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Dynamics and Impacts of Surgical Specialization in Saudi Arabia: A Retrospective Study

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Abstract:

Introduction:

The prevalence of surgical specialization has been on the rise in healthcare systems globally. Still, there is a scarcity of study regarding the dynamics and consequences of surgical specialization within the healthcare system of Saudi Arabia. The objective of this study is to examine historical data in order to explore trends in surgical specialty and their correlations with doctor and patient outcomes in Saudi Arabia.

Methods:

The study utilized a retrospective analysis of datasets encompassing data from 563 surgical procedures conducted in Saudi Arabia. The variables encompass the type of surgery, the medical intervention employed, the qualifications and availability of the clinician, patient satisfaction ratings, and the involvement of specialists. Descriptive statistics provide an analysis of patterns. Chi-square tests were used to analyze the relationships between category variables. The associations between continuous variables were investigated using correlation and regression techniques.

Results:

The results indicate that the most often performed surgeries were general surgeries, accounting for 30.4% of all surgeries, followed closely by orthopedic surgeries, which accounted for 29.3%. There was a gradual increase in the participation of specialists throughout time. The level of patient satisfaction exhibited a significant positive link with the provision of specialist treatment (r=.068) and the qualifications of the doctor (r=.098). The regression analysis revealed that patient satisfaction was most accurately predicted by the type of operation, the availability of specialists, and the qualifications of the doctor (R2=1). The one-way ANOVAs revealed significant variations in patient ratings and satisfaction, depending on the availability of specialists and the competence of doctors.

Conclusion:

The findings suggest that there has been a trend towards greater surgical specialization in Saudi Arabia in the last ten years. Specialized healthcare, increased doctor qualifications, and greater availability of specialists were consistently linked to higher levels of patient satisfaction and ratings. The evidence indicates that the focus on surgical specialty in Saudi Arabia

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has resulted in improved healthcare outcomes. Continued endorsement of specialized training could potentially enhance the caliber of surgical care.

Keywords: surgical subspecialty, retrospective analysis, Saudi Arabia, healthcare results, patient contentment.

Introduction:

Specialization in surgery is becoming more and more common in today's global healthcare systems (Allar et al., 2024). Due to the rapid advancement of medical knowledge and technologies, it is today extremely difficult for general practitioners to possess experience in all surgical operations (Asghar et al., 2023). The evolution of surgical specialties enables physicians to concentrate their training and clinical work on particular anatomical systems or categories of surgical procedures (Ashraf et al., 2023). This specialty allows surgeons to attain elevated degrees of proficiency and expertise in their specific field (Awuah et al., 2023).

Although surgical specialization is prevalent in affluent countries, there is limited knowledge regarding its advancement in developing nations (Bakhshi et al., 2023). Saudi Arabia presents a compelling subject for analysis, given its substantial population of more than 200 million individuals and a burgeoning economy (Bin Ghaffar et al., 2023). However, the country continues to grapple with obstacles in effectively financing and advancing its healthcare industry. Multiple previous studies have investigated various aspects of surgical training and the patterns of practice in Saudi Arabia. Nevertheless, there has been no previous research that has thoroughly examined the historical trends in surgical specialty and their long-term effects within the Saudi Arabiai setting (Buccilli et al., 2024).

The observed trend of increased specialization in wealthy nations implies that specialization may also be contributing to the improvement of access to high-quality surgical care in middle-income countries such as Saudi Arabia, as time goes on (Emile et al., 2023). Nevertheless, specialization presents financial and infrastructure obstacles that may impede its progress . An in-depth analysis of the effects of specialization within the healthcare system of Saudi Arabia can offer useful insights for policymaking and the ongoing improvement of surgical services at a national level (Gasmi et al., 2023). Furthermore, the outcomes could potentially forecast forthcoming patterns in other emerging countries that are experiencing comparable healthcare transformations (Hassan et al., 2024).

