Review Article

Int Neurourol J 2023;27(1):23-35
https://doi.org/10.5213/inj.2346014.007
pISSN 2093-4777 · eISSN 2093-6931

INTERNATIONAL NEUROUROLOGY JOURNAL
INJ
OPEN ACCESS

Effectiveness of Fluid and Caffeine Modifications on Symptoms in Adults With Overactive Bladder: A Systematic Review

Jeongok Park[1], Hyojin Lee[2], Youngkyung Kim[2], Christine Norton[3], Sue Woodward[3], Sejeong Lee[2]

[1]Mo-Im Kim Nursing Research Institute, Yonsei University College of Nursing, Seoul, Korea
[2]College of Nursing and Brain Korea 21 FOUR Project, Yonsei University, Seoul, Korea
[3]Florence Nightingale Faculty of Nursing, Midwifery and Palliative Care, King's College London, London, UK

Overactive bladder (OAB) is prevalent in men and women and negatively impacts physical and psychological health. Fluid and caffeine intake modifications, which are lifestyle modification interventions, are simple methods to manage OAB. However, studies that synthesized both interventions and found scientific evidence are scarce. This review aimed to synthesize scientific evidence on whether fluid and caffeine intake modifications are effective for OAB symptoms. PubMed, CINAHL (Cumulative Index for Nursing and Allied Health Literature), Embase, Scopus, the Cochrane Library, KoreaMed, and RISS (Research Information Sharing Service) were used to search for studies and 8 studies were included. The Cochrane risk of bias tool (RoB 2.0) and ROBINS-I (Risk Of Bias In Non-randomized Studies - of Interventions) were used to assess the quality of selected studies. Due to the heterogeneous outcome variables, a meta-analysis was not conducted. Among the 8 included, 7 studies were randomized controlled trials and one was a quasi-experimental study. Four studies assessed urgency. Caffeine reduction was statistically effective for urgency symptoms, but increasing fluid intake was not. Frequency was assessed in 5 studies, which showed decreasing caffeine and fluid intake was effective in treating the symptoms. Urinary incontinence episodes were assessed in 6 studies, and nocturia in 2. Restricting caffeine intake was effective in treating these 2 symptoms, but restricting both caffeine and fluid intake was not. Quality of life (QoL) was examined in 5 studies, and modifying fluid and caffeine intake significantly improved QoL in 2. Although there were limited studies, our review provides scientific evidence that fluid and caffeine intake modification effectively manages OAB symptoms. Further research should examine acceptability and sustainability of interventions in the long-term and enable meta-analysis.

Keywords: Urinary bladder, Overactive; Urinary incontinence; Drinking; Caffeine; Adult

- **Grant/Fund Support:** This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (No. 2019R1F1A1062769, No. 2020R1A6A1A03041989, No. 2022R1A2C1092084). This research was supported by the Brain Korea 21 FOUR Project funded by the NRF of Korea, Yonsei University College of Nursing. This research was supported by a 2022 International Joint Research Grant from Mo-Im Kim Nursing Research Institute, Yonsei University College of Nursing (Project No. 6–2022-0152).
- **Conflict of Interest:** No potential conflict of interest relevant to this article was reported.

INTRODUCTION

Overactive bladder (OAB) is characterized by the symptom of urinary urgency that is generally accompanied by frequent daytime voiding or nocturia, with or without urinary incontinence (UI), in the absence of urinary tract infection or other detectable diseases [1]. OAB is a prevalent condition in males and females, and the prevalence increases with age [2]. In Korea,

Corresponding author: Sejeong Lee https://orcid.org/0000-0003-0911-4613
College of Nursing and Brain Korea 21 FOUR Project, Yonsei University, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea
Email: sejeong33@yonsei.ac.kr
Submitted: January 6, 2023 / **Accepted after revision:** February 23, 2023

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (https://creativecommons.org/licenses/by-nc/4.0/) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

about 10% of men and 14.3% of women had OAB [3] and in America, 17% of men and 30% of women experienced OAB symptoms sometimes or often [4]. In China and Korea, about 20% of people aged over 40 years had OAB symptoms [2] and in eastern Europe, 39.5% of women and 26.8% of men had these symptoms [5].

OAB negatively impacts psychological and physical health. People with OAB are more likely to experience depression, anxiety, embarrassment, or shame, and hence, their quality of life (QoL) is low [6]. Specifically, among OAB women, the higher the depression and anxiety scores, the greater the severity of OAB symptoms [7]. Moreover, when comparing health-related QoL scores between people without OAB and those with severe OAB, the latter had 30% lower scores [8]. OAB also affects sexual function, working activity, and sleep. One study found that the total sexual function score was significantly different between OAB women and non-OAB women: the higher the severity of symptoms, the weaker the sexual function [9,10]. Regarding work activity, people with OAB felt 32.1% of their working time was affected by OAB symptoms and 6.5% of people felt the symptoms affected their work time [11]. Moreover, people with OAB had a higher risk of insomnia and were more likely to have sleep disturbance [12,13].

Behavioral therapies for OAB such as lifestyle modifications are recommended for the first-line treatment by the American Urological Association [14], because of their significant benefits and few side effects [15]. In addition, it is difficult to manage the symptoms completely with medication alone, so behavioral therapies are important [16]. For older adults, lifestyle modifications, one of the behavioral therapies, can be easily applied because they are simple [17]. They include fluid and caffeine intake modification, weight control, constipation management, and smoking cessation [15]. It was reported that lifestyle modifications such as adequate fluid intake, diet, and weight control, reduced OAB symptoms and improved psychological symptoms and QoL among women with OAB [18]. Moreover, a study revealed that co-morbid dysfunctions such as nocturia and sleep disturbance improved when the severity of OAB symptoms decreased by lifestyle interventions [19].

Fluid and caffeine intake modifications are considered to be one of the easiest ways to manage OAB because they are cost-effective, noninvasive, and easy to access [20]. The evidence suggests that fluid or caffeine intake modification was associated with lower urinary tract symptoms (LUTS), urinary urgency, and frequency [21,22]. There are also some recommendations to consume 6 to 8 glasses of water per day, keep away from fluid intake 2 to 3 hours before bed, and reduce caffeine intake [15].

Although there were these benefits of fluid and caffeine intake modifications for people with OAB symptoms, no previous study synthesizes the evidence on the effects of fluid and caffeine intake and analyzed them systematically.

This study aimed to review and summarize available scientific evidence about the effects of fluid or caffeine intake modifications on community-dwelling adults with symptoms of OAB.

