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REVIEW ARTICLE

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What do we really know about the role of caffeine on urinary tract symptoms? A scoping review on caffeine consumption and lower urinary tract symptoms in adults

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Abstract

Aims: The purpose of this scoping review was to map out the existing literature on caffeine intake and lower urinary tract symptoms (LUTS) in adults.

Methods: In this scoping review, we searched for all studies available until June 2019 in MEDLINE, Embase, CINAHL, Cochrane Central Register, PsycINFO, LILACS, LiSSa, Web of Science, and Joanna Briggs Institute electronic databases, in addition to a hand search of the bibliographies of all relevant articles and a gray literature search. Both intervention studies on the effects of caffeine reduction in adults with LUTS and observational studies on the association between caffeine intake and LUTS-related outcomes in adults were included and assessed for methodological quality by two independent reviewers.

Results: Fourteen intervention and 12 observational studies were included. Overall, there was a decrease in urgency episodes (level of evidence 2, grade of recommendation B) and nocturnal enuresis episodes (4, C) with caffeine reduction. Observational studies reported an unclear association between caffeine intake and LUTS-related outcomes. Most importantly, this present review highlighted high heterogeneity in the studied populations, caffeine measures, and reported outcomes. There was also unknown or high risk of bias in most identified studies.

Conclusions: Caffeine reduction appears to reduce LUTS. Future studies on caffeine reduction interventions should target populations with urgency and urge urinary incontinence, which show the most promising results, and include valid and reliable measures of caffeine intake and LUTS. Finally, future studies should also use reporting guidelines to ensure lower risk of bias.

KEYWORDS

caffeine, conservative treatment, lower urinary tract symptoms, scoping review

1 | INTRODUCTION

Lower urinary tract symptoms (LUTS) such as urgency, nocturia, increased urinary frequency and urinary incontinence (UI) of all types are highly prevalent with up to 47.9% of adult men and 52.5% of adult women reporting such symptoms "often" or more.[1] These symptoms can be very distressing and greatly alter function and quality of life.[2-4] Furthermore, they can lead to isolation, decreased levels of physical activity and social participation.[2,5]

Conservative management is considered the first-line treatment option for LUTS.[6] Guidelines on conservative management usually include lifestyle interventions, such as caffeine reduction.[6] Yet, for some people, avoiding caffeinated products can impose a heavy toll on their quality of life and be difficult to achieve.[7] Moreover, the systematic review on which are based current guidelines still hold very limited evidence supporting caffeine reduction benefits.[8] As this 2012 Cochrane review only considered randomized controlled trials (RCTs) or quasi-randomized trials, a more inclusive review would allow for a wider understanding of current evidence. Indeed, non-randomized designs can provide highly useful evidence to answer healthcare questions by complementing and further advancing RCT data.[9] In addition, existing reviews on observational studies did not specifically target adults seeking care for LUTS, but rather included studies on the association between caffeine intake and LUTS incidence among general populations or animal models.[10-13] To bridge this gap, we conducted a scoping review to map out all existing literature on the role of caffeine on adults with LUTS.

2 | METHODS

This critical systematic scoping review followed the methodological framework proposed by Arksey and O'Malley,[14,15] with further guidance of the Joanna Briggs Institute[16] and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for scoping reviews.[17] It was conducted by an interdisciplinary team gathering expertize in clinical nutrition (NP, IR), urinary incontinence assessment (LC, ML), conservative treatment of LUTS (CD, MM, and MLB) and systematic reviews (CD, MM, NP, MLB).

2.1 | Information sources and search strategy

We searched the following electronic databases until June 2019: MEDLINE, Embase, CINAHL, Cochrane Central Register, PsycINFO, LILACS, LiSSa, Web of Science and the Joanna Briggs Institute Database. We used the search terms "urgency", "enuresis", "urinary incontinence" and related terms, combined with "caffeine" and related terms through Boolean logic. There were no restrictions based on language or publication year.

Additionally, we conducted a hand search of the reference lists of all relevant articles and a search of ProQuest, MedNar, OpenGrey, Google Scholar (first 300 entries)[18] and the local gray literature catalog Germain. The MEDLINE and CINAHL search strategies are presented in Appendix S1 (additional search strategies available upon request).

2.2 | Study selection process

As scoping reviews aim to be as comprehensive as possible,[14,15] we included both intervention studies on the effects of caffeine reduction on LUTS (either as unique interventions or as part of multimodal programs), and observational studies on the association between caffeine intake and LUTS. Eligible studies: (a) presented data involving adult men or women experiencing LUTS or with a LUTS-related diagnosis; (b) included an assessment of caffeine exposure or an intervention involving changes in caffeine intakes; and (c) included outcomes specifically related to LUTS (ie, number of urgency episodes, number of nocturia episodes, urinary frequency, severity of all types of UI) (detailed in Appendix S2). Studies were screened through a two-step process (titles/abstracts, full-text) performed by two independent reviewers (MLB, YH). Both reviewers received study selection training by experimented researchers (CD, NP).

2.3 | Data items and data collection process

Data were extracted using a modified version of the Cochrane Incontinence group data extraction form (Appendix S3), specific to study type (intervention/observational). Articles were screened for (a) study characteristics (authors, year, title, journal, language, funding source); (b) study design (study objectives, study type, follow-up length); (c) study sample and setting (country, inclusion/exclusion criteria, demographics of the sample, measurements of urinary symptoms and caffeine intake, LUTS description); (d) participant flow and attrition (number of recruited and randomized participants, withdrawals, drop-outs); (e) details of the intervention or exposition (ie, intervention duration, healthcare professionals involved), and (f) reported outcomes with their different endpoints. Data extraction was conducted independently by two separate reviewers (MLB, IR). All discrepancies were resolved by consensus or through the involvement of a third-party (CD, NP).