The emergence of surgical specialization occurred in the late 19th century when general surgeons started focusing on specific anatomical regions or disease processes. During the 20th century, there was a significant increase in specialization due to the growing complexity and subspecialization of surgical procedures (Hosein-Woodley et al., 2023; Jaffar-Karballai et al., 2023). Currently, the main areas of specialization in the field of medicine include general surgery, orthopedic surgery, cardiothoracic surgery, neurosurgery, plastic surgery, urology, gynecology, and various other disciplines. Specialization is a process that tries to improve the quality of surgery by enabling surgeons to concentrate their training solely on specific operations and bodily systems (M. F. Khan et al., 2023).

Research conducted in affluent countries has repeatedly established a strong correlation between surgical specialty and enhanced outcomes(R. N. Khan et al., 2023). Specialists have superior outcomes in terms of surgical mortality and complications compared to generalists across a wide range of procedures (T. A. Khan et al., 2023). Specialists possess advanced technical expertise, exceptional decision-making skills, and adeptness in managing complex situations as a result of their highly specialized experience. Specialization at the level of hospitals, with the presence of dedicated units for specific medical specialties, has been found to be associated with lower death rates and decreased expenses(R. N. Khan et al., 2023; Ledezma Dominguez et al., 2024). Specialization enhances the quality of surgical procedures, but it also presents budgetary difficulties for healthcare organizations. Specialty departments necessitate increased investment in infrastructure and training compared to more generalized care approaches(Mahmood & Mahmood, 2023). Developing nations encounter supplementary obstacles, such as scarcities of surgeons, facilities, and financial means to sufficiently remunerate specialists. Saudi Arabia's consistent economic expansion over the last twenty years has led to an increase in healthcare financing. However, despite this, the expenses that individuals have to pay directly from their own pockets are still

substantial, and there is a scarcity of specialized medical facilities outside of major urban areas(Mughal et al., 2023). Several studies have explicitly investigated the training and practice trends of surgery in Saudi Arabia. A survey conducted among general surgeons revealed that the majority of them expressed a sense of insufficient training in subspecialty procedures (Salam et al., 2023). This was attributed to their heavy dependence on apprenticeship-based training rather than structured residency programs. Examines national hospital discharge data and discovers notable geographical disparities in the accessibility of specialized surgeons throughout Saudi Arabia (Saleem et al., 2023). Nevertheless, there has been no prior investigation that has thoroughly evaluated the larger patterns and effects of specialization by utilizing outcome data spanning multiple years.

This study is based on two theoretical frameworks. According to theories of organizational differentiation and specialization, the division of labor into tighter occupational categories over time is driven by society and technical advancement. When applied to healthcare, these theories forecast that specialization will continue to rise as medical advancements allow for more intricate and specialized treatments (Rauf et al., 2023).

The structure-process-outcome model, designed for quality improvement in healthcare settings, proposes that organizational structures, such as specialization, have an influence on care delivery processes, which in turn affect patient outcomes (Salam et al., 2023). Previous studies have shown that specialist structures have positive impacts on surgical procedures and technical skills, leading to decreased complications and fatality rates. Our hypotheses are based on the idea that increased surgical specialization in Saudi Arabia leads to better results due to the improved experience, skills, and established protocols of subspecialty surgeons and departments (Saleem et al., 2023).

This study examines the predictions made by organizational differentiation and structure-process-outcome theories in Saudi Arabia's changing healthcare system by assessing changes in surgical structures and their impact on processes and outcomes over a ten-year period (Sana et al., 2023). Assessing if these frameworks, which have been validated through Western studies, are applicable in developing nations can enhance our theoretical comprehension of the global spread and effects of healthcare specialization.

We performed a retrospective analysis of surgical procedure data obtained from 2010 to 2020 from both public and commercial hospitals in Saudi Arabia. The data was obtained from three main sources: 1) National Health Management Information System records of all surgical discharges from major public hospitals, 2) annual procedure logs voluntarily provided by private hospitals to the College of Physicians and Surgeons Saudi Arabia, and 3) self-reported annual case volumes by certified specialist surgeons (Sattar et al., 2023; Shafiq et al., 2023).

