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ORIGINAL RESEARCH

VR Simulation-Based vs Traditional Apprenticeship Training in Gynecological Laparoscopy: A Comparative Survey of Residents' Expectations, Skills Acquisition, and Training Structure

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Background: Simulation has emerged as a transformative method in surgical education, offering reproducible training in risk-free environments. While widely adopted in Western Europe and North America, traditional apprenticeship remains dominant in Central and Eastern Europe, raising concerns about skill acquisition and standardization.

Objective: This study compared obstetrics and gynecology residents' perceptions of simulation-based versus apprenticeship laparoscopy training in Poland, focusing on expectations, skills acquisition, instructor engagement, and training structure.

Methods: A cross-sectional survey was conducted among 59 residents: 29 completed structured VR simulation-based courses and 30 participated in operating room apprenticeship. Data were collected using two course-specific questionnaires, from which nine comparable parameters were extracted. Chi-square tests were applied where distributions allowed; other items were analyzed descriptively.

Results: Simulation participants reported significantly greater fulfillment of expectations (96.6% large/very large vs 6.7% apprenticeship; χ^2=48.35, p<0.05) and higher skill acquisition (86.2% high/very high vs 10% apprenticeship; χ^2=40.60, p<0.05). Training duration and repetitions were more often judged optimal in the simulation group (82.8% and 93.1%, respectively) than in the apprenticeship group (33.3% and 10%). Instructor engagement was markedly higher in simulation (96.6% high/very high vs 3.3% apprenticeship; χ^2=52.24, p<0.05). Nearly all simulation residents (96.6%) endorsed making such training mandatory, with most recommending introduction between residency years two and four.

Conclusion: VR Simulation-based laparoscopy training was perceived as superior across expectations, skills acquisition, and structural factors. These findings, aligned with international literature, support integrating simulation as a mandatory component of gynecology residency curricula in Poland to improve both resident competence and patient safety.

Plain Language Summary: Learning surgical skills is demanding and requires safe, structured training. For many years, young doctors relied on the traditional apprenticeship model—often summarized as "see one, do one, teach one". Although this approach offers direct experience with real patients, it can be inconsistent and may limit the time residents have to practice essential skills in a controlled, low-risk environment.

Simulation-based training has become an increasingly important alternative. Using virtual or physical models, residents can practice laparoscopic procedures repeatedly before performing them on patients. This reduces risk, supports gradual skill development, and ensures standardized feedback from instructors.

In our study, we compared opinions from 59 gynecology residents in Poland. Twenty-nine of them completed structured simulation-based laparoscopy training, while 30 learned only through the traditional operating-room apprenticeship model. All residents completed a questionnaire evaluating whether the training met their expectations, what skills they gained, and how engaged their instructors were.

Residents who trained with simulation reported significantly higher satisfaction. Most indicated that their expectations were fully met, they gained meaningful laparoscopic skills, and they received strong instructional support. In contrast, many residents trained exclusively by apprenticeship felt their expectations were unmet, reported minimal skill acquisition, and noted low instructor involvement.

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Overall, the results show that simulation-based training offers a safer, more effective, and more satisfying learning environment. Residents strongly supported introducing mandatory simulation as part of specialist training. Incorporating structured simulation may help ensure that young gynecologists develop core laparoscopic skills before operating on patients.

Keywords: simulation training, apprenticeship, gynecology, laparoscopy, residency education, surgical skills

Introduction

Simulation has become one of the most transformative innovations in medical education. It allows trainees to practice repeatedly in controlled environments, avoiding risk to patients and ensuring structured skill acquisition. Some authors have argued that simulation-based training is not only beneficial but an ethical imperative in modern healthcare.[1]

Traditional apprenticeship models, often described by the phrase "see one, do one, teach one", are increasingly criticized for variability and lack of standardization.[2] Reviews of simulation research confirmed substantial benefits across technical and non-technical domains, underscoring its role in surgical education reform.[3,4]

