intervention group was comparable to the groups of Bezerra et al. (2018). Thus, the urinary symptom reduction between pre- and post-treatment of game therapy was comparable to the traditional treatment.

Table 2. Summary of the main characteristics of eligible studies.

Author, year, and country	Study design	Sample (n)	Age (mean ± SD) in years	Game therapy type	Associated therapy	Treatment duration	Control group	Outcomes	Data collection
Elliott et al., 2015 (Canada)	Quasi-experimental	24	Over 65 (70.5 ± 3.6)	Freeware dance game program (StepMania)	Pelvic floor training	12 weeks	N/A	Feasibility, intervention effectiveness on MUI symptoms and QoL, and participant satisfaction with treatment.	Modified pad test, UDI-6, IIQ, and ICIQ-SF.
Fraser et al., 2014 (Canada)	Quasi-experimental	24	Over 65 (70.4 ± 3.6)	Freeware dance game program (StepMania)	Pelvic floor training	12 weeks	N/A	Executive functions, amount of urine loss, and dual-task walking.	Stroop task, trail making test, and modified pad test.
Bezerra, 2018 (Brazil)	Randomized clinical trial	32	45 to 70 (52)	Wii Fit Plus	N/A	8 weeks	Pelvic floor training	Pelvic floor muscle pressure and degree of urinary incontinence.	Pad test, manometry, ICIQ- SF questionnaire, PGI of improvement, and pelvic floor muscle strength test.

N/A = not applicable; SD = standard deviation; MUI = mixed urinary incontinence; QoL = quality of life; UDI = urogenital distress inventory; IIQ = incontinence impact questionnaire; ICIQ-SF = international consultation on incontinence questionnaire - short form; PGI = patient global impression.

Table 3. Risk of bias assessed by the Joanna Briggs Institute Critical Appraisal tools for use in JBI systematic reviews - checklist for analytical cross-sectional studies (Moola et al. 2020).

Author, year	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Percentage of yes/risk
Elliott et al., 2015	√	√	√	√	U	U	√	√	75%/low risk
Fraser et al., 2014	√	√	√	√	U	U	√	√	75%/low risk

Q.1: Were the inclusion criteria in the sample clearly defined?; Q.2: Were the study subjects and the setting described in detail?; Q.3: Was exposure measured validly and reliably?; Q.4: Were objective and standard criteria used for measuring the condition?; Q.5: Were confounding factors identified?; Q.6: Were strategies to handle confounding factors stated?; Q.7: Were outcomes measured validly and reliably?; Q.8: Was there an appropriate statistical analysis?; √ = yes; U = Unclear.

Table 4. Risk of bias assessed by the Joanna Briggs Institute Critical Appraisal tools for use in JBI systematic reviews - checklist for randomized clinical trials (Barker et al. 2023).

Author, year	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10	Q.11	Q.12	Q.13	Percentage of yes/risk
Bezerra, 2018	√	√	√	--	--	U	√	√	√	√	√	√	√	75%/low risk

Q.1: Was true randomization used for assigning participants to treatment groups?; Q.2: Was allocation to treatment groups concealed?; Q.3: Were treatment groups similar at the baseline?; Q.4: Were participants blind to treatment assignments?; Q.5: Were those delivering treatment blind to treatment assignments?; Q.6: Were outcome assessors blind to treatment assignments?; Q.7: Were treatment groups treated identically other than the intervention of interest?; Q.8: Was follow-up complete, and, if not, were follow-up differences among groups adequately described and analyzed?; Q.9: Were participants analyzed in the groups to which they were randomized?; Q.10: Were outcomes measured similarly for treatment groups?; Q.11: Were outcomes measured reliably?; Q.12: Was there an appropriate statistical analysis?; Q.13: Was the trial design appropriate, and were any deviations from the standard RCT design (individual randomization, parallel groups) considered in the conduct and analysis of the trial?; √ = yes; -- = No; U = Unclear.

Table 5. Main findings of eligible studies.

Author, year	One-hour pad test (g)		ICIQ-SF		Main findings
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	
Elliott et al., 2015	--	--	GT: 11.13 ± 3.35		Most participants showed high rates of weekly treatment attendance (91%). The participants presented a significant reduction in one-hour pad test scores post-intervention and improved results in the 72-hour urinary diary (mean voiding, leakage, and protections per day) in UDI-6, IIQ, and ICIQ-SF scores. Most participants (91%) were satisfied with the treatment.
Fraser et al., 2014	--	--	N/A	N/A	Neuropsychological indices and dual-task performance improved, and one-hour pad test scores significantly decreased post-treatment.
Bezerra, 2018	GT: 2.32 ± 1.18 CG: 2.69 ± 1.94	GT: 0.51 ± 0.31 CG: 0.41 ± 0.20	GT: 15.62 ± 3.34 CG: 12.00 ± 3.98		Manometry, one-hour pad test, and ICIQ-SF results significantly improved after therapeutic intervention in both groups (GT and GC).

