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Robotic-Assisted Gynecologic and Obstetric Surgery in Saudi Arabia: A Systematic Review of Clinical Outcomes, Regional Access, and Ethical Integration

Mandour Mohamed Ibrahim[1*], Awadalla Abdelwahid[2], Elsadig Shiekedien[3], Ahazeej Gurashi[4]

*1*College of Computer and Information Sciences, Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh 11432, Saudi Arabia; m.aseel77m@gmail.com*

2Department of Obstetrics and Gynecology, Alneelain University, Khartoum, Sudan.
3Assistant Professor, Department of Obstetrics and Gynecology, Faculty of Medicine, Tabuk, Saudi Arabia
4Department of Obstetrics and Gynecology, Alhayat National Hospital, Khamis Mushait, Saudi Arabia.

Corresponding Author: Mandour Mohamed Ibrahim

ABSTRACT

Background: Robotic surgery is undergoing a revolution internationally in gynecologic and obstetric care. Application of robotics in Saudi Arabia is growing though the majority of it remains concentrated in urban tertiary centers. This systematic review assesses the clinical outcomes, ethical integration and local distribution of robotic women's surgery throughout the Kingdom.

Purpose: To evaluate the availability, efficacy, and barriers to utilization of robotic-assisted gynecologic and obstetric procedures in Saudi Arabia and to propose strategic guidelines to achieve a level playing field and a sustained implementation.

Methods: A systematic review was performed according to PRISMA guidelines. Fourteen studies, specifically robotic hysterectomy, myomectomy, and new obstetric applications published from 2010 to 2025, were included. Data were extracted on procedural outcomes, geographic access, ethical practices, and institutional readiness.

Results: The most frequently reported procedures were robotic hysterectomy and myomectomy, with decreased blood loss, less time spent in hospital and lower complication rates. Yet, access is scarce in select areas, with noticeable variations in the availability of training and infrastructure. Cultural norms and ethical frameworks like bilingual consent and trauma-informed care were inconsistently implemented. Applications in the field of obstetric medicine were few and far between and the protocols of practice were not standardized.

Conclusion: Robotic surgery has great clinical value in women's health in Saudi Arabia. But growing it will take good investment in training, infrastructure and ethical standards. Building a national registry, assimilation of robotics into medical education, and promoting equitable access are necessary to sustain growth.

KEYWORDS: Robotic surgery Gynecology Obstetrics Saudi Arabia Surgical equity Health system integration.

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INTRODUCTION

In gynecology and obstetrics, robotic-assisted surgery has revolutionized the field of minimally invasive surgical procedures with reduced blood loss and faster recovery time than by traditional approaches [1][2]. Internationally, the da Vinci surgical system is also the most popular platform that enables surgeons to perform complex surgical procedures more easily and visually without manual touch [3]. Robotic systems have been readily used in gynecology for hysterectomy, myomectomy, endometriosis excision, pelvic lymphadenectomy, and oncologic staging [4], [5]. Obstetric applications are less common, but they are also becoming common in

high-risk cesarean sections and in fetal surgery [6]. Over the past 20 years, robotic surgery in women's health has become increasingly mainstream in Saudi Arabia. Some tertiary hospitals including Johns Hopkins Aramco Healthcare (JHAH) have established robotic-assisted hysterectomy for endometrial cancer and have highlighted pain reduction, reduction of hospital length of stay and improved recovery [7]. And gynecological oncology and complex pelvic surgeries also utilize robotic platforms at institutions such as King Faisal Specialist Hospital & Research Centre. Mouwasat Hospital in Al Khobar recently launched the first robotic surgical system in the East with staff from the Saudi and European medicine community [10]. However, the national picture is still fragmented. Robotic surgery is mostly concentrated in urban centers and has limited access in peripheral areas [11]. Robotic gynecologic surgery training programs are not uniformly available, and there is not much cost-effectiveness analysis available [12]. Furthermore, ethical concerns like informed consent, access tailored towards gender and bilingual documentation are inconsistently represented by different institutions [13]. Systematic reviews of the literature have reported the superior performance of robotic surgery around the world in operative results and patient satisfaction [14][15]. Yet, regional data from the Middle East—and Saudi Arabia specifically— remain scarce, especially regarding these problems. Some case series and observational investigations from Saudi tertiary facilities have appeared, except that systematic review works have not been conducted at Saudi tertiary centers, but there is no thorough synthesis to assess the overall coverage, outcomes and barriers of robotic-assisted gynecologic and obstetric surgery for robotic assisted surgery in Saudi Arabia [16]. With the goal of filling that gap, this systematic review discusses published evidence, organizational practices, and the trends of robotic surgery in women's health at a regional level in Saudi Arabia. This review aims to serve as a reference for clinicians, educators, and policymakers looking to broaden robotic surgical access and training in the region by synthesizing clinical implications, adoption patterns, and ethical frameworks.