A landmark randomized trial demonstrated that residents trained using virtual reality simulation performed significantly better in the operating room compared with those trained through apprenticeship.[5] More recent systematic reviews and meta-analyses confirm that simulation accelerates skill acquisition and improves performance metrics in surgery.[6]

In gynecology, simulation has been validated across several areas. Studies have confirmed sustained benefits of simulation-based ultrasound training on clinical performance, improved response in obstetric emergencies, and increased realism in communication and teamwork skills.[7–9] Furthermore, analyses of national practices suggest that structured simulation is increasingly mandated in residency curricula in Europe and North America.[10,11]

Despite this, in Central and Eastern Europe apprenticeship remains dominant. Residents in these settings often report dissatisfaction with feedback, insufficient opportunities for hands-on practice, and lack of standardized simulation exposure.[12,13] This study addresses these gaps by comparing perceptions of simulation-based laparoscopy training with apprenticeship training in a Polish residency program. By analyzing outcomes such as expectations met, skills acquired, instructor involvement, and structural elements of training, it aims to provide evidence to guide curriculum reform.

Methods

Study Design and Participants

This was a cross-sectional survey conducted among obstetrics and gynecology residents in Poland. A total of 59 residents participated: 29 who had completed structured VR simulation-based laparoscopy training (simulation group) and 30 who had trained in the operating room through apprenticeship (apprenticeship group). Participants represented multiple training centers across Poland, including university hospitals, regional referral centers, and district hospitals.

The simulation curriculum comprised four progressively structured modules, ranging from basic tasks such as camera manipulation, peg transfer, shape cutting, and electrocautery to advanced laparoscopic suturing and full-procedure simulations, including tubal clipping, management of ectopic pregnancy, and laparoscopic hysterectomy.

Recruitment and Data Collection

Data for both groups were collected as part of the project conducted by the Center of Postgraduate Medical Education (CMKP), titled "Development of specialty training of physicians in fields relevant to the epidemiological and demographic needs of the country, using endoscopic simulation techniques" between November 2019 and April 2020.

Residents assigned to the simulation group participated in structured laparoscopic training courses conducted at the Centre for Endoscopic Simulation (CSE), where they completed anonymous post-course questionnaires evaluating their training experience.

The apprenticeship group consisted of obstetrics and gynecology residents participating in the same project who attended standard minimally invasive surgery practical courses organized by the CMKP in an operating room setting.

These residents received a link to an anonymous online questionnaire assessing their training experience. The response rate was 90.9%, with 30 fully completed questionnaires included in the analysis.

The study was approved by the Bioethics Committee of the Center of Postgraduate Medical Education (approval No. 102/PB/2019), which authorized the use of specific questionnaires for educational evaluation within the project. Participation in the study involved only the analysis of anonymized educational data and did not include any clinical intervention. All participants had previously signed a Declaration of Participation in the CMKP training project, which included consent for the use of anonymized evaluation data for educational research purposes. Therefore, separate written informed consent was not required. Completion of the questionnaire was considered to indicate voluntary participation.

Survey Instrument

To enable consistent comparison between groups, shared domains were identified across both training formats, including fulfillment of expectations, perceived skill acquisition, instructor engagement, training duration, and opportunities for practice. The existing institutional questionnaire for simulation courses was adapted to match the structure of the apprenticeship training while preserving original item content. This approach ensured consistency across domains while maintaining the integrity of the institution-approved evaluation instrument. Ten parameters were extracted.
Eight comparable parameters between groups:

- Training outcome – pass/fail.
- Gender – female/male.
- Residency year.
- Extent to which training met expectations – five-point scale (not at all → very large extent).
- Endoscopic skill acquisition – five-point scale (none → very high).
- Training duration – too short, optimal, too long.
- Exercise repetitions – too few, optimal, too many.
- Instructor engagement – five-point scale (none → very high).

Two descriptive parameters (simulation group only):

- Curriculum placement – mandatory or optional.
- Preferred residency year for course delivery (years 1–6).

