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Urination Stimulation Techniques for Collecting Clean Urine Samples in Infants Under One Year: Systematic Review and Meta-Analysis

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ABSTRACT

Aim: To evaluate the efficacy of spontaneous urination stimulation techniques in infants under 1 year to obtain a clean and valid urine sample for analysis.

Methods: Systematic review of randomised clinical trials. The databases consulted were PUBMED, SCOPUS, WEB OF SCIENCE, CINALH and the Virtual Health Library. The risk of bias was assessed via the RoB2 scale. A meta-analysis was performed to analyse the success rate of urine collection for both techniques and the contamination rate of the urine samples.

Results: Seven studies were included in this review. The participants included 1122 infants, of whom a stimulation technique was performed in 667 (the technique of Herreros et al. was performed in 419 infants, and the "Quick-Wee" technique was performed in 248 infants). Success was measured by obtaining a midstream urine sample in less than 5 min. Urination stimulation is effective in obtaining a urine sample, especially at < 6 months of age.

Conclusion: Stimulation of urination in infants is a noninvasive, fast, safe, economic and effective procedure that allows the capture of a valid urine sample in the middle of the stream for analysis.

1 | Introduction

Urinary tract infection (UTI) is a common bacterial infection in childhood [1–3] with a prevalence of 2%–7% [4–9]; however, in infants, according to some studies, it can reach 10.7%–15.4% [10]. The symptoms of UTI in infants tend to be nonspecific (weakness, rejection of feeds, irritability, etc.) with the frequent presence of fever but rarely with urinary symptoms [1, 2, 5, 11] Therefore, urinalysis is recommended for a proper diagnosis [1, 12, 13], especially if the fever is high (> 39°C) and prolonged (> 48 h) [14]. Urine culture is considered the "gold standard" test for the diagnosis of UTI, but in children who lack toilet training,

Abbreviations: AAP, American Academy of Paediatrics; CG, Control Group; FJGM, Francisco Javier Gómez Manzano; IG, Intervention Group; JALA, José Alberto Laredo Aguilera; JMCT, Juan Manuel Carmona Torres; OR, odds ratio; RCT, Randomised Clinical Trials; UTI, urinary tract infection.

Summary

- We evaluated the efficacy of non-invasive techniques to obtain clean urine samples in children under 1 year of age, concluding that the Herreros technique was the best to obtain clean urine samples in children under 1 year of age.
- These have an impact on the selection of the best urine collection techniques in infants.
- The best non-invasive technique should be introduced into the protocols of paediatrics in health care centres.

it can be difficult to obtain an uncontaminated urine sample [3, 7, 15].

Bladder catheterization, especially suprapubic puncture under ultrasound control, is considered a reference method for collecting urine samples and minimising false positives [1, 3, 7, 13]. However, these procedures are invasive, annoying and painful for children and are economically more expensive than other procedures [1, 3, 7, 16–18].

Currently, there are noninvasive methods for obtaining urine samples from incontinent infants, such as the placement of a bag attached to the genitals to collect urination or the use of absorbent pads that are placed on the diaper, after which the urine is aspirated from the pad with a syringe. In both cases, these methods are easy to use but require considerable time, sometimes several attempts, and usually result in high rates of contamination of the sample [5, 7, 13, 19, 20]. Another noninvasive method consists of capturing a clean urine sample during the micturition of the infant, in the middle of the stream, for later analysis [12, 13]. This method is accepted by the NICE 2022 guidelines [12] by the clinical practice guidelines of the American Academy of Paediatrics (AAP) [13] and by the clinical practice guidelines on the diagnosis of UTIs in the paediatric population of the year 2024 in Spain [14].

In recent years, new techniques have been described, implemented by health care professionals and/or parents, which attempt to stimulate spontaneous urination in infants whose sphincters have not yet been controlled [18, 21–24]. A clean urine sample was obtained from the middle of the stream. These techniques are based on provoking parasympathetic reflex contraction of the bladder detrusor muscle [15, 17, 21]. The distention of the bladder wall stimulates efferent fibres toward the spinal cord (S2–S4), where the reflex arc occurs, and the efferent fibres stimulate the detrusor muscle that contracts the bladder and urinates [15].

1.1 | Background

In 1986, a technique to stimulate urination in infants called "Finder tap" was described to obtain urine samples [25]. Years later, Herreros et al. [15, 23] described a new bladder stimulation technique, partly based on the "Finder tap" technique, in which the feeding of the infant with breast milk or formula is combined with the performance, between 20 and 30 min after feeding, of two manoeuvres: gentle tapping in the suprapubic area (with a frequency of 100 taps/min) for 30 s and, subsequently, a circular massage with the thumbs in the infant's lumbar paravertebral area for another 30 s. Both manoeuvres alternate until urination occurs for a maximum of 5 min. Previously, the genital region was cleaned with soap and water and dried with sterile gauze. During the development of manoeuvres, Herreros et al. administered nonpharmacological analgesia to infants via nonnutritive suction or 2% sucrose syrup [15] because crying can slow the urination reflex [17]. In this case, the technique described by Herreros et al. requires the participation of three adults (health professionals and/or parents), since one must hold the infant below the armpits, with the legs hanging down in males or with the hip flexed in females, whereas another adult performs the manoeuvres described (massage, patting) and a third adult collects the urine sample in a sterile container when urination occurs [15, 26].

However, Kaufman et al. [16, 21, 27] described the technique called "Quick-Wee", which is based on rubbing, for a maximum of 5 min, by means of continuous circular movements, the suprapubic region of the infant using gauze soaked in cold saline (refrigerated at 2.8°C) held by disposable plastic forceps. Previously, the genital region was cleaned for 10 s with sterile water at room temperature [21]. The "Quick-Wee" technique can be performed by a single adult since, on the one hand, they can rub the suprapubic region of the infant with gauze soaked in cold serum, and on the other hand, they can hold sterile wide-mouth bottles for the collection of urine samples when urination occurs.

In both cases (Quick-Wee technique and Blacksmith technique), the success of these manoeuvres is defined as obtaining a clean urine sample in the middle of the stream, in infants without sphincter control, within 5 min of the start of the described manoeuvres [15, 16, 21, 23].

Although studies have been carried out in recent years to determine the effectiveness of techniques for stimulating spontaneous urination in infants, to the best of our knowledge, no known studies have analysed the current evidence in previous clinical trials. Therefore, the objective of this study was to evaluate the efficacy of spontaneous urination stimulation techniques in infants under 1 year of age to obtain a clean and valid urine sample for analysis.

2 | Methodology

2.1 | Design and Sources of Information

A systematic review of randomised clinical trials (RCTs) that analysed spontaneous urination stimulation techniques for the collection of clean urine samples from infants under one year of age was performed, and an advanced search was carried out from March to October 2024. The databases consulted were PUBMED, SCOPUS, WEB OF SCIENCE, CINALH and the VHL Virtual Health Library.

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [28]. Additionally, this

systematic review was registered in PROSPERO with the number CRD42023489050.

2.2 | Search Strategy

The search string used in each database is shown in Table 1.

The PICO question was developed according to Table 2.

2.3 | Selection Criteria

Table 3 shows the inclusion and exclusion criteria for the studies included in this systematic review.