METHODS

Study Design

A systematic review of randomized controlled trial (RCT) studies and quasi-experimental studies (QESs) which evaluated the effectiveness of fluid or caffeine intake modifications on OAB symptoms in adults. A QES is an experimental study without randomization or a control group [23]. The study protocol was prospectively registered on PROSPERO (No. CRD42022293799).

Searching for and Selecting Studies

Studies were searched electronically by using PubMed, CINAHL (Cumulative Index for Nursing and Allied Health Literature), Embase, Scopus, the Cochrane Library, KoreaMed, and RISS (Research Information Sharing Service) databases. Only studies published until February 2022 and written in English or Korean were included. The search terms included: ("OAB" OR "UI" OR "LUTS") AND ("fluid modification" OR "caffeine intake") (Supplementary Material 1). Citation tracking was also used to identify additional studies.

The inclusion criteria were as follows: (1) studies that included community-dwelling adults with OAB as participants; (2) studies that implemented fluid or caffeine intake modification interventions; (3) RCT or QES; (4) studies that reported urinary frequency, urgency, nocturia, urine leakage episodes or amount, or QoL as outcome variables. The exclusion criteria were as follows: (1) studies that included people with UI after surgery and admitted to a health institution; (2) studies with people who have a urinary disorder due to another disease as participants; (3) pharmacological or surgical treatment. Two independent researchers reviewed the search results by these criteria and through discussions, the final included studies were selected.

Risk of Bias in Included Studies

To examine the risk of bias of included studies, Cochrane tool for assessing the risk of bias (RoB 2.0) and Risk Of Bias In Non-randomized Studies - of Interventions (ROBINS-I) were applied. RoB 2.0 had 5 domains, and each criterion was appraised as high, low, or having some concerns regarding bias [24]. ROBINS-I had 7 domains, and each domain was assessed as low, moderate, serious, critical, or not informed [25]. After assessing RoB independently, the 2 researchers cochecked the results and if there were any disagreements or misunderstandings, they reached an agreement through discussion.

Data Extraction

Data extraction was performed by including first author, publication year, country where the study was conducted, design, inclusion and exclusion criteria, settings, participants' mean age, the number of participants in each study group (experimental and control groups), content of intervention, duration of intervention, time of measuring, outcome variables and findings. The data were cross-checked by 2 independent researchers.

Data Analysis

The general characteristics of studies were narratively described, and outcomes were presented as mean ± standard deviation or median (range) for continuous data. A meta-analysis could not be performed because of heterogeneity among study outcomes.

RESULTS

Search Outcome

A total of 5,900 articles were obtained through database search-

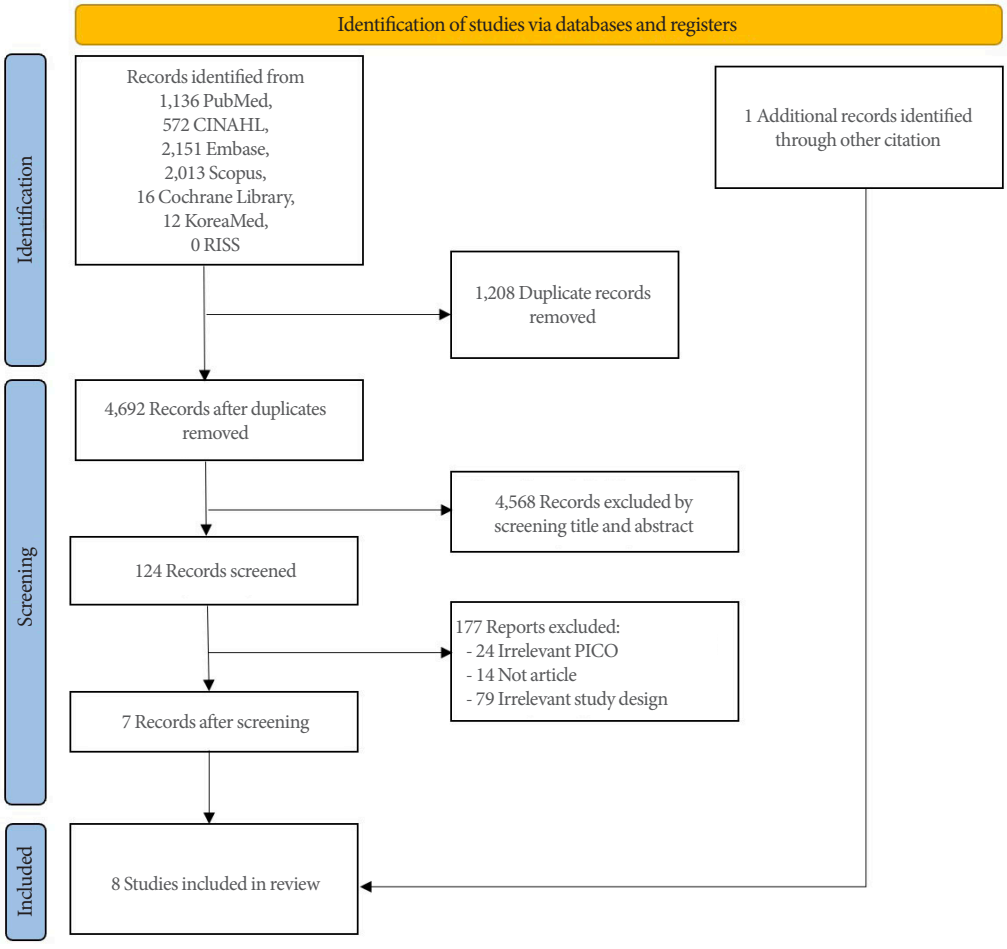

Fig. 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow chart. PICO, population, intervention, control, outcomes.

ing, and after removing duplicates, 4,692 remained. After screening the titles, 4,568 articles were excluded. The remaining 124 were examined by screening abstracts. A total of 112 studies were excluded; 19 had an irrelevant population (P), intervention (I), control (C) and/or outcomes (O), 14 were not original articles, and 79 had irrelevant study designs. Through this process, 12 articles were reviewed by their full texts, and 5 were excluded because of irrelevant data and intervention.

Finally, 8 studies were included since one additional study was found by citation tracking. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow chart shows an overview of the study selection process (Fig. 1).

Characteristics of Studies and Interventions

Table 1 presents the general characteristics of the 8 studies. There were 7 RCTs and one QES, and all studies were published in academic journals. Three were conducted in the United States of America, 2 in the United Kingdom, and 1 each in Australia, Japan, and the Netherlands. There were 5 studies on women, 1 on men, and 2 on both, and participants' mean age was over 50 in all studies.

