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REVIEW

Simulation training for pelvic examination: a systematic review

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Abstract

Objective

Pelvic examination including vaginal digital examination and speculum inspection are crucial medical skills that are challenging to teach for both professors and students, because of its intimate nature. Consequently, education has shifted from a traditional approach to a simulation-enhanced education. This literature review summarizes the level of evidence for these not-so-new training modalities.

Methods

For this systematic review, the Pubmed database have been consulted using the following keywords: (Pelvic examination OR Vaginal examination) AND simulation. Eligible studies had to be published in French or English within the past 20 years and investigate simulation training for pelvic examination in the field of gynecology and obstetrics. For each paper, the following outcomes were analyzed: competence, confidence and communication, and were classified according to the Kirkpatrick hierarchy.

Results

About competence, in initial training, one meta-analysis (9 studies of which 4 randomized studies) about pelvic examination teaching on procedural simulators have shown a significant benefit of simulation. One meta-analysis and one systematic review also demonstrated that Gynecological Teaching Associates (GTAs) teaching, who exist in Northern America and Scandinavian countries, was better than pelvic task trainers in terms of technical competence, and comfort. For the vaginal examination of women in labor, two randomized trials also showed a positive impact of pelvic task trainer on students' accuracy.

Conclusion

Simulation-enhanced education of pelvic examination brings a significant benefit in comparison to a classic education without simulation in terms of competence, confidence and communication. GTAs have the best impact on competence and communication, but they do not exist currently in France. Hybrid simulation (a patient actor combined with a pelvic task trainer) could be a solution to teach both technical skills and communication.

Keywords:

Simulation training; pelvic task trainer; low-fidelity simulators; obstetrics and gynecology; education; pelvic examination; vaginal examination; gynecologic teaching associates.

Introduction

Pelvic examination including vaginal digital examination and speculum inspection are crucial skills for cervical cancer screening¹, but also to diagnose several gynecologic disorders², causes for vaginal bleeding or pain³, and also to diagnose women in labor^{4,5}. Performing a pelvic examination is therefore important for all graduating medical students, regardless of their specialty choice^{6,7}. However, teaching pelvic examination is challenging for both professors and students⁷. Indeed, its intimate nature can prompt negative feelings such as awkwardness for the practitioner and discomfort for patients⁷. Moreover, ethical issues with patient consent for student examinations were raised^{8,9}.

Consequently, education in the field of obstetrics and gynecology had to address those problems and has progressively shifted from a traditional approach including lectures and teaching in the clinical setting on patients to a simulation-enhanced education¹⁰. The adage “never the first time on a patient” has become more and more obvious, as well as the teaching of soft skills and correct attitudes with the patient¹¹.

However, a comprehensive assessment of these training interventions, their outcomes and level of evidence has not yet been conducted in France. The findings of such a systematic review may be relevant to guide the curricula and to improve student, teacher, and patient comfort with it. We therefore sought to investigate the level of evidence for those not-so-new training modalities, including pelvic task trainers and gynecologic teaching associates (GTAs) and offer guidelines for teaching in our faculties and local hospitals.

Material and methods

This systematic review was conducted and reported in adherence with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standard of quality¹². The initial corpus of scientific publications was constructed using PubMed with the following keywords: (Pelvic examination OR Vaginal examination) AND simulation, on February 2022.

Eligible studies had to be published in French or English within the past 20 years. We selected clinical trials, randomized clinical trials, meta-analysis, reviews, and systematic reviews. We used the human filter on Pubmed as well. Studies had to investigate simulation for the specific skill of pelvic examination (digital vaginal examination OR speculum) in both fields of gynecology and obstetrics. Pediatric studies were not included in that research. References lists of obtained articles were also screened.

Two reviewers (MLL and LD) performed the initial screening of the studies based on their titles and abstracts. The texts of all relevant studies were then reviewed independently. For each paper, the following outcomes were reported: competence, confidence and communication as well as the study characteristics (i.e., authors, year of publication, type of study, sample size, outcomes and main result, as well as the level of the study on the Kirkpatrick hierarchy). We also reported the level of the study on the KirkPatrick pyramid, which classifies the simulation studies into 4 categories : 1) satisfaction and knowledge ; 2) skills improvement ; 3) transfer to clinical practice ; 4) benefit to patient¹³.