2.4 | Study Selection

Two researchers (FJGM and JMCT) selected studies on the basis of the inclusion and exclusion criteria mentioned above. Initially, 238 articles were obtained; once the duplicates (28 studies) had been eliminated via the Zotero computer program, the title and abstract of the remaining articles were read. The selection process followed the flow chart detailed in the PRISMA statement [28] (Figure 1). Thus, 203 studies were eliminated because they did not meet the inclusion criteria established for this systematic review. In cases of doubt or discrepancy, a third investigator (JALA) was consulted.

TABLE 1 | Search string.

Database consulted	Search string used
PUBMED	(((((clean catch urine [Title/Abstract]) OR (quick wee [Title/Abstract])))) OR (quick-wee [Title/Abstract])) OR (bladder stimulation [Title/Abstract])) OR (physical stimulation [Title/Abstract])
WEB OF SCIENCE	((((ti = (clean catch urine)) or ti = (quick wee)) or ti = (quick-wee)) or ti = (bladder stimulation)) or ti = (physical stimulation)
SCOPUS	Clean AND catch AND urine OR quick AND wee OR quick-wee OR bladder AND stimulation OR physical AND stimulation
CINAHL	TI "clean catch urine" OR TI "quick wee" OR TI "bladder stimulation"
VHL Virtual Library	Clean AND catch AND urine OR quick AND wee OR quick-wee OR bladder AND stimulation OR physical AND stimulation

2.5 | Evaluation of the Quality of the Studies

The RoB-2 scale was used [29] as a tool to detect biases and assess the quality of the randomised clinical trials (RCTs) included in this systematic review.

The RoB-2 tool for RCTs consists of five domains that assess the risk of bias in (1) the randomization process, (2) planned interventions, (3) data loss, (4) measurement of variables of results and (5) selection of the reported results. Within these five domains, there are twenty-two different items whose answers can be one of the following six options: (a) yes, (b) most likely yes, (c) most likely not, (d) no, (e) not applicable (N/A) and (f) not informed (N/I).

For each domain, the risk of bias was calculated. The total risk of bias was calculated as follows: (1) if the risk of bias was low in all domains, then the total risk was categorised as low; (2) if there was a risk of bias of some concern in any domain, the total risk was labelled "Some concern"; and (3) if there was a high risk of bias or multiple domains had some concern, the total risk of the study was categorised as high risk.

The quality assessment was independently reviewed by two authors (FJGM and JMCT), and any discrepancies were discussed with a third investigator (JALA) until agreement was reached.

2.6 | Data Extraction

Two researchers (FJGM and JMCT) carried out the study. The following data were collected from each selected study:

- Article identification: title, authors, publication date.
- Study design: type of clinical trial.
- Sample characteristics: Sample size, selection, age, and sex of the participants.
- Characteristics of the intervention: type of noninvasive technique or manoeuvre performed to stimulate spontaneous urination and obtain a urine sample.
- Main results of the intervention: success in obtaining the urine sample, time until obtaining the urine sample, percentage of contaminated samples, and complications observed.

TABLE 2 | PICO question structure.

P (population)	I (intervention)	C (comparison)	OR (outcome)
Paediatric population (infants) less than one year of age.	Collection of a clean urine sample "in the middle of the stream" by means of noninvasive manoeuvres to stimulate spontaneous urination.	Collection of urine samples using other invasive and noninvasive techniques.	To evaluate the efficacy of spontaneous urination stimulation techniques in infants under 1 year of age to obtain clean urine samples.

TABLE 3 | Inclusion/exclusion criteria.

Inclusion criteria	Exclusion criteria
Randomised clinical trials (RCTs) that analyse noninvasive techniques or manoeuvres to stimulate spontaneous urination for the collection of a clean urine sample.	Clinical trials that analyse invasive techniques for urine collection
Paediatric population (infants) less than 1 year of age	Studies that analyse urine collection techniques through a collection bag attached to the genitals or pads placed inside the infant's diaper.
Studies in Spanish or English	

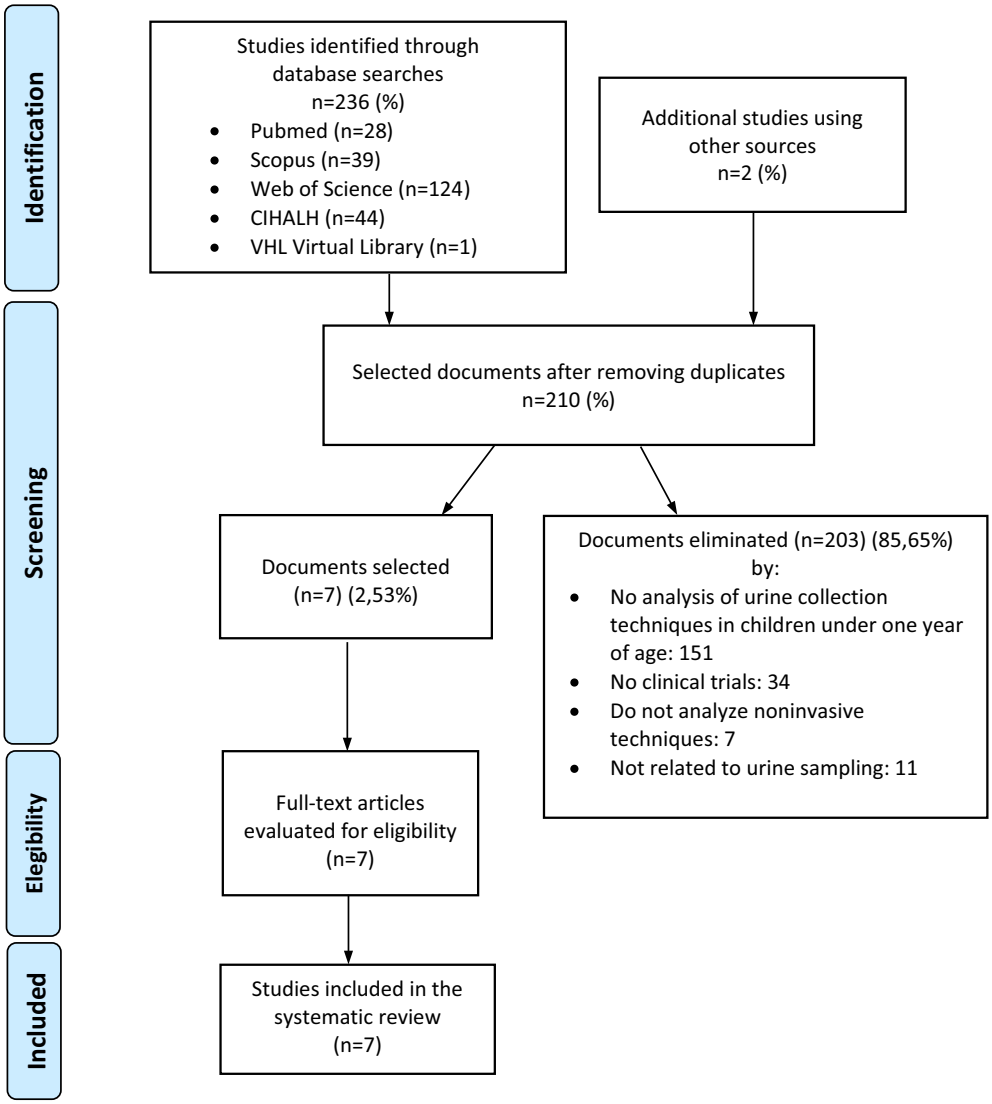

FIGURE 1 | PRISMA flow diagram [28].

