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RESEARCH

# Prior video game exposure and ureteroscopic skill: correlation or coincidence?

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## Abstract

**Purpose** With simulation-based training becoming increasingly common, identifying experiences that enhance surgical aptitude has become a growing area of research. However, data specific to urology remains limited. Video game exposure may enhance visuomotor and cognitive skills relevant to urological procedures. This study aimed to compare ureteroscopic performance between gaming and non-gaming students and to evaluate associations between gaming habits and task performance.

**Methods** In this prospective study, undergraduates with no prior ureteroscopic experience completed a demographics and gaming history questionnaire, played one tablet- and one smartphone-based game, then performed diagnostic ureteroscopic and stone extraction tasks on a bench model, with completion times and game high scores recorded.

**Results** A total of 160 students were included. Gamers, defined as playing > 3 h/week at the peak of their gaming history, outperformed non-gamers in both ureteroscopic ($p < 0.01$) and video game tasks ($p < 0.01$). Ureteroscopic performance correlated with years of gaming experience ($p = 0.001$) and peak weekly gaming hours ($p = 0.002$), regardless of gamer status. Current gaming time showed no correlation. Hand dominance had no significant effect, while male participants outperformed females in all tasks ($p < 0.04$), irrespective of gaming status.

**Conclusion** Prior video game exposure was associated with superior baseline ureteroscopic performance. These findings suggest video gaming may support psychomotor skill development relevant to urology. Further research should define the transferable skills involved and identify additional life experiences influencing ureteroscopic aptitude. Integrating these insights into surgical training could enhance skill acquisition and help identify individuals with greater innate aptitude for urological specialization.

**Keywords** Ureteroscopy · Simulation · Gaming · Gamer · Aptitude · Urology

## Introduction

Does time spent playing video games correlate with superior dexterity or enhanced spatial abilities relevant to ureteroscopic performance? Research indicates that higher gaming proficiency is associated with improved attention, psychomotor speed, and visuospatial working memory [1]. Video game play has also been shown to enhance manual dexterity [2], and certain game types can serve as instructional tools for developing spatial skills [3]. Meta-analyses report a moderate but significant training effect on cognitive performance from video game interventions [4]. Long-term gaming exposure has even been linked to neuroanatomical changes, including increased cortical thickness and modifications within visuospatial and sensorimotor networks on MRI [5]. These findings suggest that gaming can strengthen

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psychomotor and cognitive domains fundamental to endoscopic surgery, including ureteroscopic tasks. Yet, it remains unclear whether a history of gaming translates to a superior innate ability in performing ureteroscopic procedures. Despite growing research on predictors of surgical aptitude, data specifically linking gaming experience to urological procedural skills remains limited.

In the field of urological innovation, endoscopic procedures have been well established as primary treatment modalities for a wide range of urological pathologies [6]. Ureteroscopic procedures have been statistically validated for safety and efficacy, and multiple indicators support their designation as a highly effective treatment for stone disease [7].

Studies have investigated whether surgical technical aptitude can be reliably predicted. However, a systematic review concluded that no single test accurately forecasts performance [8]. Assessing innate dexterity and visuospatial reasoning has been proposed as a potential tool for selecting future surgical candidates [9]. This focus on inherent abilities has prompted hypotheses that certain life experiences or exposures may enhance baseline skills essential for performing specialized procedures.

Video games are often seen as purely recreational. Techopedia defines a gamer as "an individual or hobbyist who enjoys playing various types of digital or online games" [10]. Yet, this hobby has fuelled a multi-billion-dollar global industry. With numerous platforms, the industry generated approximately $186 billion in revenue, far exceeding the music ($28.6 billion) and film ($33.9 billion) industries [11].

In urology, evidence remains limited, with few studies and generally small sample sizes. One analysis found that prior video gaming experience did not significantly influence the learning curve for transurethral resection of the prostate (TURP) [12]. Similarly, a study examining video game experience and ureteroscopic skill concluded that gaming history was not a significant predictor of ureteroscopic ability [13].

With the rapid integration of technology into medicine, particularly urology, steep learning curves may be mitigated by identifying innate abilities that predict surgical proficiency. A study on ureteroscopy learning curves among residents show that the stone-free rate plateaus after roughly 50 cases, highlighting the procedure's technical demands [14]. Identifying life experiences that enhance ureteroscopic skills could aid in selecting candidates likely to perform well initially and support incorporating targeted activities to develop these aptitudes into surgical training.

This study therefore aims to address an important question: does time spent playing video games correlate with improved baseline ureteroscopic performance?