Results

A total of 36 studies were screened, from which 13 articles were selected based on the title and the abstract in PubMed (**Figure 1** – Article flow chart) and 6 were added from the bibliographies, and a total of 19 studies were analyzed. Study characteristics (i.e., authors, year of publication, type of study, sample size, outcomes and main result, as well as the level of the study on the Kirkpatrick hierarchy) are displayed in **Table 1**.

Mainly two meta-analyses and a systematic review of the literature have evaluated the impact of simulation on learning the pelvic examination compared with more traditional learning^{7,14,15}. The three main outcomes found in the literature were technical competence, assessed objectively through objective structured clinical examinations (OSCEs) or checklists,

student's confidence with the procedure, assessed more subjectively through self-questionnaires, and communication with the patient.

1. Technical competence

The first and oldest meta-analysis was published in 2013 by Dilaveri et al. gathered nine trials on learning pelvic examination on low-fidelity mannequin, of which 4 were used for the meta-analysis and 2 were randomized controlled trials^{16,17}. It showed a benefit of simulation with a pooled effect size of 1.18 (95% CI 0.40-1.96; $p = 0.003$) compared with more conventional training modalities such as lectures or clinical companionship¹⁴.

The second meta-analysis published in 2015 by Smith et al. in the journal *Medical Education* assessed the specific value of simulation involving gynecological teaching associates (GTAs). These professionals are women especially trained to be examined by students and provide them real-time and reassuring feedback¹⁵. Simulation using real patients have been introduced mostly in North America and Scandinavia to overcome the lack of realism of inanimate models, teach how to interact with the patient during pelvic examinations and to increase skill transfer to clinical practice. Eleven studies were included, including 5 randomized controlled trials and 6 nonrandomized observational studies, mostly American studies, that compared GTAs versus more traditional low-fidelity simulation training and companionship. Competence was generally, except for 2 studies^{18,19}, assessed in a single-blind manner, with the assessors not knowing which group the student belonged to, and competence was assessed using competency scores combining dichotomous or 5-point items, from 4 days to 12 weeks after the procedure. This second meta-analysis found a pooled effect size of 0.57 (95% CI, 0.33-0.81) in favor of teaching on GTAs for technical skills. However, there was inconsistency between studies, with a heterogeneity of $I^2 = 58\%$ ¹⁵.

In a cost-effective study published by Janjua et al. in 2018, conducted at Birmingham University, it was shown that training using GTAs was more effective than a traditional lecture and a low-fidelity simulation training for undergraduate students learning pelvic examination. Indeed, respectively 28 and 12 more students achieved a "merit" and "distinction" level in the GTA group, out of a total of 492 students. However, GTA training was more expensive than low-fidelity training (£45.06 per student versus £7.40)¹⁰.

A recent systematic review of the literature, published in 2021 by Kirubarajan et al. gathered a total of 50 studies and with 6174 students, including 16 randomized controlled trials, 11 non-randomized controlled trials, and 23 studies without a control group (self-completed questionnaires, before-and-after studies, or qualitative studies)⁷. A total of 16 studies

objectively investigated students' competencies after GTA training. Twelve of these studies found improvements after training, including communication (n=3), familiarity with the technique (n=4), delicacy (n=1), good visualization of the cervix (n=1), and overall competence (n=9)²⁰. The remaining 4 studies found non-inferiority of GTAs training versus pelvic task trainer or clinical companionship alone.

For vaginal examination during labor specifically, two comparative studies have shown a positive impact of pelvic task trainer on student competence compared with clinical companionship alone. The first one, a French randomized trial included 66 students during their 5th year of medicine training and evaluated the competence of cervix examination (dilation, consistency, length, position and fetal presentation), compared with an experienced midwife examining a real women in labor (level 3 of the KirkPatrick pyramid)²¹. They showed a positive impact of pelvic task trainer on student competence compared with clinical companionship alone after 10 simulated examinations²¹. In another study, simulation training also dramatically improved student accuracy in labor cervical examinations after an average of 27 to 44 simulated examinations²². For the pelvic examination, the impact on patient morbidity and mortality has not yet been proven (no level 4 studies on the Kirk-Patrick pyramid). A study suggested that the order of instruction was important, starting with GTAs first and then pelvic task trainers²³, but another one suggested it should be the other way, starting first with pelvic task trainers²⁴. In general, all studies emphasized the need for more simulation training in the field of gynecological examinations.