Interventions could be divided into 3 main categories: caffeine modification only, fluid modification only, and fluid and caffeine modification.

Two studies restricted caffeine intake. Bryant et al. [26] restricted caffeine to less than 100 mg a day and provided bladder training. Wells et al. [27] divided the participants into 2 groups and allowed them to drink caffeine or decaffeinated drinks for 14 days. Then, each group was allowed to drink decaffeinated or caffeine drinks on the contrary after a 14-day washout period.

The 2 periods were compared.

Two studies controlled the amount of fluid intake. Dowd et al. [28] asked participants drink fluid less, more, or maintain their current amount, and Spigt et al. [29] asked the intervention group to drink 1.5 L of extra water per day.

A total of 4 studies modified both caffeine and fluid intake. Kincade et al. [30] provided individualized counseling regarding self-monitoring techniques for adequate caffeine and fluid consumption and simple pelvic floor muscle training (PFMT). Kyoda et al. [31] provided cognitive behavioral therapy (CBT), which included caffeine restriction and decreased water intake in the evening. Swithinbank et al. [32] asked patients with urodynamic stress incontinence and idiopathic detrusor overactivity to restrict their caffeine intake for 3 weeks. During the last 2 weeks of caffeine restriction, participants were divided into increasing or decreasing fluid intake groups. Tomlinson et al. [33] provided self-monitoring techniques to manage their continence symptoms, such as decreasing caffeine and increasing fluid intake.

Risk of Bias in Included Studies

Figs. 2 and 3 presents the RoB results among the included studies. Overall, RoB was low in 4, high in 3 studies, and moderate in 1 QES.

For RCTs, all studies were at low risk regarding the measurement of the outcome and deviation from intended interventions. Regarding the randomization process, 5 studies were at low risk and 2 had some concerns because 2 did not explain the exact method of randomization. Four studies were at low risk regarding missing outcome data and 3 were at high risk. Studies with high risk had not only incomplete outcome data, but they also did not mention how they handled the dropouts. Furthermore, there was no specific evidence that the result was not biased because of missing outcome data. Four RCTs were at low risk, and the other 3 had some concerns regarding the selection of the reported result. This is because of the lack of information regarding whether the data were analyzed according to a prespecified analysis plan.

For the QES, selection of participants, classification of interventions, deviations from intended interventions, missing data and selection of the reported result were at low risk, and confounding and measurement of outcomes were at moderate risk of bias. Tomlinson et al. [33] did an initial assessment such as physical assessment and health history, potential confounding could still exist. In addition, outcome assessors were aware of the intervention, this could be the risk of bias.

Outcomes

Table 2 shows the intervention effect of the included studies through the outcome variables urinary urgency, urinary frequency, UI, nocturia, and QoL.

Urinary urgency

Four studies assessed urinary urgency, and it was reported by the number of urgency episodes in 24 hours or the score of the International Prostate Symptom Score (IPSS) which evaluates irritative symptoms. Studies that restricted caffeine intake [26,27] reported fewer urgency episodes in the intervention group than the control group. In the study by Spigt et al. [29], both 2 groups had differences between baseline and after the

Table 1. Characteristics of included studies

Study	Country	Design	Inclusion/exclusion criteria	Settings	Age (yr)	No. of participants (N, at baseline→at outcome measurement)	Intervention		
							Experimental	Duration	Control
Bryant et al. (2002) [26]	Australia	RCT	- Adults with symptoms of urinary urgency, frequency and/or urge incontinence and who routinely ingested caffeine ≥ 100 mg daily	Home	E: 56 ± 18[a] C: 58 ± 16[a]	Total: 95→74 E: 48→36 C: 47→38	Caffeine reduction education and bladder training	4 Weeks	Bladder training only
Dowd et al. (1996) [28]	USA	RCT	- Women aged over 50 with UI for 6 months or more - Independent in self-care, scored over 20 on the MMSE - English speaking	Home	70.25 (52–89)[b]	Total: 58→32 Increase: 20→14 Decrease: 20→10 Maintain: 18→8	Increase fluid intake by 500 mL or decrease by 300 mL	5 Weeks	Maintain current fluid intake
Kincade et al. (2007) [30]	USA	RCT	Inclusion: - Community-dwelling women with UI, aged 18 and over, living in North Carolina Exclusion: - Involuntary urine loss of less than 1 g in 24 hr - UTI, bladder cancer or kidney cancer patients - Prior treatment of UI with biofeedback - Urinary catheter - Post void residual of 100 mL or more - Unable to keep bladder diaries - Pregnant	Home	18–39 yr: 12.5% 40–64 yr: 62.5% 65+ yr: 25%	Total: 224→184 E: 117→90 C: 107→94	Individualized counseling about caffeine consumption, fluid intake, simple PFMT	3 Weeks	Waitlist
Kyoda et al. (2021) [31]	Japan	RCT	Inclusion: - Patients with nocturia with aged 40 and over - Scored IPSS Q7 of 2 or over - Patients with OAB: scored OABSS Q3 of 2 or over and total score of 3 or over Exclusion: - Prescribed medications for LUTS - Malignant or infectious diseases in the lower urinary tract - Postvoid residual volume > 200 mL	Home	E: 72.9 ± 9.0[a] C: 71.9 ± 8.4[a]	Total: 100→78 E: 50→37 C: 50→41	CBT and FVC including caffeine restriction and decrease water intake in the evening.	4 Weeks	FVC only
Spigt et al. (2006) [29]	Netherlands	RCT	Inclusion - Men with moderate LUTS (IPSS 8 to 19) aged between 55and 75 Exclusion - Mild or severe LUTS (IPSS 0–7 or 20–35) - Self-reported fluid intake greater than 2L/day - Diabetes, Parkinson disease, renal disease - Previous surgery of lower urinary tract - Prostate or bladder cancer - Use of diuretics, medication for LUTS, tricyclic antidepressive agents	Home	55–75	N = 141→138 E: 70→69 C: 71→69	Extra intake of daily 1.5-L water	6 Months	One tablespoon of placebo syrup daily

(Continued)

Table 1. Characteristics of included studies (Continued)