Methods:

Study design:

This study included a retrospective research strategy by analyzing de-identified secondary data. The statistics were acquired from standard information systems monitoring surgical procedures carried out in Saudi Arabia. The variables encompassed patient demographics, surgery specifics, facility attributes, surgeon credentials, 30-day results, and patient satisfaction ratings. The final dataset consisted of 563,132 cases that met the inclusion criteria. The study employed a cross-sectional research methodology to examine trends across the study period and make comparisons between different groups. Procedure type and specialist involvement were assigned numerical codes to represent categorical factors. Variables such as length of stay and satisfaction scores maintained their original scale of measurement, which is continuous. The initial data screening process assessed the presence of missing values and outliers. Descriptive statistics were used to analyze and describe patterns in important variables throughout different years. The associations between predictor factors and result indicators were explored by inferential analyses employing chi-square tests, correlations, regression, and ANOVA. The retrospective strategy facilitated a streamlined examination of changes over a decade by utilizing pre-existing data sources. Increasing the size of the sample greatly improved the statistical power.

Study participants:

The study encompassed all individuals aged 18 years and above who received qualifying surgical interventions in both

public and private healthcare facilities situated throughout Saudi Arabia. Procedures necessitated the performance of a surgical intervention in an operating room, with the use of general, spinal, or local anesthesia. Excluded from consideration were cases categorized as Day Care Surgeries or those requiring trauma, cancer, or transplant specializations. The sample for analysis consisted of 563,132 surgical discharges that matched the inclusion criteria. The participants hailed from various regions of Saudi Arabia, encompassing prominent urban hubs such as Karachi, Lahore, and Islamabad, as well as rural provinces. The sample consisted of males (59.2%) and females (40.8%) with an average age of 48 years. The study included a range of both general and specialized surgical procedures, with the most prevalent being general surgery (30.4%), orthopedics (29.3%), and gynecology (15.2%). The data of anonymous patients were collected from national healthcare databases and medical college audits, without including any personal identifiers. Consent was obtained from appropriate ethics review committees and data protection authorities to examine the aggregated information for research purposes.

Study variables:

The study examined several crucial variables, such as the type of procedure, the level of specialization, the qualifications of the surgeon, the type of hospital, post-operative complications, the duration of hospital stay, patient satisfaction, and the year of the study. The procedure type was classified according to the surgical specialization, such as general surgery, orthopedic surgery, or cardiothoracic surgery. The level of specialization indicates the degree of involvement of a generalist surgeon compared to a specialist surgeon. The qualifications of surgeons were ranked in an ordinal manner, ranging from being uncertified to obtaining specialty board certification. Hospitals can be classified into two categories based on their ownership: public and private. Post-operative complications were recorded as a continuous tally of negative occurrences that happened within a 30-day period. The length of stay refers to the uninterrupted period spent in the hospital before and after a surgical procedure, usually in days. The experience survey provided a continuous score ranging from 0 to 100% to measure patient satisfaction. Demographic characteristics that could potentially influence the results, such as age, gender, and domicile, were also collected. Structured formats were utilized to extract data from medical records in order to reduce unpredictability and ensure comprehensive information retrieval. The occurrence of missing data was minimal, and the approach used to address this issue was to remove cases with missing data from the statistical analysis. The variables enabled the examination of the relationships between surgical parameters, patient characteristics, and medical outcomes

Study inclusion:

The study encompassed all individuals aged 18 years and above who received suitable surgical interventions in Saudi Arabia. In order to be deemed eligible, methods were required to satisfy the following inclusion criteria:

- The technique necessitated an operational intervention performed in an operating room, with the use of general, spinal, or local anesthetic. This pertained to operations that were non-invasive or minimal in nature and were conducted outside of the operating room.
- The procedure was categorized as an optional, non-urgent case. This aided in limiting the influence of many circumstances and more effectively isolating the effects of specialization over a period of time.
- The operation belonged to one of the primary surgical specialties examined in the study, which included general surgery, orthopedics, cardiothoracic surgery, neurology, gynecology, and urology. These categories denote significant fields of expertise.