## Materials and methods

### Cohort, criteria, setting and sample size

Participation was voluntary and required written consent. Recruitment was conducted via electronic invitations and in-person requests following routine tutorials or simulations at the university's simulation unit. Participants were eligible if they attended a scheduled study session and were enrolled in an undergraduate program within the Faculty of Health Sciences. Ethical clearance was granted exclusively for students from this faculty.

Inclusion criteria required no prior training, exposure, or experience in endoscopy or ureteroscopic procedures. Exclusion criteria included any contraindications to using simulators or gaming devices.

The required sample size was based on data from a study by Sun et al. [13], which reported an approximate 39-second performance difference between gamers and non-gamers. With 95% confidence, 80% power, and $\alpha = 0.05$, the calculated sample size was 146 (73 per group), allowing for a conservative estimation of the effect.

### Questionnaire

A questionnaire covering demographic data, gaming history (self-identified gamer status, years played, peak and current hours per week), preferred platform/genre, and hand dominance.

### Ureteroscopic tasks

Participants completed two ureteroscopic tasks. Each task was explained and demonstrated once, with a tutorial on equipment, common challenges, and suggested techniques. Questions were allowed, but no practice was permitted.

Task time, from ureteroscope insertion to removal, was recorded by a timekeeper blinded to gaming status. All tasks used the same flexible digital ureteroscope (HugeMed© HU30S) and retrieval basket (ROCAMED© ROSZ1300ST), tested before each session. The validated Frere intrarenal Surgical Trainer (FiST) [15] was used with a standardized setup (Fig.1)

Stone task: Students inserted the scope into the bladder, advanced it through the left ureter to the renal pelvis with five stones, and retrieved one using an assistant-operated basket.

Diagnostic task: Students inserted the scope into the bladder, advanced it through the right ureter to the renal pelvis, and identified five of eight labelled minor calyces (numbered 1–8).

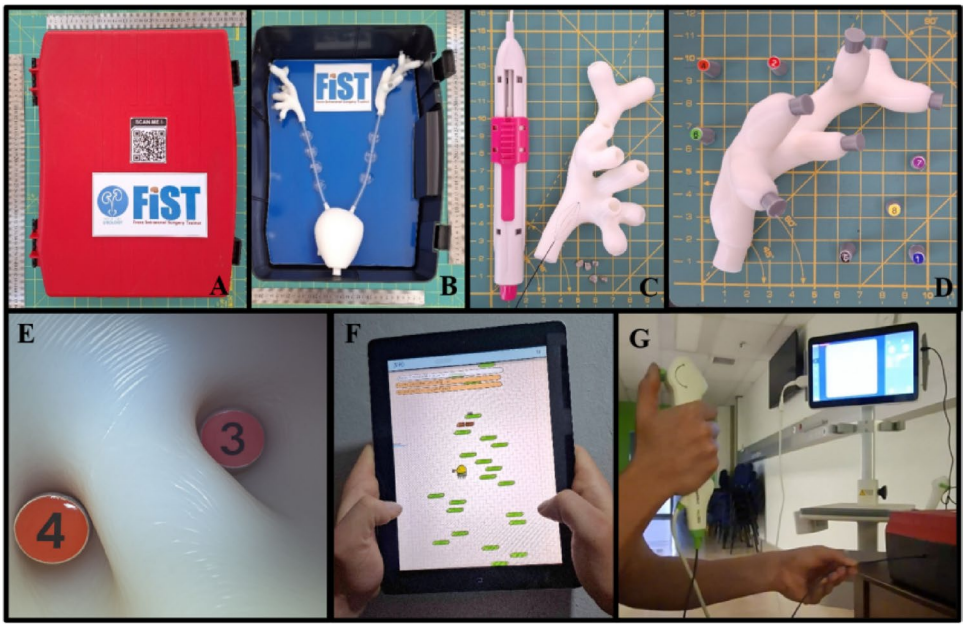


**Fig. 1** Frere Intrarenal Surgery Trainer bench top model, external view (A), contents of case (B), 3-D printed collecting system and retrieval basket (C), 3-D printed collecting system and numbered calyces (D), endoscopic view of a numbered calyx (E), tablet game task (F), simulations setup (G)

## Video game tasks

Due to the lack of a universal definition of a gamer, participants played two video games prior to performing ureteroscopic tasks to directly assess gaming skills and familiarity with fundamental gaming principles. Although not specifically designed to measure gaming ability, the selected games simulate common gaming movements and cognitive processes. This approach aimed to confirm whether participants with prior gaming experience demonstrated greater understanding of game mechanics and superior skill, and to identify individuals with inherent gaming aptitude despite no prior exposure. It also accounted for the potential impact of time elapsed between prior gaming and study enrolment. Each participant played both games twice, with objectives and controls explained via video and live demonstration. Questions were allowed, but no practice attempts were permitted.