2.7 | Analysis of the Data Obtained

A synthesis of each of the studies included in the present systematic review was performed. The data were analysed by comparing the results of different techniques or manoeuvres to stimulate spontaneous urination in infants.

Regarding the quantitative synthesis, the RevMan 5.4 computer program was used to perform a random effects meta-analysis to analyse the success rate of urine collection via the Herreros et al. technique and the quick-weekly (IG) technique compared with the control group (CG). A second fixed-effect meta-analysis was performed to analyse the contamination rates of the urine samples obtained via the quick-wee (IG) technique compared with those of the control group (CG). Statistical heterogeneity was assessed via the I^2 statistic and defined as follows: I^2 intervals $\leq 25\%$, 26%–50% or $\geq 51\%$ indicate low, medium or high heterogeneity, respectively. Statistical significance was set at 0.05, and

publication bias was assessed by visual inspection of the funnel plot.

3 | Results

After an exhaustive search of different databases, 238 articles were initially obtained. The Zotero computer tool was used to eliminate duplicates and manage references. A PRISMA flow diagram [28] was used.

3.1 | Characteristics of the Included Studies

Finally, 7 randomised clinical trials were selected [17, 18, 21, 26, 30–32] to carry out this systematic review (Figure 1), with a total of 1122 infants analysed. All studies were written in English. Five studies analysed the technique of Herreros et al. and included infants < 6 months of age [17, 26, 30–32], and two studies analysed the "Quick-Wee" technique and included infants between 1 and 12 months of age [18, 21]. Among the total number of children included, the technique of Herreros et al. was performed in 419 infants, and the "Quick-Wee" technique was performed in 248 infants.

Table 4 shows the characteristics and the most relevant data of the clinical trials included in this review.

3.2 | Risk of Bias

The RoB 2 tool was used [29] to assess the risk of bias of the randomised clinical trials included in this systematic review. All the clinical trials analysed presented a low risk of bias.

Figure 2 shows the risk of bias.

3.3 | Success Rate

Herreros et al. reported a success rate (obtaining a urine sample during the first three or 5 min after the manoeuvres were started) of 62.5%–82% in infants < 3 months of age [17, 26, 31, 32] and 48%–54% in infants < 6 months of age [30].

When the "Quick-Wee" technique was used, the success rate of obtaining urine was 25%–31% [18, 21] for infants 1–12 months of age.

On the other hand, Weill et al. (2019) hypothesised that performing a bladder ultrasound before performing the technique of Herreros et al. could increase the success rate in identifying infants with an empty bladder [30]. After its study, at < 6 months of age, no benefit was shown from the use of ultrasound; urine samples were obtained from 48 out of 100 infants (48%) in the intervention group (ultrasound was performed), whereas samples were obtained from 55 out of 101 infants (54%) in the control group (ultrasound was not performed). Weill et al. (2019) reported a significantly higher success rate among younger infants [30].

In addition, a random effects meta-analysis (Figure 3) was performed with three RCTs that compared the technique of Herreros et al. with waiting for urination. The meta-analysis revealed an odds ratio of 3.88 (2.28–6.60) in favour of the technique of Herreros et al., with an I^2 heterogeneity of 72%. The risk of publication bias of this meta-analysis is reflected in Figure 4.

A random effects meta-analysis (Figure 5) was also performed with two of the RCTs that used the quick-wee technique compared with cleaning the perineum with gauze at room temperature and waiting for urination. The meta-analysis revealed an odds ratio of 2.38 (1.08–5.23) in favour of the Quick-Wee technique, with an I^2 heterogeneity of 61%. The risk of publication bias of this meta-analysis is reflected in Figure 6.

3.4 | Time Needed to Obtain a Urine Sample

Of the total number of articles included in this systematic review, the time required to obtain the urine sample was analysed in five articles [17, 18, 26, 30, 32]. When the manoeuvres of Herreros et al. were applied in infants < 3 months, urine samples were obtained at 60–61 s [17, 26, 32], and in infants < 6 months, samples were collected at a mean time of 93 s [30].

Merelo et al. (2020) reported significant differences according to the sex and age of the baby; urine samples were obtained more quickly when the infant was younger and when the infant was male [17].

Branagan et al. (2022), applying the "Quick-Wee" technique, reported a mean time of 121 s in the IG and 150 s in the CG [18].

In two of the studies analysed, the time elapsed from the start of the manoeuvres to obtaining the urine sample was not recorded [21, 31].

The heterogeneity of the results (Table 5) prevented a meta-analysis.

3.5 | Contamination Rates of the Urine Samples

Of the total articles included, four were analysed for contamination of the urine samples. In the study by Merelo et al. (2020), urine culture was performed on all the urine samples, and contamination rates of 5.5% (3 samples of 54) were obtained by stimulating urination, whereas 2.8% (2 contaminated samples of 71) of the urine was obtained via bladder catheterization [17]. The studies by Kaufman et al. (2017) and Branagan et al. (2022) reported the highest contamination rates, 27%–54% in the IG and 46%–60% in the CG [18, 21].

In three of the clinical trials included in this review, the degree of contamination of the urine samples was not analysed [30–32].

A fixed effects meta-analysis (Figure 7) was also performed with two RCTs that compared urine samples contaminated with the quick-oe technique on the basis of samples analysed with the traditional method (cleaning the perineum with gauze at room temperature). The meta-analysis revealed an odds ratio of 0.54 (0.17–1.69) in favour of the Quick-Wee technique, with an I^2

TABLE 4 | Characteristics of the studies included in the systematic review.

Study	Sample	Age	Urine collection technique	Inclusion and exclusion criteria	Results	Conclusions
Altuntas et al. (2014)	$N = 127$ 63 Intervention Group (IG) (52% males, 45% females) 64 Control Group (CG) (53% males, 49% females) No significant differences in age, gestation, birth weight and sex between both groups	Between 3 years 30 days	IG: Feeding with milk (breast or formula) + Support below the armpits and performance of the Technique of Herreros et al. CG: Feeding with milk (breast or formula) + Holding below the armpits and waiting for urination	Inclusion criteria: • Newborns fully fed by mouth (breast milk or formula). Exclusion criteria: • Poor diet • Dehydration • Oliguria/Anuria • Treatment with nephrotoxic drugs • Serious diseases that affect the mobility of the baby	*Primary outcome*: Obtaining urine in 300 s (5 min): Total 70 infants • IG: 49 infants de 63 (78%) • CG: 21 infants de 64 (33%) $p < 0{,}0001$ Meantime (IQR) to collect the urine sample: • IG: 60 s (64.5 s). • CG: 300 s (95 s) $p < 0.001$ *Secondary outcome*: Success rate (obtaining the urine sample) by sex: • IG: 25 females (76%) y 24 males (80%) $p < 0.767$ • CG: 11 females (32%) y 10 males (33%) $p < 0.999$ There were no significant differences according to sex Contamination rate of urine sample: • No significant differences between CG and IG $p = 0.770$ In both groups (IG + CG): 19 of 70 samples (27.2%) ○ Females: 34.2% ○ Males: 20% $p < 0.28$ No adverse effects were observed during the study except the crying of the babies.	Stimulation of the bladder and lumbar paravertebral massage is a safe, fast and effective method for obtaining clean urine samples in newborns and works in both sexes.
Kaufman et al. (2017)	$N = 344$ infants 174 Intervention Group (IG) (55% males, 45% females) 170 Control Group (CG) (45% males, 55% females)	Between 1 and 12 months (Average: 5.4 meses)	IG: Technique "Quick-Wee" CG: Clean the perineum with a gauze soaked in sterile water at room temperature and wait for urination	Inclusion criteria: • Infants precontinents between 1 and 12 months of age requiring a urine sample for analysis Exclusion criteria: • Neonates (< 1 month old) • Infants with anatomical or neurological abnormalities that affected avoidance or sensitivity	*Primary outcome*: Obtaining urine in 300 s (5 min): Total 74 infants • IG: 54 infants of 174 (31%) • CG: 20 infants of 170 (12%) 95% CI (11%–28%) $p < 0.001$ *Secondary outcomes*: Success rate in obtaining urine sample: • IG: 52 infants of 174 (30%) • CG: 15 infants of 170 (9%) $p < 0.001$ Sample contamination: No significant differences between groups • IG: 12 out of 44 positive urine cultures (27%) • CG: 5 out of 11 positive urine cultures (46%) $p = 0.29$ Satisfaction of parents and health workers: • Median of 2 points obtained according to a rating scale of 1 point (very satisfied) to 5 points (very dissatisfied). $p < 0.001$ No adverse effects were observed during the performance of the technique.	The "Quick-Wee" method can improve the collection of clean urine by increasing the speed and success of obtaining urine samples. It is a simple technique that requires few resources and avoids the pain and anguish associated with invasive methods for obtaining urine in infants.