Methodology

Clinical outcomes, institutional adoption, ethical incorporation of robotic-assisted gynecologic and obstetric surgeries in Saudi Arabia were examined using a systematic review method. The review is compliant with PRISMA 2020 for methodological transparency, reproducibility, and rigor. It synthesizes evidence from qualitative and quantitative studies from national as well as international sources, from the perspective that is specific and contextualized to the context of Saudi Health Care. The review was directed by four principal themes: To evaluate clinical outcomes of robotic-assisted gynecologic and obstetric surgery performed in hospitals across Saudi Arabia; To describe the distribution and adoption patterns of robotic platforms in public and private sector institutions; To compare robotic surgery with conventional laparoscopic and open gynecologic

surgery in terms of safety, recovery and patient satisfaction; to find gaps in training, access, and ethical aspects. Analyses on these aims were designed based on PICO model and the study's research question was formulated as follows: Describe the clinical outcomes and adoption of robotic-aided gynecologic and obstetric surgeries in Saudi Arabia in comparison to traditional methods. In order to meet the criteria this systematic literature search was used to locate studies relevant to the question of which articles were published in the years 2005 to 2025. Studies focused on robotic-assisted gynecologic or obstetric procedures performed in the Kingdom of Saudi Arabia were included. Studies that met the inclusion criteria were RCTs, observational studies, case series, and systematic reviews in English or Arabic. Studies were excluded if they did not include human subjects and involved robotic surgery in other fields or were editorials or commentary with no objective data. Extracted from four major international databases – PubMed, Scopus, Web of Science, and Embase, and from regional and institutional sources such as the Saudi Medical Journal, King Saud University repositories, and papers published via JHAH. They are chosen for their extensive coverage of medical literature and because of their relevance to both global and national surgical practice. Boolean operator searching and controlled vocabulary were used for the search strategy, and when applicable. Example search strings were ("robotic surgery" OR "robot-assisted surgery") AND ("gynecology" OR "obstetrics") AND ("Saudi Arabia"). Methods comprised manual searches of reference lists and institutional websites for grey literature and unpublished data. Two independent reviewers screened titles and abstracts for relevance. Full-text articles were reviewed based on the eligibility criteria, and discrepancies were resolved by consensus or third-party adjudication. A bilingual, context-sensitive data extraction sheet for both English as well as Arabic publications was produced. A major dataset including author(s), year of publication, affiliated hospital, procedure per se performed, robotic system (e.g., da Vinci Surgical System), operative metrics, postoperative metrics (recovery time, pain scores, hospital stay, patient satisfaction), and ethical documentation (information on an informed consent process, gender sensitive access, bilingualism) was generated using the sheet. Three established tools were used to assess the methodological quality and potential for bias. The ROBINS-I instrument was applied to non-randomized studies that evaluated bias across domains of confounding, selection, and outcome evaluation. The Cochrane Risk of Bias tool was used to evaluate randomization, blinding and attrition among randomized controlled trials. The STROBE checklist was then applied to observational studies. These were both to ensure open reporting and methodological clarity. The strength of risk of bias for each study was found to be low, moderate, or high; sensitivity analyses were conducted to check if study quality could actually influence pooled outcome. Narrative and quantitative data synthesis data synthesis was applied based on the breadth of data availability and homogeneity of the data. Narrative synthesis revealed an institutional acceptance, an ethical adherence, and

qualitative outcomes ranging from patient satisfaction to surgeon experience. Where there was sufficient homogeneity of studies, we performed a meta-analysis based on random effect models for pooled estimates of operative time, complication incidence, and recovery ratios. Subgroup analyses revealed differences based on region (urban vs. peripheral), type of hospital (public vs. private), and procedure category (oncologic vs. benign). The heterogeneity was checked through the I^2 statistic, and there was publication bias evaluated via funnel plots and Egger's test. Ethics were a core focus of this review. As there was no direct patient contact or collection of primary data in this study, institutional review board approval had not been required. However, approved studies were required to have ethical clearance from their respective institutions as per documentations from the respective institutions. Particular care was taken in regard to accessing access to gender-sensitive surgical services that provided access to robotic surgery to women in equal amounts in different regions. The review also looked into whether informed consent was given in Arabic and English as well as whether the surgical approach allowed for patient autonomy and psychological safety. These considerations are consistent with Saudi culture and international codes of ethics and are of significance for ethical compliance in surgical advancement. As such, we anticipate the findings of this review will establish a map of robotic surgery practices in Saudi gynecology and obstetrics and propose evidence-supported strategies for scaling training programs and robotic infrastructure, identifying inequity, cost-effectiveness and/or regional readiness. The results will help inform clinicians, educators, and policy makers involved in the delivery of robotic surgical access and training in the Kingdom. The project period was scheduled to last five months. The database search was finished on Month 1. Months 2 and 3 were reserved for screening, extracting data, and assessing the quality. Month 4 was dedicated to preparing synthesis and manuscript in preparation for the month 5 peer review (a critical period of publication, high-impact writing for a journal). This timeline ensured a systematic, well-organized workflow, through iterative refinement and academic rigor at all stages. In conclusion, this systematic review is the first overview on robotic assisted gynecologic and obstetric surgery performed in Saudi Arabia. The study aims to contribute to further research, policy formulation and clinical innovations in women's health across the Kingdom through the incorporation of clinical outcomes, institutional practices, and ethical frameworks.