The first game task was *Doodle Jump*© (Lima Sky LLC), a platform strategy game played on an iPad©. Players tilt the device to climb platforms while avoiding obstacles and shooting monsters by tapping the screen.

The second game task was *Aim Lab Mobile*© (State Space Labs Inc.), a first-person shooter training application on a smartphone. Participants navigated the crosshair with their left hand and fired with their right .

## Statistical analysis

Data was analysed using IBM SPSS Statistics (version 29; IBM Corp., Armonk, NY). Group comparisons were performed following assessment of variance and overall group differences using ANOVA and independent sample t-tests. Pearson's correlation coefficient was used to assess relationships between continuous variables. For the relationship between categorical variables, the Chi-squared test was applied. A p-value of $<0.05$ was considered statistically significant.

## Data cleaning

To improve data normality, extreme univariate outliers were removed after visual inspection of histograms, boxplots, and QQ plots. Of 160 participants, four were excluded from the stone task and seven from the diagnostic task. After exclusions, mean completion time for Task 1 (Stone task) was 118.20 s (SD = 54.18; $\gamma_1 = 1.016$), and for Task 2 (Diagnostic task) was 114.05 s (SD = 53.2; $\gamma_1 = 1.245$).

# Results

A total of 160 undergraduate students was included. Gamers were defined as individuals who played more than 3 h of video games per week during their peak gaming period. Due to the absence of a universal definition of a "gamer", this criterion was adapted from a previous study that compared laparoscopic proficiency between gamers and non-gamers [16]. Non-gamers completed the stone and diagnostic tasks in 134.43 ± 60.28 and 126.24 ± 56.77 s, respectively. Gamers completed them in 102.78 ± 42.60 and 102.63 ± 47.18 s. Gamers significantly outperformed non-gamers at both tasks. For the stone task: t (134.35) = 3.77, $p<0.001$, d = 0.6,

**Table 1** Gamers versus Non-Gamer demographics, game and task performance comparison

| Demographics and Tasks | Gamer (>3 h played per week at peak of gaming history) ($n=80$) | Non-Gamer (≤3 h played per week at peak of gaming history) ($n=80$) | $p$-value |
|---|---|---|---|
| Age (Mean ± SD) | 22.15 ± 2.11 | 21.98 ± 1.92 | 0.58 |
| Gender (Male[$n=55$]/ Female[$n=105$]) | 46(83.6%)/34(32.4%) | 9(16.4%)/71(67.6) | < 0.001 |
| Degree (BCMP [$n=32$], BDS [$n=1$], BHSc [$n=1$], Bpharm [$n=6$], MBBCH [$n=120$]) | 11(34.4%)/1(100%)/0/2(33.3%)/66(55%) | 21(65.6%)/0/1(100%)/4(66.7%)/54(45%) | 0.14 |
| Current year of study (2 [$n=9$] / 3[$n=54$] / 4[$n=18$] / 5[$n=71$] / 6[$n=8$]) | 5(55.6%)/22(40.7%)/16(88.9%)/33(46.5%)/4(50%) | 4(44.4%)/32(59.3%)/2(11.1%)/38(53.5%)/4(50%) | 0.01 |
| Years playing video games (Mean ± SD) | 9.54 ± 5.04 | 1.3 ± 2.81 | < 0.001 |
| Hours played per week during peak of gaming history (Mean ± SD) | 18.5 ± 14.17 | 0.54 ± 1.01 | < 0.001 |
| Hours currently played per week (Mean ± SD) | 3.84 ± 5.29 | 0.06 ± 0.24 | < 0.001 |
| Hand Dominance (R[$n=149$] / L[$n=11$]) | 75(50.3%) / 5(45.5%) | 74(49.7%) / 6(54.5%) | 0.75 |
| Video Game 1 Attempt 1 High Score (Mean ± SD), ($n=160$) | 6098.14 ± 5085.69 | 4077.05 ± 3983.06 | 0.006 |
| Video Game 1 Attempt 2 High Score (Mean ± SD), ($n=160$) | 7257.68 ± 5501.00 | 4974.54 ± 4681.88 | 0.005 |
| Video Game 2 Attempt 1 High Score (Mean ± SD), ($n=160$) | 5324.84 ± 3020.68 | 3596.04 ± 2230.07 | < 0.001 |
| Video Game 2 Attempt 2 High Score (Mean ± SD), ($n=159$) | 6807.57 ± 2764.24 | 4373.5 ± 2269.59 | < 0.001 |
| Ureteroscopic Task 1 – Stone task in seconds (Mean ± SD), ($n=156$) | 102.78 ± 42.60 | 134.43 ± 60.28 | < 0.001 |
| Ureteroscopic Task 2 – Diagnostic Task in seconds (Mean ± SD), ($n=153$) | 102.63 ± 47.18 | 126.24 ± 56.77 | 0.006 |

95% CI [0.29,0.93]. For the diagnostic task: t (151) = 2.81, $p=0.006$, d = 0.5, 95% CI [0.13,0.77].