There is only few data concerning continuing education for professionals, with only one study published by FitzPatrick et al. in 2012¹⁴. It included 17 graduate nurses participating in a simulation-based training program in clinical pelvic examination for sexual assault. The author noted an improvement in knowledge assessed by questionnaires consisting of 20 knowledge control questions before and after training (Pre-test score 69.1% \pm 1.7 versus Post-test score 84.4% \pm 2.6, P < .001). They also showed a benefit in terms of competence (> 85% of the acts in a checklist of 34 acts correctly performed) after their second scenario in a training program consisting of 4 high-fidelity scenarios of 45 minutes to 90 minutes in a simulation-based clinical pelvic examination training program for sexual assault²⁵.

2. Comfort

A trial published by Pugh *et al.* in 2009 looked at the impact of pelvic task trainers training performed before a gynecological clinical examination on the comfort of first-year

medical students during the pelvic examination. This was evaluated before and after the training on a pelvic task trainer, and scored from 1 to 6 (1= extremely uncomfortable to 6 = very comfortable). After a session of approximately 4 hours, there was an improvement of 0.83 points ($p<0.001$) for the speculum examination and 0.54 ($p<0.001$) for the bimanual vaginal touch when examining the GTA and students went from "extremely uncomfortable" to "relatively comfortable" with the pelvic examination²⁴.

In Smith *et al.*'s meta-analysis that compared GTAs with other methods, 2 trials were combined to assess students' perceived self-confidence, but they were quite old (1982 and 1978)^{26,27}. No difference in terms of student confidence between teaching with GTAs versus another method was found $RR = 0.37$ (95% CI, -0.23-0.96)¹⁵. However, in a more recent randomized controlled trial from UK including 407 students, self-reported confidence was higher in students taught by GTAs compared with those taught on pelvic task trainers (median score GTA 6.3; vs. conventional 5.8; $p=0.03$)²⁸.

In Kirubarajan *et al.*'s recent literature review, the benefits of simulation teaching in terms of student comfort or confidence were reported in 100% of the studies that evaluated it (23/23). Objective data included reduced self-reported anxiety ($n=5$), increased confidence ($n=11$), increased satisfaction ($n=2$) and also less discomfort ($n=5$)^{7,29,30}. GTA-led instruction was particularly helpful for students of the opposite sex³¹.

Looking at the French context where learning on GTAs does not currently exist, there are 3 recent studies evaluating students' feelings about learning the pelvic examination³²⁻³⁴. In a study from Paris published by Hugon-Rodin *et al.*, which was descriptive and carried out on 432 3rd and 5th year medical students, self-questionnaires evaluating comfort were distributed before and after training in pelvic examination using pelvic task trainer³³. Initially, 62% were embarrassed to perform it and 72% were apprehensive. After the training, 87% of the students declared themselves less embarrassed than initially. We also note that 77% and 97.9% of the students declared that their theoretical and practical knowledge had been improved, even if there was no control group. Another study from Lille by Piessen *et al.*, evaluated the satisfaction of 2nd year medical students after a similar training program in pelvic examination using a video combined with a pelvic task trainer exercise through self-questionnaires³⁴. In that study, students reported being either very satisfied (56.6%) or satisfied (43.2%) with the training. The teachers were also either very satisfied (13.4%) or satisfied (86.6%) with the training³⁴.

Similarly, in the study by Bouet *et al.* conducted in Angers, there was a significant decrease in students' apprehension about the gynecological examination at the end of the session [41% (29/71) vs. 15% (11/71), $p<0.05$]³². However, another study from Paris study revealed

that students were more satisfied with a video than with simulation-based teaching (very satisfied 57% vs. 33%, satisfied 39% vs. 66%, dissatisfied 4% vs. 1% respectively ($P < 0.004$)).

3. Communication

The meta-analysis by Smith *et al.* has shown a modest gain in communication learning in favor of GTAs versus clinical companionship or use of pelvic task trainers with a pooled effect size of 0.64 (95% CI, 0.07-1.21) but heterogeneity was high ($I^2=90\%$). Subgroup analysis by type of comparator: clinical companionship or pelvic task trainer simulation could not be performed in this meta-analysis due to insufficient data¹⁵.

Discussion

This review shows that learning pelvic examination through a simulation-enhanced education brings a significant benefit in comparison with classical learning without simulation in initial training. It improves technical skills, student's comfort and communication with the patient. Teaching with GTAs seems to perform even better than teaching with pelvic task trainers, although they exist mainly in northern America and northern Europe and require a considerable material and human cost.