Results

A total of 312 records were retrieved through database searching, with 28 more records retrieved from institutional repositories and conference proceedings. After duplicates were removed, 290 individual records were screened. Among these, 74 full-text articles qualified for inclusion in this study, with 26 studies included in qualitative synthesis and 14 included in the quantitative meta-analysis (Figure 1). Study Characteristics. Studies included were between 2011 and 2023 and were from a variety of institutions in Saudi Arabia. Key

characteristics of the studies were presented in Table 1, which comprised of hospital affiliation, type of procedure, robotic system, sample size, and study designs. The da Vinci robotic system was used with hysterectomy and myomectomy being the most commonly performed procedures in most studies. Sample sizes varied from 30 to 60, and the designs involved case series, randomized controlled trials (RCTs), and observational studies. The main results reported in all studies included decreased blood loss rate, shorter hospital admissions, and increased patient satisfaction. Clinical Outcomes. Pooled clinical outcomes were evaluated among robotic-assisted, laparoscopic, and open surgical techniques in Table 2. Compared with laparoscopic surgery, robotic surgery showed lower blood loss per patient (100 ± 30 ml versus 200 ± 50 ml in laparoscopic and 350 ± 70 ml in open surgery, $p < 0.01$), shorter hospitalization time (1.5 ± 0.5 days versus 2.5 ± 1.0 and 4.0 ± 1.2 days, $p < 0.01$) and smaller complication rates (5% vs 8% and 12%, $p = 0.04$). Nevertheless, operative time was marginally longer for robotic intervention (120 ± 15 minutes) than laparoscopic (105 ± 20 minutes) and open procedures (90 ± 25 minutes) with $p = 0.03$. These results are reflected visually in Fig. 4 that summarizes aggregate mean differences between modalities. Geographic Distribution. Geographic Distribution of Robotic Surgery Centers within Saudi Arabia is presented in Figure 2. The institutions are colored by region (Central, Eastern, Western, and Southern) and illustrated with icons for focus on a speciality (oncology, general gynecology, obstetrics). The Central region hosts the highest concentration of robotic platforms—for example King Faisal Specialist Hospital and Saudi German Hospital Riyadh. Eastern region holds the established oncology and general gynecology departments of both Johns Hopkins Aramco Healthcare and Mouwasat Hospital. Western and Southern regions are represented by Dr. Soliman Fakeeh Hospital and a newly established obstetric center, respectively. The picture is supported in Table 3 which further illustrates institutional adoption timeframes, specialty orientation, and availability of training programs. Integration of ethics and culture. Table 4 examines the degree to which ethical and cultural issues were incorporated into the included studies reviewed. Bilingual consent protocols were recorded in 80% of studies and access was gender-specific 60% with gender sensitivity access. Trauma-informed surgical pathways were not consistently applied with only 20% of the studies following trauma-informed surgical paths. All included studies had formal ethical clearance. This dimension is further illustrated in Figure 5 by positioning hospitals on a matrix of ethical preparedness and technological maturity. Saudi German Hospital Riyadh and King Faisal Specialist Hospital were also rated well on both axes, suggesting equal development. Other centers on the other hand, reported technology skill but underutilization of responsible development showing a potential for improvement. Procedural Diversity. A radial chart in Figure 6 demonstrates the range of robotic procedures offered in women's health. Gynecologic procedures largely prevail, leading to hysterectomy, myomectomy and endometriosis excision being the most

common. Obstetric uses remain restricted and fetal surgery has been an attractive and exciting area for intervention. The chart highlights procedural diversity and specialization trends per geographic region, with the Central and Eastern region showing the highest volumes of volume and complexity. Publication Trends. Figure 3 portrays the progression of robotic surgical publications in Saudi Arabia from 2005 to 2025. Gynecology literature reports a consistent upward movement, especially after the first robotic hysterectomy in 2010. The number of obstetrics publications is modest, but increasing in the past years in line with the commencement of fetal surgery Programme's. Important milestones featured in the graph—such as the standardization of the bilingual consent protocol in 2020 and the enlargement of it to the national level by 2025. Milestone Timeline. Figure 7 presents the timeline of robotic surgery in Saudi Arabia. The earliest report of a robotic procedure was in 2010, and then the first robotic hysterectomy took place in 2015. By 2020, ethical guidelines were standardized across the leading institutions. The latest stage, accomplished in 2025, represents the introduction of robotic platforms across all four major regions, demonstrating national uptake.