2.4 | Methodological quality appraisal

Both intervention and observational studies were assessed for methodological quality by two independent reviewers (MLB, IR) using the Mixed Methods Appraisal Tool (MMAT), a validated and reliable tool that offers criteria specific to each study design, including quantitative and qualitative designs.[19,20] MMAT scores are largely used for assessing health-related literature.[21,22] Disagreements were resolved by consensus or involvement of a third-party (CD, NP). No study was excluded based on MMAT scores.

2.5 | Data synthesis

We conducted a narrative synthesis of the characteristics and reported outcomes of the included studies, grouped by study type (intervention/observational).[23] We then looked for patterns within and across groups to explore factors that might explain similarities or differences in direction and effect size across included studies. We performed sensitivity analyses by exploring the results with and without studies with at least one high risk MMAT item.[19] When relevant, the level of evidence and the grade of recommendation were determined using the Oxford scale.[24] The Oxford scale has been selected to facilitate comparison with the ICI.[25] The selected intervention studies were also assessed to determine their suitability for data pooling to conduct meta-analysis.

3 | RESULTS

3.1 | Literature search

We identified 1992 records from electronic databases and additional hand searches. Of these, 1786 were not eligible based on the title/abstract and 178 based on the full-text. A total of 14 intervention and 12 observational studies, and their companion papers were included (Figure 1). All were published in English between 1984 and 2018. Their characteristics are summarized in Tables 1 and 2.

3.2 | Intervention studies on the effects of caffeine reduction

3.2.1 | Characteristics of the studies

Among the 14 intervention studies, eight were RCTs,[26-34] six were quasi-experimental studies, including four with a pre-post design[35-38] and two were interrupted time series.[39,40]

Nine studies included women participants only, four included both men and women and one did not report any sex data. Study populations presented diverse types of LUTS: urgency (3/14; 21%),[26,27,29,34] nocturnal enuresis (1/14; 7%),[39] unspecified UI (6/14; 43%),[28,30,31,36,37,40] or multiple LUTS (4/14; 29%).[32,33,35,38]

Measures of caffeine intake were heterogeneous with 6/14 (43%) studies not reporting specific measurement methods.[32-34,36,37,39] Other studies used coffee or caffeine diaries covering periods from 1 day[26,27] to 13 weeks.[40] There was also heterogeneity in LUTS reporting, with 3/14 (21%) using unspecified tools[29,30,36] and 2/14 (14%) using nonvalidated or informal tools, such as staff reports of pad or bed wetting.[39,40] Validated tools included bladder diaries covering periods from 1 day[26,27] to 4 weeks,[33] pad tests[31,33] and various standardized questionnaires such as the International Consultation on Incontinence Questionnaire Overactive Bladder Module (Table 1).[31,34,38]

Eight studies reported the effects of caffeine reduction alone[26-29,33-35,39,40] while six reported the effects of multimodal interventions including caffeine reduction.[30-32,36-38] None of the studies on caffeine reduction alone (0/8) were deemed at "low risk" of bias in all five MMAT categories and 5/8 (63%)[26-28,30,33,34] had at least one item deemed at "high risk". More specifically, blinding of outcome assessors was deemed at low risk for only 1/8 (13%) of the studies.[34] Randomization and complete outcome reporting were both at low risk for only 3/8 (38%) (Table 3).

3.2.2 | Results of intervention studies focusing on the effects of caffeine reduction alone

Most frequently reported outcomes were UI episodes (n = 7) and urinary frequency (n = 4). For both, results were inconsistent across studies. For UI episodes, 2/7 studies reported that reducing caffeine improved symptoms,[39,40] 2/7 found no significant effect,[28,33] and 3/7 studies reported beneficial trends while not reaching statistical significance or no improvement.[26,27,35] For urinary frequency, 2/4 studies reported improvement of symptoms with caffeine reduction,[26,27,34] while 2/4 reported no significant effect.[29,33] No data pooling was possible among the intervention studies due to incomplete or heterogeneous data reporting (ie, report of means without standard deviations, report of medians only). This prevented meta-analyses for any outcome of interest.

Results were the most consistent for urgency episodes (n = 3) and nocturnal enuresis episodes (n = 2). For

