REVIEW

Characterizing Research Hotspots and Trends in Simulation-Based Training in Obstetrics and Gynecology 1961-2024: A Bibliometric Analysis

Hui Xie[1,2], Yugang Li[3], Pengjie Zhang[2,4], Wei Zhu[1,2]

[1]Clinical Training Center, The International Peace Maternity and Child Health Hospital, School of Medicine, Shanghai Jiao Tong University, Shanghai, People's Republic of China; [2]Shanghai Key Laboratory of Embryo Original Diseases, Shanghai, People's Republic of China; [3]School of Population Medicine & Public Health, Chinese Academy of Medical Sciences/Peking Union Medical College, Beijing, People's Republic of China; [4]Department of Medical Affairs, The International Peace Maternity and Child Health Hospital, School of Medicine, Shanghai Jiao Tong University, Shanghai, People's Republic of China

Correspondence: Wei Zhu, Clinical Training Center, The International Peace Maternity and Child Health Hospital, School of Medicine, Shanghai Jiao Tong University, #168, Wanghe Road, Fengxian, Shanghai, 200030, People's Republic of China, Email elainezhuwei@163.com

Background: Simulation-based training (SBT) has long been applied in obstetrics and gynecology (O&G) professional education. However, its current research status and trends remained understudied. This study aimed to examine the research performance and dynamics of SBT in O&G professional education.

Methods: A bibliometric analysis was conducted. Systematic searches were performed in the Web of Science. A total of 980 publications were included in the analyses. Summary statistics and visualizations were generated to present research performance and dynamics. A zero-inflated negative binomial regression model was developed to identify factors associated with total citations.

Results: The number of publications showed an upward trend between 1961 and 2024, with an annual growth rate of 7.35%. The most productive country was the USA, contributing to 41.84% of total publications. The most productive author was Sorensen JL, accounting for 1.43%. Citations per publication ranged from 0 to 304, with an average of 13.31. The top 10 keywords were simulation, obstetrics, training, education, gynecology, medical education, laparoscopy, simulation training, patient safety, and surgical education. Total citations peaked in 2013 at 1203, while average citations per publication peaked in 2009 at 53.57. The keywords skills, simulation, and performance remained dominating throughout the analyzed period. The research collaboration among the USA, UK, and Canada was predominant. Regression analysis revealed that every additional year since being published, funded research, every additional ten cited references, O&G-oriented research, SCIE-indexed research and every additional ten usage counts since 2013 were significantly associated with higher total citations (all p values < 0.05).

Conclusion: Although this research field is progressing rapidly, publications remain insufficient. Future research should focus on objective assessment of SBT in O&G professional education, long-term effectiveness assessment of SBT among O&G trainees, and optimization of implementation of advanced O&G simulators.

Keywords: simulation training, gynecology, obstetrics, professional education, bibliometrics

Introduction

Simulation-based training (SBT) has a long-standing application in health professions education and has become an integral component thereof.[1] SBT offers a non-actual yet realistic and immersive teaching and learning environment.[2] Within the environment, simulated clinical scenarios closely mirror real-world clinical practices and clinical trainees are able to acquire both technical and non-technical skills without the need for direct contact with real patients.[1–3] This effectively averts the occurrence of medical errors and the imposition of risks on patients.[3] Moreover, it has been well-established that SBT significantly contributes to enhancing healthcare efficiency.[4,5]

Almost all clinical specialties widely adopt SBT as a crucial instrument for professional education.[6] Specifically, SBT is employed to facilitate the implementation of training programs that center on tasks such as arranging surgical

3633

schedules, providing assistance in pain alleviation during childbirth, promoting cognitive-behavioral therapies in mental healthcare, and developing interpersonal skills among individuals with autism spectrum disorder.[6]

However, when compared with other clinical specialties, obstetrics and gynecology (O&G) is characterized by an extremely high level of complexity and precision in surgical procedures.[7] There are also growing demands to treat high-risk and emergency patients, necessitating enhanced teamwork and communication.[8,9] As to O&G professional education, several challenges cannot be ignored. For instance, in resource-constrained settings, O&G students often encounter limited access to training in clinical skills prior to commencing clinical practice.[10] This issue may render O&G professional education less effective. Additionally, male students may experience gender bias from actual patients. Such bias can lead to reduced opportunities for interactions with real-world patients.[11,12] SBT holds great potential as an essential tool to tackle these challenges.

Although guidelines acknowledge the role of SBT in health professions education,[6] challenges persist at both macro and micro levels. At the micro level, issues regarding simulation content, feedback quality, and assessment reliability remain.[13–15] At the macro level, challenges include insufficient funding for SBT implementation, an uneven distribution of qualified SBT educators, and limited adoption of advanced technologies.[13,14]

To guide targeted solutions, it is imperative to elaborate on the current status and patterns of research on SBT in O&G professional education. Bibliometric analysis can well serve as an analytical method.[16] By employing bibliometric analysis, researchers can examine published studies and their meta data to identify research hotspots, track trajectories of research topics, assess the impact of published works and uncover hidden collaboration patterns.[16]

Although several bibliometric analyses have been conducted in the fields of SBT and O&G respectively,[17–19] they rarely focused on the application of SBT in O&G professional education. Moreover, given the global shortage of O&G health professionals,[20,21] how to train individuals into qualified health professionals to meet the demands of O&G practice and how to expedite the adoption of SBT in O&G professional education, remain crucial questions to answer. Therefore, new insights into research dynamics are needed to guide educational practice, research practice and funding policies within this field. In this bibliometric study, we aimed to examine the current research hotspots, dynamics and intellectual structure of the application of SBT in O&G professional education. We also aimed to explore factors associated with the impact of research in this field.

Materials and Methods

This study was reported following the preliminary guideline for reporting bibliometric reviews of the biomedical literature (BIBLIO).[22] Since this study did not use primary data directly collected from human samples, ethical review was not required.

Data Sources and Search Strategy

Searches for relevant research were performed in the Web of Science Core Collection. This database was chosen over Scopus and PubMed because it provides comprehensive academic indexes (covering life science and education science) and has a strict index selection process that ensures quality. The following search terms and formula were used: TS = ((simulat*) AND (training* OR education* OR learning* OR teaching* OR study OR studies OR instruction*) AND (obstetrics OR gynecology)). Searched records were restricted to articles, reviews, and proceedings papers. Additionally, an English language filter and a date filter (up to 2024) were applied. Searches were performed on December 3, 2024.

Inclusion and Exclusion Criteria

Studies were included if they were original articles (quantitative, qualitative, or mixed-method research), review articles, and proceeding papers. Studies were excluded if they were duplicates, retracted articles, comments, perspectives, theses, abstracts, and news. Studies were also excluded if they were not related to SBT or O&G.