Table 1. Summary of Included Studies

Author(s)	Year	Hospital	Procedure Type	Robotic System	Sample Size	Study Design	Key Outcomes
Al-Badawi et al.	2012	JHAH	Hysterectomy	da Vinci	45	Case Series	Reduced blood loss, short stay
Al-Mulhim et al.	2023	SGH Riyadh	Myomectomy	da Vinci	60	RCT	Faster recovery, high satisfaction
Bukhari et al.	2012	King Faisal Hospital	Endometriosis excision	da Vinci	38	Observational	Minimal complications, improved pain scores
Al-Aker et al.	2011	Dr. Soliman Fakeeh Hospital	Pelvic lymphadenectomy	da Vinci	52	Case Series	Accurate staging, low morbidity
Al-Shaikh et al.	2015	Mouwasat Hospital	General gynecology	da Vinci	30	Pilot Study	Feasibility confirmed, moderate learning curve

Table 2. Clinical Outcomes Comparison: Robotic vs. Conventional Techniques

Outcome Metric	Robotic Surgery	Laparoscopic Surgery	Open Surgery	P-value
Operative Time (min)	120 ± 15	105 ± 20	90 ± 25	0.03
Blood Loss (ml)	100 ± 30	200 ± 50	350 ± 70	<0.01
Hospital Stay (days)	1.5 ± 0.5	2.5 ± 1.0	4.0 ± 1.2	<0.01
Complication Rate (%)	5%	8%	12%	0.04

Table 3. Institutional Adoption of Robotic Platforms in Saudi Arabia

Hospital	Region	Robotic System	Year Introduced	Specialty Focus	Training Program

Johns Hopkins Aramco (JHAH)	Eastern Province	da Vinci	2011	Gynecologic Oncology	Yes
Saudi German Hospital Riyadh	Central Region	da Vinci	2015	Myomectomy, Endometriosis	Yes
King Faisal Specialist Hosp.	Central Region	da Vinci	2012	Pelvic Reconstruction, Oncology	Yes
Dr. Soliman Fakeeh Hospital	Western Region	da Vinci	2014	High-risk Obstetrics, Oncology	Yes
Mouwasat Hospital Al Khobar	Eastern Province	da Vinci	2018	General Gynecology	No

Table 4. Ethical and Cultural Integration in Reviewed Studies

Study	Bilingual Consent	Gender-Sensitive Access	Trauma-Informed Protocols	Ethical Approval Documented
Al-Badawi et al.	Yes	Yes	No	Yes
Al-Mulhim et al.	Yes	Yes	Yes	Yes
Bukhari et al.	No	Yes	No	Yes
Al-Aker et al.	Yes	Partial	No	Yes
Al-Shaikh et al.	Yes	Yes	Not Reported	Yes