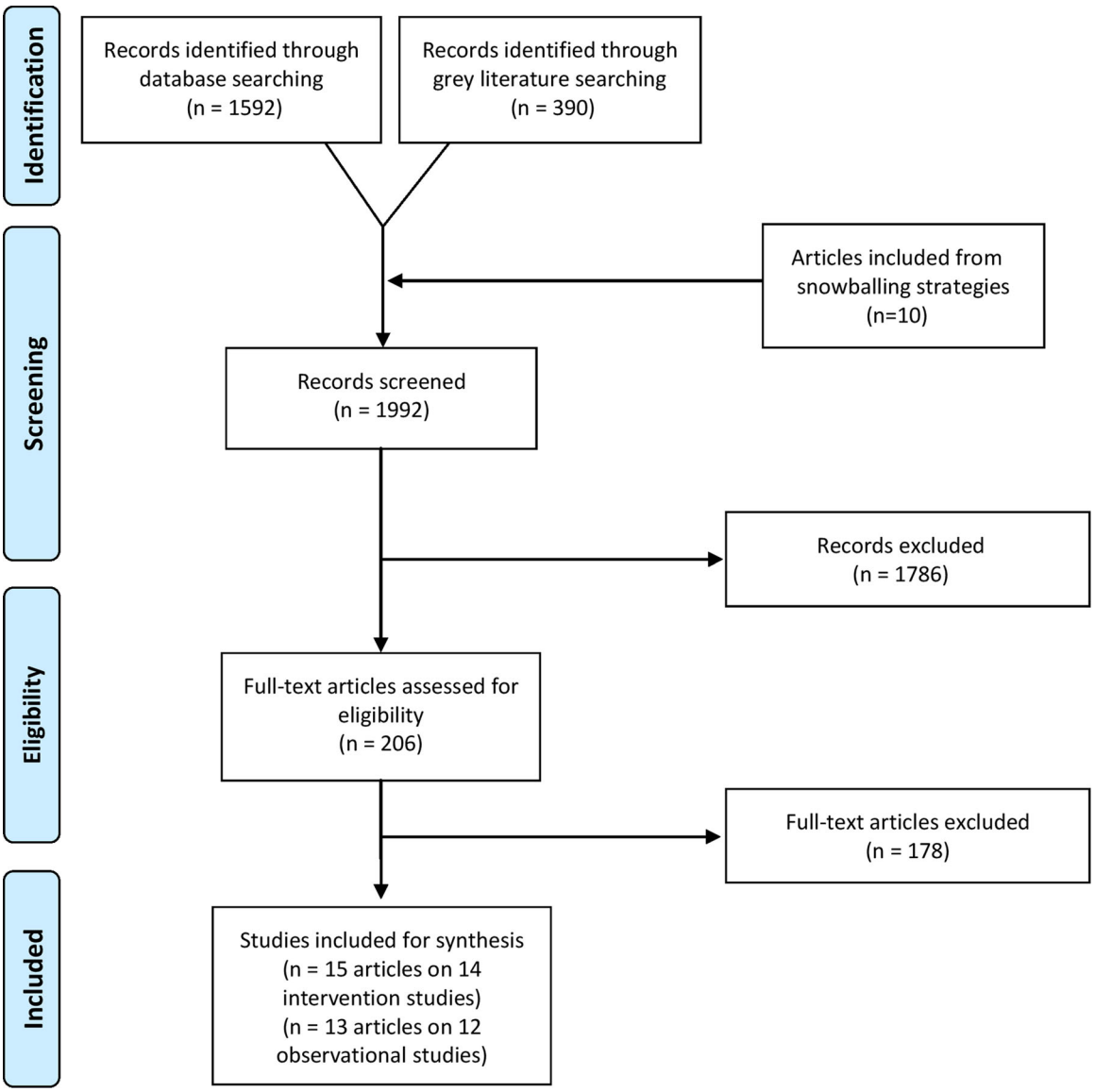

FIGURE 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of study selection

urgency episodes, two studies reported symptom improvement with caffeine reduction.[26,27,34] Yet, they were both deemed at "high risk" of bias[26,27,34] and one had a small sample size (n = 15) and did not report any measure of caffeine intake.[34] The third study did not report any changes with caffeine reduction.[33] For nocturnal enuresis episodes, both studies reported symptom improvement with caffeine reduction.[39,40] Again, they were both deemed at high risk of bias.[39,40] In addition, one was an interrupted time series with a small sample size (n = 18)[40] and the other did not report any measure of caffeine intake.[39]

For other LUTS outcomes, namely amount of urine loss (n = 1),[33] symptom severity (n = 2)[29,34] and quality of life (n = 1),[29] results were unclear or insufficient to draw any conclusions. Also, among the eight studies examining the effect of caffeine reduction on LUTS, four had a follow-up period that was longer than 4 weeks.[28,34,39,40] Interestingly, only 1/4 reported no significant effect.[28] The other three reported significant reductions in urgency episodes,[34] urinary frequency,[34] UI episodes,[40] nocturnal enuresis episodes[39,40] and symptom severity.[34]

3.2.3 | Results of multimodal intervention studies

Multimodal interventions included other treatment modalities, such as pelvic muscle exercises, biofeedback, education or counseling (ie, bowel habits, weight control) in addition to caffeine reduction. Although

TABLE 1 Summary of findings of intervention studies on the effects of caffeine reduction on lower urinary tract symptoms in adults