Data Analysis

Mean (standard deviation) and frequency(percent) were calculated to summarize research performance, including the most productive authors, countries, dominant keywords, and highly cited publications. Visualizations were generated to

illustrate temporal trends in publication volume, total and average citations, keyword occurrence, and journal contributions. Collaborations among authors, countries, and institutions were analyzed and visualized to present collaborations. The conceptual structure of the studied field was examined using multiple correspondence analysis (MCA).

To investigate determinants of research impact (total citations through 2024), a zero-inflated negative binomial regression model was developed. This type of model was selected based on the following considerations: 1) our study outcome was more like count data rather than continuous data; 2) the Vuong test confirmed that the zero-inflated model was preferred; and 3) over-dispersion was observed (dispersion parameter = 14.35).

The predictors included years since being published, author count, funding status, cited reference count, publishers, research types, research areas, science citation index expanded (SCIE)-indexed status, usage count since 2013 (full-text link clicks), and corresponding authors' locations. The final model was estimated with a robust standard error. All analyses were performed with R version 4.0. The bibliometric analyses were performed with the R package "bibliometrix".[23]

Results

Study Selection

The study selection process can be found in Figure 1. In brief, initial searches returned 1105 records. Sequential exclusions were applied as follows: 55 records not belonging to articles, reviews, or proceeding papers, 48 non-English publications, four duplicates, and 18 domain-irrelevant studies. Finally, 980 records were included in the analyses.
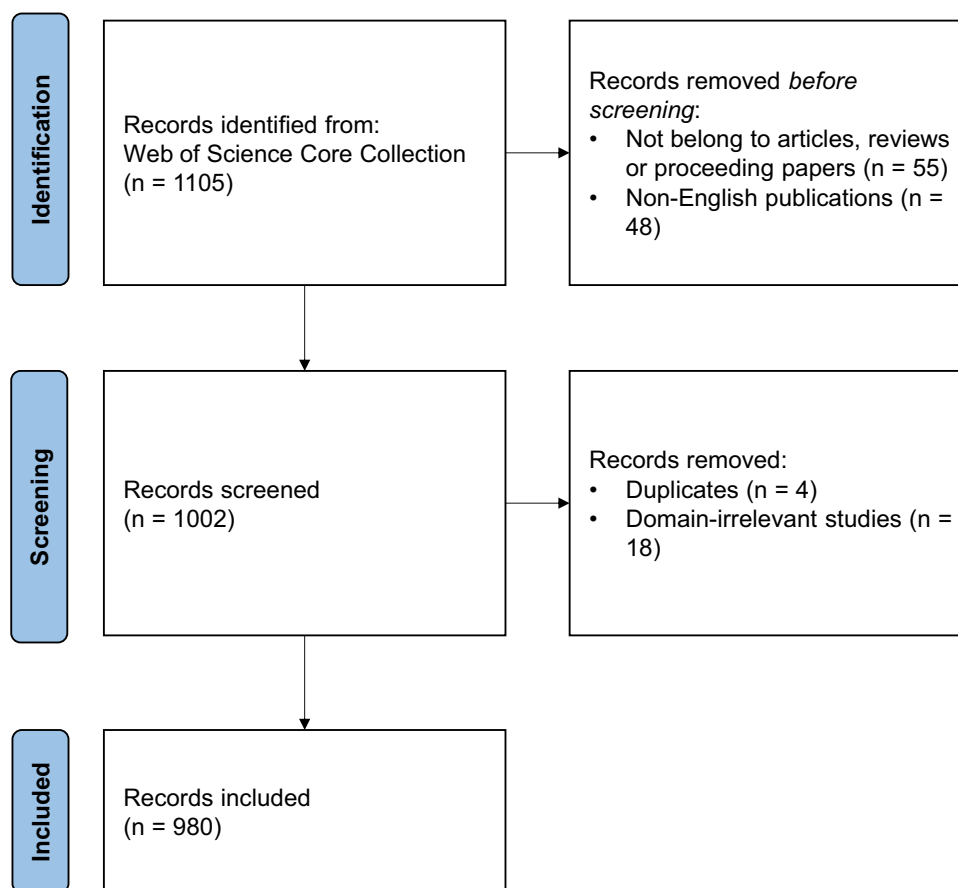
Figure 1 Study selection process.
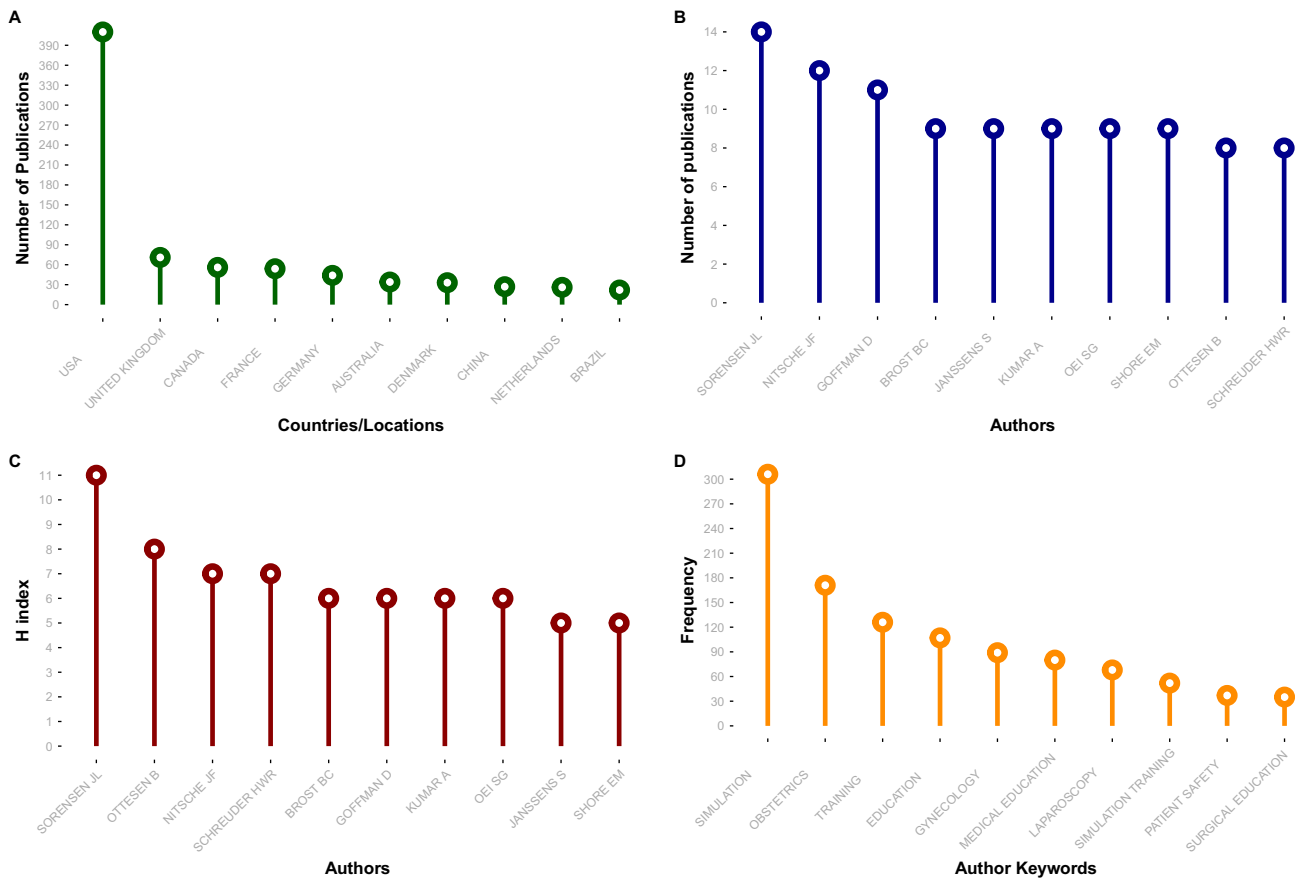
Research Performance