Study	Country	Design	Inclusion/exclusion criteria	Settings	Age (yr)	No. of participants (N, at baseline→at outcome measurement)	Intervention		
							Experimental	Duration	Control
Swithinbank et al. (2005) [32]	UK	RCT	Inclusion: - Women with USI or IDO, diagnosed of LUTS and before starting any treatment Exclusion: - UTI, hepatic, cardiac or renal disease, diabetes	Home	54.8 (31–76)[b]	Total: 69 USI: 39 IDO: 30	3 Weeks of caffeine restriction. During week 3 and 4, increase decaffeinated fluids to 3L/day or decreased decaffeinated fluids to 750 mL/day	4 Weeks	None
Tomlinson et al. (1999) [33]	USA	QES	Inclusion: - Rural women living at home with UI, aged 55 or older - Involuntary urine loss at least twice a week and of 1 g per day or more - Stress, urge, or mixed UI - Negative urine test for bacteria Exclusion: - Bladder cancer, kidney disease - Urinary catheter - Retention of 100 mL or more	Home	67.65 ± 8.04[a] E: 65.8 ± 7.2[a]	Total: 94 E: 41 C: 53	Complete home visiting self-monitoring of the behavioral management for continence intervention and encouraged to decrease their caffeine intake and increase their fluid intake	2–4 Weeks	Usual care
Wells et al. (2014) [27]	UK	RCT	Inclusion - Community-dwelling women who newly diagnosed with OAB - Reported frequency of 7 or more voids per day and 2 at night - Self-rated urgency and/or urge UI - Consumption of 2 or more caffeinated drinks per day Exclusion - Stress UI - Estrogen-containing oral contraceptive prescription - Caffeine-containing medication - Postvoid residual > 100ml - History of frequent UTI - Inability to complete a bladder diary - Smoking	Home	52 (27–79)[b]	Total: 14→11 Caffeinated: 7→5 Decaffeinated: 7→6	14-Day caffeinated drink, 14-day washout period, 14-day decaffeinated drink or 14-day decaffeinated drink, 14-day washout period, 14-day caffeinated drink	6 Weeks	None

RCT, randomized controlled trial; E, experimental; C, control; UI, urinary incontinence; UTI, urinary tract infection; MMSE, mini-mental state examination; PFMT, pelvic floor muscle training; IPSS, International Prostate Symptom Score; OAB, overactive bladder; OABSS, overactive bladder symptom score; LUTS, lower urinary tract symptom; CBT, cognitive behavior therapy; FVC, frequency volume chart; IDO, idiopathic detrusor overactivity; USI, urodynamic stress incontinence; QES, quasi-experimental study.
[a]Mean ± standard deviation. [b]Mean (range).

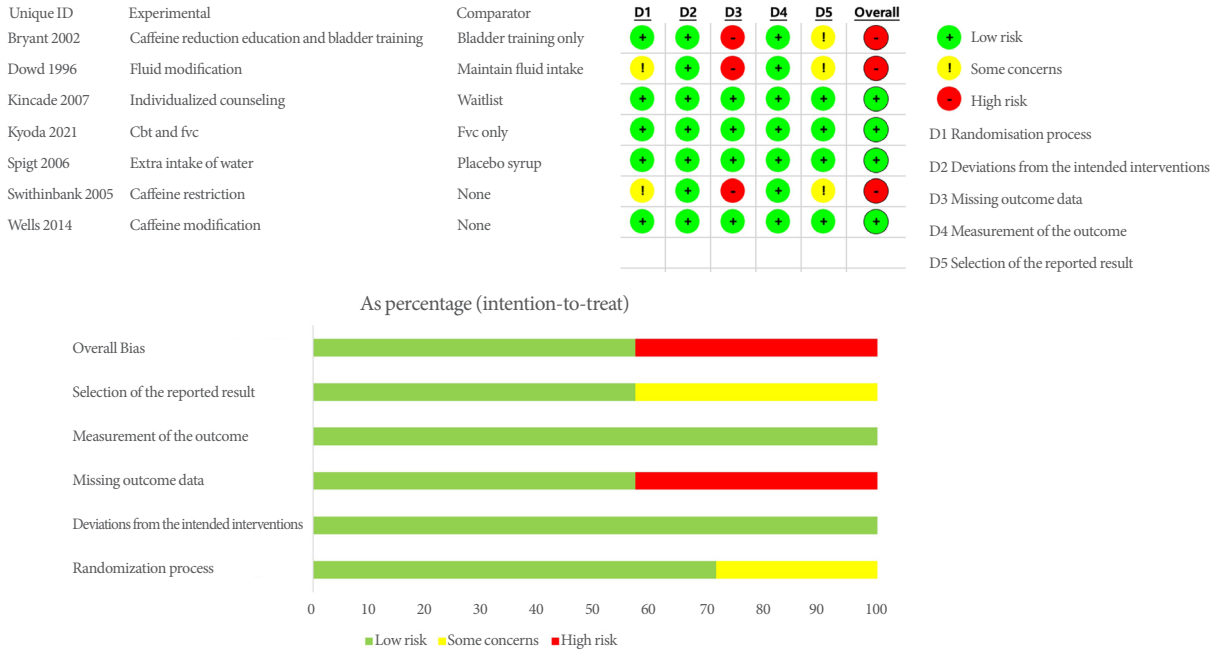

Fig. 2. The risk of bias results of randomized controlled trials. CBT, cognitive behavioral therapy; FVC, frequency volume chart.

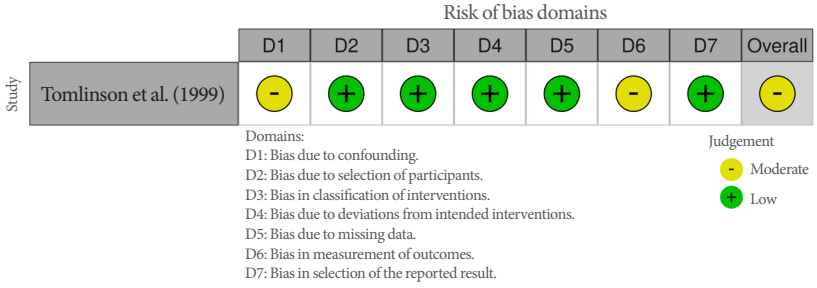

Fig. 3. The risk of bias results of a nonrandomized controlled trial.

intervention, but the control group indicated bigger differences than the intervention group from 5.7 to 4.4 of the IPSS score. Swithinbank et al. [32] compared fluid increase and decrease groups among IDO participants. The urgency episodes were increased in the group who increase fluid intake and decreased in the group drinking less fluid.

Urinary frequency

Urinary frequency was reported in 5 studies by assessing the number of voids in 24 hours. Studies that reduced caffeine intake found significant improvement in both groups with the intervention group showing a more significant effect than the comparative group [26,27]. However, when managing both caffeine and fluid intake [31-33], it was reported that increasing fluid intake increased the number of urinary voids.