					Reported outcomes							
Reference	**Population**	**Caffeine measures**	**Study design Follow-up length**	**Details of the intervention**	**Urgency episodes**	**Urinary frequency**	**UI episodes**	**Amount of urine loss**	**Nocturnal enuresis episodes**	**Symptoms severity**	**Use of protections**	**Quality of life**
Caffeine reduction interventions												
Bryant et al,[26,27] Australia	95 ♂/♀ Urgency Mean age: 57 y old (community-dwelling)	24 h caffeine diary (in mg)	Randomized controlled trial 4 wk	Control: bladder training only Intervention: bladder training (urgency management, lifestyle modifications) and educational intervention to reduce caffeine intake to less than 100 mg a day	+ (24 h bladder diary)	+ (24 h bladder diary)	? (24 h bladder diary)					
Dowd et al[28, a] United States	58 ♀ Unspecified UI Mean age: 70 y old (community-dwelling)	5-wk diary (coffee only) (in ml)	Randomized controlled trial 5 wk	Control: maintain fluid intake Intervention 1: increase fluid intake Intervention 2: decrease fluid intake			− (5-wk bladder diary)					
Edelstein et al,[39] United States	30 (sex not reported) Nocturnal enuresis No age data reported (psychiatric hospital inpatients)	Not reported	Interrupted time series 17 wk	Baseline: ordinary daily procedure Intervention 1: withdrawal of caffeinated beverages from the hospital living areas and kitchens Intervention 2: withdrawal of caffeinated beverages from the hospital general areas			+ (healthcare staff reports)		+ (healthcare staff reports)			
James et al,[40] Australia	18 ♂/♀ Unspecified UI Mean age: 77 y old (psycho-geriatric unit inpatients)	13-wk caffeine diary (health-care staff) (in cups or glasses)	Interrupted time series 13 wk	Control (caffeine phases): specified amounts of caffeine powder were added to the beverages (70 mg of caffeine per 225 mL cup of coffee and tea) before they were served to the patients Intervention (caffeine-free phases): the same quantity of decaffeinated coffee and tea were served, with no caffeine added			+ (healthcare staff reports)		+ (healthcare staff reports)			

(Continues)

TABLE 1 (Continued)

Reference	Population	Caffeine measures	Study design Follow-up length	Details of the intervention	Reported outcomes							
					Urgency episodes	Urinary frequency	UI episodes	Amount of urine loss	Nocturnal enuresis episodes	Symptoms severity	Use of protections	Quality of life
Omotosho et al,[29] United States	85 ♀ Urgency No age data reported (community-dwelling)	3-d caffeine diary (in mg)	Randomized controlled trial 3 d	Control: review of voiding diary with no counseling to reduce caffeine Intervention: review of voiding diary with counseling to reduce caffeine but maintain total fluid intake		– (3-d bladder diary)				– (unspecified urinary symptom severity question-naire)		– (unspecified quality of life question-naire)
Swithinbank et al,[33,b] United Kingdom	84 ♀ Multiple symptoms Mean age: 55 y old (community-dwelling)	Not reported	Randomized controlled trial 4 wk	Baseline: usual caffeine and fluid intake Intervention 1: caffeine restriction (parameters not described) Intervention 2: caffeine restriction and increased fluid intake Intervention 3: caffeine restriction and decreased fluid intake	– (4-wk bladder diary)	– (4-wk bladder diary)	– (4-wk bladder diary)	– (24 h pad test)				
Tomlinson et al,[35] United States	41 ♀ Multiple symptoms Mean age: 67 y old (community-dwelling)	3-d caffeine diary (in ml)	Pre-Post 2-4 wk	Baseline: usual caffeine and fluid intake Intervention: self-monitoring activities, including reducing caffeine consumption, altering the quantity and timing of fluid intake, reducing excessively long daytime voiding intervals, and changing bowel habits			**?** (3-d bladder diary)					

TABLE 1 (Continued)

Reference	Population	Caffeine measures	Study design Follow-up length	Details of the intervention	Reported outcomes							
					Urgency episodes	Urinary frequency	UI episodes	Amount of urine loss	Nocturnal enuresis episodes	Symptoms severity	Use of protections	Quality of life
Wells et al,[34] United Kingdom	15 ♀ Urgency Mean age: 52 y old (community-dwelling)	Not reported	Randomized controlled trial 8 wk	Control: supply of specific caffeinated tea and coffee products and instructions to consume these products (hidden labels) Intervention: supply of specific decaffeinated tea and coffee products and instructions to consume these products (hidden labels)	+ (3-d bladder diary)	+ (3-d bladder diary)	? (3-d bladder diary)			+ (ICIQ-OAB question-naire)		
Multimodal interventions												
Borrie et al,[30] Canada	421 ♂/♀ Unspecified UI Mean age: 63 y old (community-dwelling)	7-d caffeine diary (in mL)	Randomized controlled trial 25 wk	Control: usual activities Intervention: lifestyle and behavioral interventions, including counseling related to caffeine and fluid intake, pelvic muscle exercises and bladder training, using regular timed voiding			+ (7-d bladder diary)				+ (unspecified question-naire)	
Fried et al,[36] United States	54 ♂/♀ Unspecified UI Mean age: 60 y old (community-dwelling with disabilities)	Not reported	Pre-Post 52 wk	Baseline: usual activities Intervention: pelvic muscle exercises with biofeedback, adjustments in bowel program, caffeine intake, fluid intake, toileting schedules, transfer training, and medications			+ (unspecified bladder diary)					

(Continues)

TABLE 1 (Continued)

Reference	Population	Caffeine measures	Study design Follow-up length	Details of the intervention	Reported outcomes							
					Urgency episodes	Urinary frequency	UI episodes	Amount of urine loss	Nocturnal enuresis episodes	Symptoms severity	Use of protections	Quality of life
Holroyd-Leduc et al,[37] Canada	103 ♀ Unspecified UI Mean age: 63 y old (community-dwelling)	Not reported	Pre-Post 12 wk	Baseline: usual activities Intervention: use of a self-management behavior change tool targeting six modifiable risk factors (pelvic floor muscle strength, caffeine intake, excess weight, constipation, vision and hearing impairment, and smoking)			+ (3-d bladder diary)					
Kincade et al,[31] United States	224 ♀ Unspecified UI Mean age not reported (12.5% aged 18-39, 62.5% aged 40-64, 25% aged over 65) (community-dwelling)	3-d caffeine diary (in mg)	Randomized controlled trial 3 wk	Control: waitlist Intervention: self-monitoring and individualized counseling about caffeine consumption, amount of and timing of fluid intake, voiding frequency, constipation, and teaching of pelvic floor muscle contraction				+ (48 h pad test)				+ (Incontinence Impact questionnaire)
Miller et al,[38,c] United States	35 ♀ Multiple symptoms Mean age: 58 y old (community-dwelling)	3-d caffeine diary (in ounces)	Pre-post 3 wk	Baseline: usual caffeine and fluid intake Intervention 1: elimination of all potentially irritating beverages (including caffeine) Intervention 2: reintroduction of 50% of baseline potentially irritating beverages	+ (urgency0 scale questionnaire)	+ (3-d bladder diary)				+ (OAB-q questionnaire)		