The earliest publication identified dates back to 1961, with a single study recorded. The latest year when any publication can be found was 2024, in which 87 studies were published. Citations per publication ranged from 0 to 304, with an average of 13.31. The most productive country was the USA, with 410 (41.84%) studies being published, followed by the UK with 71 (7.24%) and Canada with 56 (5.71%) (Figure 2A). The most productive author was Sorensen JL (14 studies, 1.43%), followed by Nitsche JF (12, 1.22%) and Goffman D (11, 1.12%) (Figure 2B). As to the H index (Figure 2C), Sorensen JL had the highest score at 11, followed by Ottesen B (8), Nitsche JF (7), and Schreuder HWR (7). The top ten keywords were simulation, obstetrics, training, education, gynecology, medical education, laparoscopy, simulation training, patient safety, and surgical education (Figure 2D). The ten most cited publications and associated total citations are listed in Table 1. The most relevant journal was the Journal of Minimally Invasive Gynecology.

Research Dynamics

A significant surge was found in the number of publications in 2008; in that year, 21 studies were published with an increase of 15 relative to 2007. Following 2008, a significant increasing trend can be observed. The first year when there were over 100 studies published was 2022 (Figure 3A). The annual growth rate of publication volume was 7.35%.

The average number of citations peaked in 2009 at 53.57 citations per publication; thereafter, this statistic presented a gradual decline. Total citations reached three peaks in 2009, 2012, and 2013, with values of 1125, 1096, and 1203 in those years respectively (Figure 3B and C).

The top three keywords over the analyzed period were skills, simulation, and performance. Before 2018, the occurrence of keyword performance dominated that of keywords skills and simulation; this situation was reversed

Figure 2 Research performance on simulation-based training in obstetrics and gynecology professional education. (**A**) Top 10 countries/locations with the highest productivity; (**B**) Top 10 authors with the highest productivity; (**C**) Top 10 authors with the highest H index; (**D**) Top 10 keywords.

Table 1 Top ten Highly Cited Publications

Rank	Publication	DOI	Total Citations	Design
1	Effect of virtual reality training on laparoscopic surgery: randomised controlled trial	10.1136/bmj.b1802	304	RCT
2	Interprofessional education in team communication: working together to improve patient safety	10.1136/postgradmedj-2012-000952rep	247	Pre-post design
3	Multidisciplinary team training in a simulation setting for acute obstetric emergencies: a systematic review	10.1097/AOG.0b013e3181d9f4cd	204	Review
4	Trends and research issues of mobile learning studies in nursing education	10.1016/j.compedu.2017.09.001	139	Review
5	Impact of a comprehensive patient safety strategy on obstetric adverse events	10.1016/j.ajog.2009.01.022	138	Quality improvement initiative
6	Recurrent obstetric management mistakes identified by simulation	10.1097/01.AOG.0000265208.16659.c9	125	Curriculum development
7	Validation of a tool to measure and promote clinical teamwork	10.1097/SIH.0b013e31816fdd0a	117	Tool validation
8	Using objective structured assessment of technical skills to evaluate a basic skills simulation curriculum for first-year surgical residents	10.1016/j.jamcollsurg.2009.05.005	112	Pre-post design
9	Team training in the neonatal resuscitation program for interns: teamwork and quality of resuscitations	10.1542/peds.2009–1635	108	RCT
10	To the point: medical education, technology, and the millennial learner	10.1016/j.ajog.2017.06.001	98	Review

Note: total citations are from Web of Science.
Abbreviation: RCT, randomized controlled trial.

after 2018 (Figure 3D). Other keywords, including obstetrics, education, and management, consistently remained dominated by the top three keywords throughout the analyzed period.

Although the American Journal of Obstetrics and Gynecology published the earliest relevant research among the top 10 journals, its dominance in publication volume was replaced by the Journal of Minimally Invasive Gynecology and Simulation in Healthcare from 2012 onwards. Notably, the Cureus Journal of Medical Science emerged as a significant source of relevant publications starting in 2019, with a sharp increase in annual output (Figure 3E).

Most authors published the majority of their work between 2013 and 2020. Most authors showed a nearly even distribution of total citations over time, except for Sorensen JL and Oei SG (Figure 3F).

Co-Word and Collaboration Analysis Results

The keyword skills had mild-to-strong connections with several other keywords, such as simulation, performance, obstetrics, education, and impact. The keywords management, care, delivery, shoulder dystonia, and trial were interconnected. The keyword surgery had mild-to-strong connections with the keywords validation, curriculum, and operating room. The keyword residents had strong connections with surgical skills (Figure 4).

The USA was the most productive country, collaborating primarily with the UK and Canada. German-speaking countries, including Germany, Switzerland, and Austria also showed some level of collaboration. Collaboration among other countries seemed to be uniformly weak (Figure 4).

Conceptual Structure Analysis Results

MCA identified three clusters of keywords. The first cluster was primarily related to communication, teamwork, and patient safety. The second cluster focused on medical students/residents and surgical training. The third cluster consisted of midwifery and interprofessional (Figure S1).

Factors Associated with Total Citations

The zero-inflated model results showed that with a one-unit increase in years since being published, the odds of receiving zero citations decreased by 82% (OR = 0.18, p<0.001). Other examined factors seemed to show no significant effects (all p values > 0.05, Table S1).