Data Analysis

Responses were recorded in aggregated form, with frequencies for each category in both groups. Descriptive statistics were expressed as absolute numbers and percentages. For comparisons between simulation and apprenticeship groups, chi-square tests of independence were applied. Where categories contained zero values across groups, significance testing was not performed, and distributions were reported descriptively. Statistical significance was set at $p<0.05$.

Results

The survey included 59 obstetrics and gynecology residents, 29 in the simulation group and 30 in the apprenticeship group. All participants (100%) in both groups successfully completed their respective training programs.

Gender Distribution

The simulation group consisted of 24 women (83%) and 5 men (17%), while the apprenticeship group included 24 women (80%) and 6 men (20%). Gender distribution was similar between groups.

Residency Year

The timing of course completion showed similar medians in both groups (year 3), although the simulation group demonstrated a wider distribution (IQR 2–5 vs 2–3.75), as illustrated in Figure 1. A Mann–Whitney U-test showed no significant difference between groups (U=317.0, p=0.064).

Extent to Which Training Met Expectations

Expectations were consistently higher in the simulation group. Of 29 simulation participants, 28 (96.6%) reported that their expectations were met to a large or very large extent, while only 1 (3.4%) rated fulfilment as medium. In contrast, only 2 of 30 apprenticeship residents (6.7%) reported large or very large fulfilment. A substantial proportion expressed dissatisfaction: 13 (43.3%) said expectations were not met at all, 11 (36.7%) indicated they were met only to a small extent, and 4 (13.3%) selected medium. The difference in distributions between groups was statistically significant (χ^2=48.35, p<0.05; Figure 2).

Assessment of Endoscopic Skill Acquisition

In the simulation group, 25 residents (86.2%) reported high or very high levels of skill acquisition (14 high 48.3% and 11 very high 37.9%), while 3 (10.3%) reported medium. None reported low or no skill gain. By contrast, half of the apprenticeship group (15 residents, 50%) stated that they had acquired no skills, 7 (23.3%) reported low, 5 (16.7%) medium, and only 3 (10%) high. None reported very high skill acquisition. The difference was statistically significant (χ^2=40.60, p<0.05; Figure 3).

Training Duration

Most simulation participants (24 of 29, 82.8%) rated the duration as optimal, while 5 (17.2%) felt it was too short. None considered it too long. In the apprenticeship group, however, 16 of 30 (53.3%) stated that training was too short, 10 (33.3%) regarded it as optimal, and 4 (13.3%) felt it was too long. This distribution was significantly different (χ^2=15.51, p<0.05).

Number of Exercise Repetitions

In the simulation group, 27 residents (93.1%) felt that the number of repetitions was optimal, while 2 (6.9%) reported too few. None selected the "too many" option. In the apprenticeship group, 27 of 30 (90%) reported too few repetitions, and only 3 (10%) regarded the number as optimal. None selected "too many". Because both groups had empty categories, chi-square testing was not reliable; however, the contrast in distributions was evident.

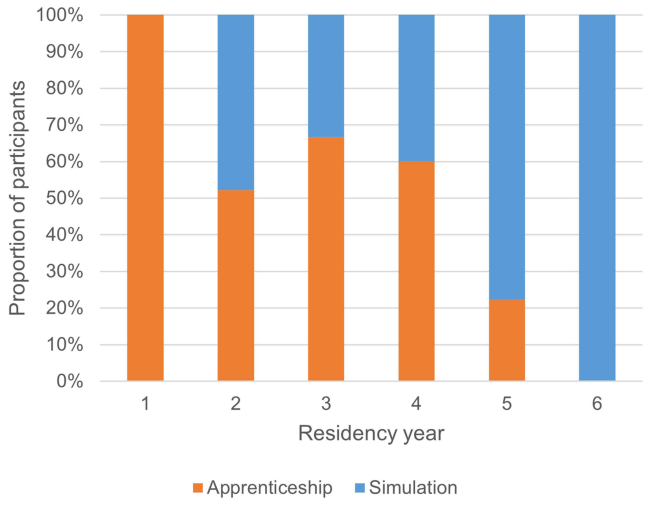

Figure 1 Residency year at which the course was completed.