TABLE 1 (Continued)

Reference	Population	Caffeine measures	Study design Follow-up length	Details of the intervention	Reported outcomes Urgency episodes	Urinary frequency	UI episodes	Amount of urine loss	Nocturnal enuresis episodes	Symptoms severity	Use of protections	Quality of life
Schimpf and Miller,[32] United States	62 ♀ Multiple symptoms Mean age: 46 y old (community-dwelling)	Not reported	Randomized controlled trial 25 wk	Control: education on healthy eating Intervention: education on the role of potentially irritating beverages, tips and tricks on how to reduce or eliminate potentially irritating beverages without reducing total intake volume	– (unspecified questionnaire)	? (3-d bladder diary)				? (unspecified questionnaire)		

Note: Reported outcomes: +, significant symptoms improvement reported; ?, unclear effect or only trends reported; –, no significant effect reported.

[a]In this study by Dowd et al,[28] "no [associations] were found between caffeine intake and UI episodes", for both interventions 1 and 2.

[b]In this study by Swithinbank et al,[33] "changing to decaffeinated fluids made no difference in storage lower urinary tract symptoms", for none of the interventions 1, 2, and 3.

[c]In this study by Miller et al,[38] "women reported reduction in symptoms of urge, inability to delay voiding, and bother during both phases", therefore, had significant symptoms improvement for both interventions 1 and 2.

5/6 (83%)[30,31,36-38] studies reported favorable results in terms of symptom improvement, only 1/6 (17%)[36] included secondary analyses aiming to determine if the effect can be attributed to caffeine reduction. In this study, secondary analyses indicated that the beneficial effect of the multimodal intervention on UI episodes was not attributable to caffeine reduction per se.

3.3 | Observational studies

3.3.1 | Characteristics of the studies

Eight of the 12 observational studies were designed as cross-sectional studies or surveys[41-48]; other designs included qualitative (n = 1),[49] case-control (n = 1),[50] longitudinal (n = 1),[51] and case report (n = 1).[52]

Eight studies included women participants only, one included men participants only, two included both men and women and one did not report any sex data. Study populations presented diverse types of LUTS: urgency (3/12; 25%),[39,45,46] nocturnal enuresis (1/12; 8%),[52] unspecified UI (5/12; 42%),[42,43,47,49,51,53] stress UI only (1/12; 8%),[44] or multiple symptoms (2/12; 17%).[48,50]

Measures of caffeine intake were heterogeneous and 3/12 (25%)[41,45,52] studies did not describe their measurement methods. Other studies used either caffeine or fluid diaries covering periods of 2[50] to 3 days[47] or questionnaires about lifestyle,[44] fluids[42,43,46,53] or dietary[48,51] habits. There was also heterogeneity in LUTS reporting, with 4/12 (33%) studies using unspecified tools.[48,51-53] Validated tools included urodynamic testing,[50] bladder diaries,[45,47] pad tests[47] and various standardized questionnaires such as the ICIQ,[44] the Boyarsky symptom score,[41] the American Urological Association Symptom Score,[53] the Incontinence Severity Index,[42,43] and the Patient Perception of Bladder Condition questionnaire (Table 2).[46]

Nine studies reported on the association between caffeine intake and LUTS-related outcomes, eight included statistical associations and one study included a thematic analysis of qualitative data.[31,41-43,48-50,52,53] Three additional studies reported the effect of caffeine intake on the success of LUTS treatment (ie, pharmacologic treatment, pelvic floor muscle training).[44-46] Overall, 3/9 (33%) studies on the association between caffeine intake and LUTS-related outcomes were deemed at "low risk" of bias in all five MMAT[42,43,47,49] and 1/9 (11%) had at least one "high risk" item.[41] More specifically, well-defined and justified outcome measures were found in only 2/8 (25%) cross-sectional studies, and confounding considerations were reported in only 2/8 studies (25%) (Table 3).