ICIQ-SF = international consultation on incontinence questionnaire - short form; N/A = not applicable; GT = game therapy group; CG = control group; UDI-6 = urogenital distress inventory; IIQ = incontinence impact questionnaire.

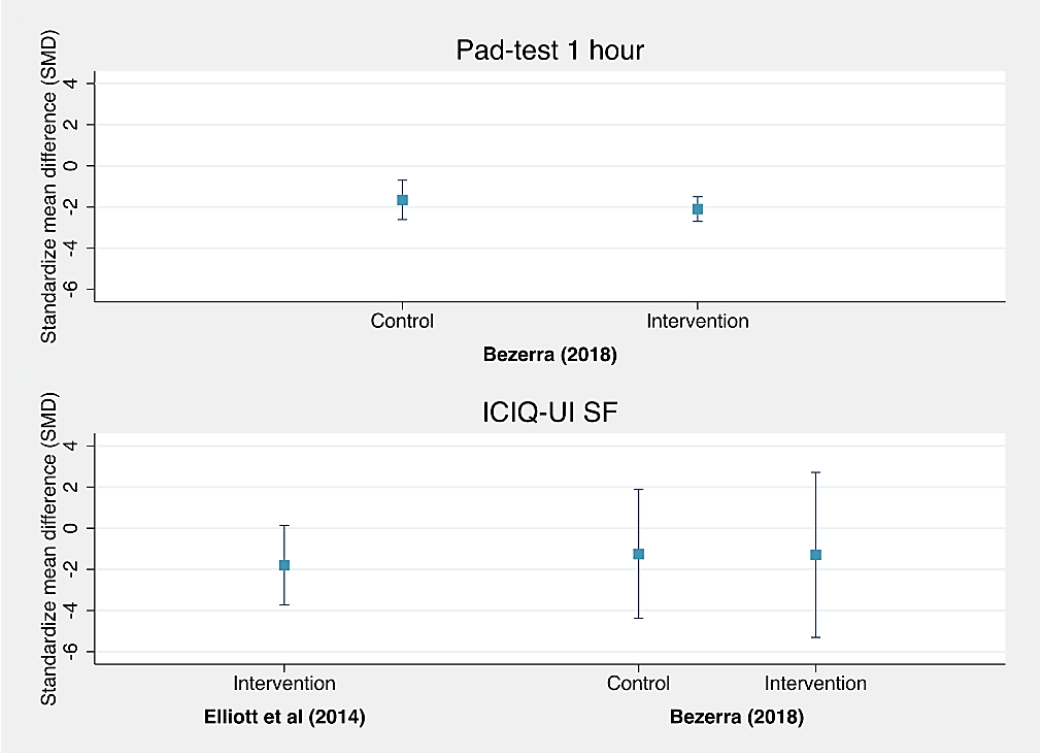

Figure 2. Standardized mean difference between post- and pre-intervention categorized by the applied test and allocation group.

4. Discussion

This study is the first to assess game therapy effects on treating urinary incontinence patients. Game therapy, as a resource of pelvic floor muscle training, benefited urinary incontinence patients,

reducing urinary symptoms and one-hour pad test scores and improving neuropsychological indices. Moreover, the reduction of urinary symptoms was similar between game therapy and the conventional treatment for the pelvic muscle, and it was not a determinant of treatment prognosis.

Pelvic floor muscle training adherence of urinary incontinence patients is among the more challenging conditions for therapeutic success (Elliott et al. 2015). Game therapy based on virtual reality is a compelling alternative, combining interaction and immersion and providing patients with different exercise choices. The present systematic review showed that urinary incontinence patients had a high treatment adherence rate (exercise performance) and fewer urinary symptoms. Therefore, we strongly suggest this approach as an additional tool for treating urinary incontinence.

Game therapy has been used in several areas, such as Parkinson's disease rehabilitation, phobia treatments, and the rehabilitation of patients who had a brain stroke (Dockx et al. 2016; Choi 2018). However, few studies assess the impact on urinary incontinence patients (Fraser et al. 2014; Elliott et al. 2015; Bezerra 2018). The advantage of this approach is the possibility of increasing treatment adherence by combining game movements and ensuring visual and auditory feedback (Merians et al. 2002). That is particularly relevant for urinary incontinence patients because adherence to a regular exercise program is directly responsible for failure (Alewijnse 2001).