Figure 3 Research dynamics on simulation-based training in obstetrics and gynecology professional education. (**A**) Temporal trends in publication volume; (**B**) Temporal trends in average article citations; (**C**) Temporal trends in total citations; (**D**) Cumulative occurrences of keywords; (**E**) Cumulative occurrences of journals; (**F**) Temporal trends in author productivity.
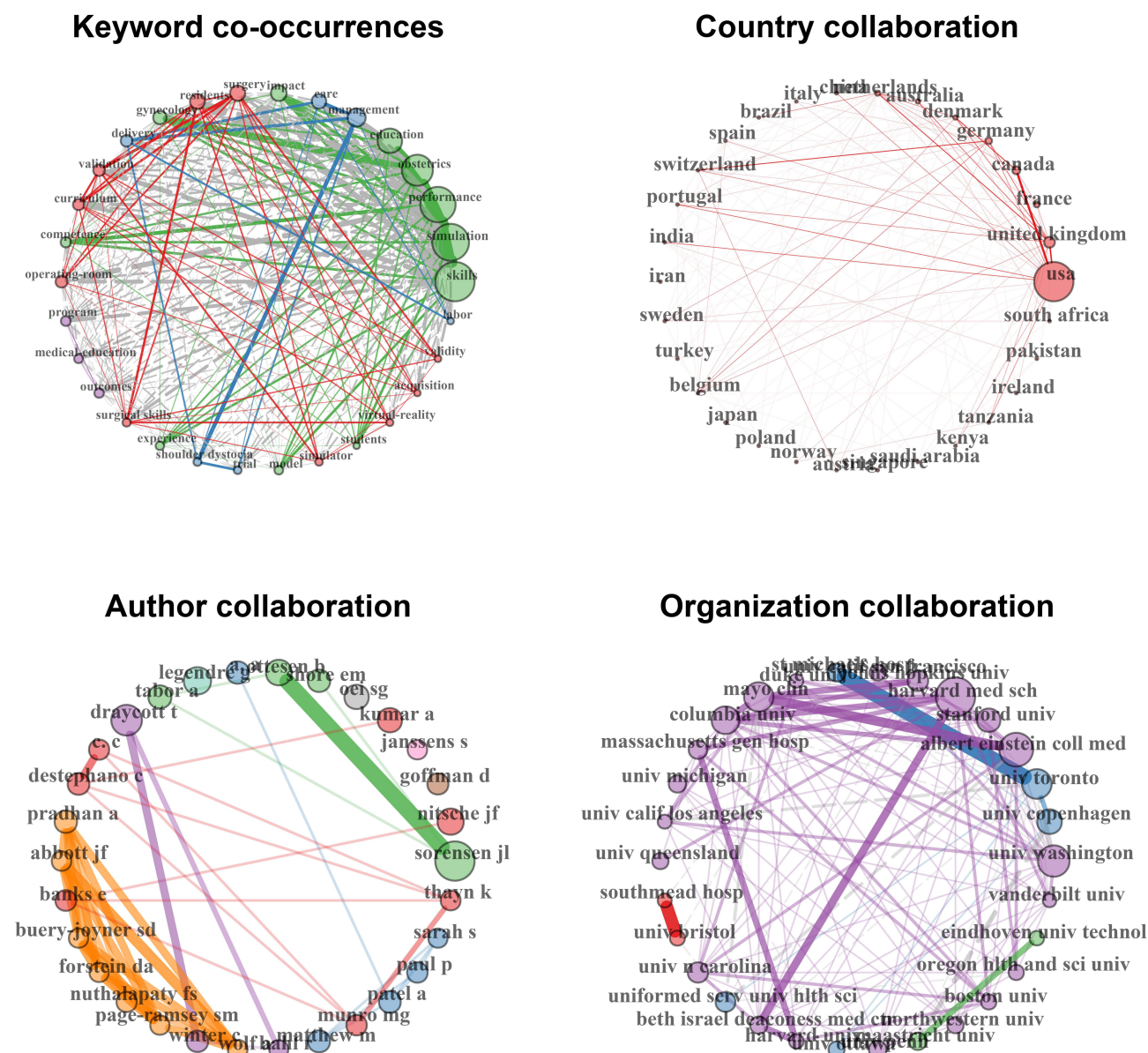
Notes: Journal 1: journal of minimally invasive gynecology; Journal 2: simulation in healthcare-journal of the society for simulation in healthcare; Journal 3: journal of surgical education; Journal 4: obstetrics and gynecology; Journal 5: international journal of gynecology and obstetrics; Journal 6: American journal of obstetrics and gynecology; Journal 7: European journal of obstetrics and gynecology and reproductive biology; Journal 8: surgical endoscopy and other interventional techniques; Journal 9: bmc medical education; Journal 10: cureus journal of medical science.

The count model results showed that each additional year since being published was associated with a 14% increase in total citations (RR = 1.14, p<0.001). Funded research was associated with a 28% increase in total citations (RR = 1.28, p = 0.001). Every additional ten cited references was associated with a 6% increase in total citations (RR = 1.06, p = 0.004). Relative to education-oriented research, O&G-oriented research was associated with a 29% increase in total citations (RR = 1.29, p = 0.024). SCIE-indexed research was associated with a 70% increase in total citations (RR = 1.70, p <0.001). Every additional ten usage counts since 2013 was associated with a 48% increase in the total citations (RR = 1.48, p < 0.001). Other examined factors seemed to show no significant effects (all p values > 0.05, Figure 5).

Discussion

Using a bibliometric analysis approach, we investigated research hotspots and trends in SBT in O&G professional education. Our study findings could offer an important opportunity to uncover the profiles and dynamics of the domain investigated.