(Continues)

TABLE 4 | (Continued)

Study	Sample	Age	Urine collection technique	Inclusion and exclusion criteria	Results	Conclusions
Kapoor & Mekle. (2017)	$N = 120$ infants 60 Intervention Group (IG) 60 Control Group (CG)	Newborn (NB)	IG: Technique. Blacksmiths et al. CG: Sterile adhesive urine bag staining on the genitals	Inclusion criteria: • Healthy NBs with the informed consent of the parents. Exclusion criteria: • NB < 1500 g birth weight. • Hemodynamically unstable NBs (with respiratory and/or vasopressor assistance) NB with surgical conditions that prevent performing the urination stimulation manoeuvres.	*Primary outcome*: Obtaining urine: • IG. Within 5 min of starting the manoeuvres: 53 of 60 infants (88.3%) • CG. In the first attempt after applying the sterile bag to the genitals: 52 out of 60 (86.67%). Urine leakage in 8 infants. *Secondary outcomes*: Time to obtain a urine sample: • IG: Average time 61.76 s ± 43.62 s. Median 55 s (IQR: 40 s) • CG: Average time 68.7 min ± 20.45 min. Median 70 min (IQR: 25 min). ($p < 0.001$) No correlation was found between the time interval since the last feeding and the time it took for the manoeuvres to start urination ($p = 0.57$)	The external bladder stimulation technique is an effective, noninvasive, fast and safe method of collecting clean urine in neonates, saving a lot of time compared to the bag collection method.
Weill et al. (2019)	$N = 201$ infants (104 males y 97 females) 100 Intervention Group (IG) Previous ultrasound 101 Control Group (CG) Mandatory feeding	< 6 months (Middle age: 2 months)	IG: Ultrasound, if transverse bladder diameter. ≥ 2 cm, the Herreros et al. Technique was performed. < 2 cm, a mandatory feeding period of 20 min was imposed. before performing another ultrasound. CG: Mandatory feeding period with breastfeeding or Formula 20 min. Before performing the Herreros et al.	Inclusion criteria: • Infants < 6 months of age who required urinalysis and/or urine culture. Exclusion criteria: • Medical problem that made it impossible to obtain a urine sample • Serious illness • Situation in which the infant could not be fed • Inability to obtain informed consent from parents	*Primary outcome*: Obtaining urine in 300 s (5 min): Total 110 infants (55%) of which 103 (51%) obtained an adequate amount of urine. • IG: 48 de 100 infants (48%) • CG: 55 de 101 infants (54%) 95% CI (−7.3 a 19.8%) The success rate (urine collection) was significantly higher in age groups 0–29 days (OR 2.75 95% CI 1.03–7.36) and 30–59 days of age (OR 3.59 95% CI 1.67–7.69). The sex of the infant, the low oral intake according to the parents and the last urination in the hour before the procedure were not associated with the success rate of the procedure. *Secondary outcomes*: Time from randomization to urine collection: • IG: 11.9 min • CG: 16.7 min 95% CI (−1.0 a 10.6 min) Time from start of manoeuvres to urine collection: • IG: 93 s • CG: 121 s 95% CI (−7 a 62 s) Time spent by the assistant until obtaining the urine: • IG: 9 min • CG: 7.8 min 95% CI (−0.2 a 2.2 min)	No benefit has been demonstrated from the use of ultrasound prior to performing the technique of Herreros et al. in infants. The technique described by Herreros et al. it is effective in obtaining clean urine samples in approximately half of infants under 6 months of age.

(Continues)

TABLE 4 | (Continued)

Study	Sample	Age	Urine collection technique	Inclusion and exclusion criteria	Results	Conclusions
Merelo et al. (2020)	$N = 126$ infants 63 Intervention Group (IG) (38 males, 25 females) 63 control group (CG)	< 3 months of age	IG: Feeding with milk (breast or formula) + Technique of Herreros et al. CG: Feeding with milk (breast or formula) + Bladder catheterization	Inclusion criteria: • Infants < 3 months • With fever without focus or any sign of suspected infection Exclusion criteria: • Congenital urological or gynaecological malformations • Infants with antibiotic treatment • Infants who underwent a bladder catheterization in the previous 72 h	*Primary outcome*: Obtaining urine in 300 s (5 min): • IG: 54 of 63 infants (82%) In 9 infants (5 males and 4 females) the Blacksmith technique was suspended after 5 min. After which, in 8 the urine sample was obtained by bladder catheterization and 1 infant was discharged. • CG (urinary catheterization): 71 infants (100%); 63 from the CG + 8 infants who came from the IG. *Secondary outcomes*: Average time to collect the urine sample: • IG: 61.37 s (Standard deviation: 61.2 s. y median 49.5 s.). ○ By sex: Males 46.63 s. and Females 81.66 s. ○ By age: • Males: 0–1 months (32.18 s.), 1–2 months (52.10 s.) 2–3 months (80.42 s.) • Females: 0–1 months (50.54 s.), 1–2 months (89.14 s.), 2–3 months (178.33 s.) • CG (Bladder catheterization): 53.45 s. ○ By sex: Males 50.75 s. and Females 56.16 s. Complications during the urine collection technique: • Crying in both groups during the development of the techniques • IG: No other complications • CG (bladder catheterization): 13 light bleeding (12 men due to physiological phimosis and 1 woman due to vulvar synechia). • No late complications (48–72 h) Contamination of the urine sample (urine culture): • IG: 3 samples (5.56%) CG (Bladder catheterization): 2 samples (2.82%)	The urination stimulation technique (Herreros et al.) Is fast, safe, effective and minimises risks and complications. It is not invasive or painful and reduces the cost of material, being effective for collecting valid urine samples for the study of urinary tract infections compared to bladder catheterization.