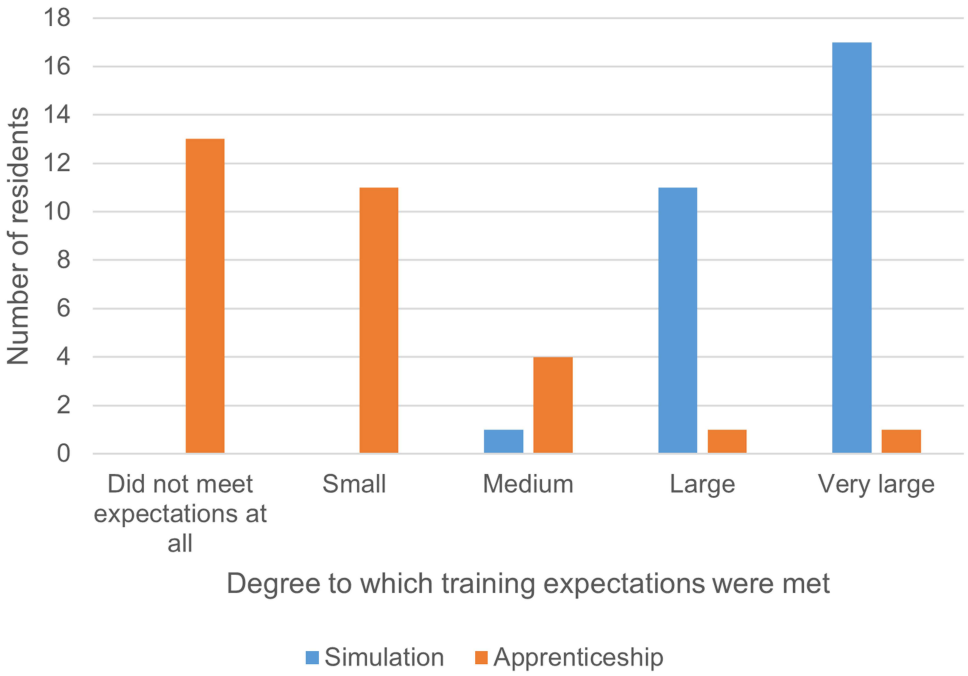

Figure 2 Reported degree to which training expectations were met in the apprenticeship and simulation groups ($p < 0.05$).

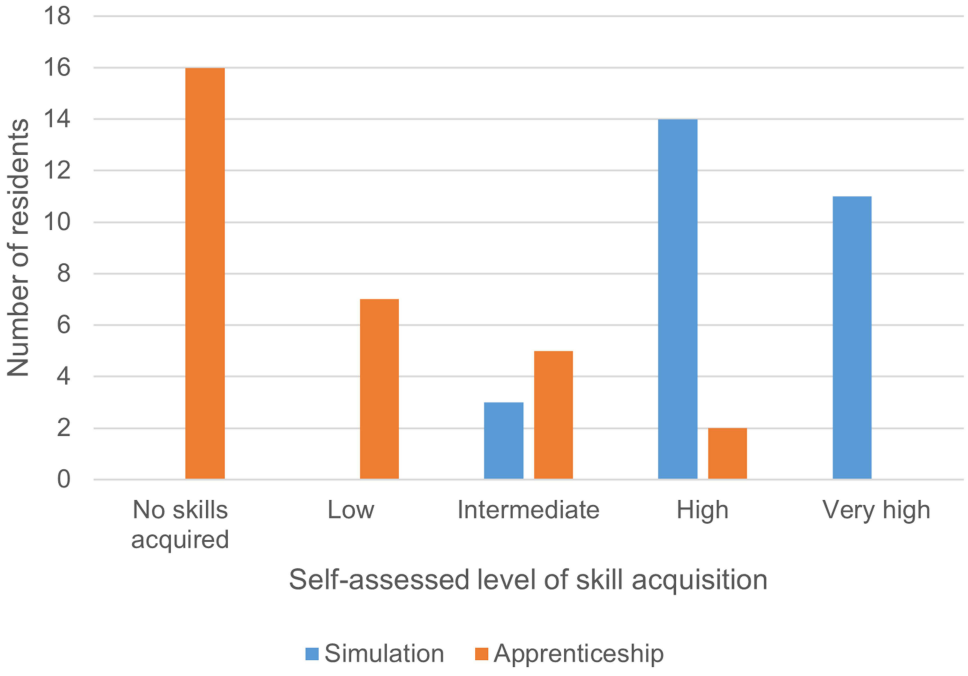

Figure 3 Self-assessed endoscopic skill acquisition in the apprenticeship and simulation groups ($p < 0.05$).