Keyword co-occurrences

Country collaboration

Author collaboration
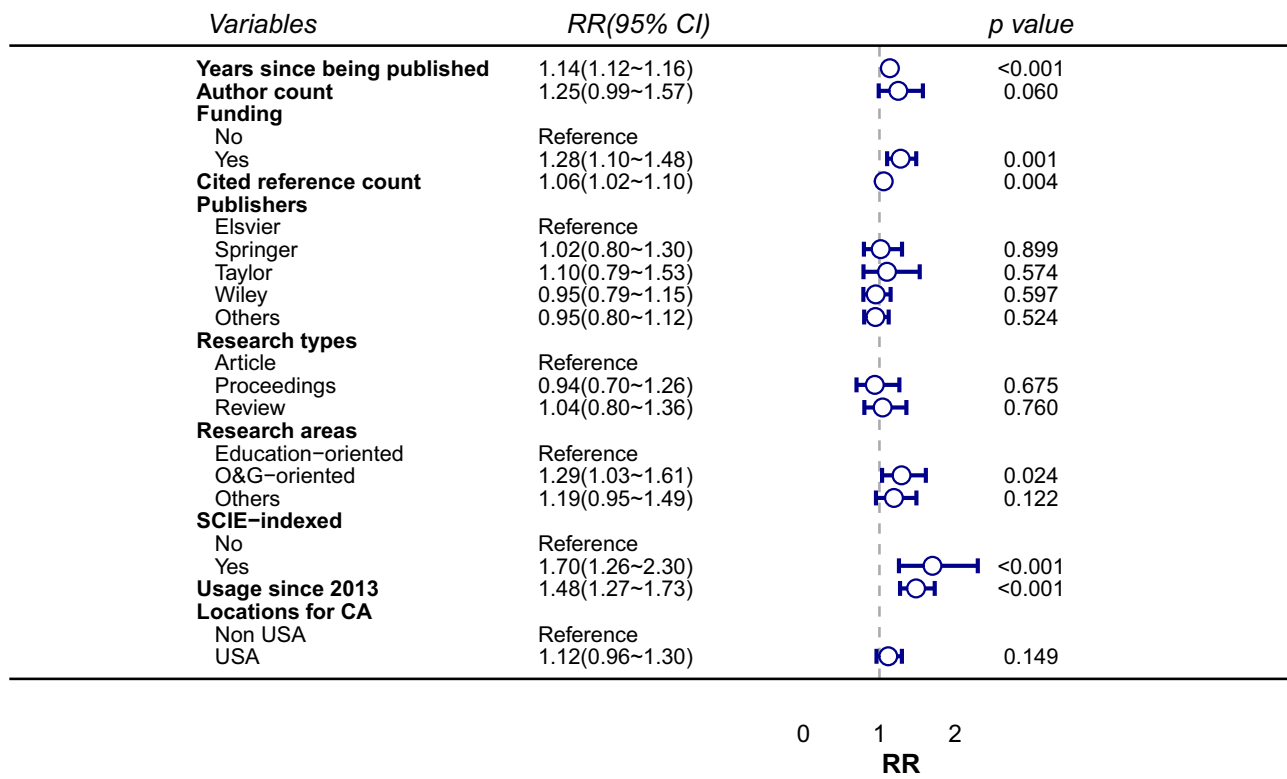

Organization collaboration

Figure 4 Co-word and collaboration analysis results.

Main Findings

We found that publications increased over time in this field, peaking in 2022. This peak is likely attributable to COVID-19. Social quarantine during this period forced most SBT programs to shift from offline to online delivery,[24,25] driving the adoption of advanced technologies such as virtual reality (VR), augmented reality (AR), and pre-recorded videos for SBT implementation.[26,27] This transition highlighted the urgent need to address challenges in adapting SBT to digital platforms. Concurrently, researchers prioritized developing hybrid SBT delivery models that integrate online and offline approaches.[26] In parallel, given the significant impact of COVID-19, exploring how to utilize SBT to enhance health professionals' capacity to address emergent issues was also a critical research focus.[28,29]

The three countries with the highest publication outputs were the USA, the UK, and Canada. Among the top 10 most productive countries, China and Brazil were the only economically developing countries. This pattern may highlight the uneven global distribution of research activity and advancement in SBT in O&G professional education. Evidently, research efforts on SBT remain concentrated in high-income economies.[30] This is not beyond

Variables	RR(95% CI)		p value
Years since being published	1.14(1.12~1.16)		<0.001
Author count	1.25(0.99~1.57)		0.060
Funding			
No	Reference		
Yes	1.28(1.10~1.48)		0.001
Cited reference count	1.06(1.02~1.10)		0.004
Publishers			
Elsvier	Reference		
Springer	1.02(0.80~1.30)		0.899
Taylor	1.10(0.79~1.53)		0.574
Wiley	0.95(0.79~1.15)		0.597
Others	0.95(0.80~1.12)		0.524
Research types			
Article	Reference		
Proceedings	0.94(0.70~1.26)		0.675
Review	1.04(0.80~1.36)		0.760
Research areas			
Education−oriented	Reference		
O&G−oriented	1.29(1.03~1.61)		0.024
Others	1.19(0.95~1.49)		0.122
SCIE−indexed			
No	Reference		
Yes	1.70(1.26~2.30)		<0.001
Usage since 2013	1.48(1.27~1.73)		<0.001
Locations for CA			
Non USA	Reference		
USA	1.12(0.96~1.30)		0.149

Figure 5 Forest plot for factors associated with total citations.
Abbreviations: RR, relative risk; CI, confidence interval; O&G, obstetrics and gynecology; SCIE, science citation index expanded.

expectation. Economically developed countries demonstrate significant advantages in resources and budgets that can be invested in simulation infrastructure, professional development for educators, and institutional capacity building. Leading medical institutions in the USA and the UK, for instance, maintain cutting-edge simulation settings equipped with high-fidelity simulators and auxiliary systems.[31–33] Such technologies enable the replication of complex O&G clinical scenarios with exceptional fidelity, thereby advancing research on SBT in O&G professional education. Additionally, robust funding mechanisms and research ecosystems that prioritize healthcare education innovation create sustained momentum for scholarly exploration in this domain.[34,35]

However, the relatively limited research outputs in developing economies may not indicate a reduced demand for SBT in these regions. Conversely, this situation underscores an urgent imperative to scale both implementation and scholarly assessment of SBT.[10,36,37] A WHO report shows that maternal mortality is higher in developing economies than in high-income countries.[38] This elevated maternal mortality can be partly attributed to health professionals' insufficient clinical skills and competencies in managing obstetric emergencies such as postpartum hemorrhage. Continuous provision of training in essential skills, such as midwifery, cesarean section, and management of postpartum hemorrhage, within a safe and realistic environment is crucial for enhancing health professionals' clinical capabilities and improving maternal outcomes.[39–41]

Research Hotspots

We determined research hotspots by simultaneously considering the top 10 publications with the highest citations, the top 10 keywords, and the three research clusters identified in the MCA.

Hotspot 1: SBT for O&G Surgical Education

The prominence of keywords "surgical education" and "laparoscopy" indicates the research community's prioritization of SBT in developing surgical competencies. In particular, the emphasis on laparoscopy reflects a research focus on minimally invasive techniques, which demand high precision and specialized training.[42] This observed research hotspot

can also be supported by the publication with the highest citation, which evaluated the effectiveness of the VR simulator in improving procedural quality in gynecological surgeries.[43]

Traditional laparotomy often involves large incisions, which can cause significant trauma to the body.[44,45] Minimally invasive surgeries such as laparoscopy and hysteroscopy only require a few small incisions or natural orifices in the abdomen or vagina, greatly reducing tissue damage.[46–48] Furthermore, many patients with gynecological diseases require fertility preservation. Minimally invasive surgeries enable minimization of the impact on fertility, and maximization of the chance of conception after surgery.[49] SBT has been demonstrated to be effective in helping trainees acquire such skills in minimally invasive surgeries.[42]

Hotspot 2: SBT and Patient Safety

The keywords "simulation", "training" and "patient safety" imply a research priority in examining the role of SBT in ensuring patient safety. We also identified a research cluster that consisted of communication, teamwork, and patient safety. This finding could further suggest that the research community pays substantial attention to investigating the effectiveness of communication and teamwork via SBT on patient safety. Of the 10 identified highly cited publications, several explored the effectiveness of teamwork training in reducing medical errors and improving patients' safety in O&G practice.[50–52] Admittedly, ensuring patient safety is of utmost importance. SBT has been recognized as an effective strategy to achieve this goal.[53,54] For example, ensuring patient safety in O&G practice requires complex communication with patients and their families. This is because O&G clinical decisions often involve high complexity due to the need to balance reproductive health and systemic health, necessitating a shared decision-making process that actively involves patients and their families.[55,56]