Urinary incontinence

The episodes or amount of UI were assessed by 6 studies. Caffeine restriction resulted in fewer UI episodes in the intervention group than the control group, but it was not statistically significant [26,27]. Dowd et al. [28] compared UI episodes among 3 groups and found that decreasing fluid had more effect on UI than increasing or maintaining fluid intake. Kincade et al. [30] measured the amount of urine loss and found significant improvement in the intervention group. Tomlinson et al. [33] found improvement in UI from completing a self-monitoring phase. One study showed caffeine plus fluid reduction was more effective in reducing UI episodes than caffeine reduction with fluid increase among IDO patients [32].

Table 2. Interventions and outcomes of selected studies

Study	Intervention	Time of measuring	Outcome variables (mean, at baseline → at outcome measurement)					Findings
			Urinary urgency	Urinary frequency	UI	Nocturia	QoL	
Bryant et al. (2002) [26]	Caffeine restriction less than 100 mg a day	Baseline, 4 wk after baseline	Occasions of urgency per 24 hr E: 4.8→1.6 C: 4.6→3.2 (P = 0.002)	Voids per 24 hr E: 11.4→6.8 C: 11.2→7.9 (P = 0.037)	Occasions of leakage per 24 hr E: 2.8→1.2 C: 3.1→1.4 (P = 0.219)			The experimental group reduced their caffeine intake than the control group (P < 0.001). Urgency and frequency outcomes were significantly improved.
Wells et al. (2014) [27]	Group A: caffeinated drinks for 2 wk, washout period for 2 wk, decaffeinated drinks for 2 wk, Group B: decaffeinated drinks for 2 wk, washout period for 2 wk, caffeinated drinks for 2 wk.	Baseline, after caffeinated period, decaffeinated period, washout period	Urgency episodes/day CP: 9 (7.3–9.5)[a] DP: 7 (6.2–8.3)[a]	Frequency epi-sodes/day CP:9 (7.3-10.5) [a] DP:7.3 (6.5-10.3) [a]	UI episodes/day CP: 0.3 (0–1.3)[a] DP: 0 (0–0.8)[a]	ICIQ-OAB nocturia score CP: 2, DP: 1 P = 0.031	Overall ICIQ-OABQoL score CP: 69, DP: 50 P = 0.065	Significant reduction was found in urgency and frequency and total ICIQ-OAB score
Dowd et al. (1996) [28]	Increase fluid intake by an extra 500 mL or decrease it by 300 mL	Baseline, 4 times of weekly follow-up after baseline			UI episodes Increase: 0.6→0.61→0.67→0.5→0.55 Decrease: 0.54→0.26→0.17→0.14→ 0.07 Maintain: 0.48→0.71→0.81→0.57→0.48			Quantitative results were not significant. UI episodes decreased the most in the decrease group.
Spigt et al. (2006) [29]	Drinking daily extra 1.5-L water	Baseline, 6 mo after baseline	Irritative symptoms (IPSS items 2,4,7) E: 6.0→5.8 C: 5.7→4.4 (effect size: 1.3; P < 0.001)				IPSS QoL E: 2.6→2.3 C: 2.9→2.5 (effect size: 0.1; P = 0.06)	Water consumption in the intervention group increased by 359ml per day than in the control group. Statistically significant effect was found for bladder pressure and bladder wall stress. Subjective parameters were improved in both groups but no statistically significant differences were found.
Kincade et al. (2007) [30]	Individualized counseling about caffeine consumption, and amount and timing of fluid intake	Baseline, 3 wk after baseline			Amount of urine loss E:27.6→19 C:45.8→47.4 (t = 2.53, P = 0.012)		Incontinence impact questionnaire E: 125.4→99.3 C: 119.9→ 112.1 (t = -1.91, P = 0.059)	Self-monitoring on grams of urine loss was significant but that on episodes of urine loss was not. The intervention group lost lesser urine, average of 13.3 g, and had improved 26.1 points in QoL The intervention group reduced their caffeine intake but did not increase their fluid intake compared to the control group.

(Continued)

Table 2. Interventions and outcomes of selected studies (Continued)

Study	Intervention	Time of measuring	Outcome variables (mean, at baseline → at outcome measurement)					Findings
			Urinary urgency	Urinary frequency	UI	Nocturia	QoL	
Kyoda et al. (2021) [31]	Behavioral therapy includes avoiding the intake of caffeine from the evening and trying to drink less water from the evening	Baseline, 4 wk after baseline		Total No. of voids/24 hr E: 9.2→8.9 C: 10.1→9.9		IPSS Q7 (night-time frequency) E: 3.6→2.6 (P < 0.01) C: 3.7→3.1 (P < 0.01) Episodes of nocturia/24 hr E: 2.3→1.9 C: 2.8→2.4 (P = 0.039)	N-QoL E: 25→20.8 (P = 0.019) C: 22.3→22.3 (P = 1.000)	There were no significant differences in night-time frequency and QoL between two groups but after removing six patients with achievement of CBT < 50%, night-time frequency was significantly lower in the intervention group.
Swithinbank et al. (2005) [32]	3 Weeks of caffeine restriction. - First week: drink normally - Second and third week: increased decaffeinated fluids to 3 L/day or decreased decaffeinated fluids to 750 mL/day	Baseline, 3 times of weekly follow-up after baseline	IDO group Increase: 5.2→5.4→7.6 Decrease: 5.2→5.4→4.3	Fluid increase USI: 7.2→7→8.3 IDO: 9→8.9→10.8 Fluid decrease USI: 7.2→7→6.3 IDO: 9→8.9→7.7	No. of wetting episodes Fluid increase USI: 1.6→0.8→0.7 IDO: 0.9→0.6→1.1 Fluid decrease USI: 1.6→0.8→0.5 IDO: 0.9→0.6→0.5 (P = 0.006)		USI & IDO Decreasing fluid intake showed significant improvement compare with baseline week (P < 0.003 each)	In the IDO group, decreasing fluid intake significantly decreased voiding frequency, urgency, and wetting episodes while improved quality of life. In the USI group, there was significant decrease in wetting episodes when fluid intake was decreased.
Tomlinson et al. (1999) [33]	- Decrease their dietary caffeine intake: gradually replacing caffeinated beverages with non-caffeinated ones - Achieve fluid intake of 1,800–2,400 mL/day	Baseline, 4 wk after baseline		Voiding interval 2.41→2.38 Frequency episodes/day 9.96→10.08	Episodes of urine loss 2.6→1.68 (P = 0.0744)			The most frequently recommended intervention was caffeine restriction and increasing fluid intake.