(Continues)

TABLE 4 | (Continued)

Study	Sample	Age	Urine collection technique	Inclusion and exclusion criteria	Results	Conclusions
Branagan et. al (2022)	$N = 140$ Infants 73 Intervention Group (IG) 67 Control Group (CG)	Between 1 and 12 months 92 infants (1–6 months) 48 infants (6–12 months)	IG: Technique "Quick-Wee" CG: Clean the perineum with a gauze soaked in sterile water at room temperature and wait for urination	Inclusion criteria: • Infants between 1 and 12 months • Obtaining informed consent from parents Exclusion criteria: • Anatomical abnormalities that affect urination • Infants with pathology that requires immediate treatment Inability to obtain informed consent from parents	*Primary outcome*: Obtaining urine in 300 s (5 min): • IG: 18 infants (25%) ○ From 1 to 6 months of age: 12 infants of 44 (27%) ○ From 6 to 12 months of age: 6 infants of 29 (21%) • CG: 12 infants (18%) ○ From 1 to 6 months of age: 11 infants of 48 (23%) ○ From 6 to 12 months of age: 1 infants of 19 (5%) 95% CI (−7 a 20%) $p = 0.4$ *Secondary outcomes*: Average time needed to urinate: • IG: 121 s • CG: 150 s $p = 0.47$ Contamination of the urine sample: • IG: 6 of 11 samples sent to the laboratory (54%) • CG: 3 of 5 samples sent to the laboratory (60%) Satisfaction of health personnel and parents: Likert polls from 0 (very dissatisfied) to 5 (very satisfied) • Average score for fathers/mothers: 4.16 • Average score for health personnel: 4.35	The "Quick-Wee" technique is a simple and inexpensive method that did not show a statistically significant effect on the increase in urine samples obtained from precontinent infants.

(Continues)

TABLE 4 | (Continued)

Study	Sample	Age	Urine collection technique	Inclusion and exclusion criteria	Results	Conclusions
Korkmaz et. al (2024)	$N = 64$ infants 32 Intervention Group (IG) 18 males and 14 females. 32 Control group (CG) 15 males and 17 females.	Newborn (NB) Mean gestation age 38.75 ± 1.15 weeks and mean postnatal age of 7.90 ± 3.12 days	IG: Feeding with milk (breast or formula) + Technique of Herreros et al. CG: Feeding with milk (breast or formula) + Sterile adhesive urine bag staining on the genitals	Inclusion criteria: • Full-term newborn with > 37 weeks of gestation. • Request for a urine sample from the NB. • NB fed orally. • Informed written consent of the parents. Exclusion criteria: • Poor general clinical condition (respiratory distress, ventilation mechanical ventilation, etc.) • Malnutrition, dehydration, oliguria and anuria. • Presence of neurological and anatomical abnormalities that may affect bladder function. • Presenting a condition that prevents the application of the stimulation manoeuvre (necrotizing enterocolitis, neural tube defect, etc.)	*Primary outcome*: Obtaining urine in 180 s (3 min): • IG: 20 of 32 infants (62.5%) • CG: 9 of 32 infants (28%) $p = 0.006$ *Secondary outcomes*: Score on the scales: COMFORT, COMFORT NRS-pain and COMFORT NRS-stress. (All scales were applied before starting the procedure, 1 min and 3 min after starting the procedure) • Before starting the procedure: No significant differences between IG and CG. ($p > 0.05$) • At 1 min and at 3 min: Higher scores for IG NBs ($p < 0.05$) Oxygen saturation: • Before starting the procedure: No significant differences between IG and CG ($p > 0.05$) • At 1 min and at 3 min: Lower scores for IG NBs ($p < 0.05$) Heart rate: • Before starting the procedure: No significant differences between IG and CG ($p > 0.05$) • At 1 min and at 3 min: Higher scores for IG NBs ($p < 0.05$)	The bladder stimulation technique was a more satisfactory and effective method in 3 min than the collection of urine in sterile bags. The comfort levels of the NBs decrease minimally after 3 min and present moderate pain and anguish during the application of bladder stimulation.

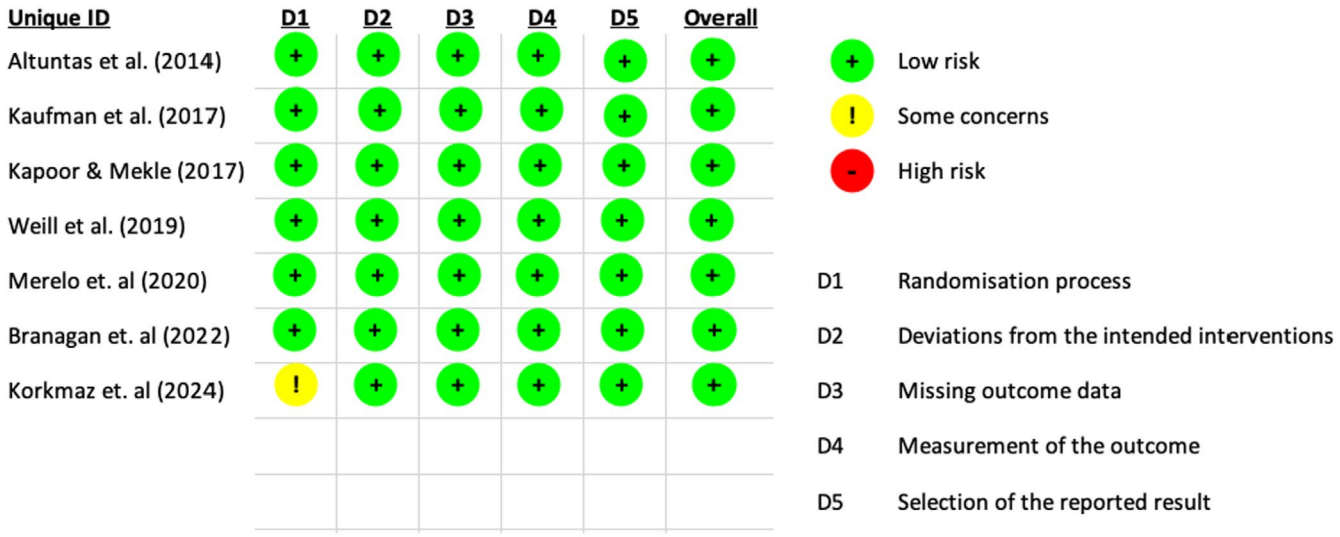

FIGURE 2 | Risk of bias according to RoB 2.

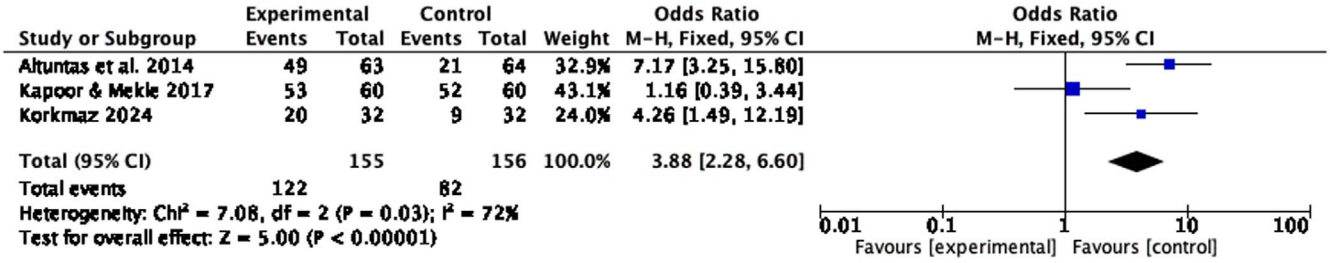

FIGURE 3 | Meta-analysis of the Herreros et al. technique for urine collection.

