



Comparative Study of a Novel Machine Learning Augmented Mobile Acoustic Uroflowmetry and Conventional Uroflowmetry: A Systematic Review

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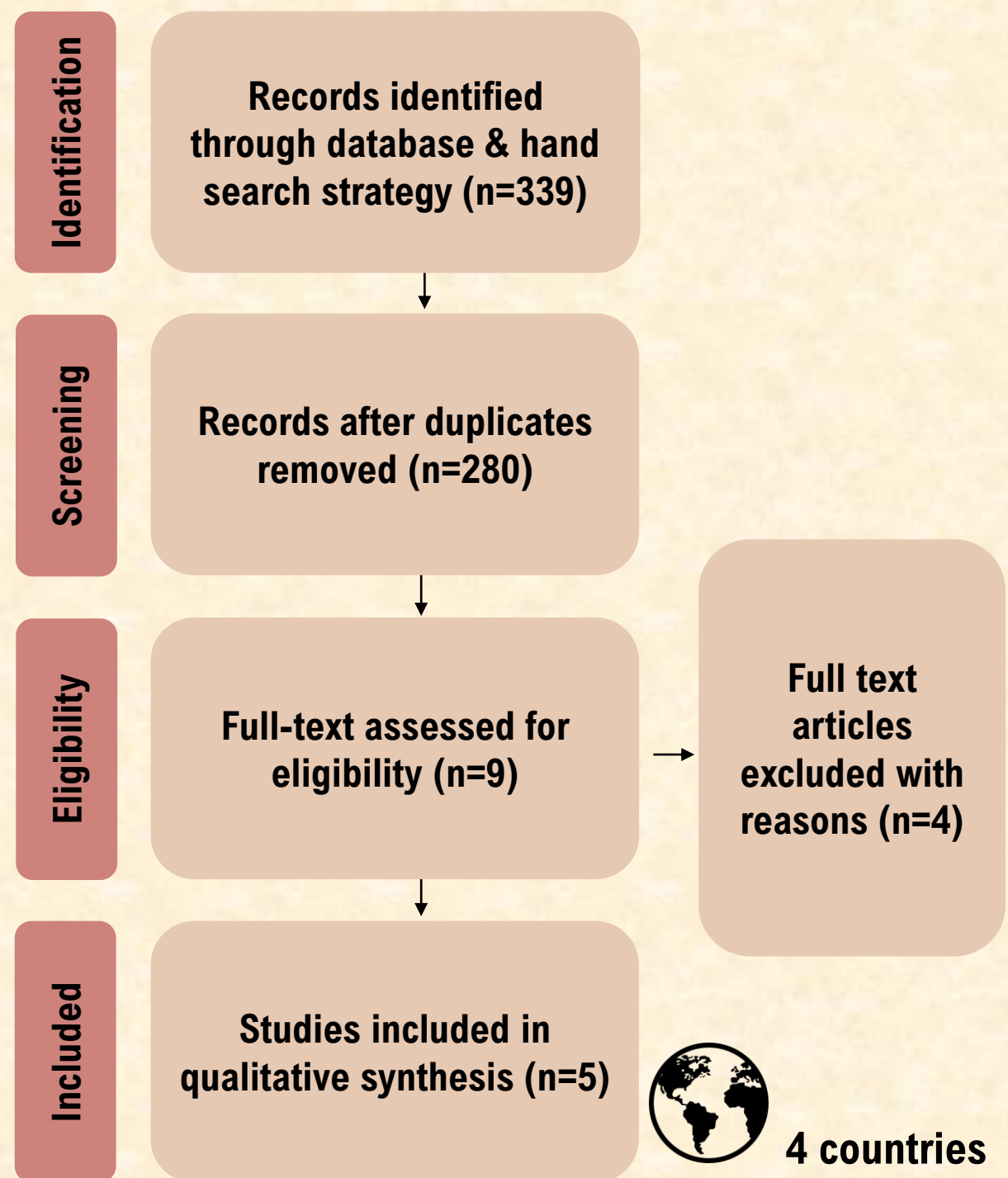
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INTRODUCTION

- Uroflowmetry is a non-invasive technique for determining the volume of urine discharged over a period.
- This enables the assessment of voided volume (voided volume), voiding time, average flow rates (Qavg), and maximum flow rate (Qmax), and aberrant flow patterns.
- Latest uroflowmetry technologies have been developed in response to the need for accessible and portable home devices.
- These advancements include mobile acoustic uroflowmetry (sonouroflowmetry), optical uroflowmetry, and video-based emptying devices.
- No previous systematic reviews are available, a systematic review is conducted to assess the accuracy and reliability of acoustic and traditional uroflowmetry in the hope of enlightening further research in the future.