Hotspot 3: SBT for Interprofessional Education for Midwifery Practice

Midwives play a significant role in the well-being of mothers and children during the prenatal, labor, and postnatal phases.[57,58] SBT can simulate various clinical scenarios specific to midwifery, such as labor and delivery, emergency situations (like shoulder dystocia), and patient consultations, thereby enhancing the practical competencies of midwives. Moreover, midwives can practice interpersonal communication and collaboration by interacting with other healthcare professionals, such as obstetricians, nurses, and neonatologists in a controlled and shared environment. For example, a simulation of a high-risk delivery requires midwives to communicate effectively with the entire healthcare team, coordinate efforts for safe delivery, and manage potential complications. Earlier studies demonstrated the positive effectiveness of simulation-based interpersonal training among midwives.[59,60]

Factors Associated with Total Citations in This Field

O&G-oriented publications tended to receive more citations than education-oriented ones. This discrepancy may stem from differences in the nature of the subjects. In other words, publishing and disseminating study results is more urgent in medical and clinical research areas than in educational research areas. This is because clinical research is related to life and death, directly dealing with human health and survival. Once new therapies or interventions are validated to be of great effectiveness and value, they can be applied to clinical practice by as many health professionals as possible via publishing the study results. We also found that SCIE-indexed publications received more citations than those not indexed in SCIE. This may result from more stringent selection criteria for SCIE-indexed publications. Such criteria could lead to higher quality, visibility and dissemination efficiency, which could expose the publications to a wider audience.

Research Trends Forecast

Although we identified that surgical skills acquisition via SBT was one research hotspot, we failed to determine a research hotspot regarding the assessment of the effectiveness of SBT. One of the major challenges in SBT is to generate effective evidence with an objective and patient-related method.[61] Currently, most research focusing on SBT generally relies on subjective and self-reported methods to evaluate trainee-centered outcomes (eg, trainees' knowledge, self-confidence, and attitude), whereas objective methods for evaluating patient-centered clinical

endpoints—such as reduced risk of neonatal asphyxia or improved neonatal survival—remain underutilized.[19,62] Moreover, most SBT assessments focus on trainees' immediate performance in knowledge, self-confidence, and skills, lacking long-term assessment of sustained impacts on clinical skills and trainees' careers. Long-term assessment enables more crucial insights into the benefits of SBT.[2] Specific to O&G, we believe that this research trend would apply as well.

We failed to identify the integration of VR/AR technologies within SBT for O&G professional education as a research hotspot. Previous evidence has shown that VR/AR technologies significantly enhance trainees' clinical competency and psychological preparedness. Also, VR/AR technologies enable the simulation of clinical scenarios while eliminating the dependency on physical simulators, which can contribute to a cost-effective, reusable, and learner-friendly SBT.[63] However, real-world implementation of VR/AR in SBT faces some challenges, and addressing them could become a research hotspot. For example, VR simulators may fail to provide adequate force perception when simulating gynecological bi-manual examinations.[63,64] Given this, we predict that the research topic of optimization of technological adaptability of AR/VR simulators for the O&G specialty would be growing.

Strengths and Limitations

Our study's limitations should not be ignored. First, we only used a single database for publication searches. While the Web of Science can provide us with high-quality publications, it may miss out on low-quality non-peer-reviewed publications that potentially explore emerging research topics. Also, we excluded studies that were published in languages other than English, which may introduce some level of selection bias. Second, we are unable to be highly confident that the identified research hotspots based on top keywords, highly cited publications, and identified research clusters were actual research focuses. This challenge may be addressed through content analysis of each publication. However, given the large number of included publications (roughly 1000), this was not possible within one study. Third, due to limited data sources, we failed to investigate all possible factors associated with total citations in our regression analyses.

Conclusions

Our study suggests that although this research field is progressing rapidly, publications remain insufficient. Furthermore, as this interdisciplinary domain bridges O&G and education, borrowing strength from each other would benefit both the quantity and quality of research outputs. Finally, future research should focus on objective assessment of SBT in O&G professional education, long-term effectiveness assessment of SBT among O&G trainees, and optimization of implementation of advanced O&G simulators.

Data Sharing Statement

The data used in this study were obtained from Web of Science, a publicly accessible database.

Ethics Approval and Consent to Participate

Ethical review is not required for this study, as only secondary literature data are used.

Consent for Publication

Informed consent was obtained from the study participants.

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.

Funding

Disclosure

The authors declare that they have no competing interests in this work.