The one-hour pad test quantifies urinary loss, classifying incontinence as mild, moderate, and severe (Abrams et al. 2003). This method uses a tampon, and patients are asked to perform physical efforts typical of their routine, allowing the analysis of daily activities (Abrams et al. 2003). All studies in the present systematic review used the one-hour pad test to assess urinary loss before and after game therapy (Fraser et al. 2014; Elliott et al. 2015; Bezerra 2018), possibly because of its easy application, low cost, non-invasiveness, and clinical study applications (Abrams et al. 2003). Moreover, this test has higher sensitivity and specificity than the urodynamic examination (Albuquerque et al. 2011).

However, only one study provided pad test results before and after game therapy, and they were satisfactory because the experimental group showed lower test scores post-intervention (Bezerra 2018). Although they did not present numerical results, Elliot et al. (2015) reported a significant one-hour pad test score reduction post-intervention.

Similarly, Steenstrup et al. (2014) verified improvements in the posture of patients undergoing game therapy, improving the automatic activation of pelvic floor muscles and potentially improving continence (Steenstrup et al. 2014). One study showed that game therapy might replace the conventional treatment for upper limb rehabilitation after a cerebral vascular accident (Choi 2014). That is particularly relevant because these patients present severe motor impairments, further reinforcing the potential effect of game therapy on rehabilitation programs.

The ICIQ-SF also assessed urinary symptoms. It is a short, simple questionnaire of easy application in the clinical routine. Two studies in the present systematic review used the ICIQ-SF and showed fewer urinary symptoms (Elliott et al. 2015; Bezerra 2018). The most relevant difference was in the experimental group (game therapy), which might have occurred because of the coactivation of pelvic floor muscles during game therapy. A recent study found an increase in the electrical activity of pelvic floor muscles after game therapy and suggested that contracting the transverse abdominal muscle during the virtual game favors the coactivation of pelvic floor muscles (Silva et al. 2016). Thus, game therapy may directly affect urinary symptom reduction.

Adherence to a regular exercise program is among the main challenges of treating urinary incontinence (Alewijnse et al. 2001), as treatment adherence is directly responsible for therapeutic failure, and it is a determinant of rehabilitation effectiveness in the short and long terms (Chen et al. 1999; Kim et al. 2011). Only one study in our systematic review reported participant adherence, and the results were promising, with 92% during the regular exercise program combined with game therapy (Elliott et al. 2015). Similarly, Meldrum et al. (2015) studied patients with unilateral peripheral buccal loss undergoing game therapy, finding high exercise adherence (± 77%) (Meldrum et al. 2015).

These positive results may be attributed to the easy application of game therapy, increasing the likelihood of patient acceptance (Perez-Marcos et al. 2017). Corroborating these findings, a study verified an increased contraction force of pelvic floor muscles associated with decreased urinary symptoms and anterior wall prolapses, resulting in a higher quality of pelvic floor muscle functionality (Martinho et al.

2016). Thus, the coordinated action of the pelvic floor and abdominal muscles should be the goal of rehabilitation (Junginger et al. 2010). Moreover, game therapy provides auditory and visual biofeedback, promoting patient learning, gradually changing muscle recruitment, and improving the coordination of vital muscles for urinary continence (Hung et al. 2010; Silva 2015; Vilott et al. 2017).

Thus, the present systematic review suggests that game therapy is relevant for treating urinary incontinence patients. Its strengths must be highlighted, as it is the first systematic review of the influence of game therapy on urinary incontinence patients.

We used an extensive and careful search strategy to capture potentially eligible studies without language, year, or publication status restrictions.

However, further studies are strongly suggested, especially those lasting more than 12 weeks, to enable an accurate treatment adherence assessment until the findings construct scientific evidence. It is worth noting that, after learning the effects of game therapy on healthy women, this assessment must be performed in populations with symptoms Comparable results should be achieved by following the design patterns of studies and necessary information during publication.

5. Conclusions

Game therapy has promising effects on urinary incontinence, such as reducing urinary symptoms and one-hour pad test scores and improving neuropsychological indices. Further studies should be performed with higher methodological rigor and protocol standardization for applying result-measuring methods, allowing more consistent recommendations.

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References

ABRAMS, P. *et al*. The standardisation of terminology in lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. *Urology*. 2003; **61** (1), 37-49. https://doi.org/10.1016/s0090-4295(02)02243-4.

ABRAMS, P. *et al*. *6th International Consultation on Incontinence*. Bristol UK: ICI-ICS. International Continence Society, 2017. ISBN: 978-0956960733.