Instructor Engagement

Instructor engagement received markedly higher scores in the simulation group: 24 residents (82.8%) described involvement as very high, 4 (13.8%) as high, and 1 (3.4%) as medium. None reported low or absent engagement. In the apprenticeship group, 9 residents (30%) reported no engagement, 12 (40%) low, 8 (26.7%) medium, and only 1 (3.3%) high. None described it as very high. The difference between groups was statistically significant (χ^2=52.24, p<0.05).

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Curriculum Integration (Simulation Group Only)

Among simulation residents, 28 of 29 (96.6%) stated that the training should be mandatory in the residency curriculum, while only 1 (3.4%) considered it optional. When asked about timing, most residents favored early integration: 10 (34.5%) selected the third year, 9 (31%) the second year, and 8 (27.6%) the fourth year. Only one participant each (3.4%) chose the first or fifth year, and none selected the sixth. Because these items were not administered to the apprenticeship group, no statistical comparison was possible.

Discussion

This survey demonstrates a consistent and robust advantage of simulation-based laparoscopy training over traditional apprenticeship across multiple trainee-reported domains. Although both groups reported positive overall outcomes (100% completion), detailed comparisons revealed substantial and statistically significant differences in how residents experienced the two training formats. Expectations fulfillment was markedly higher in the simulation group (96.6% large/very large) than in the apprenticeship group (6.7% large/very large), echoing longstanding arguments that simulation offers reproducible, structured learning experiences.[1,2]

Resident satisfaction and perceived usefulness followed the same pattern. Simulation trainees reported very high usefulness and satisfaction in the vast majority of cases, whereas apprenticeship trainees clustered in low or medium categories. These findings are consistent with systematic reviews showing that simulation improves learner satisfaction and preparedness in surgical specialties.[3,6] Controlled studies confirm that simulation translates into better operative performance and steeper learning curves than apprenticeship alone.[5,6,13]

Skill acquisition emerged as one of the most striking outcomes of this study. In our data, 86.2% of simulation participants reported high or very high levels of skills acquisition, whereas "none/low" responses predominated among apprenticeship trainees. These findings are consistent with previous evidence demonstrating that simulation-based training shortens the learning curve and improves intraoperative performance.[5] Systematic reviews further confirm this advantage: robotic surgery studies have shown that simulation and structured training can reduce conversion rates compared with laparoscopic methods, particularly during early stages of the learning curve.[14] Other analyses suggest that while initial performance gains during robot-assisted surgery may stabilize or even decline over time, sustained benefits depend on ongoing practice, highlighting the importance of simulation to maintain and enhance surgical proficiency.[15] Moreover, reviews of reporting standards in robotic surgery underline the need for consistent evaluation of learning curves, reinforcing the crucial role of simulation in establishing surgical competence.[16] Findings from gynecology and related specialties add further weight, indicating that skills acquired through simulation transfer effectively into clinical practice when training is based on structured repetition and feedback.[7,17] Collectively, this evidence underscores simulation as a vital element in contemporary surgical education, essential for effective and durable skill acquisition.

Instructor engagement was consistently stronger in the simulation cohort. The overwhelming proportion rating engagement as high or very high contrasts with the apprenticeship group, where low and absent ratings predominated. This reflects broader findings that simulation centers provide protected teaching time, enabling structured feedback.[8,11] Figure 4 shows a resident performing laparoscopic training on a high-fidelity virtual reality simulator, representative of the training environment used in the study.