References

1. Bradley P. The history of simulation in medical education and possible future directions. *Med Educ*. 2006;40(3):254–262. doi:10.1111/j.1365-2929.2006.02394.x
2. Elendu C, Amaechi DC, Okatta AU, et al. The impact of simulation-based training in medical education: a review. *Medicine*. 2024;103(27):e38813. doi:10.1097/MD.0000000000038813
3. Aggarwal R, Mytton OT, Derbrew M, et al. Training and simulation for patient safety. *Qual Saf Health Care*. 2010;19 Suppl 2(Suppl 2):i34–43. doi:10.1136/qshc.2009.038562
4. Nickson CP, Petrosoniak A, Barwick S, Brazil V. Translational simulation: from description to action. *Adv Simul*. 2021;6(1):6. doi:10.1186/s41077-021-00160-6
5. Weldon SM, Buttery AG, Spearpoint K, Kneebone R. Transformative forms of simulation in health care-the seven simulation-based'I's: a concept taxonomy review of the literature. *Int J Healthcare Simul*. 2023;1–3. doi:10.54531/tzfd6375
6. Diaz-Navarro C, Armstrong R, Charnetski M, et al. Global consensus statement on simulation-based practice in healthcare. *Adv Simul*. 2024;9(1):19. doi:10.1186/s41077-024-00288-1
7. Park J, Bak S, Song JY, et al. Robotic surgery in gynecology: the present and the future. *Obstet Gynecol Sci*. 2023;66(6):518–528. doi:10.5468/ogs.23132
8. Detlefs SE, Goffman D, Buttle RA, et al. Correlation between medical management and teamwork in multidisciplinary high-fidelity obstetrics simulations. *Am J Obstet Gynecol MFM*. 2022;4(4):100626. doi:10.1016/j.ajogmf.2022.100626
9. Salman H. Most significant barriers and proposed solutions for medical schools to facilitate simulation-based undergraduate curriculum in OBGYN. *Arch Gynecol Obstet*. 2021;304(6):1383–1386. doi:10.1007/s00404-021-06133-4
10. Meza PK, Bianco K, Herrarte E, Daniels K. Changing the landscape of obstetric resident education in low- and middle-income countries using simulation-based training. *Int J Gynaecol Obstet*. 2021;154(1):72–78. doi:10.1002/ijgo.13526
11. Chang JC, Odrobina MR, McIntyre-Seltman K. The effect of student gender on the obstetrics and gynecology clerkship experience. *J Women's Health*. 2010;19(1):87–92. doi:10.1089/jwh.2009.1357
12. Craig LB, Buery-Joyner SD, Bliss S, et al. Undergraduate medical education committee, association of professors of gynecology and obstetrics. To the point: gender differences in the obstetrics and gynecology clerkship. *Am J Obstet Gynecol*. 2018;219(5):430–435. doi:10.1016/j.ajog.2018.05.020
13. Undergraduate Medical Education Committee, Association of Professors of Gynecology and Obstetrics, Crofton, MD; Everett EN, Forstein DA, Bliss S, et al. To the Point: the expanding role of simulation in obstetrics and gynecology medical student education. *Am J Obstet Gynecol*. 2019;220(2):129–141. doi:10.1016/j.ajog.2018.10.029
14. Owen H, Pelosi MA. A historical examination of the budin-pinard phantom: what can contemporary obstetrics education learn from simulators of the past? *Acad Med*. 2013;88(5):652–656. doi:10.1097/ACM.0b013e31828b0464
15. Thomas MP. The role of simulation in the development of technical competence during surgical training: a literature review. *Int J Med Educ*. 2013;4:48–58. doi:10.5116/ijme.513b.2df7
16. Ninkov A, Frank JR, Maggio LA. Bibliometrics: methods for studying academic publishing. *Perspect Med Educ*. 2022;11(3):173–176. doi:10.1007/s40037-021-00695-4
17. Sun W, Jiang X, Dong X, Yu G, Feng Z, Shuai L. The evolution of simulation-based medical education research: from traditional to virtual simulations. *Heliyon*. 2024;10(15):e35627. doi:10.1016/j.heliyon.2024.e35627
18. Chen S, Huang J, Zhang L, Xu Y, Zhang Z. Simulation-based training in robotic surgery education: bibliometric analysis and visualization. *J Robot Surg*. 2024;18(1):324. doi:10.1007/s11701-024-02076-5
19. Yao S, Tang Y, Yi C, Xiao Y. Research hotspots and trend exploration on the clinical translational outcome of simulation-based medical education: a 10-year scientific bibliometric analysis from 2011 to 2021. *Front Med*. 2022;8:801277. doi:10.3389/fmed.2021.801277
20. Holmer H, Lantz A, Kunjumen T, et al. Global distribution of surgeons, anaesthesiologists, and obstetricians. *Lancet Glob Health*. 2015;3 Suppl 2:S9–11. doi:10.1016/S2214-109X(14)70349-3
21. Stonehocker J, Muruthi J, Rayburn WF. Is there a shortage of obstetrician-gynecologists? *Obstet Gynecol Clin North Am*. 2017;44(1):121–132. doi:10.1016/j.ogc.2016.11.006
22. Montazeri A, Mohammadi S, M Hesari P, Ghaemi M, Riazi H, Sheikhi-Mobarakeh Z. Preliminary guideline for reporting bibliometric reviews of the biomedical literature (BIBLIO): a minimum requirements. *Syst Rev*. 2023;12(1):239. doi:10.1186/s13643-023-02410-2
23. Aria M, Cuccurullo C. bibliometrix: an R-tool for comprehensive science mapping analysis. *J Informetr*. 2017;11(4):959–975. doi:10.1016/j.joi.2017.08.007
24. Calhoun KE, Yale LA, Whipple ME, Allen SM, Wood DE, Tatum RP. The impact of COVID-19 on medical student surgical education: implementing extreme pandemic response measures in a widely distributed surgical clerkship experience. *Am J Surg*. 2020;220(1):44–47. doi:10.1016/j.amjsurg.2020.04.024
25. Corvetto MA, Kattan E, Varas J, Caro I, Altermatt FR. Designing sustainable solutions to implement a distance-based simulation basic life support training program during COVID-19 pandemic in low-income countries. *Simul Healthc*. 2022;17(5):351–352. doi:10.1097/SIH.0000000000000651

26. Boutros P, Kassem N, Nieder J, et al. Education and training adaptations for health workers during the COVID-19 pandemic: a scoping review of lessons learned and innovations. *Healthcare*. 2023;11(21):2902. doi:10.3390/healthcare11212902

27. Pan D, Rajwani K. Implementation of simulation training during the COVID-19 pandemic: a new york hospital experience. *Simul Healthc*. 2021;16 (1):46–51. doi:10.1097/SIH.0000000000000535

28. Aldekhyl SS, Arabi YM. Simulation role in preparing for COVID-19. *Ann Thorac Med*. 2020;15(3):134–137. doi:10.4103/atm.ATM_114_20

29. Dubé M, Kaba A, Cronin T, Barnes S, Fuselli T, Grant V. COVID-19 pandemic preparation: using simulation for systems-based learning to prepare the largest healthcare workforce and system in Canada. *Adv Simul*. 2020;5(1):22. Erratum in: Adv Simul (Lond). 2021 Apr;6:13. doi: 10.1186/ s41077-021-00165-1. doi:10.1186/s41077-020-00138-w

30. Martinerie L, Rasoaherinomenjanahary F, Ronot M, et al. Health care simulation in developing countries and low-resource situations. *J Contin Educ Health Prof*. 2018;38(3):205–212. doi:10.1097/CEH.0000000000000211

31. High Fidelity Simulators. UCLA simulation center. Available from: https://sim.ucla.edu/resources/high-fidelity-simulators. Accessed February. 28, 2025.

32. Simulation Center. Cleveland Clinic. Available from: https://my.clevelandclinic.org/departments/education/professional-development/sim-center. Accessed February. 28, 2025.

33. GAPS-Technology Enhanced Learning & Teaching. Advanced patient simulation & skills centre. Available from: https://gapssimulation.com/. Accessed February. 28, 2025.