METHODS

- Medline, Embase, and the Cochrane Central Register of Controlled Trials were used for this analysis.
- Keyword : "(Acoustic uroflowmetry OR Sonouroflowmetry) AND (Conventional uroflowmetry OR Contemporary uroflowmetry) AND (Comparison).
- Limited to English-language publications published between January 2009 - December 2021
- Studies on adult populations who had undergone sonouroflowmetry or conventional uroflowmetry were included. Participants who had undergone both measurements were not excluded.
- Participants with voided volume <100 mL were excluded.
- Outcomes were uroflowmetry parameters, at least one of the following components:
 - 1) voiding volume,
 - 2) voiding time
 - 3) average urine flow rate,
 - 4) maximum urine flow rate.
- Quality assessment using Checklist for Diagnostic Test Accuracy Studies by JBI.



RESULTS & DISCUSSION

- All studies included male participants for the urine flow measurement, with one including pediatric male patients and one including female participants in their study.
- Only one study include pathologic subjects, with the rest testing only normal populations.

Study	Study Design	Country	Setting and Participants	Outcome Measure	Key Findings
Lee et al. 2021	Prospective validation study	Korea	Patients involved n = 112 Male and female subjects aged 20 years or more were divided into two groups, with or without urologic comorbidities	1,2,3,4	<ul style="list-style-type: none"> • Conventional uroflowmetry and acoustic uroflowmetry showed significant correlation across all uroflowmetry parameters in the female population • Average urine flow rate and voided volume across two interventions were found to be very highly correlated in male populations, while maximum flow rate was highly correlated
Helou et al. 2021	Prospective cohort study	Lebanon	Patients involved n = 44 The study comprised male individuals aged 18-65 years old who did not have LUTS or a history of neurological comorbidities	2,3,4	<ul style="list-style-type: none"> • A high correlation (rho = 0.993) on the accuracy of flow rate estimation over time was found between sonouroflowmetry and conventional uroflowmetry • The high error rates for small frame durations in the voiding duration were found from the sonouroflowmetry
Song et al. 2020	Pilot cohort study	USA	Patients involved n = 11 The research included male patients aged 4-18 years.	1,2,3,4	<ul style="list-style-type: none"> • Significant correlation between acoustic uroflowmetry and conventional uroflowmetry among male paediatric patients was found from the following parameters: maximal urine flow rate (r = 0.798, p = .006), voiding time (r = 0.704, p = .023), and voiding volume (r = 0.902, p < .001) • Average urine flow rate was not significantly correlated (r=0.503, p=0.138)
Aslim et al. 2019	Prospective cohort study	Singapore	Patients involved n = 25 Male subjects aged 21-50 years old and having no history of LUTS	1,3	<ul style="list-style-type: none"> • Flow time and duration between sonouroflowmetry and conventional uroflowmetry were found to be strongly correlated (PCC = 0.87) • The voided volume between sonouroflowmetry and conventional uroflowmetry was found to be moderately correlated (PCC = 0.68)
Kohut et al. 2015	Pilot cohort study	USA	Patients involved n = 25 Male subjects aged 18-63 y.o	1,4	<ul style="list-style-type: none"> • A good correlation across voiding volume and maximal flow time was found between uroflowmetry readings and audio-uroflowmetry readings.

1 Voided volume → Two studies reported a moderate correlation, one high correlation

3 Average urine flow rate → Three studies reported a highly significant correlation

2 Voiding time → One study showed significant correlation, two studies did not report significant changes

4 Maximum flow rate → All studies reported a significant correlation

- Female participants were reported to have a significant correlation in all variables of uroflowmetry. These findings might be attributed to the sound production as the sonouroflowmetry depends on the amplitude of sounds produced by the urine. As only one study included female participants, the accuracy and reliability of sonouroflowmetry remain unknown compared to conventional uroflowmetry in female population.
- Additionally, urological conditions such as obstruction in the urinary tract might cause the flow to be reduced. Hence the sound might get diminished.
- Sudden external noise and quality of sounds (i.e., voiding while standing vs voiding while sitting) can contribute to the quality of produced sound.
- Future randomized, controlled, double-arm experimental studies need to be conducted to determine the causal relationship between intervention and outcome, with abilities to control bias present in this study design.
- Focusing on the importance of the diagnostic necessity for female urinary tract symptoms, future clinical trials of sonouroflowmetry for female populations are needed to be conducted (adjustment due to the urination position)

CONCLUSIONS

- Sonouroflowmetry was shown to be a promising alternative to urine flow measurement.
- However, further research with good quality design is necessary to evaluate the practicality of sonouroflowmetry in everyday life.
- Studies in the female population, RCTs, and meta-analyses need to be conducted to determine the actual effect of the intervention on the outcome.

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