Structural aspects such as training duration and repetition also favored simulation. Simulation trainees overwhelmingly rated both aspects as optimal, while apprenticeship residents frequently found training too short and repetitions insufficient. This is consistent with deliberate practice theory, which emphasizes repeated, structured practice with feedback as the cornerstone of skill acquisition.[18]

Finally, nearly all simulation residents advocated for mandatory inclusion of simulation in residency curricula, with a preference for early integration in years 2–4. This reflects international trends toward embedding simulation into core residency training.[10,19] Introducing structured courses in the early stages of residency appears to reduce the variability inherent in traditional apprenticeship, where opportunities depend largely on clinical workload and supervisor availability. This aligns with evidence showing that early, standardized simulation accelerates the acquisition of foundational psychomotor skills and prepares residents for more efficient progression through the operative learning curve.[18,20,21] In

Figure 4 Resident performing laparoscopic training on a high-fidelity virtual reality simulator.

this context, our findings suggest that simulation not only improves the quality of training but also helps ensure more equitable access to early technical-skill development across residency programs.

This study reflects data from a single institutional program and is not representative of the national resident population. Because all available participants were included, no a priori power analysis was performed and results should be interpreted descriptively. The institutional, non-validated questionnaires and use of self-reported outcomes may limit reproducibility and introduce response bias.

Conclusions

This study provides clear evidence that VR simulation-based laparoscopy training is perceived by obstetrics and gynecology residents as superior to traditional apprenticeship across multiple domains. While both groups successfully completed their program, simulation participants consistently reported greater fulfillment of expectations, higher levels of laparoscopic skill acquisition, stronger instructor engagement, and more adequate training structure in terms of duration and repetition. Many of these differences were not only substantial but also statistically significant, underscoring the robustness of the findings.

The near-unanimous preference among VR simulation trainees for making such training mandatory within the residency curriculum highlights its perceived indispensability. Moreover, the concentration of recommendations for early to mid-residency (years 2–4) suggests that simulation is most desirable before or alongside initial operative exposure.

Taken together with international evidence, these results argue strongly that simulation should no longer be considered an optional supplement but rather a mandatory element of modern gynecology residency education. Its integration promises not only to improve resident satisfaction and competency but also to enhance patient safety by ensuring adequate preparation before independent surgical practice.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that there are no conflicts of interest associated with this article.