Technical competences of the students were usually assessed thanks to checklists or Objective and Structured Clinical Evaluations (OSCEs), but also a hetero evaluation by the GTA herself or an auto evaluation of the difficulty perceived by the student. The type of competences that were assessed were: vaginal digital examination 's accuracy (consistence, length, dilation of the cervix), speculum placement (correct visualization of the cervix), delicacy, the technique for smear test, and overall competence. Most studies assessed those a single blind manner, meaning that the evaluator did not know in which group the student was trained, but obviously the student was aware of the type of training he received. All the studies converged to the same conclusion: simulation teaching enhanced medical students' skills, with level 3 evidence on the KirkPatrick hierarchy. The literature about simulation teaching of breast examination is also abundant, but it was not analyzed in this review.

Confidence or comfort were rated more subjectively by auto questionnaires fulfilled by students before and after or only after the teaching. This was declined under various forms: satisfaction with the teaching method, self-reported apprehension, perceived difficulty of the task, comfort with the examination, self-confidence, stress or fear. Some studies also tried to objectively assess students' stress by measuring blood pressure or heart rate, but those vital signs were not well correlated to students' comfort²³. In French studies, the use of pelvic task trainers showed a positive impact on students' confidence although there were only pre and post-test comparison with no comparator group³²⁻³⁵.

Communication was much less investigated, and mainly for GTA-led teaching in Smith *et al.* meta-analysis. The GTAs and/or a blinded physician were asked to score the communication between her on the student using a 5 point Likert scale or more complex scores, showing again a modest superiority of GTAs¹⁵. However, although patient experts and professional actors are new professions developing in universities, proper GTA training for pelvic examinations does not exist in France and is not currently generalizable and feasible. Further research in the best way to teach and assess communication skills to give explanations and support patients during vaginal examination would be worthwhile.

The main limits of current literature about simulation for gynecological examination teaching is that there is no evidence of direct benefit to patients (no level 4 study on the Kirkpatrick pyramid for pelvic examination). However, there is evidence about the translation of skills learned during simulation to clinical practice, especially for vaginal examination during labor²¹. If competence, confidence and comfort of both patients and medical students is improved, the quality and quantity of diagnosis should be improved as well as their precocity. This should also help future clinicians to achieve a more precise and precocious examination, and increase their consciousness about gynecological conditions. In the field of obstetric complications though, simulation has already proven its level 4 impact for shoulder dystocia (diminution of brachial plexus injury)³⁶ and cord prolapse (reduction of the time to delivery interval)³⁷.

Although there is good evidence of the utility of simulation in initial training for medical students and midwifery students, only one study was found about continuing education for professionals²⁵. Those basic skills address mainly early medical students. However, soft skills such as communication and attitude toward the patient courses may still help experienced professionals.

Conclusion

Learning pelvic examination through a simulation-enhanced education brings a significant benefit in comparison with classical learning without simulation in initial training of medical and midwifery students. It improves technical skills, student's comfort with it and communication with the patient. GTAs have the best impact on competence and communication, but they do not exist currently in France. Hybrid simulation (a patient actor combined with a pelvic task trainer) could be a solution to teach both technical skills and communication.