TABLE 2 Summary of findings of observational studies reporting on the association between caffeine intake and lower urinary tract symptoms or the impact of caffeine intake on the success of lower urinary tract symptoms treatment in adults

Reference	Population	Study design Follow-up length	Caffeine measures	Reported outcomes					
				Urgency episodes	Urinary frequency	UI episodes	Amount of urine loss	Nocturnal enuresis episodes	Symptoms severity
Association between caffeine intake and lower urinary tract symptoms									
Arya et al,[50] United States	259 ♀ Multiple symptoms Mean age: 51 y old (community-dwelling)	Case-control N/A	48 h caffeine diary (in mg)	+ (urodynamic testing)					
Egilmez,[41] Turkey	100 ♀ Urgency Mean age: 48 y old (community-dwelling)	Cross-sectional N/A	Not reported	− (Boyarsky symptom score)	− (Boyarsky symptom score)				+ (Boyarsky symptom score)
Grajower et al,[53] United States	100 ♂/♀ Unspecified UI Mean age: 47 y old (community-dwelling, with multiple sclerosis)	Cross-sectional N/A	Fluid intake questionnaire (in ml)					? (not reported)	− (American Urological Association Symptom Score)
Herati et al,[48] United States	201 (sex not reported) Multiple symptoms No age data reported (community-dwelling)	Survey N/A	Dietary questionnaire (no units reported)						+ (unspecified questionnaire)
Kincade et al,[47] United States	525 ♀ Unspecified UI Mean age: 55 y old (community-dwelling)	Cross-sectional N/A	3-d caffeine diary (in ounces)			? (3-d bladder diary)	? (48 h pad test)		
Koch,[49] Australia	4 ♂ Unspecified UI Mean age not reported (age range of 48-62) (community-dwelling, with multiple sclerosis-related urinary incontinence)	Qualitative study N/A	Not measured (qualitative study)	+ (qualitative interview)	+ (qualitative interview)				
Mohr & Sharpley,[52] Australia	1 ♀ Enuresis 21 y old (community-dwelling, with mild mental retardation)	Case study 48 wk	Not reported (case study)					+ (not reported)	
Segal,[42] Segal,[43] United States	256 ♀ Unspecified UI Mean age: 53 y old (community-dwelling)	Cross-sectional N/A	Fluid intake questionnaire (in mL)						? (Incontinence Severity Index)

TABLE 2 (Continued)

Reference	Population	Study design Follow-up length	Caffeine measures	Reported outcomes					
				Urgency episodes	Urinary frequency	UI episodes	Amount of urine loss	Nocturnal enuresis episodes	Symptoms severity
Townsend et al,[51] United States	21 564 ♀ Unspecified UI Mean age: 58 y old (community-dwelling)	Prospective longitudinal cohort study 104 wk	Dietary questionnaire (in cups)						– (unspecified questionnaire)
Impact of caffeine intake on the success of lower urinary tract symptoms treatment									
Nystrom et al,[44] Sweden	62 ♀ Stress UI Mean age: 45 y old (community-dwelling)	Cross-sectional N/A	Lifestyle questionnaire (in cups)						+ (ICIQ-UI SF questionnaire)
Schneider et al,[45] Germany	3,766 ♂/♀ Urgency Mean age: 63 y old (community-dwelling)	Cross-sectional N/A	Not reported			- (3-d bladder diary)			
Weissbart et al,[46] United States	442 ♀ Urgency Mean age: 57 y old (community-dwelling)	Cross-sectional N/A	Fluid intake questionnaire (in mL)						– (Patient Perception of Bladder Condition questionnaire)

Note: Reported outcomes: +, significant symptoms improvement reported; ?, unclear effect or only trends reported; –, no significant effect reported.

TABLE 3 Mixed Methods Appraisal Tool (MMAT) scores of included studies

	Reference	Quality appraisal				
Intervention studies						
Quantitative randomized controlled trials		Randomization	Groups characteristics	Outcome data	Blinding	Adherence to intervention
	Borrie et al[30]	✓	✓	X	X	✓
	Bryant et al[26,27]	X	X	X	Can't tell	Can't tell
	Dowd et al[28]	Can't tell	X	X	X	X
	Kincade et al,[31]	✓	✓	✓	Can't tell	✓
	Omotosho et al[29]	Can't tell	✓	✓	Can't tell	✓
	Schimpf and Miller[32]	Can't tell	Can't tell	Can't tell	Can't tell	Can't tell
	Swithinbank et al[33]	Can't tell	✓	✓	X	✓
	Wells et al[34]	✓	Can't tell	X	✓	✓
Quantitative nonrandomized studies		Representative sample	Measurements	Outcome data	Confounders	Intervention/ Exposure
	Edelstein et al[39]	Can't tell	✓	✓	X	X
	Fried et al[36]	✓	X	✓	X	Can't tell
	Holroyd-Leduc et al,[37]	✓	X	✓	X	✓
	James et al[40]	Can't tell	✓	X	✓	✓
	Miller et al[38]	✓	✓	✓	✓	✓
	Tomlinson et al[35]	✓	Can't tell	✓	✓	Can't tell
Observational studies						
Qualitative studies		Qualitative approach	Data collection	Findings	Interpretation	Coherence between sources
	Koch et al[49]	✓	✓	✓	✓	✓
Quantitative nonrandomized studies		Representative sample	Measurements	Outcome data	Confounders	Intervention/ Exposure
	Arya et al[50]	✓	Can't tell	✓	Can't tell	✓
	Egilmez,[41]	✓	Can't tell	✓	X	Can't tell
	Grajower et al[53]	Can't tell	Can't tell	✓	Can't tell	Can't tell
	Kincade et al,[47]	✓	✓	✓	✓	✓
	Nystrom et al[44]	✓	Can't tell	✓	X	Can't tell
	Schneider et al[45]	✓	Can't tell	Can't tell	X	Can't tell
	Townsend et al[51]	✓	✓	Can't tell	✓	✓
	Weissbart et al[46]	✓	Can't tell	✓	Can't tell	✓
Quantitative descriptive studies		Sampling strategy	Representative sample	Measurements	Nonresponse bias risk	Statistical analysis
	Herati et al[48]	Can't tell	✓	Can't tell	Can't tell	Can't tell
	Mohr & Sharpley[52]	✓	✓	Can't tell	✓	✓
	Segal et al,[42] Segal et al,[43]	✓	✓	✓	✓	✓

Note: ✓, the paper adequately responds to the methodological quality criterion; X, the paper does not adequately respond to the methodological quality criterion; Can't tell, the paper does not report appropriate information to answer "Yes" or "No" or reports unclear information related to the methodological quality criterion.