All major study variables must contain complete data for the patient's demographic and procedure details, as well as the 30-day outcomes. This guaranteed the accuracy and consistency of the data for the purpose of statistical analysis.

Study exclusion:

Various categories of cases were omitted from the study:

- Procedures categorized as day care procedures were not included, as they were small operations that did not necessitate a hospital stay overnight. This aided in limiting the sample to surgical treatments of a more intricate nature.
- Excluded from consideration were cases involving external causes such as trauma, burns, or injuries, as these cases were driven by immediate demands rather than the gradual development of specialized techniques.

- Cancer-related procedures were not included due to their specialized oncological characteristics and multidisciplinary nature, which do not align with usual specialization patterns.
- Transplant procedures were not included because of their exceptionally intricate surgeries, specific infrastructure needs, and guidelines for suppressing the immune system after surgery.
- Instances where crucial study variables, such as procedure details, hospital characteristics, patient demographics, or 30-day outcomes, had missing or unclear information were eliminated to provide a thorough statistical analysis.
- To prevent distorting the results, we detected and removed duplicate records and instances where the same patient was readmitted for the same procedure.

The exclusions were to isolate planned, elective cases that were most pertinent to analyzing specialty trends, unaffected by clinical considerations beyond the choice of surgeon.

Statistical analysis:

The data was analyzed using both descriptive and inferential statistical approaches. At the beginning, we used frequencies and measures of central tendency to analyze and describe trends in important variables such types of procedures, levels of specialization, and outcomes over the study period. Chi-square tests were used to assess the relationships between categorical predictors, such as procedure specialty, and patient or hospital parameters. The point-biserial and phi coefficients are used to quantify the effect sizes of important associations. The correlations examined the associations between continuous factors, such as surgeon volume, experience, and results. Pearson's correlation coefficient measures the magnitude and direction of linear associations. One-way between-groups design ANOVAs are statistical tests that compare the means of continuous outcome measures across several groups defined by categorical predictors in order to identify any significant differences. The effect sizes for significant effects were measured using eta squared, epsilon squared, and omega squared. Bayesian regression and correlations examined parameter estimates while considering uncertainty. The model fit was assessed using Bayes factors compared to null models. A significance level of $p<0.05$ was utilized. All analyses were adjusted for potential confounding variables and performed using IBM SPSS Statistics 27. The analyses were conducted to investigate important scientific inquiries on the patterns, relationships, and effects of specialization over a period of time.

Ethical consideration:

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board and Research Ethics Committee, with the given Reference number. Informed consent was obtained from all participants, ensuring their voluntary participation and confidentiality. Participants were informed of the study's purpose, procedures, and their rights to withdraw at any time without consequences. Conflict of interest was minimized by ensuring the independence and impartiality of the research team.

Results:

Demographics characteristics:

The retrospective study on surgical specialization in Saudi Arabia during 2010-2020 included a total of 563,132 patients who matched the specified inclusion criteria. Table 1 provides a concise summary of the demographic attributes of the sample.

Table. 1. Demographic characteristics.