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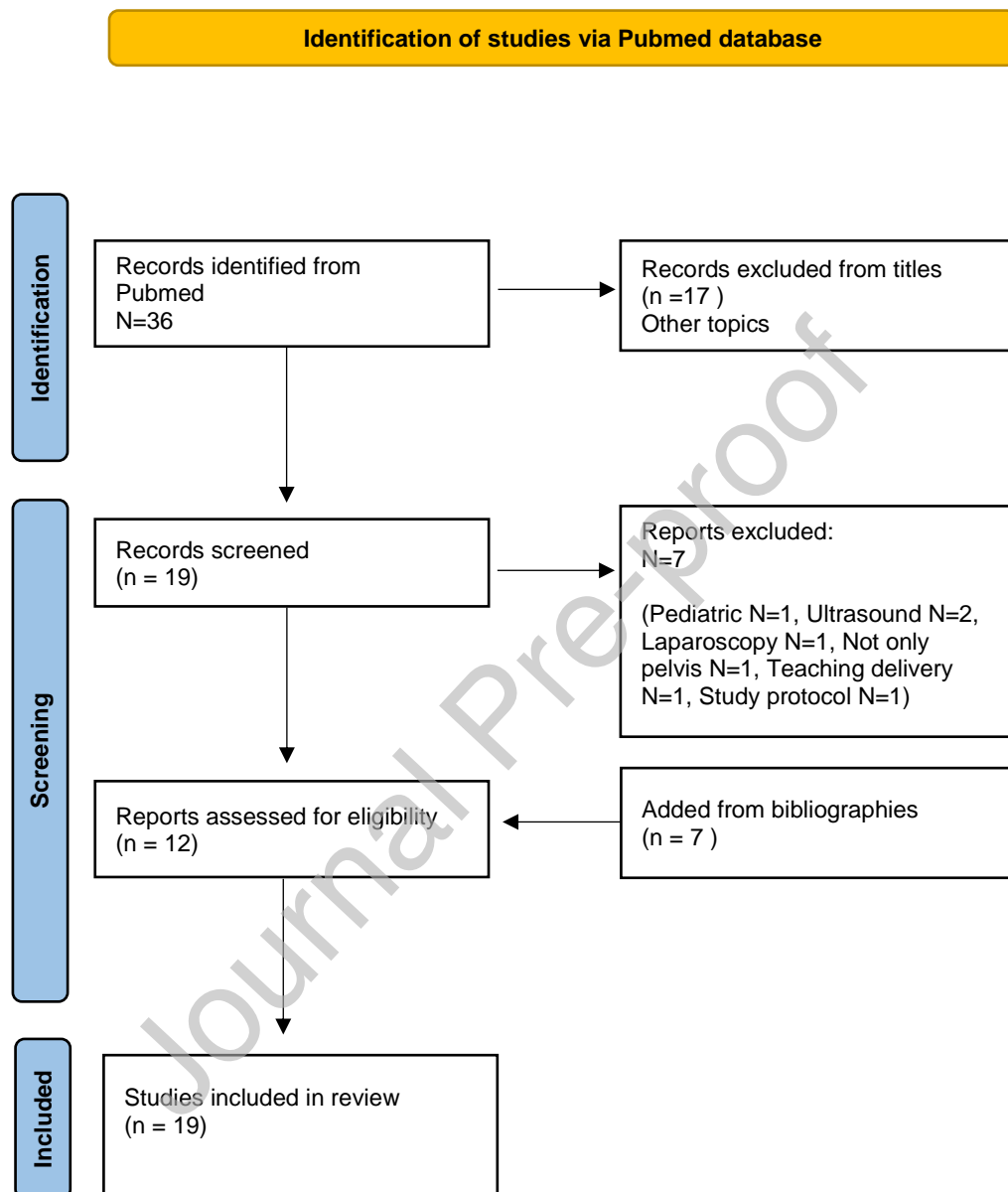
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Journal Pre-proof

Figure 1. Flow Chart



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71

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Table 1. Study characteristics

Reference	Study design	Population	Intervention	Control	Main result RR (IC 95%) Or mean score \pm DS p	Outcomes studied	Kirk Patrick's Level
Dilaveri 2013 (USA)	Meta-analysis : 4 études 9 studies for meta-analysis Including 2 RCTs	MS, residents N=2036	Pelvic Task Trainers	Pre/post test	1.18 (0.40 – 1.96) P=0.003	Competence	2
Smith 2015 (UK)	Meta-analysis 11 studies including 5 RCTs	MS, nurse students N=856	Pelvic Task Trainers +- video	GTAs	0.57 (0.33 - 0.81) 0.37 (0.23 - 0.96) 0.64 (0.07–1.21)	Competence Confidence Communication	2
Seago 2012 (USA)	RCT	MS, 2 nd year N=168	GTAs first	Pelvic Task Trainers first	The decrease in fear scores between the first and the second sessions was significantly greater for the GTA/SIM sequence as compared with the SIM/GTA sequence (difference in decreases, 17.7; 95% CI, 8.7–26.7). Learning activity performance scores were not affected by the sequence of instruction (28.7 vs. 28.9; $t = 0.45$, $df = 166$, $P = 0.65$)	Competence Fear score Blood pressure	2
Arias 2016 (France)	RCT	MS, 5 th year N=66	Pelvic Task Trainers	Clinical teaching only	Vaginal-examination accuracy score 21.7 \pm 2.3 vs 13.6 \pm 2.1 P<0.001	Competence (Vaginal-examination accuracy score on a real patient in labor)	3
Duffy 2016 (UK)	RCT	MS N=94	GTAs	Pelvic Task Trainers	Moderate effect on knowledge (difference 29.9% (95% CI 11.2-48.6%); $P = 0.002$) and confidence (difference 1 (95% CI 0-2) $P < 0.001$) Large effect on student comfort (difference 1.8 (95% CI 0.6-3.0) $P = 0.004$)	Knowledge Competence Confidence (Likert) Comfort	2
Wanggren 2010 (Sweden)	Descriptive	MS N=39	Outpatient clinic	Post-test only	The teaching session was regarded as important and useful by both students and CPs	Feelings, Attitudes and Competence (Autoquestionnaires)	1
Wanggren 2010 (Sweden)	Prospective controlled study	MS N=87	GTAs	Clinical teaching only	No difference in competences scores according to the student, the teacher of the patient between both training groups	Competence in a clinical setting (autoquestionnaires and patient questionnaire)	3