3.3.2 | Results of observational studies reporting on the association between caffeine intake and LUTS

Most frequent LUTS outcomes were symptom severity (n = 5) and urgency episodes (n = 3). For symptom severity, 2/5 studies reported positive associations with caffeine intake,[41,48] including one study presenting one high-risk item,[41] while 2/5 found no association.[51,53] One study found a positive association between caffeine intake and urgency UI severity but not with stress UI severity.[42] Of note, this study was deemed at low

risk of bias for all five MMAT items (Table 3). For urgency episodes, 2/3 studies reported positive associations with caffeine intake[49,50] and 1/3 found no association.[41] Together, results from these seven studies may indicate that caffeine intake has a specific role in urgency symptoms.

For other LUTS outcomes, namely urinary frequency (n = 2), UI episodes (n = 1), amount of urine loss (n = 1), and nocturnal enuresis episodes (n = 2), results were unclear or insufficient, precluding any conclusion.

3.3.3 | Results on the modulating effect of caffeine intake on the success of LUTS treatment

Studies reported inconsistent results. One reported a decrease[44] while another reported no change in symptom severity.[46] A third study reported no change in UI episodes.[45]

4 | DISCUSSION

The present scoping review includes 26 studies, far exceeding previous reviews on the role of caffeine in LUTS, which included three to 10 studies each.[8,13,25,54] A synthesis of this present review's results revealed possible beneficial effects of complete caffeine cessation or a reduction to under 100 mg of caffeine per day (equivalent of one cup of percolated coffee)[26] on urgency episodes (level of evidence 2, grade of recommendation B)[24] and nocturnal enuresis episodes (level 4, grade C).[24] However, both articles reporting on nocturnal enuresis episodes had a psychiatric/psychogeriatric inpatient population, possibly limiting the generalizability of this last recommendation. In addition, few studies presented low risk of bias and many criteria could not be appraised due to the lack of information, underlining the need for high-quality research on this topic. The targeted LUTS were also heterogeneous and measured with various methods. Consequently, no conclusion could be made for several LUTS because of inconsistent or insufficient data.[24]

Similar to these findings, the International Consultation on Incontinence (ICI) published in 2017 a grade B recommendation (level 2) in favor of reducing caffeine to help prevent "UI and related symptoms".[25] However, 3/4 studies reviewed by ICI were cross-sectional and investigated LUTS prevalence with caffeine consumption in urinary continent participants. This review's conclusions were based exclusively on studies investigating men and women, who were already experiencing LUTS. Therefore, the ICI recommendations target the general population with the aim of preventing LUTS, while this review aimed to improve LUTS in patients seeking treatment. Findings of the present scoping review are therefore relevant for clinicians in the field, who are treating patients with LUTS. Its conclusions are hence limited to this specific population.

Previously published systematic reviews on lifestyle interventions for LUTS were restricted to RCTs or quasi-randomized trials, hence limiting the number of studies included. However, these reviews have also indicated that these studies were of poor quality. For example, in a Cochrane review on lifestyle interventions for LUTS,[8] the authors concluded that the studies provided "insufficient reporting to enable an analysis", and therefore no conclusions could be drawn. The present review, while not providing a higher level of evidence for clinical recommendations, offers additional information for analysis through an inclusive approach. Four other reviews focused on observational studies examining the association between caffeine intake and incident UI[10,11] or various LUTS among general populations (including both continent and incontinent participants)[12,13] from a preventive perspective. They found no association with UI incidence,[10,11] or "unclear", "limited", "conflicting" or "mixed" results for various LUTS.[12,13] Yet, one review including studies on both human and animal models concluded that high caffeine doses may have a possible role in two LUTS, namely urinary frequency and urgency episodes—the latter being in line with our conclusions.[13]

Caffeine is generally considered a mild diuretic,[55] with an increased water excreting action, especially for doses above 250 mg.[56] Consequently, while the diuretic effect is less certain for daily consumers due to habituation, caffeine intake could generally accelerate urine production.[7,56] Caffeine and related methylxanthines were also shown to have an additional excitatory effect on the detrusor smooth muscle and lower the sensation threshold of the bladder filling phase.[7,55] These physiological effects support our conclusion regarding the role of caffeine reduction on urgency symptoms. Together, they also suggest that caffeine reduction interventions should primarily target patients with urgency and urge UI, rather than all patients with LUTS. Yet, only 3/14 (21%) of all intervention studies in this review have explicitly targeted patients with these specific symptoms. Future trials may consider consolidating evidence, focusing on patients with these specific LUTS and including validated measures of these symptoms as primary outcomes.