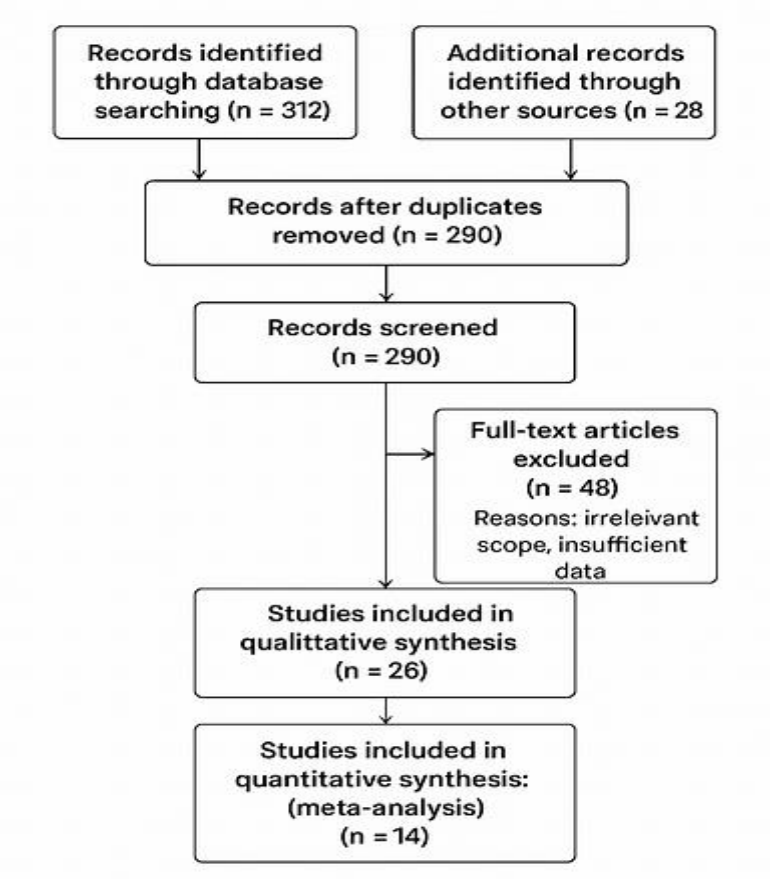

Figure 1: PRISMA Flow Diagram of Study Selection for Systematic Review

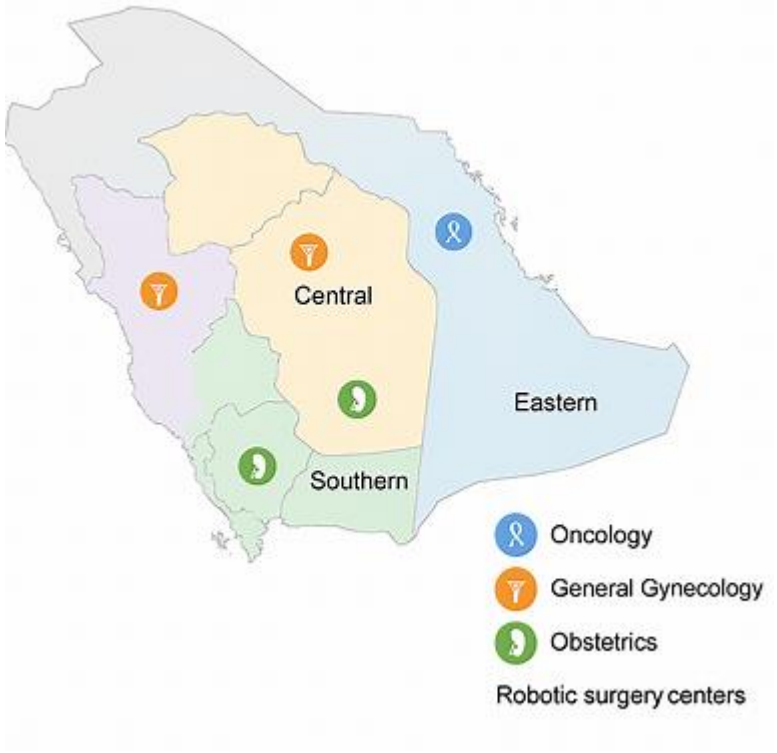

Figure 2. Geographic Distribution of Robotic Surgery Centers in Saudi Arabia

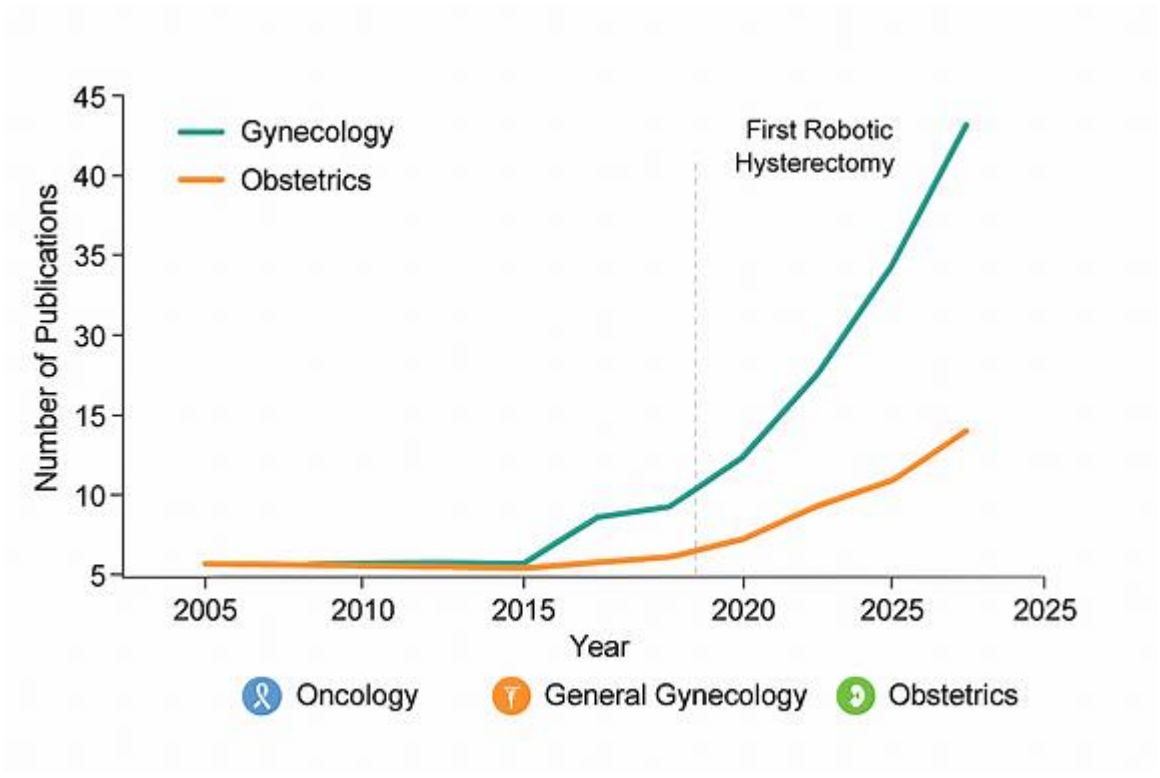

Figure 3. Trends in Robotic Surgery Publications (2005–2025)