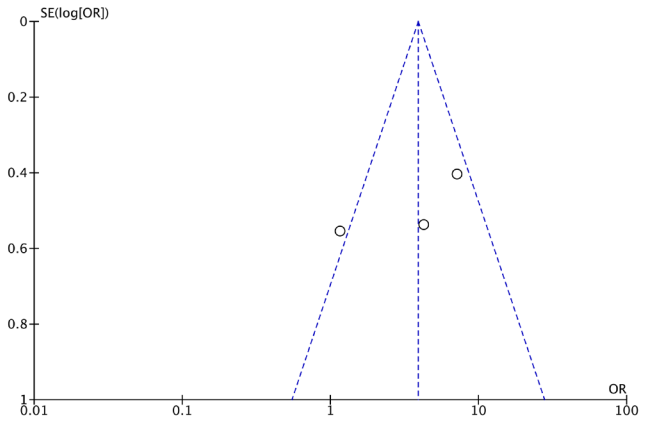

FIGURE 4 | Funnel plot of the risk of publication of the technique of Herreros et al.

heterogeneity of 0%. The risk of publication bias of this meta-analysis is reflected in Figure 8.

4 | Discussion

The performance of a technique to stimulate urination in infants, especially those < 6 months of age, is effective in obtaining a urine sample for analysis in less than 5 min. These techniques are safe for infants, do not cause serious complications, and present a relatively low percentage of contamination of the sample.

4.1 | Success Rate

According to the studies analysed, when the manoeuvres of Herreros et al. were applied, the success rate of obtaining a urine sample was high, with an odds ratio (OR) of 3.88 (2.28–6.60) [26, 31, 32] compared with that of waiting for urination. Similarly, other studies have shown similar success rates of 49%–64% in infants < 6 months [8, 9, 13, 33]. Therefore, these data could indicate that when the manoeuvres of Herreros et al. are applied, the probability of obtaining a urine sample increases with decreasing age of the child.

With respect to the "Quick Wee" technique, success rates of 25%–31% are obtained in infants < 12 months [18, 21]. The meta-analysis revealed an odds ratio of 2.38 (1.08–5.23) in favour of the Quick Wee technique with respect to cleaning the perineum with gauze moistened with sterile water at room temperature. If we compare both techniques at < 6 months of age, a greater percentage of success is observed when the technique of Herreros et al. is used. One possible explanation is that the age of the participants is greater in the Quick Wee studies [18, 21] The infant's previous oral intake before starting the manoeuvres does not seem to be an essential factor if the infant is adequately hydrated by oral lactation or a nasogastric tube every 2 h [32].

On the other hand, the performance of a bladder ultrasound prior to the stimulation of urination has not shown greater success in

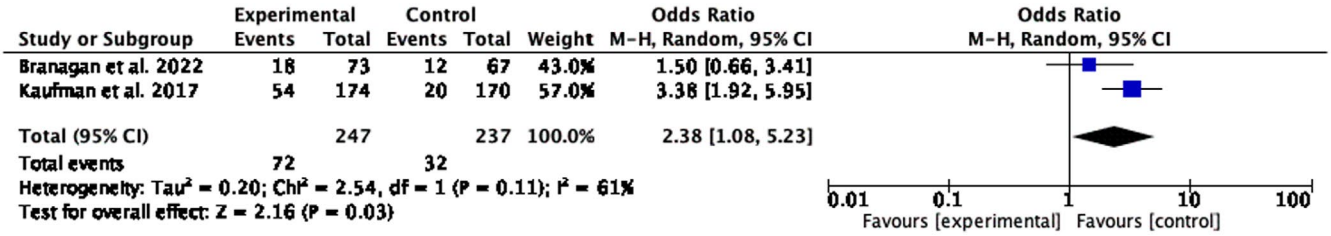

FIGURE 5 | Meta-analysis of the quick-wee technique for urine collection.

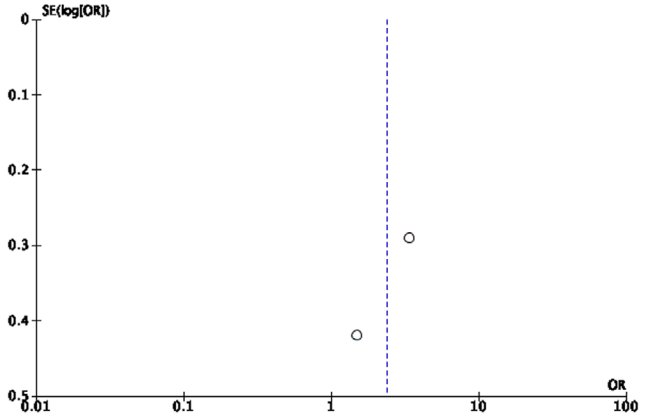

FIGURE 6 | Funnel plot of the risk of publication of the Quick-Wee technique.

the capture of urine [30]. However, if no stimulation manoeuvre is performed and only the urination of the child is expected, bladder ultrasound can accelerate the process [34], likely because the application of gel and the slight pressure exerted on the bladder area by the ultrasound scanner stimulate the voiding reflex.

However, considering the small number of clinical trials, more RCTs are needed to support these results.

4.2 | Differences According to the Sex of the Infant

The studies analysed do not show significant differences in the success of obtaining urine samples according to the sex of the infant [26, 30]. This finding agrees with the results of other studies [9, 13]. Only Merelo et al. (2020) reported significant differences according to sex, indicating that men require less time than women do to induce spontaneous urination [17]. The explanation for this result is not clear, so further research should be carried out to confirm that this variability is dependent on the sex of the infant.

4.3 | Contamination of the Urine Sample

Three of the studies included in this systematic review did not analyse this variable [30–32]. In four other studies, if the contamination of the urine samples was analysed [17, 18, 21, 26], there was heterogeneity in the results obtained depending on the study. This may be due to differences in the definition of "contamination" since not all samples obtained were subjected to urine culture. However, although all the studies analysed coincided in that there were no significant differences between the intervention groups (urination stimulation technique) and the control groups, our meta-analysis revealed an odds ratio of 0.54 (0.17–1.69) in favour of the quick-wee technique with respect to the control group.

On the other hand, there are studies that have shown that samples of clean urine obtained in the middle of urination have precision similar to that of samples obtained by suprapubic aspiration for the diagnosis of UTIs [35], although suprapubic aspiration continues to have relatively low contamination rates [6, 20].

With respect to the sex of the infant, Altuntas et al. (2014) reported greater contamination in urine samples obtained from women [26]. In other studies, significant differences were also observed according to the sex of the infant, with greater contamination in girls [8, 13, 20]. According to Mulcrone et al. (2020), this may be due to errors in the capture of urine in women (collection of the first stream instead of capturing the urine in the middle of the stream, capture of urine after draining through the skin of the perineum, buttock or girl's leg, etc.) [13]. Therefore, new clinical trials detailing the urine collection technique and urine culture analysis of all samples obtained are needed.

4.4 | Adverse Effects During the Study

Both techniques (Herreros et al. and "Quick-Wee") include safe manoeuvres that cause only slight discomfort to the infant during their application [17, 18, 21, 26, 30, 32] and changes in physiological parameters that are not clinically significant [31].