Groups were similar in age, academic degree, and hand dominance, but differed significantly by gender. As expected, gamers reported significantly longer gaming history, peak, and current weekly playtime. In terms of task performance, gamers significantly outperformed non-gamers in both gaming and ureteroscopic tasks (Table 1).

An additional analysis considered self-reported gaming status, independent of gameplay duration or intensity, with participants classifying themselves as a gamer or non-gamer by selecting one of two questionnaire options.

Of 160 participants, 88 identified as gamers and 72 as non-gamers. Self-reported gamers completed both tasks significantly faster: stone task, 101.33 ± 40.98s, t(147.13) = 3.86, $p < 0.001$, d = 0.6, 95% CI [0.28, 0.92]; diagnostic task, 98.09 ± 42.3s, t(148.19) = 3.63, $p < 0.001$, d = 0.6, 95% CI [0.25, 0.89]. These results support an association between self-identified gamer status and enhanced task performance, independent of specific gaming history.

Finally, participants were categorized as current gamers or non-current gamers. Current gamers played > 3 h per week at the time of the study. Thirty participants met this criterion; 130 did not. Current gamers did not significantly outperform non-current gamers, based on t-tests: stone task: t (154) = 1.51, $p = 0.13$, d = 0.3, 95% CI [-0.09,0.71]; diagnostic task: t (151) = 1.95, $p = 0.05$, d = 0.4, 95% CI [0.0,0.81]. While there was a trend toward faster performance among current gamers, the differences did not reach statistical significance.

The study included 55 males and 105 females. Males outperformed females in both video games (Game 1 and Game 2: $p < 0.01$) and ureteroscopic tasks (Stone: $p < 0.001$; Diagnostic: $p = 0.03$), independent of gaming status. Hand dominance did not significantly affect performance on the stone ($p = 0.99$) or diagnostic task ($p = 0.22$), independent of gaming status.

A Pearson correlation assessed the relationship between the two ureteroscopic tasks and revealed a significant positive correlation ($p = 0.002$), with a small effect size (0.26). This indicates that participants who performed well on one task also tended to perform well on the other, suggesting consistent performance rather than random variation.

Independent of group classification, years of gaming experience were significantly associated with better performance, stone and diagnostic tasks: $p = 0.001$. Peak weekly gaming hours also correlated significantly, stone and diagnostic tasks: $p = 0.002$. In contrast, current gaming hours were not significantly related to task performance (stone: $p = 0.20$; diagnostic: $p = 0.07$), suggesting that long-term or peak gaming activity is more predictive of ureteroscopic performance than recent gameplay.

Mean video game scores, as an objective measure of gaming proficiency, were correlated with ureteroscopic task performance, independent of participant group or self-reported gaming history. Video Game 1 scores correlated with both the stone ($p = 0.01$) and diagnostic ($p = 0.01$) tasks, while Video Game 2 scores also showed significant correlations (stone: $p = 0.01$; diagnostic: $p = 0.02$). These findings suggest that the direct measurement of gaming skill demonstrated in video game performance overlap with the skills required for ureteroscopic tasks.

Lastly, no significant differences in ureteroscopic task performance were found based on preferred gaming genre. Regarding favourite platform, no significant correlation was found for the diagnostic task ($p = 0.69$), for the stone task two reported preferred platforms performed better: $p = 0.01$, Console: 96.42 ± 38.24, Computer: 94.91 ± 48.08, Mobile: 111.77 ± 45.72, Tablet: 128.42 ± 43.7. As expected, participants who preferred mobile or tablet platforms performed significantly better on gaming tasks conducted on those devices.

## Discussion

Simulation-based training has transformed medical education by enhancing clinical competency and enabling new research opportunities. Numerous studies have demonstrated its benefits, including the development of technical skills, reduced error rates, and a safe environment for repeated practice without risk to patients [17]. The increasing availability of 3D-printed models has facilitated the development and validation of cost-effective simulators for trainees and researchers, exemplified by the FiST model used in our study [15].