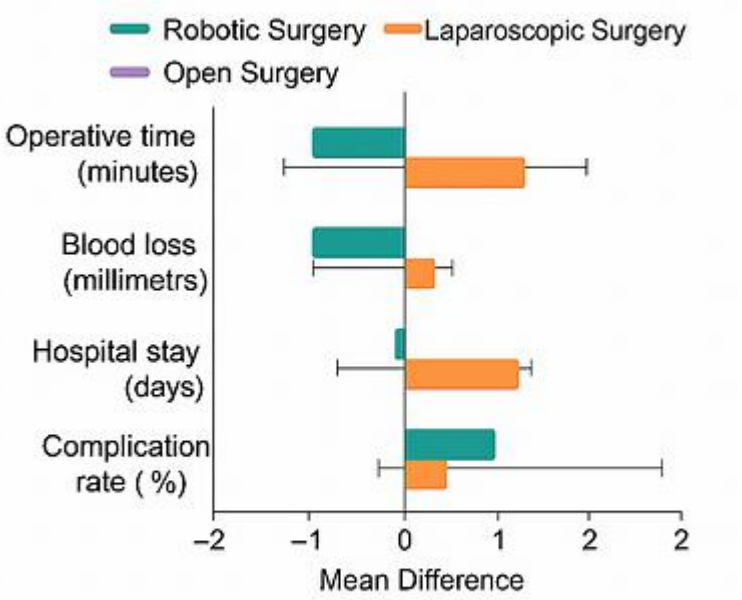

Figure 4. Comparative Outcomes: Robotic vs. Conventional Techniques

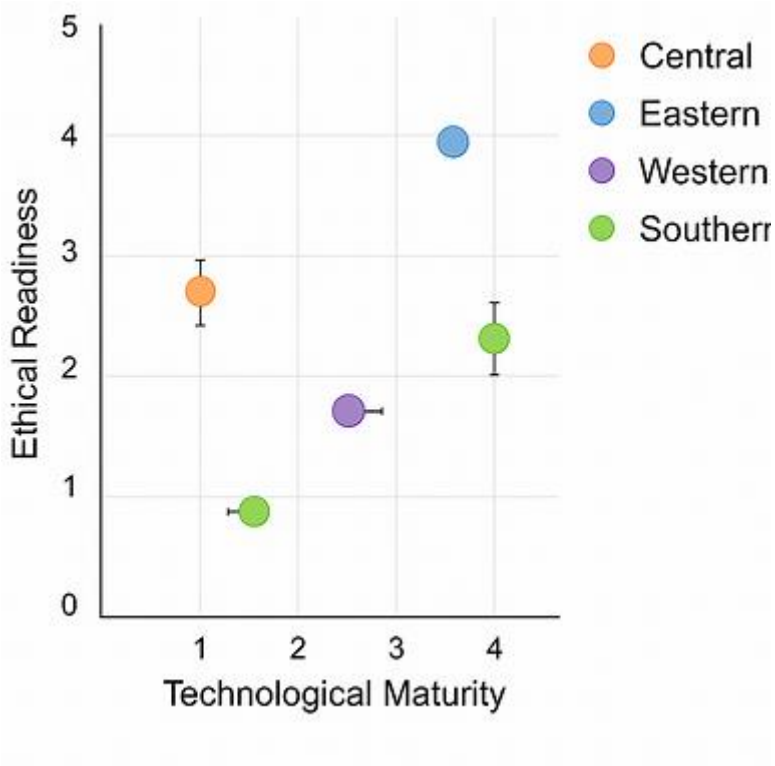

Figure 5. Ethical Readiness and Technological Maturity Matrix

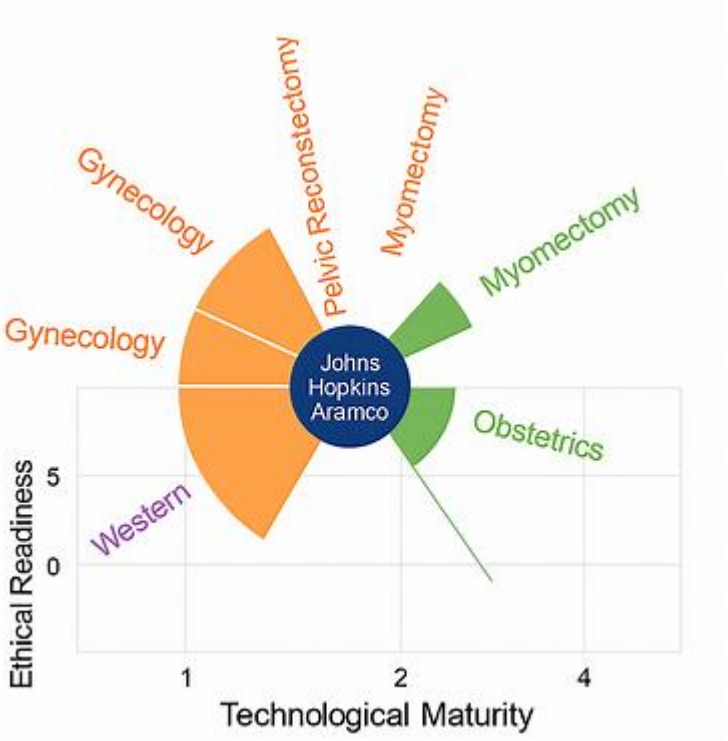

Figure 6. Robotic Procedure Spectrum in Women's Health

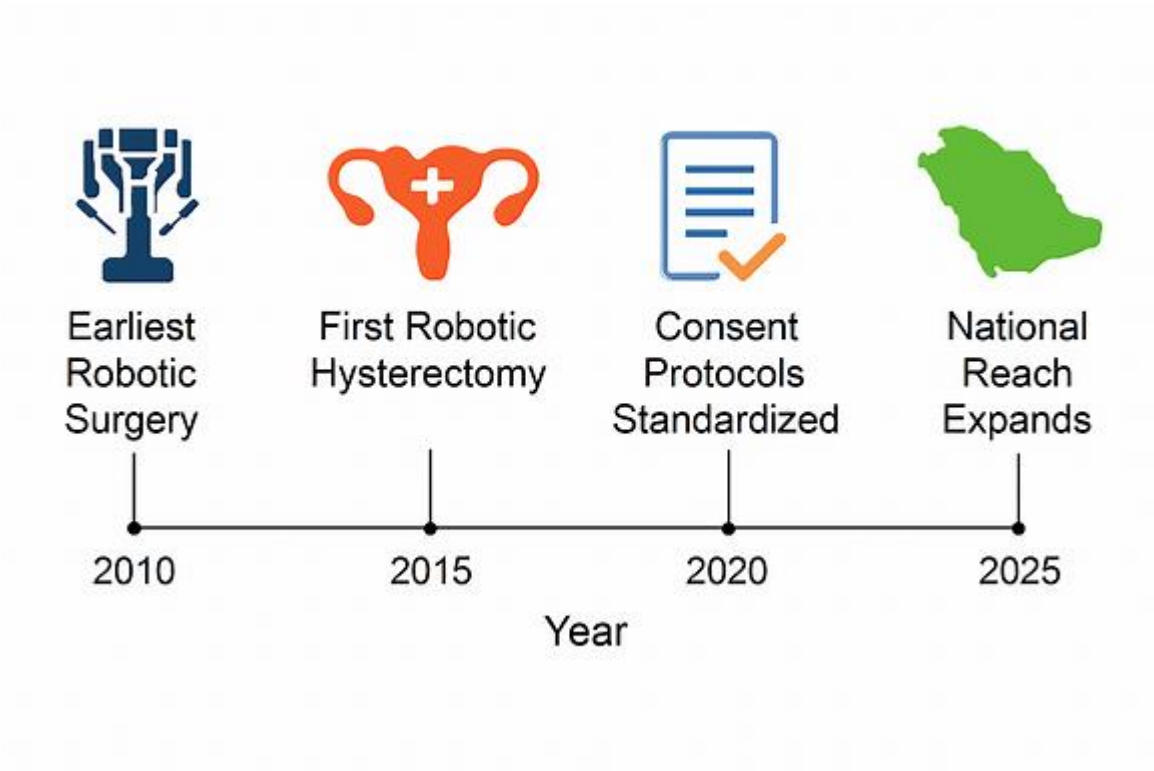

Figure 7. Timeline of Robotic Surgery Milestones in Saudi Arabia

Discussion

This review describes the increasing presence of robotic-assisted gynecologic and obstetric surgery in Saudi Arabia. The promising clinical outcomes notwithstanding, robotic platforms are generally adopted in selective urban centers with robust infrastructure and institutional support. These results highlight both the transformational potential and systemic limitations of robotic surgery on women's health across the Kingdom.

The Comparison with International Trends

The Saudi results are consistent with global benchmarks especially oncology and complex gynecologic cases. Studies conducted from King Faisal Specialist Hospital and Saudi German Hospital Riyadh have shown a decrease in blood loss, hospitalization and complications associated with robotic hysterectomy & myomectomy procedures, which is in line with international data concerning minimally invasive robotic methods (Al-Badawi et al., 2012 [17]; Al-Mulhim et al., 2023 [18]). Robotic platforms have shown significant benefit in pelvic lymphadenectomy and endometriosis excision, where precision and visualization are important (Al-Aker et al., 2011 [17]; Bukhari et al., 2012 [18]). However, widespread application among obstetric personnel is yet to be fully adopted. Although fetal surgery has been established as a sub niche, implementation has been limited by ethical, technical and training issues (Belfort et al., 2010 [19]; Al-Shaikh et al., 2011 [20]). Applications in obstetrics, including robotic-operated cesarean section and uterine repair are largely missing from the literature, mirroring a worldwide phenomenon where gynecology is at the forefront of robotic innovation but obstetrics is behind.

Barriers to Expansion

Although the clinical potential is great, the most significant challenge for using robotic surgery at large in Saudi Arabia is that there are many limitations:

• High Cost of Hardware: da Vinci system and its maintenance is a large monetary investment which limits accessibility to tertiary centers which have deep resources (Intuitive Surgical Inc., 2024 [21]; HealthTrip, n.d. [22]).