ALBUQUERQUE, M. T. *et al*. Correlation between complaints of stress urinary incontinence and the one-hour pad test in postmenopausal women. *Revista Brasileira de Ginecologia e Obstetrícia*. 2011; **33**, 70-74. https://doi.org/10.1590/S0100-%2072032011000200003.

ALEWIJNSE, D. *et al*. Predictors of intention to adhere to physiotherapy among women with urinary incontinence. *Health Education Research*. 2001; **16** (2), 173-86. https://doi.org/10.1093/her/16.2.173.

AROMATIS, E., MUNN, Z (Editors). JBI Manual for Evidence Synthesis. JBI, 2020. Available from https://synthesismanual.jbi.global. https://doi.org/10.46658/JBIMES-20-01

BARDSLEY, A. An Overview of Urinary Incontinence. *British Journal of Nursing*. 2016; **25** (18), S14-S21. https://doi.org/10.12968/bjon.2016.25.18.S14.

BARKER, T. H. et al. The revised JBI critical appraisal tool for the assessment of risk of bias for randomized controlled trials. *JBI Evidence Synthesis*. 2023; **21** (3), 494-506.

BEZERRA, L.O. Avaliação comparativa da eficácia do treinamento da musculatura do assoalho pélvico e da gameterapia no tratamento da incontinência urinária mista: Ensaio clínico randomizado [Dissertation]. Natal: Universidade Federal do Rio Grande do Norte; 2018. Available from: https://repositorio.ufrn.br/handle/123456789/25532. Accessed in 2021.

BØ, K. and SHERBURN, M. Evaluation of female pelvic-floor muscle function and strength. *Physical Therapy*. 2005; **85** (3), 269-82.

CHEN, H. Y. *et al*. Efficacy of pelvic floor rehabilitation for treatment of genuine stress incontinence. *Journal of the Formosan Medical Association*. 1999; **98** (4), 271-6.

CHOI, Y.H. and PAIK, N.J. Mobile Game-based Virtual Reality Program for Upper Extremity Stroke Rehabilitation. *J. Vis. Exp*. 2018; (133), e56241. https://doi.org/10.3791/56241.

DE BRUIN, E. D. *et* al. Use of virtual reality technique for the training of motor control in the elderly. Some theoretical considerations. *Zeitschrift für Gerontologie und Geriatrie*. 2010; **43** (4), 229–34. https://doi.org/10.1007/s00391-010-0124- 7.

DOCKX, K. *et al*. Virtual reality for rehabilitation in Parkinson's disease. *Cochrane Database Syst Rev*. 2016; **12** (12), CD010760. https://doi.org/10.0.3.234/14651858.CD010760.pub2.

EICKMEYER, S.M. Anatomy and Physiology of the Pelvic Floor. *Physical Medicine and Rehabilitation Clinics of North America*. 2017; **28** (3), 455-60. https://doi.org/10.1016/j.pmr.2017.03.003.

ELLIOTT, V., DE BRUIN, E. D. and DUMOULIN, C. Virtual reality rehabilitation as a treatment approach for older women with mixed urinary incontinence: a feasibility study. Neurourology and Urodynamics. 2015; **34** (3), 236–43. https://doi.org/10.1002/nau.22553.

FELDE, G., EBBESEN, M. H. and HUNSKAAR S. Anxiety and depression associated with urinary incontinence. A 10-year follow-up study from the Norwegian HUNT Study (EPINCONT). *Neurourology and Urodynamics*. 2017; **36** (2), 322-8. https://doi.org/10.1002/nau.22921.

FRASER, S. A. *et al*. The Effects of Combining Videogame Dancing and Pelvic Floor Training to Improve Dual-Task Gait and Cognition in Women with Mixed-Urinary Incontinence. *Games for Health Journal*. 2014; **3** (3), 172-8. https://doi.org/10.1089/g4h.2013.0095.

HIGGINS, J. P. T. *et al*. Cochrane Handbook for Systematic Reviews of Interventions version 6.0 (updated July 2019). Cochrane 2019. www.training.cochrane.org/handbook

HUNG, H. C. *et al*. An alternative intervention for urinary incontinence: retraining diaphragmatic, deep abdominal and pelvic floor muscle coordinated function. *Manual Therapy*. 2010; **15** (3), 273-9. https://doi.org/10.1016/j.math.2010.01.008.

IRWIN, G. M. Urinary Incontinence. *Primary Care*. 2019; **46** (2), 233-42. https://doi.org/10.1016/j.pop.2019.02.004.