UI, urinary incontinence; QoL, quality of life; E, experimental; C, control; CP, caffeinated period; DP, decaffeinated period; ICIQ-OAB (QoL), international consultation on incontinence-overactive bladder module (quality of life); IPSS, International Prostate Symptom Score; N-QoL, nocturia quality of life questionnaire; CBT, cognitive behavioral therapy; IDO, idiopathic detrusor overactivity; USI, urodynamic stress incontinence.

[a)]Median (interquartile range).

Nocturia

Two studies reported this outcome. Wells et al. [27] measured nocturia with an international consultation on the incontinence-overactive bladder module (ICIQ-OAB) score. In the decaffeinated period, nocturia symptoms improved. Kyoda et al. [31] assessed nighttime frequency and episodes of nocturia for one day and found significant improvement in the intervention group.

Quality of life

QoL was reported by 5 studies, and all studies showed better QoL scores in the intervention group. However, QoL was evaluated by different measurements among studies and only 2 found a statistically significant improvement [31,32].

DISCUSSION

This systematic review was conducted to assess the effectiveness of interventions for fluid and/or caffeine intake modification in adults with OAB. The main finding suggests caffeine intake restriction as a priority in managing OAB symptoms because all outcome variables improved, and reducing fluid intake was more effective than increasing it. However, most results were not statistically significant. Regarding applying caffeine and fluid modification interventions to OAB adults, decreasing caffeine and fluid intake was more effective for improving urinary frequency, urgency, UI, and QoL.

Regarding the effectiveness of decreasing caffeine intake, Kosilov et al. [34] found differences in daytime and nighttime urinary frequency, urgency, and UI episodes between older adults who consumed more than 300 mg of caffeine per day as tea or coffee and those who consumed less than 300 mg per day [34]. It was also found that the United States women whose caffeine intake was more than 204 mg per day were more likely to have UI [35]. Among the studies included in this research, caffeine was mostly consumed as a beverage (e.g., coffee, tea, and soft drinks) except in one where it was also consumed in the form of chocolates and medications. Most included studies that reduced caffeine intake also used the method of replacing caffeine with decaffeinated fluids to restrict the intake. Also, other previous studies often controlled caffeine in beverages [34,35], which means that the exact amount was not measured because caffeine contained in other foods or drugs was not included. Moreover, since most included studies measured caffeine intake by self-reporting, a reporting error is possible. Therefore, accurate information and guidelines on caffeine, including beverages and foods, are needed to modify caffeine intake.

This review also found that when fluid intake was decreased, OAB symptoms were relieved [28,31,32]. This result is consistent with several previous studies that showed fluid reduction was more effective [20,36]. However, excessive reduction of fluid intake can cause dehydration, and hence, it negatively impacts OAB symptoms [37]. Inadequate hydration status may critically affect older adults and results in dehydration, hypotension, and constipation [38]. Therefore, maintaining the appropriate fluid intake is important but there is no exact guideline for OAB adults. Previous studies also suggested that in the case of polydipsia, a gradual reduction of total daily fluid was needed by total of 1.5–2 L per day for adult women with OAB symptoms [39]. Another study suggested that restricting fluid intake to 6 to 8 glasses of water per day was effective in relieving OAB symptoms [40]. Moreover, in this review, the participants might not report the exact amount of fluid because some foods such as fruits or soup also contained fluid but it is hard to measure. Therefore, future studies should identify the appropriate amount of fluid intake for older adults with OAB symptoms and consider a suitable method for accurate measuring of fluid intake.

Among the outcome variables, UI was evaluated by 6 studies, but only 2 identified statistically significant results. Kincade et al. [30] found that the amount of urine lost was decreased in the experimental group after the intervention, especially for women who had 9 or more episodes of UI per day. Swithinbank et al. [32] found that increased fluid intake improved SUI symptoms, while decreased fluid intake was associated with improvement in both SUI and IDO symptoms, especially so for SUI. There are several UI types, such as stress, urge, and mixed. The symptoms of each UI type are different, but most studies included in this review did not distinguish between them. Swithinbank et al. [32] analyzed the results by dividing them into SUI and IDO groups, but the remaining studies included all types of UI or only urge UI.

Since the symptoms of each UI type are different, interventions should be changed accordingly [41]. However, possibly because the interventions were applied collectively and the results were not statistically significant. Moreover, according to previous studies, fluid intake may not influence an incident rate of UI, but increased caffeine intake was likely to increase the number of urge UI episodes. Hence, there was no need to reduce fluid intake to control UI, but reducing caffeine was helpful [42,43]. Moreover, the National Institute for Health and Care Excellence guideline suggested that women with UI could

modify their fluid intake as high or low, but it did not indicate the applicable methods for each subtype of UI in detail [44]. Therefore, more studies should be conducted to identify the exact intake of fluid and caffeine by UI types.

This study has several limitations. First, there is a lack of the experimental studies required for better evaluation of lifestyle modification and other interventions for OAB symptoms. Only 8 intervention studies were selected, indicating that a small number of interventional studies has been conducted. Moreover, only 2 were published within the last 10 years. This result is opposed to the study of Park and Kim [45] that the number of nonpharmaceutical intervention research studies was increasing. It is because this review only included studies with fluid and caffeine modification interventions among various nonpharmaceutical interventions such as education, acupuncture, or exercise. Moreover, recent studies have provided mixed interventions of pharmacological and nonpharmacological interventions rather than solely modifying fluid and/or caffeine intake [46,47]. Furthermore, there are other behavioral therapies, such as PFMT, bladder training, lifestyle modifications, constipation management, and weight control [39], making various kinds of experimental studies. There is a need to confirm whether lifestyle modifications that are easily accessible, such as fluid and caffeine modifications, can be as effective as other interventions for better OAB therapy. This is because feasibility, adherence, and sustainability that result from accessibility should be considered as a part of the criteria for the optimal intervention. Therefore, further lifestyle modification intervention trials need to be conducted.

Second, it cannot be guaranteed whether the results of the included studies were directly affected by fluid and/or caffeine modifications. More than half of them included fluid or caffeine modification as a part of their whole intervention. Bryant et al. [26], for example, provided education on caffeine reduction and bladder training. Kincade et al. [30] conducted studies with interventions involving individualized counseling that included self-monitoring techniques about caffeine consumption and fluid intake, and PFMT. In the study by Kyoda et al. [31], fluid and caffeine modifications were part of their CBT, and Tomlinson et al. [33] provided self-monitoring interventions such as behavioral therapy, which included reducing caffeine and increasing water intake. It indicates that the results may not be derived from the effects of fluid or caffeine modifications, but rather from the effects of other interventions provided along with them. Therefore, the pure effects of fluid or caffeine intake should be identified by further studies.