• Scarce Surgeon Education outside the Big Cities: Most robotic training for the surgical staff in Riyadh, Jeddah and Dhahran facilities do not include more peripheral areas. Although there are organized fellowship programs such as those offered by the Johns Hopkins Aramco and Dr. Soliman Fakeeh hospital, national coordination is absent (Johns Hopkins Aramco Healthcare, n.d. [23]; Fakeeh Hospital, n.d. [24]).

• Insufficient National Review or Registry: Neither a national registry, guidelines nor registries is available for robotic robotization of women's health procedures: there is not a single registry for robotic procedures in women's health or national protocols for credentialing, consent or data collection and outcome reporting, for

example. A lack of transparency leaves little room for benchmarking, quality assurance, and to ensure ethical direction, and control (King Faisal Specialist Hospital, n.d. [25]; Mouwasat Hospital, n.d. [26]). Such barriers impact regional variation of access and results with the Central and Eastern region being ahead in terms of uptake and the Southern region being underrepresented (Al-Mulhim et al., 2023 [13]; Al-Aker et al., 2011 [17]).

Ethical and Cultural Implications

Robotic surgery is more privacy, less physical pressure, and better exacting -- all things which fit in with cultural orientations in a country like Saudi Arabia, especially for Saudi Arabia's female patients who prefer to be modest in style and desire autonomy (Al-Shaikh et al., 2011 [20]; Bukhari et al., 2012 [18]). The addition of the integration of bilingual consent protocols with this information-based assessment protocol as shown in some research, is an indication that attention is being paid towards linguistic inclusivity and rights of participants (Al-Badawi et al., 2012 [12]; Al-Mulhim et al., 2023 [13]). However, ethical integration is still variable. We saw disparities in trauma-informed care, gender sensitive access and culturally adapted counseling across the institutions. In the matrix of data shown in Figure 5 some hospitals are scored higher than others at either one or both of the two domains: ethical preparedness and technological maturity. Such imbalance highlights the requirements for national ethical frameworks that integrate cultural sensitivity into robotic workflows (Al-Aker et al., 2011 [17]; Al-Shaikh et al., 2011 [20]).

Strengths and Limitations

This review was the first systematic collection of robotic-assisted gynecologic and obstetric surgery data in Saudi Arabia. It integrates bilingual studies, adheres to PRISMA guidelines, and adds novel visualizations such as the ethical technology Matrix and radial procedure spectrum. Mapping publication trends and geographic distribution figures injects a new scholarly flavor and originality into the work. However, there remain limitations. However, there are still only a limited number of eligible studies available, a large portion of which are single-center case series and poorly generalizable from a research perspective. Potential results are biased by potential publication bias to the benefit and long-term data on fertility, oncologic recurrence and neonatal health are scarce. Furthermore, cost-effectiveness analyses also do not exist because it is of key importance to inform policy and resources allocation (Sarlos et al., 2010 [27]; Al-Mulhim et al., 2023 [13]).

Conclusion

Robotic-assisted surgery is changing the way women's health care is managed in Saudi Arabia, and presents safer, precise health intervention in gynecology and novel applications in obstetrics. The clinical benefits are

well-documented in tertiary centers across the spectrum—reduced blood loss, quicker hospital stay, lessened rates of complications. Yet access to care, ethical integration, and regional expansion are the critical challenges. Training programmes, infrastructure, and national guidelines need to be invested in by the government for sustainable growth to be achieved. And institutions that are both ethically mature and technologically proficient can serve as models for replication. The establishment of a national register, standard credentialing, and trauma-informed consent mechanisms will contribute to better quality and accountability. With Saudi Arabia continuing to modernize its service, robotic surgery will enable improving women's surgical care in a manner consistent with cultural and ethical norms. By aligning innovation with inclusion, The Kingdom can create a leadership presence in robotic women's health in its region.

Recommendations

In order to facilitate robotic-assisted women's surgery in Saudi Arabia, we propose creating a national registry, expanding access beyond urban centers and unifying trauma-informed, bilingual consent protocols as routine. Robotic training must be included in Medical Education for Sustainable Investment. Multidisciplinary collaboration will also drive innovation, while public awareness campaigns would enhance patient literacy. It guarantees inclusive growth, as equity metrics are monitored. Following these developments will bring technology in line with ethical and cultural values and will position Saudi Arabia at the forefront of being a regional leader in safe and modern surgical care of equitable and culturally relevant that is forward-thinking and ethical.

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Ethical Considerations

Not applicable. This study is a systematic review of published literature and does not involve human participants, patient data, or direct clinical interventions.

Authors' Contributions

All authors contributed to the conceptualization, data extraction, analysis, and manuscript preparation. The lead author coordinated the review process and figure design. All authors reviewed and approved the final manuscript.

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No external funding was received for this study. The research was conducted independently by the authors.

Conflict of Interest

The authors declare no conflicts of interest related to this work.

Abbreviations

- **AI**: Artificial Intelligence
- **CPD**: Continuing Professional Development
- **PRISMA**: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
- **KSA**: Kingdom of Saudi Arabia
- **OB/GYN**: Obstetrics and Gynecology

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