JUNGINGER, B. *et al*. Effect of abdominal and pelvic floor tasks on muscle activity, abdominal pressure and bladder neck. *International Urogynecology Journal*. 2010; **21** (1), 69-77. https://doi.org/10.1007/s00192-009-0981-z.

KIM, H., YOSHIDA, H. and SUZUKI, T. The effects of multidimensional exercise on functional decline, urinary incontinence, and fear of falling in community dwelling elderly women with multiple symptoms of geriatric syndrome: a randomized controlled and 6-month follow-up trial. *Archives of Gerontology and Geriatrics*. 2011; **52** (1), 99–105. https://doi.org/10.1016/j.archger.2010.02.008.

MARTINHO, N. M. *et al*. The effects of training by virtual reality or gym ball on pelvic floor muscle strength in postmenopausal women: a randomized controlled trial. *Brazilian Journal of Physical Therapy*. 2016; **20** (3), 248-57. https://doi.org/10.1590/bjpt-rbf.2014.0148.

MELDRUM, D. *et al*. Effectiveness of Conventional Versus Virtual Reality-Based Balance Exercises in Vestibular Rehabilitation for Unilateral Peripheral Vestibular Loss: Results of a Randomized Controlled Trial. *Archive of Physical Medicine and Rehabilitation*. 2015; **96**(7), 1319-1328. https://doi.org/10.1016/j.apmr.2015.02.032.

MERIANS, A.S. *et* al. Virtual reality-augmented rehabilitation for patients following stroke. *Physical Therapy*. 2002; **82**(9), 898-15.

MESSELINK, B. et al. Standardization of terminology of pelvic floor muscle function and dysfunction: report from the pelvic floor clinical assessment group of the International Continence Society. *Neurourology and Urodynamics*. 2005, **24**(4), 374-80. https://doi.org/10.1002/nau.20144.

MOOLA, S. *et al.* Systematic reviews of etiology and risk. In: Aromataris, E., Munn, Z., eds. *JBI Manual for Evidence Synthesis*. 2020. Available from https://synthesismanual.jbi.global

PAGE, M.J. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Syst Rev. 2021; **10**(89). https://doi.org/10.1186/s13643-021-01626-4

PAGE, M. J. *et al*. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *PLoS Medicine*. 2021; **18**(3), e1003583. https://doi.org/10.1371/journal.pmed.1003583

PEREZ-MARCOS, D. *et al*. Increasing upper limb training intensity in chronic stroke using embodied virtual reality: a pilot study. *Journal of NeuroEngineering and Rehabilitation*. 2017; **14** (1), 119. https://doi.org/10.1186/s12984-017-0328-9.

RAGHAV, K. *et al*. Efficacy of virtual reality exposure therapy for treatment of dental phobia: a randomized control trial. *BMC Oral Health*. 2016; 16:25. https://doi.org/10.1186/s12903-016-0186-z.

SILVA, V. R. Comportamento dos músculos do assoalho pélvico e transverso do abdômen/oblíquo interno frente a dois programas de treinamento abdominopélvico em mulheres jovens nulíparas, continentes: estudo controlado, randomizado [Dissertation]. Campinas: Universidade Estadual de Campinas; 2015. Available from: http://repositorio.unicamp.br/handle/REPOSIP/313089.

SILVA, V. R. *et al*. Training through gametherapy promotes coactivation of the pelvic floor and abdominal muscles in young women, nulliparous and continents. *International Brazilian Journal of Urology*. 2016; **42** (4), 779-86. https://doi.org/10.1590/S1677-5538.IBJU.2014.0580.

STEENSTRUP, B. *et al*. Evaluation of the electromyography activity of pelvic floor muscle during postural exercises using the Wii Fit Plus™. Analysis and perspectives in rehabilitation. *Progrès en Urologie*. 2014; **24** (17), 1099-105. https://doi.org/10.1016/j.purol.2014.09.046.

TYRALA-SEWERYN, K., SEWERYN, M. and KRYSTA, K. Analysis of Urinary Incontinence and Depression Among Young Women. *Psychiatria Danubina*. 2017; **29** (Suppl 3), 565-567.

VILLOT, A. *et al*. Influence of cognitive rehabilitation on pelvic floor muscle contraction: A randomized controlled trial. *Neurourology and Urodynamics*. 2017; **36** (6), 1636-1644. https://doi.org/10.1002/nau.23169.

WU, J.M. *et al*. Prevalence and trends of symptomatic pelvic floor disorders in U. S. women. *Obstetrics & Gynecology*. 2014; **123** (1), 141-148. https://doi.org/10.1097/AOG.0000000000000057.

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