Mastering operations in a two-dimensional visual field while performing intricate procedures, often without tactile feedback, is particularly challenging in endoscopic surgery. Ureteroscopic tasks require precise hand-eye coordination, spatial awareness, and familiarity with complex instruments. Acquiring these skills typically involves simulation-based training, formal coursework, and supervised clinical practice [18], with structured, repetitive training necessary to achieve proficiency in endoscopic procedures such as laparoscopy [19]. In our study, ureteroscopic simulation using a bench model assessed the baseline aptitude of 160 participants with no prior endoscopic experience, aiming to identify natural ability before formal training or repetition.

Prior studies have shown that individuals with gaming experience perform better on laparoscopic simulators [20]. A meta-analysis found that trainees and experienced surgeons who regularly played video games outperformed non-gamers in laparoscopic tasks [21]. Our results support these findings, with gamers outperforming non-gamers in both video game and ureteroscopic simulations.

Previous research shows that video game experience enhances cognitive functions relevant to surgery, including divided and selective attention [22, 23]. A 2013 meta-analysis found that spatial skills gained from shooter games rival those from formal training [24]. Our findings align with this, showing that prior gaming experience significantly correlates with baseline ureteroscopic performance.

The primary aim of our study was to confirm whether a correlation exists between video gaming experience and baseline ureteroscopic performance, rather than to identify

the specific transferable skills involved. Future studies could investigate the precise cognitive and motor abilities underlying this relationship. Although task completion time was our primary performance metric, other validated tools, such as the Objective Structured Assessment of Technical Skills (OSATS) and global rating scales, may provide a more comprehensive evaluation of ureteroscopic proficiency [25]. However, as participants were novices and practice attempts were avoided to prevent skill acquisition, the applicability of these tools is limited in this context. Further research is needed to develop scoring systems tailored for novices, enabling detailed assessment across skill domains. Future studies could compare gaming and non-gaming cohorts after structured training to determine whether prior gaming experience confers an advantage, accelerates skill acquisition, or leads to higher overall proficiency.

Our study found that male participants outperformed females in ureteroscopic tasks, independent of gaming history, which may reflect cognitive, psychomotor, or experiential differences and warrants further investigation. Notably, the cohort included 50 more females than males, highlighting the need for a larger male sample in future studies before drawing definitive conclusions. We also observed that long-term gaming experience, measured by years of play and peak weekly hours, was associated with better performance, whereas current gaming activity showed no significant correlation. This suggests that sustained exposure over time may be more influential than recent gameplay, consistent with prior research showing that motor acuity improvements from first-person shooter games develop over prolonged practice [26]. Future studies could recruit participants across different age groups to assess the impact of age and extended gameplay, and examine associations with surgical interest, manual task experience, musical instrument proficiency, and sports participation.

Notable strengths of our study include the large sample size, the blinding of investigators to participants' gaming status during performance and demographic homogeneity (including hand dominance). Furthermore, the inclusion of a gaming task added internal validity to further confirm the correlation between gaming and ureteroscopic tasks. Finally, the strong correlation observed between the two ureteroscopic task results, independent of demographic variables or gaming history, suggests inherent individual differences in psychomotor aptitude that merit further investigation.

## Conclusion

The results of this study demonstrate a significant positive correlation between video game experience and baseline ureteroscopic skill, suggesting that shared visuospatial and cognitive abilities may underlie both gaming and endoscopic urological procedures. The use of simulators and bench models has proven valuable in identifying personal attributes and prior experiences that contribute to surgical proficiency. This study opens several promising avenues for new research, including exploring specific gaming platforms, genres, and individual games that may contribute to the development of relevant surgical skills. Future work could examine other life experiences or hobbies that may influence urological surgical aptitude and attempt to investigate the specific cognitive and psychomotor skills developed through these experiences. Identifying whether confirmed associations like baseline ureteroscopic skill and video gaming in our study is transferable to other urological procedures also warrants investigation. Furthermore, exploring the integration of targeted strategies, such as encouraging residents to engage in video game–based activities during their urological training, and assessing whether those who play video games achieve proficiency along the learning curve more rapidly could provide valuable insights, such findings may ultimately support the incorporation of video games into future surgical training curricula.

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**Author contributions** MVR: study conception and design, protocol, data collection and analysis and writing of main manuscript. NS: supervisor of research, study design conception, design and methods and editing of manuscript. AA: supervisor of research, study design conception, design and methods and editing of manuscript.

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**Data availability** The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Declarations

**Conflict of interest** The authors declare no competing interests.

**Ethical approval** Ethical approval was granted from the University of the Witwatersrand – Clearance Certificate No. M240828.

**Informed consent** Written informed consent was obtained from all individual participants included in the study.

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