Janjua 2018 (UK)	Cost effective study	MS N=492	GTA	Pelvic Task Trainers	GTA : £45.06 Pelvic Task trainer : £7.40 (per student)	Cost effectiveness	—
Posner 2013 (Canada)	RCT	MS N=145	GTA	Pelvic Task Trainers	Impact of small talk on competence: Students trained in the 'plastic' condition outperformed those in the "small talk GTA" condition ($p = 0.013$).	Competence	2
Kirubarajan 2021 (Canada)	Literature review 50 studies Including 16 RCTs	MS N=6174	Pelvic Task Trainers, GTA	No simulation training	NA	NA	—
Janjua 2017 (UK)	RCT	Final year MS N=492	GTA	Pelvic Task Trainers	Self-reported confidence was higher in students taught by GTAs compared with pelvic task trainers (median score GTA 6.3; vs. conventional 5.8; $p=0.03$). Competence was also higher in those taught by GTAs when assessed by an examiner (median global score GTA 7.1 vs. conventional 6.0; $p<0.001$) and by a GTA ($p<0.001$)	Self-reported confidence Competence scored by examiner and by GTA	2
Brady 2015 (Australia)	RCT	Midwifery students N=69	Progressive fidelity (part task trainer and a simulated standardized patient)	Pelvic Task Trainers and life-sized poster of a pregnant woman)	The competence scores were higher in the progressive fidelity group compared to the low fidelity groups ($p=0.009$ and 0.012)	Competence (global rating score and Integrated Procedural Performance Instrument)	2
Nitsche 2015 (France)	RCT	MS N=98	Pelvic Task Trainers	No simulation training	Cervical examination: simulation trained students were more accurate in assessing dilation and effacement than controls ($P<.001$)	Competence (during labor)	2
Hugon_Rodin 2017 (France)	Pre-Post test design study	MS 3rd and 5th yeras N=432	Pelvic Task Trainers	Pre-Post test	More than 80% felt less uncomfortable after training.	Confidence	2
Piessen 2014 (France)	Post test design study	MS 2nd year N=419	Pelvic Task Trainers	Pre-Post test	High satisfaction with the pelvic task trainers training.	Satisfaction of students and teachers	1
Bouet 2016 (France)	Pre-Post test design study	MS 5 th year N=71	Pelvic Task Trainers	Pre-Post test	A significant ($P<0.05$) number of MS estimated the procedure's level of difficulty as being low at the end of the session.	Competence (Level of difficulty rated by students)	2
Fitzpatrick 2012 (USA)	Pre-Post test design study	Emergency Department personnel N=17	Pelvic Task Trainers	Pre-Post test	Significant gains in knowledge between pre-test and post-test (pre-test mean score of 69.1 ± 1.7 vs. post-test mean score of 84.4 ± 2.6 , $P < .001$).	Confidence Competence (checklist)	2

Pugh 2009 (USA)	Pre-Post test design study	Firs year MS N=344	Pelvic Task Trainers	Pre-Post test	Pelvic task trainers increased student comfort levels ($p < .001$).	Comfort	2
Grynberg 2012 (France)	Post test only	N=79 2 nd and 3 rd year MS	Pelvic Task Trainers and videos	Post-test only	The video clip had a higher degree of satisfaction than the task trainer.	Satisfaction	1

RCT : Randomized Control Study

GTA : Gynecologic Teaching Associate

MS : medical students

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