34. Morciano C, Errico MC, Faralli C, Minghetti L. An analysis of the strategic plan development processes of major public organisations funding health research in nine high-income countries worldwide. *Health Res Policy Syst*. 2020;18(1):106. doi:10.1186/s12961-020-00620-x

35. Cassola A, Baral P, Røttingen JA, Hoffman SJ. Evaluating official development assistance-funded granting mechanisms for global health and development research that is initiated in high-income countries. *Health Res Policy Syst*. 2022;20(1):55. doi:10.1186/s12961-022-00859-6

36. Traynor MD, Owino J, Rivera M, et al. Surgical simulation in East, Central, and Southern Africa: a multinational survey. *J Surg Educ*. 2021;78 (5):1644–1654. doi:10.1016/j.jsurg.2021.01.005

37. Chou WK, Ullah N, Arjomandi Rad A, et al. Simulation training for obstetric emergencies in low- and lower-middle income countries: a systematic review. *Eur J Obstet Gynecol Reprod Biol*. 2022;276:74–81. doi:10.1016/j.ejogrb.2022.07.003

38. Say L, Chou D, Gemmill A, et al. Global causes of maternal death: a WHO systematic analysis. *Lancet Glob Health*. 2014;2(6):e323–33. doi:10.1016/S2214-109X(14)70227-X

39. Jaufuraully S, Dromey B, Stoyanov D. Simulation and beyond - Principles of effective obstetric training. *Best Pract Res Clin Obstet Gynaecol*. 2022;80:2–13. doi:10.1016/j.bpobgyn.2021.10.004

40. Hale S. Evidence-based education programs to improve maternal outcomes. *J Obstet Gynecol Neonatal Nurs*. 2024;54(2):S0884–2175(24)00297–1. doi:10.1016/j.jogn.2024.09.006

41. Amatullah AF. Using interprofessional simulation-based training to improve management of obstetric emergencies: a systematic review. *Clin Simul Nurs*. 2018;14:45–53. doi:10.1016/j.ecns.2017.10.014

42. Spiliotis AE, Spiliotis PM, Palios IM. Transferability of simulation-based training in laparoscopic surgeries: a systematic review. *Minim Invasive Surg*. 2020;2020:5879485. doi:10.1155/2020/5879485

43. Larsen CR, Soerensen JL, Grantcharov TP, et al. Effect of virtual reality training on laparoscopic surgery: randomised controlled trial. *BMJ*. 2009;338(may14 2):b1802. doi:10.1136/bmj.b1802

44. Burger JW, Van't Riet M, Jeekel J. Abdominal incisions: techniques and postoperative complications. *Scand J Surg*. 2002;91(4):315–321. doi:10.1177/145749690209100401

45. Rajaretnam N, Okoye E, Burns B. Laparotomy. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing; 2025. Available from https://www.ncbi. nlm.nih.gov/sites/books/NBK525961/.

46. Cui N, Liu J, Tan H. Comparison of laparoscopic surgery versus traditional laparotomy for the treatment of emergency patients. *J Int Med Res*. 2020;48(3):300060519889191. doi:10.1177/0300060519889191

47. Wang J, Cheng L, Liu J, et al. Laparoscopy vs laparotomy for the management of abdominal trauma: a systematic review and meta-analysis. *Front Surg*. 2022;9:817134. doi:10.3389/fsurg.2022.817134

48. Galaal K, Donkers H, Bryant A, Lopes AD. Laparoscopy versus laparotomy for the management of early stage endometrial cancer. *Cochrane Database Syst Rev*. 2018;10(10):CD006655. doi:10.1002/14651858.CD006655.pub3

49. Motan T, Antaki R, Han J, Elliott J, Cockwell H. Guideline No. 435: minimally invasive surgery in fertility therapy. *J Obstet Gynaecol Can*. 2023;45(4):273–282.e2. doi:10.1016/j.jogc.2023.03.004

50. Brock D, Abu-Rish E, Chiu CR, et al. Interprofessional education in team communication: working together to improve patient safety. *BMJ Qual Saf*. 2013;22(5):414–423. doi:10.1136/bmjqs-2012-000952

51. Pettker CM, Thung SF, Norwitz ER, et al. Impact of a comprehensive patient safety strategy on obstetric adverse events. *Am J Obstet Gynecol*. 2009;200(5):492.e1–8. doi:10.1016/j.ajog.2009.01.022

52. Maslovitz S, Barkai G, Lessing JB, Ziv A, Many A. Recurrent obstetric management mistakes identified by simulation. *Obstet Gynecol*. 2007;109 (6):1295–1300. doi:10.1097/01.AOG.0000265208.16659.c9

53. Lopez CM, Laffoon K, Kutzin JM. Use of simulation for improving quality and patient safety. *Nurs Clin North Am*. 2024;59(3):463–477. doi:10.1016/j.cnur.2024.01.006

54. Lynch A. Simulation-based acquisition of non-technical skills to improve patient safety. *Semin Pediatr Surg*. 2020;29(2):150906. doi:10.1016/j. sempedsurg.2020.150906

55. Lippke S, Derksen C, Keller FM, Kötting L, Schmiedhofer M, Welp A. Effectiveness of communication interventions in obstetrics-A systematic review. *Int J Environ Res Public Health*. 2021;18(5):2616. doi:10.3390/ijerph18052616

56. Chang YS, Coxon K, Portela AG, Furuta M, Bick D. Interventions to support effective communication between maternity care staff and women in labour: a mixed-methods systematic review. *Midwifery*. 2018;59:4–16. doi:10.1016/j.midw.2017.12.014

57. Bahri Khomami M, Walker R, Kilpatrick M, de Jersey S, Skouteris H, Moran LJ. The role of midwives and obstetrical nurses in the promotion of healthy lifestyle during pregnancy. *Ther Adv Reprod Health*. 2021;15:26334941211031866. doi:10.1177/26334941211031866

58. Gauci J, Parascandalo RP. The lived experiences of newly qualified midwives in supporting women during labor and birth: a hermeneutic phenomenological study in Malta. *Eur J Midwifery*. 2025;9(February):1–11. doi:10.18332/ejm/200073

59. Branch R, Cole K, Gibbons W, Clement D, Wands L. Piloting an interdisciplinary simulation-based educational experience with nurse anesthesia, nurse midwifery, and prelicensure nursing students. *Clin Simul Nurs*. 2025;100:101690. doi:10.1016/j.ecns.2025.101690

60. Edwards SE, Platt S, Lenguerrand E, et al. Effective interprofessional simulation training for medical and midwifery students. *BMJ Simul Technol Enhanc Learn*. 2015;1(3):87–93. doi:10.1136/bmjstel-2015-000022

61. Zendejas B, Brydges R, Wang AT, Cook DA. Patient outcomes in simulation-based medical education: a systematic review. *J Gen Intern Med*. 2013;28(8):1078–1089. doi:10.1007/s11606-012-2264-5

62. Harder N. Simulation and patient safety: continuing to provide evidence. *Clin Simul Nurs*. 2019;29:38–39. doi:10.1016/j.ecns.2019.03.006

63. Chahal B, Aydin A, Ahmed K. Virtual reality vs. physical models in surgical skills training. An update of the evidence. *Curr Opin Urol*. 2024;34(1):32–36. doi:10.1097/MOU.0000000000001145

64. Hiemstra E, Terveer EM, Chmarra MK, Dankelman J, Jansen FW. Virtual reality in laparoscopic skills training: is haptic feedback replaceable? *Minim Invasive Ther Allied Technol*. 2011;20(3):179–184. doi:10.3109/13645706.2010.532502

Journal of Multidisciplinary Healthcare

Dovepress
Taylor & Francis Group

Publish your work in this journal