The studies that applied the "Quick-Wee" technique showed, by means of a Likert-type assessment scale, a high degree of satisfaction of parents and health care personnel during the procedure [18, 21]. The remaining studies included in this review did not assess this aspect; however, other studies also reported a high degree of satisfaction among parents and health personnel during the application of the technique of Herreros et al. versus bladder catheterization [33].

4.5 | Cost of Treatment

Only Merelo et al. (2020) analysed the cost of obtaining urine, showing, according to the prices of the year 2017–2018, a greater cost in the performance of the bladder catheterization technique (€ 2.608) than in the cost of urination stimulation manoeuvres

TABLE 5 | Average time (in seconds) from the start of the manoeuvres to obtaining a urine sample.

Study	Age	Average time	Average time according to the sex of the infant
Altuntas et al. (2014)	3–30 days	IG: 60 s. CG: 300 s.	NA
Kaufman et al. (2017)	1–12 months	NA	NA
Kapoor & Mekle (2017)	Newborns	IG: 61.76 s ± 43.62 s. CG: 68.7 min ± 20.45 min.	NA
Weill et al. (2019)	< 6 months	IG: 93 s. CG: 121 s.	NA
Merelo et al. (2020)	< 3 months	IG: 61.37 s. CG: 53.45 s.	IG: Males 46.63 s and Females 81.66 s. CG: Males 50.75 s and Females 56.16 s.
Branagan et al. (2022)	1–12 months	IG: 121 s. CG: 150 s.	NA
Korkmaz et al. (2024)	Newborns	NA	NA

Abbreviations: CG: control group; IG: intervention group; NA: not available.

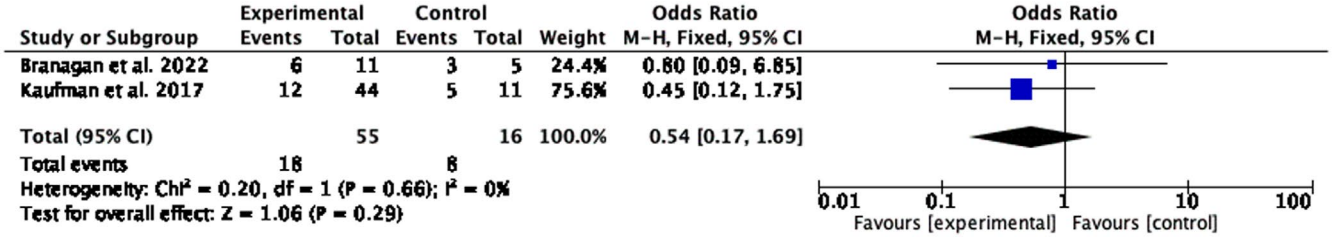

FIGURE 7 | Meta-analysis of the quick-wee technique for urine collection.

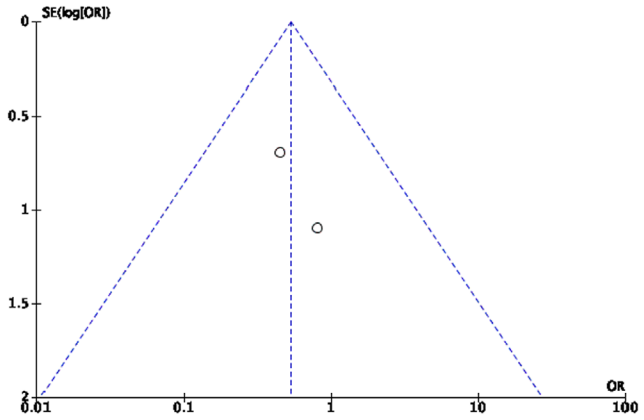

FIGURE 8 | Funnel plot of the risk of publication of the Quick-Wee technique for urine collection.

(€ 2.18), that is, a difference of +16.41%, which may indicate that urination stimulation manoeuvres are cost-effective.

4.6 | Limitations of the Study

Regarding the limitations of this study, some studies could not be included in the meta-analysis on the contamination of urine samples, and not all studies could be included in the meta-analysis of the effectiveness of the technique (success rate) because the control group was not homogeneous. The small number of RCTs found makes it difficult to draw definitive conclusions. The absence of results stratified by age and sex prevented the analysis from being stratified by age groups and sex.

Regarding strengths, it should be noted that all the included studies were RCTs with a low risk of bias. Additionally, to our knowledge, this is the first systematic review and the first meta-analysis performed that analyses the Quick-Wee and Blacksmith techniques in infants < 1 year of age.

5 | Conclusions

In infants with suspected UTIs, stimulation of spontaneous urination is a noninvasive, fast, safe, inexpensive and effective procedure that allows the capture of a midstream urine sample for analysis, especially for younger patients These manoeuvres can be used both in hospital and out-of-hospital settings; they do not depend on the technical knowledge of a clinician or involve greater contamination of the samples with respect to the control group, so they can be an alternative to be incorporated into the clinical practice of paediatric services instead of traditional invasive methods (bladder catheterization and suprapubic puncture). Therefore, health policy-makers can include this technique in the different protocols of paediatric units that require obtaining a urine sample for analysis. However, for future studies, more randomised clinical trials would be necessary to obtain more solid conclusions that detail the

urine capture procedure by age and sex groups and analyse all the urine samples obtained via urine culture.

Author Contributions

Francisco Javier Gómez-Manzano: conceptualization, investigation, writing – original draft, methodology, data curation. **Esperanza Barroso-Corroto:** conceptualization, writing – review and editing, validation, supervision, formal analysis. **José Alberto Laredo-Aguilera:** supervision, data curation, writing – review and editing. **Rosa María Molina-Madueño:** writing – review and editing, supervision. **Sergio Rodríguez-Cañamero:** writing – review and editing, supervision, visualization. **Juan Manuel Carmona-Torres:** conceptualization, investigation, funding acquisition, formal analysis, project administration.

Disclosure

The authors affirm that the methods used in the data analyses are suitably applied to their data within their study design and context, and the statistical findings have been implemented and interpreted correctly.

Conflicts of Interest

The authors declare no conflicts of interest.

References

1. National Collaborating Centre for Women's and Children's Health (UK), *Urinary Tract Infection in Children: Diagnosis, Treatment and Long-Term Management* (RCOG Press, 2007).

2. A. K. C. Leung, A. H. C. Wong, A. A. M. Leung, et al., "Urinary Tract Infection in Children," *Recent Patents on Inflammation & Allergy Drug Discovery* 13, no. 1 (2019): 2–18, https://doi.org/10.2174/1872213X13666181228154940.

3. O. W. May, "Urine Collection Methods in Children: Which Is the Best?," *Nursing Clinics of North America* 53, no. 2 (2018): 137–143.

4. N. Shaikh, N. E. Morone, J. E. Bost, et al., "Prevalence of Urinary Tract Infection in Childhood: A Meta-Analysis," *Pediatric Infectious Disease Journal* 27, no. 4 (2008): 302–308, https://doi.org/10.1097/INF.0b013e31815e4122.

5. A. M. Serrano, R. L. López, A. J. J. Nieto-Márquez, M. G. Ferrer, M. V. De Dios García, and M. V. P. Munarriz, "Evaluation of Urine Collection Methods in < 2-Year-Olds in a Paediatric Emergency Unit," *Metas Enfermeria* 24, no. 4 (2021): 7–14.

6. S. Teo, J. A. Cheek, and S. Craig, "Improving Clean-Catch Contamination Rates: A Prospective Interventional Cohort Study," *Emergency Medicine Australasia* 28, no. 6 (2016): 698–703.