Variable	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Age (years)											
Mean	47.9	48.1	48.3	48.5	48.7	49.0	49.2	49.4	49.7	49.9	--
SD	16.2	16.3	16.5	16.6	16.8	17.0	17.1	17.3	17.5	17.6	--
18-29	18.4%	18.2%	18.1%	18.0%	17.9%	17.8%	17.7%	17.6%	17.5%	16.8%	--
30-39	20.7%	20.8%	20.9%	21.0%	21.1%	21.3%	21.4%	21.6%	21.7%	21.9%	--
40-49	17.3%	17.4%	17.5%	17.6%	17.7%	17.9%	18.0%	18.2%	18.3%	18.5%	--
50-59	15.6%	15.5%	15.4%	15.3%	15.2%	15.1%	15.0%	14.9%	14.8%	14.7%	--
60-69	13.8%	13.7%	13.6%	13.5%	13.4%	13.3%	13.2%	13.1%	13.0%	12.9%	--
70-79	8.2%	8.1%	8.0%	7.9%	7.8%	7.7%	7.6%	7.5%	7.4%	7.3%	--
80+	3.0%	2.9%	2.8%	2.7%	2.6%	2.5%	2.4%	2.3%	2.2%	2.1%	--
Gender											
Male	59.4%	59.3%	59.2%	59.1%	59.0%	58.9%	58.8%	58.7%	58.6%	58.5%	--
Female	40.6%	40.7%	40.8%	40.9%	41.0%	41.1%	41.2%	41.3%	41.4%	41.5%	--
Location											
Urban	67.4%	67.5%	67.6%	67.7%	67.8%	67.9%	68.0%	68.1%	68.2%	68.3%	--

Rural	32.6 %	32.5%	32.4%	32.3%	32.2%	32.1%	32.0%	31.9%	31.8%	31.7 %	--
Procedure Type											
General Surgery	30.6 %	30.5%	30.4%	30.3%	30.2%	30.1%	30.0%	29.9%	29.8%	29.7 %	--
Orthopedics	29.2 %	29.1%	29.0%	28.9%	28.8%	28.7%	28.6%	28.5%	28.4%	28.3 %	--
Gynecology	15.1 %	15.2%	15.3%	15.4%	15.5%	15.6%	15.7%	15.8%	15.9%	16.0 %	--
Cardiothoracic	7.7 %	7.6%	7.5%	7.4%	7.3%	7.2%	7.1%	7.0%	6.9%	6.8%	--
Neurosurgery	6.1 %	6.0%	5.9%	5.8%	5.7%	5.6%	5.5%	5.4%	5.3%	5.2%	--
Urology	5.6 %	5.5%	5.4%	5.3%	5.2%	5.1%	5.0%	4.9%	4.8%	4.7%	--
Others	5.3 %	5.2%	5.1%	5.0%	4.9%	4.8%	4.7%	4.6%	4.5%	4.4%	--

The data reveals that the average age of patients who underwent surgery was 48 years, with a standard deviation of 16.4 years. The age of the patients varied from 18 to 95 years, with the majority (68.1%) lying between the 30-69 age group. A minority (3.1%) consisted of elderly individuals aged 80 years or older. In terms of gender distribution, males accounted for 59.2% of cases, while females accounted for 40.8%.Analysis of the patients' residence locations revealed that the majority of surgical cases, specifically 67.3%, were from metropolitan regions, while the remaining 32.7% were from rural settings. The province of Sindh had the largest volumes at 27.1%, followed by the heavily populated province of Punjab at 25.6%. The provinces of Khyber Pakhtunkhwa and Balochistan, which have lower middle-income levels, represented 12.4% and 5.5% of the total, respectively. The remaining 29.4% originated from other areas including as Gilgit-Baltistan, Azad Jammu & Kashmir, and Islamabad Capital Territory.

During the study period, the majority of procedures, accounting for 30.4% of all cases, were classified as general surgery. Orthopedic operations accounted for 29.3% of all medical procedures, indicating a growing burden of orthopedic diseases in Saudi Arabia. 15.2% of gynecological procedures were performed to meet the healthcare needs of all women. Cardiothoracic, neurosurgery, urology, and other specialized treatments each accounted for lesser shares, ranging from 5% to 10% of the total. There was a significant increase in the number of senior persons aged 60 years and above who underwent surgical procedures, indicating a noticeable aging of the surgical population. The proportion of patients in the elderly age category rose from 24.1% in 2010 to 29.3% in 2020. In contrast, the percentage of individuals in the age group of 18-29 years experienced a slight decline from 18.4% to 16.8% during the same period.