References

1. Ziv A, Wolpe PR, Small SD, Glick S. Simulation-based medical education: an ethical imperative. *Acad Med*. 2003;78(8):783–788. doi:10.1097/00001888-200308000-00006
2. Reznick RK, MacRae H. Teaching surgical skills--changes in the wind. *N Engl J Med*. 2006;355(25):2664–2669. doi:10.1056/NEJMra054785
3. McGaghie WC, Issenberg SB, Petrusa ER, Scalese RJ. A critical review of simulation-based medical education research: 2003-2009. *Med Educ*. 2010;44(1):50–63. doi:10.1111/j.1365-2923.2009.03547.x
4. Yi WS, Rouhi AD, Duffy CC, Ghanem YK, Williams NN, Dumon KR. A systematic review of immersive virtual reality for nontechnical skills training in surgery. *J Surg Educ*. 2024;81(1):25–36. doi:10.1016/j.jsurg.2023.11.012
5. Seymour NE, Gallagher AG, Roman SA, et al. Virtual reality training improves operating room performance: results of a randomized, double-blinded study. *Ann Surg*. 2002;236(4):458–63; discussion 463–4. doi:10.1097/00000658-200210000-00008
6. Shahrezaei A, Sohani M, Taherkhani S, Zarghami SY. The impact of surgical simulation and training technologies on general surgery education. *BMC Med Educ*. 2024;24(1):1297. doi:10.1186/s12909-024-06299-w
7. Tolsgaard MG, Ringsted C, Dreisler E, et al. Sustained effect of simulation-based ultrasound training on clinical performance: a randomized trial. *Ultrasound Obstet Gynecol*. 2015;46(3):312–318. doi:10.1002/uog.14780
8. Espey E, Baty G, Rask J, Chungtuyco M, Pereda B, Leeman L. Emergency in the clinic: a simulation curriculum to improve outpatient safety. *Am J Obstet Gynecol*. 2017;217(6):699.e1–699.e13. doi:10.1016/j.ajog.2017.09.008
9. Gavin NR, Satin AJ. Simulation training in obstetrics. *Clin Obstet Gynecol*. 2017;60(4):802–810. doi:10.1097/grf.0000000000000322
10. Marlier M, Chevreau J, Gagneur O, Sergent F, Gondry J, Foulon A. Practice and expectations regarding simulation for residents in obstetrics and gynecology. *J Gynecol Obstetrics Human Reprod*. 2022;51(3):102306. doi:10.1016/j.jogoh.2021.102306
11. Weimer J, Recker F, Hasenburg A, et al. Development and evaluation of a "simulator-based" ultrasound training program for university teaching in obstetrics and gynecology-the prospective GynSim study. *Front Med*. 2024;11:1371141. doi:10.3389/fmed.2024.1371141
12. Vidotti SP, Batista NA. A Simulação Clínica na Formação do Residente em Obstetrícia e Ginecologia na Perspectiva do Programa de Residência Médica [Clinical Simulation in the Training of Obstetrics and Gynecology Resident from the Perspective of Medical Residency Programs]. *Rev Bras Ginecol Obstet*. 2023;45(5):266–272. doi:10.1055/s-0043-1770127
13. Taksøe-Vester C, Dyre L, Schroll J, Tabor A, Tolsgaard M. Simulationsbasiertes ultraschalltraining in geburtshilfe und gynäkologie: eine systematische übersicht und metaanalyse [Simulation-based ultrasound training in obstetrics and gynecology: a systematic review and meta-analysis]. *Ultraschall Med*. 2021;42(6):e42–e54. doi:10.1055/a-1300-1680
14. Flynn J, Larach JT, Kong JCH, Waters PS, Warrier SK, Heriot A. The learning curve in robotic colorectal surgery compared with laparoscopic colorectal surgery: a systematic review. *Colorectal Dis*. 2021;23(11):2806–2820. doi:10.1111/codi.15843
15. Soomro NA, Hashimoto DA, Porteous AJ, et al. Systematic review of learning curves in robot-assisted surgery. *BJS Open*. 2020;4(1):27–44. doi:10.1002/bjs5.50235
16. Lam K, Clarke J, Purkayastha S, Kinross JM. Uptake and accessibility of surgical robotics in England. *Int J Med Robot*. 2021;17(1):1–7. doi:10.1002/rcs.2174
17. Yerra AK, Jogi S, Emmadisetty S, Animalla V, D'Souza A. Simulation-based training on basic obstetrics and gynecology ultrasound skills during COVID pandemic. *J Obstet Gynaecol India*. 2023;73(2):166–171. doi:10.1007/s13224-022-01719-7
18. Ericsson KA. Deliberate practice and acquisition of expert performance: a general overview. *Acad Emerg Med*. 2008;15(11):988–994. doi:10.1111/j.1553-2712.2008.00227.x
19. Antonelli G, Voiosu AM, Pawlak KM, et al. Training in basic gastrointestinal endoscopic procedures: a European Society of Gastrointestinal Endoscopy (ESGE) and European Society of Gastroenterology and Endoscopy Nurses and Associates (ESGENA) Position Statement. *Endoscopy*. 2024;56(2):131–150. doi:10.1055/a-2205-2613
20. Aggarwal R, Grantcharov TP, Eriksen JR, et al. An evidence-based virtual reality training program for novice laparoscopic surgeons. *Ann Surg*. 2006;244(2):310–314. doi:10.1097/01.sla.0000218094.92650.44
21. Crochet P, Aggarwal R, Dubb SS, et al. Deliberate practice on a virtual reality laparoscopic simulator enhances the quality of surgical technical skills. *Ann Surg*. 2011;253(6):1216–1222. doi:10.1097/SLA.0b013e3182197016