Third, the results are based only on short-term outcomes. Most selected studies measure the outcome variables after 4 to 6 weeks from the baseline, except for one [29], which has a 6-month follow-up. Modifying one's behavior requires time-consuming effort, such as the continuous interest of healthcare professionals and the willingness of people with OAB to continue interventions longer term [48]. Therefore, further studies should identify the long-term effects of fluid and caffeine intake modification.

Finally, overall RoB was high because of missing outcome data. RoB 2.0 generally judges the overall RoB as corresponding to the highest RoB [24]. Three RCTs were at high risk of overall bias because they had high risk in the missing outcome data domain. In this domain, it is first checked whether the data for the outcome is available for all or almost all and participants are randomized. If not, it is examined whether there is evidence for not causing bias due to dropouts and if that depends on the true value [24]. Several studies included in this review had different rates and reasons for dropout data, which may over or underestimate the effects of interventions [49]. For example, Bryant et al. [26] presented the reason for withdrawal, but not a statistical method for how they dealt with the dropout data. Dowd et al. [28] had a 45% dropout rate and included 55% for analysis, which may have caused bias. Swithinbank et al. [32] had 15 dropouts and 69 women completed the study, but there was no reason given for their dropping out. The reason for dropouts should be described, and statistical analysis that can correct this should be used when analyzing data.

In conclusion, this review confirmed the effectiveness of fluid and/or caffeine intake modifications for improving OAB symptoms in adults. Since fluid and caffeine modifications are effective, they can be included in OAB interventions. Further research is necessary to identify the long-term effects and perform further analysis such as meta-analysis.

SUPPLEMENTARY MATERIAL

Supplementary Material 1 can be found via https://doi.org/10.5213/inj.2346014.007.
Supplementary Material 1. Searching strategy

AUTHOR CONTRIBUTION STATEMENT

· Conceptualization: *JP, SL*
· Data curation: *JP, HL, YK, SL*

· Formal analysis: *JP, HL, YK, SL*
· Funding acquisition: *JP*
· Methodology: *JP, HL, YK, CN, SW, SL*
· Project administration: *JP, HL, YK, SL*
· Visualization: *JP, SL*
· Writing - original draft: *JP, CN, SW, SL*
· Writing - review & editing: *JP, HL, YK, CN, SW, SL*

ORCID

Jeongok Park	0000-0003-4978-817X
Hyojin Lee	0000-0003-0519-4548
Youngkyung Kim	0000-0002-3696-5416
Christine Norton	0000-0003-2259-0948
Sue Woodward	0000-0001-5390-7253
Sejeong Lee	0000-0003-0911-4613

REFERENCES

1. D'Ancona C, Haylen B, Oelke M, Abranches-Monteiro L, Arnold E, Goldman H, et al. The International Continence Society (ICS) report on the terminology for adult male lower urinary tract and pelvic floor symptoms and dysfunction. Neurourol Urodyn 2019;38:433-77.
2. Chuang YC, Liu SP, Lee KS, Liao L, Wang J, Yoo TK, et al. Prevalence of overactive bladder in China, Taiwan and South Korea: results from a cross-sectional, population-based study. Low Urin Tract Symptoms 2019;11:48-55.
3. Lee YS, Lee KS, Jung JH, Han DH, Oh SJ, Seo JT, et al. Prevalence of overactive bladder, urinary incontinence, and lower urinary tract symptoms: results of Korean EPIC study. World J Urol 2011;29:185-90.
4. Coyne KS, Sexton CC, Bell JA, Thompson CL, Dmochowski R, Bavendam T, et al. The prevalence of lower urinary tract symptoms (LUTS) and overactive bladder (OAB) by racial/ethnic group and age: results from OAB-POLL. Neurourol Urodyn 2013;32:230-7.
5. Przydacz M, Golabek T, Dudek P, Lipinski M, Chlosta P. Prevalence and bother of lower urinary tract symptoms and overactive bladder in Poland, an Eastern European Study. Sci Rep 2020;10:19819.
6. Kinsey D, Pretorius S, Glover L, Alexander T. The psychological impact of overactive bladder: a systematic review. J Health Psychol 2016;21:69-81.
7. Melotti IGR, Juliato CRT, Tanaka M, Riccetto CLZ. Severe depression and anxiety in women with overactive bladder. Neurourol Urodyn 2018;37:223-8.
8. Kim SK, Kim SH. The impact of overactive bladder on health-related quality of life in Korea: based on the results of a Korean Community Health Survey. Qual Life Res 2021;30:1017-24.
9. Hakimi S, Aminian E, Alizadeh Charandabi SM, Bastani P, Mohammadi M. Risk factors of overactive bladder syndrome and its relation to sexual function in menopausal women. Urologia 2018;85:10-4.
10. Juliato CRT, Melotti IGR, Junior LCS, Britto LGO, Riccetto CLZ. Does the severity of overactive bladder symptoms correlate with risk for female sexual dysfunction? J Sex Med 2017;14:904-9.
11. Rapariz M, Mora AM, Roset M. Impact of overactive bladder symptoms on work activity: the ACTIVHA study. Actas Urol Esp (Engl Ed) 2018;42:176-84.
12. Ge TJ, Vetter J, Lai HH. Sleep disturbance and fatigue are associated with more severe urinary incontinence and overactive bladder symptoms. Urology 2017;109:67-73.
13. Przydacz M, Golabek T, Dudek P, Skalski M, Sobanski J, Klasa K, et al. Overactive bladder symptoms negatively affect sleep quality of patients with depression. Int Neurourol J 2021;25:59-68.
14. Lightner DJ, Gomelsky A, Souter L, Vasavada SP. Diagnosis and treatment of overactive bladder (non-neurogenic) in adults: AUA/SUFU Guideline Amendment 2019. J Urol 2019;202:558-63.
15. Willis-Gray MG, Dieter AA, Geller EJ. Evaluation and management of overactive bladder: strategies for optimizing care. Res Rep Urol 2016;8:113-22.
16. Vouri SM, Kebodeaux CD, Stranges PM, Teshome BF. Adverse events and treatment discontinuations of antimuscarinics for the treatment of overactive bladder in older adults: a systematic review and meta-analysis. Arch Gerontol Geriatr 2017;69:77-96.
17. Shaw C, Wagg A. Overactive bladder in frail older adults. Drugs Aging 2020;37:559-65.
18. Cayir G, Kizilkaya Beji N. The effect of a counseling and training program on the treatment of women with overactive bladder. Psychol Health Med 2022;27:1726-38.
19. Chin KS, Rose GE, Ervin CF, Ong TJ, Whishaw DM, Bower WF. Does successful treatment of overactive bladder improve co-morbidities in patients with nocturia? Australas J Ageing 2019;38:242-8.
20. Hashim H, Abrams P. How should patients with an overactive bladder manipulate their fluid intake? BJU Int 2008;102:62-6.
21. Bradley CS, Erickson BA, Messersmith EE, Pelletier-Cameron A, Lai HH, Kreder KJ, et al. Evidence of the impact of diet, fluid intake, caffeine, alcohol and tobacco on lower urinary tract symptoms: a systematic review. J Urol 2017;198:1010-20.
22. Robinson D, Hanna-Mitchell A, Rantell A, Thiagamoorthy G, Car-