7. C. Karacan, N. Erkek, S. Senel, S. Akin Gunduz, G. Catli, and B. Tavil, "Evaluation of Urine Collection Methods for the Diagnosis of Urinary Tract Infection in Children," *Medical Principles and Practice* 19, no. 3 (2010): 188–191, https://doi.org/10.1159/000273068.

8. M. Labrosse, A. Levy, J. Autmizguine, and J. Gravel, "Evaluation of a New Strategy for Clean-Catch Urine in Infants," *Pediatrics* 138, no. 3 (2016): e44fb777.

9. A. Tran, C. Fortier, L. Giovannini-Chami, et al., "Evaluation of the Bladder Stimulation Technique to Collect Midstream Urine in Infants in a Pediatric Emergency Department," *PLoS One* 11, no. 3 (2016): e9.

10. M. Arshad and P. C. Seed, "Urinary Tract Infections in the Infant," *Clinics in Perinatology* 42, no. 1 (2015): 17–28.

11. K. O'Brien, N. Stanton, A. Edwards, et al., "Prevalence of Urinary Tract Infection (UTI) in Sequential Acutely Unwell Children Presenting in Primary Care: Exploratory Study," *Scandinavian Journal of Primary Health Care* 29, no. 1 (2011): 19–22, https://doi.org/10.3109/02813432.2011.554268.

12. NICE Guideline, "Overview|Urinary Tract Infection in Under 16s: Diagnosis and Management|Guidance|NICE," 2022, https://www.nice.org.uk/guidance/ng224.

13. A. E. Mulcrone, M. Parikh, and F. A. Ahmad, "Reducing Infant Catheterization in the Emergency Department Through Clean-Catch Urine Collection," *JACEP Open* 1, no. 6 (2020): 1533–1541.

14. J. D. G. Rodríguez, G. M. F. Rodríguez, C. J. G. Vera, et al., "Actualización de la guía de práctica clínica española sobre infección del tracto urinario en la población pediátrica. Síntesis de las recomendaciones sobre diagnóstico, tratamiento y seguimiento," *Anales de Pediatría* 101, no. 2 (2024): 132–144, https://doi.org/10.1016/j.anpedi.2024.06.001.

15. M. L. Herreros Fernández, N. González Merino, A. Tagarro García, et al., "A New Technique for Fast and Safe Collection of Urine in Newborns," *Archives of Disease in Childhood* 98, no. 1 (2013): 27.

16. J. Kaufman, P. Fitzpatrick, S. Tosif, et al., "The QuickWee Trial: Protocol for a Randomised Controlled Trial of Gentle Suprapubic Cutaneous Stimulation to Hasten Non-Invasive Urine Collection From Infants," *BMJ Open* 6, no. 8 (2016): e011357.

17. J. J. P. Merelo, M. Sánchez, R. C. González, and S. C. Sánchez, "Efectividad de la Técnica de Estimulación Vesical Frente al Sondaje Vesical en Lactantes Menores de 3 Meses," 2020.

18. A. Branagan, N. Canty, E. O'Halloran, M. Madden, and M. B. O'Neill, "Evaluation of the Quick Wee Method of Inducing Faster Clean Catch Urine Collection in Pre-Continent Infants: A Randomized Controlled Trial," *World Journal of Pediatrics* 18, no. 1 (2022): 43–49.

19. J. Escribano, "Toma de Muestras de Orina por Métodos Invasivos en el Niño Incontinente," 2007.

20. J. Diviney and M. S. Jaswon, "Urine Collection Methods and Dipstick Testing in Non-Toilet-Trained Children," *Pediatric Nephrology* 36, no. 7 (2021): 1697–1708.

21. J. Kaufman, P. Fitzpatrick, S. Tosif, et al., "Faster Clean Catch Urine Collection (Quick-Wee Method) From Infants: Randomised Controlled Trial," *BMJ* 7, no. 357 (2017): j1341.

22. C. Ochoa-Sangrador and A. Fernández-Rodríguez, "Efficacy of Bladder Stimulation Techniques for Urine Collection From Infants: A Systematic Review and Meta-Analysis," *Emergencias* 34, no. 2 (2022): 128–135.

23. M. L. Herreros, A. Barrios, A. Sánchez, R. del Valle, M. Pacheco, and P. Gili, "Urine Collection Methods in Precontinent Children Treated at the Paediatric Emergency Department," *Acta Paediatrica* 112, no. 3 (2023): 550–556.

24. A. Tran, "The Quick-Wee Infant Urine Collection Method," *Journal of Pediatrics* 188 (2017): 308–311.

25. M. R. Taylor, M. Dillon, and C. T. Keane, "Reduction of Mixed Growth Rates in Urine by Using a "Finger Tap" Method of Collection," *British Medical Journal (Clinical Research Ed.)* 292, no. 6526 (1986): 990.

26. N. Altuntas, A. C. Tayfur, M. Kocak, H. C. Razi, and S. Akkurt, "Midstream Clean-Catch Urine Collection in Newborns: A Randomized Controlled Study," *European Journal of Pediatrics* 174, no. 5 (2015): 577–582.

27. J. Kaufman, "How to... Collect Urine Samples From Young Children," *Archives of Disease in Childhood. Education and Practice Edition* 105, no. 3 (2020): 164–171.

28. D. Moher, A. Liberati, J. Tetzlaff, et al., "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement," *PLoS Medicine* 6, no. 7 (2009): e1000097.

29. J. A. C. Sterne, J. Savović, M. J. Page, et al., "RoB 2: A Revised Tool for Assessing Risk of Bias in Randomised Trials," *BMJ* 366 (2019): l4898.

30. O. Weill, M. Labrosse, A. Levy, M. P. Desjardins, E. D. Trottier, and J. Gravel, "Point-Of-Care Ultrasound Before Attempting Clean-Catch Urine Collection in Infants: A Randomized Controlled Trial," *CJEM* 21, no. 5 (2019): 646–652.

31. N. Korkmaz, F. K. Narter, B. Mutlu, K. Şahin, and H. Özgörü, "Effects of the Bladder Stimulation Technique on Urine Sample Collection in Newborns: A Randomized Controlled Study," *International Journal of Nursing Practice* 30, no. 5 (2024): e13255.

32. A. M. Kapoor, "Effectiveness of External Bladder Stimulation for Collection of Urine Sample in Neonates," *Pediatric Oncall Journal* 14 (2017): 10–12, https://doi.org/10.7199/ped.oncall.2017.33.

33. Y. Ravichandran, S. Parker, A. Farooqi, and A. DeLaroche, "Bladder Stimulation for Clean Catch Urine Collection Improved Parent and Provider Satisfaction," *Pediatric Emergency Care* 38, no. 1 (2022): E29–E33.

34. R. Lennon, A. Krishnamohan, L. Fitzpatrick, and M. Gillett, "CATCH IT: The Effect of Bladder Ultrasound in Decreasing the Time to Collect a Clean-Catch Urine Sample in the Nontoilet-Trained Child: A Randomized Control Trial," *Pediatric Emergency Care* 40, no. 2 (2024): 98–102.

35. P. Whiting, M. Westwood, L. Bojke, et al., "Clinical Effectiveness and Cost-Effectiveness of Tests for the Diagnosis and Investigation of Urinary Tract Infection in Children: A Systematic Review and Economic Model," *Health Technology Assessment (Winchester)* 10, no. 36 (2006): 1–154.