Caffeine measures were highly heterogeneous in the studies, ranging from medical staff reports to diaries of different lengths, and questionnaires. Some of these measures only considered coffee intake while others

TABLE 4 Research gaps and future research recommendations following the PICO framework

PICO framework	Research gaps and future research recommendations
P - Population	Few studies have specifically focused on urgency, polyuria and urge UI patients so far. Yet, in light of our findings and the potential excitatory effect of caffeine on the detrusor smooth muscle, this population could be more receptive to caffeine reduction interventions. Future studies on caffeine reduction interventions or caffeine intake should: Target more specifically patients with urgency, polyuria and urge UI symptoms. To classify accurately the population and describe its symptoms severity, validated tools should be used.[67,68]
I – Intervention/ Exposition	There is currently a high heterogeneity in reported caffeine measures, ranging from non-standardized medical staff reports, to fluid intake diaries of various lengths, to a variety of questionnaires. Some of these measures only consider coffee while others list multiple sources of caffeine from the diet. There is also a lack of standard units of caffeine dosing. Future studies on caffeine reduction interventions or caffeine intake should:
C - Comparison	Include indications and guidance on items containing caffeine, instructions on serving sizes and calculations in relation to body mass, along with a daily self-report consumption log to optimize the exactitude of reporting and accurately capture the patterns and timing of caffeine intake. Some instruments are already being developed for that purpose.[59,61] Validating standardized tools and harmonizing data collection processes across studies would be highly helpful. Retrospectively asking for caffeine intake habits may be subject to recall bias, particularly as individuals are most often unaware of their real caffeine consumption. Additionally, as the half-life of caffeine is 4 to 6 h, acute effects could be different from longer-term effects. There is also possibly a wide variation in consumption patterns across days. Finally, from our results, interventional studies with a follow-up period over 4 wk reported more positive results than studies with shorter follow-up periods. This 4-wk period is commonly used for exposition and washout phases in caffeine-related research. Future studies on caffeine reduction interventions or caffeine intake should: Record patterns in caffeine consumption through a daily self-report consumption log, for more accuracy and since the timing of the intake could be important for LUTS. To account for day-to-day variations and reflect real consumption habits, the data collection tool used should cover a period longer than 24 h. The intervention or exposition period should be of at least 4 wk. Very few studies controlled for total fluid intake in their intervention or exposure. However, this factor could have an important impact on the LUTS of patients. Future studies on caffeine reduction interventions or caffeine intake should: Consider fluid intake as a potential confounder and adjust their analyses or their study protocol accordingly. Few randomized controlled studies had a low risk of bias for randomization and blinding. Few quantitative nonrandomized studies had a low risk of bias for outcome and intervention/exposure measurements and for taking into account potential confounders. Future studies on caffeine reduction interventions or caffeine intake should: Follow adequate randomization strategies and include blinding in their protocol when applicable. Future studies should also use standardized measurement tools, and take into account fluid intake as a potential confounder in their analysis or study protocol. To ensure a general lower risk of bias, reporting guidelines are available for a wide variety of study designs to assist in both conducting and reporting future studies. The CONSORT, the STROBE and the CARE reporting guidelines could be useful for RCTs, observational studies and case reports respectively.
O - Outcomes	There is currently a wide diversity of reported outcomes and measurement tools used to report the different LUTS-related outcomes, not all being standardized and validated. Future studies on caffeine reduction interventions or caffeine intake should: Include valid and reliable measures of the studied LUTS-related outcomes. Some tools already exist and their more consistent use across studies could help to compare and combine results to obtain conclusions that are more robust.

listed multiple caffeine sources from the diet. In addition, intervention studies with more than 4-week follow-up periods were more likely to report symptom improvement than others. Interestingly, 4-week periods are commonly used for both exposition and washout phases in caffeine-related research.[57,58] As the half-life of caffeine is 4 to 6 hours, the timing of intake could also be important in the manifestation of LUTS.[59] Also, assessing

caffeine intake retrospectively might not be accurate due to the recall bias.[59,60] Other difficulties in measuring caffeine intake are the lack of standard units of caffeine dosing and the wide variation in consumption patterns between individuals and between days for a given individual.[59] Guidance on caffeinated items and serving sizes, calculations in relation to body mass and daily self-reporting may then be helpful to optimize the accuracy of reporting.[56,59] Some instruments are already being developed for that purpose, such as the Caffeine Consumption Questionnaire-revised (CCQ-R) or the 24-hour Caffeine Intake Recall (CIR-24).[59,61] Future trials should therefore use validated instruments to measure caffeine intake from all sources, as well as the consumption pattern. Validated instruments will also allow researchers to identify patients who consume caffeine above a certain level, and thus who would be more likely to benefit from caffeine reduction. Additionally, quality appraisal of existing studies revealed that few verified if caffeine reduction led to decreased total fluid intake, a factor known to be associated with various LUTS,[62] such as overactive bladder.[63] Therefore, future trials should also consider measuring fluid intake as a potential confounder. Finally, to improve the overall quality of future studies, researchers should use recognized guidelines such as CONSORT,[64] STROBE,[65] and CARE.[66]

The present scoping review is based on a comprehensive search strategy and rigorous methodology. Yet, the heterogeneity across outcomes and measurement tools, as well as the high-risk bias or "unknown risk of bias" in most studies, limit the robustness of our conclusions. It also prevented any data pooling or meta-analyses. However, this review narrowed the scope of current recommendations on caffeine reduction by taking a symptom-specific approach, hence providing guidance for designing future trials and maximizing the impact and relevance of their findings (Table 4).

5 | CONCLUSION

This scoping review aimed to map out the existing literature on the role of caffeine on LUTS in adults. Current data suggest that caffeine reduction may lead to improvement of urgency symptoms. However, the poor quality of published studies precludes any strong conclusions. Future studies may consider targeting patients with urgency and urge UI and use validated measures of LUTS and caffeine intake as well as reporting guidelines.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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