dozo L. Are we justified in suggesting change to caffeine, alcohol, and carbonated drink intake in lower urinary tract disease? Report from the ICI-RS 2015. Neurourol Urodyn 2017;36:876-81.
23. Miller CJ, Smith SN, Pugatch M. Experimental and quasi-experimental designs in implementation research. Psychiatry Res 2020 Jan;283:112452 [Epub]. DOI: 10.1016/j.psychres.2019.06.027.
24. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ 2019;366:l4898.
25. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ 2016;355:i4919.
26. Bryant CM, Dowell CJ, Fairbrother G. Caffeine reduction education to improve urinary symptoms. Br J Nurs 2002;11:560-5.
27. Wells MJ, Jamieson K, Markham TC, Green SM, Fader MJ. The effect of caffeinated versus decaffeinated drinks on overactive bladder: a double-blind, randomized, crossover study. J Wound Ostomy Continence Nurs 2014;41:371-8.
28. Dowd TT, Campbell JM, Jones JA. Fluid intake and urinary incontinence in older community-dwelling women. J Community Health Nurs 1996;13:179-86.
29. Spigt M, van Schayck O, Knipschild P, Westerterp K, van de Beek C, van Kerrebroeck P, et al. Is it possible to improve elderly male bladder function by having them drink more water? A randomized trial of effects of increased fluid intake/urine output on male lower urinary tract function. Urology 2006;68:1031-6.
30. Kincade JE, Dougherty MC, Carlson JR, Hunter GS, Busby-Whitehead J. Randomized clinical trial of efficacy of self-monitoring techniques to treat urinary incontinence in women. Neurourol Urodyn 2007;26:507-11.
31. Kyoda Y, Okada M, Kato R, Matsuki M, Ito N, Takahashi A, et al. Does cognitive behavioral therapy using a self-check sheet improve night-time frequency in patients with nocturia? Results of a multicenter randomized controlled trial. Int J Urol 2021;28:444-9.
32. Swithinbank L, Hashim H, Abrams P. The effect of fluid intake on urinary symptoms in women. J Urol 2005;174:187-9.
33. Tomlinson BU, Dougherty MC, Pendergast JF, Boyington AR, Coffman MA, Pickens SM. Dietary caffeine, fluid intake and urinary incontinence in older rural women. Int Urogynecol J Pelvic Floor Dysfunct 1999;10:22-8.
34. Kosilov KV, Loparev SA, Ivanovskaya MA, Kosilova LV. Caffeine as a Probable Factor for Increased Risk of OAB Development in Elderly People. Curr Urol 2016;9:124-31.
35. Gleason JL, Richter HE, Redden DT, Goode PS, Burgio KL, Markland AD. Caffeine and urinary incontinence in US women. Int Urogynecol J 2013;24:295-302.
36. Callan L, Thompson DL, Netsch D. Does increasing or decreasing the daily intake of water/fluid by adults affect overactive bladder symptoms? J Wound Ostomy Continence Nurs 2015;42:614-20.
37. Hashim H, Al Mousa R. Management of fluid intake in patients with overactive bladder. Curr Urol Rep 2009;10:428-33.
38. Karon BS. Acute-care testing at the point of care: now and in the future. MLO Med Lab Obs 2009;41:22, 24-6.
39. Raju R, Linder BJ. Evaluation and Treatment of Overactive Bladder in Women. Mayo Clin Proc 2020;95:370-7.
40. Hutchinson A, Nesbitt A, Joshi A, Clubb A, Perera M. Overactive bladder syndrome: management and treatment options. Aust J Gen Pract 2020;49:593-8.
41. Roberts K, Mahajan S. Management of urgency and mixed urinary incontinence. Clin Obstet Gynecol 2021;64:306-13.
42. Jura YH, Townsend MK, Curhan GC, Resnick NM, Grodstein F. Caffeine intake, and the risk of stress, urgency and mixed urinary incontinence. J Urol 2011;185:1775-80.
43. Townsend MK, Jura YH, Curhan GC, Resnick NM, Grodstein F. Fluid intake and risk of stress, urgency, and mixed urinary incontinence. Am J Obstet Gynecol 2011;205:73.e1-6.
44. National Institute for Health and Care Excellence. Urinary incontinence and pelvic organ prolapse in women: management [Internet]. London: NICE guideline; 2019 [cited 2022 Aug 5]. Available from: https://www.nice.org.uk/guidance/ng123.
45. Park J, Kim N. Effects of non-pharmacological interventions designed for adults with overactive bladder syndrome: a systematic literature review. Korean J Adult Nurs 2020;32:341-53.
46. Burgio KL, Kraus SR, Johnson TM 2nd, Markland AD, Vaughan CP, Li P, et al. Effectiveness of combined behavioral and drug therapy for overactive bladder symptoms in men: a randomized clinical trial. JAMA Intern Med 2020;180:411-9.
47. Funada S, Watanabe N, Goto T, Negoro H, Akamatsu S, Uozumi R, et al. Clinical feasibility and acceptability of adding cognitive behavioral therapy to pharmacotherapy for drug-resistant overactive bladder in women: a single-arm pilot study. Low Urin Tract Symptoms 2021;13:69-78.
48. Wyman JF, Burgio KL, Newman DK. Practical aspects of lifestyle modifications and behavioural interventions in the treatment of overactive bladder and urgency urinary incontinence. Int J Clin Pract 2009;63:1177-91.
49. Bell ML, Kenward MG, Fairclough DL, Horton NJ. Differential dropout and bias in randomised controlled trials: when it matters and when it may not. BMJ 2013;346:e8668.