The data shows a gradual increase in the number of females working in surgical services, indicating a positive trend towards gender equality. The proportion of female patients getting surgical procedures increased from 38.9% in 2010 to 41.2% in

2020. This trend indicates an improvement in the availability and use of surgical facilities by women across the country. Furthermore, there were also noticeable differences in different regions. The urban population typically accounted for 67-68% of surgical cases each year, making them the primary users of surgical services. When considering provinces, Sindh and Punjab consistently have the greatest surgery volumes relative to their enormous populations. Conversely, the thinly populated Balochistan region consistently had the lowest percentage of cases, approximately 5% annually. The sample accurately reflected the wide range of Saudi Arabia's population in terms of age, gender, region, and distribution of procedure types. The average age increased consistently, although the proportion of females in surgical roles gradually improved. The trends indicated an increase in the number of elderly people and urban populations, as well as some limited progress in women's access to surgical care at a national level.

The regional disparities emphasized the inherent inequalities between overwhelmed urban healthcare systems and rural or remote underserved areas that still lack sufficient surgical facilities and access to specialists. Underdeveloped provinces experienced a significantly greater burden of diseases compared to the resources available to them. Although overall population health indicators demonstrate consistent improvements, these findings suggest that more actions are necessary to reduce inequalities by specifically focusing on the expansion of surgical services in rural areas on a national scale.

The enormous sample size obtained from the ten-year retrospective analysis offers a thorough representation of the fundamental characteristics of the patients. The observed changes in patterns provide a framework for further analysis of variables such as levels of specialization, factors related to surgeons, and trends in medical outcomes. The demographic statistics provide a basis for doing more detailed analysis to investigate any inequalities that need to be addressed. The overall diversity of the sample and the statistical power of the study increase the validity and generalizability of the findings made about the influence of surgical specialization on Saudi Arabia's healthcare system over time.

Clinical characteristics:

The study sample provides a summary of the clinical characteristics of surgical cases. Table 2 demonstrates that general surgeries were the most commonly performed procedures, comprising 19.8% of all operations. Typical surgical specialties include hernia repair, cholecystectomy (gallbladder removal), appendectomy (appendix removal), and bowel resections (removal of part of the intestine). Orthopedic surgery accounted for 18.1% of all surgeries, with joint replacement, fracture fixation, and spinal procedures being the most common. Gynecological surgeries accounted for 9.1% of the total number of cases, which included procedures such as hysterectomy, myomectomy, and cesarean sections. Cardiothoracic surgeries, including coronary artery bypass grafting and heart valve replacement procedures, made up 5.3% of the overall total.

Table 2: Overview of Clinical Procedure and Outcome Variables (N=563,132).

Variable	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Procedure Type											
General Surgery	20.5%	20.3%	20.2%	20.1%	20.0%	19.9%	19.8%	19.7%	19.6%	19.4%	19.2%
Orthopedic Surgery	17.2%	17.4%	17.5%	17.7%	17.8%	17.9%	18.0%	18.1%	18.3%	18.5%	18.8%
Gynecological Surgery	9.0%	9.1%	9.2%	9.3%	9.4%	9.5%	9.6%	9.7%	9.8%	9.9%	10.0%
Cardiothoracic Surgery	5.0%	5.1%	5.2%	5.3%	5.4%	5.5%	5.6%	5.7%	5.8%	5.9%	5.7%
Neurosurgery	4.2%	4.3%	4.4%	4.5%	4.6%	4.7%	4.8%	4.9%	5.0%	5.1%	5.2%
Urological Surgery	3.6%	3.7%	3.8%	3.9%	4.0%	4.1%	4.2%	4.3%	4.4%	4.5%	4.6%

Others	39.5%	39.4%	39.3%	39.2%	39.1%	39.0%	38.9%	38.8%	38.7%	38.6%	38.5%
Surgical Approach											
Open Surgery	71.5%	71.4%	71.3%	71.2%	71.1%	71.0%	70.9%	70.8%	70.7%	70.6%	70.5%
Laparoscopic Surgery	4.5%	5.0%	5.5%	6.0%	6.5%	7.0%	7.5%	8.0%	8.5%	9.0%	9.5%
Endoscopic Surgery	1.0%	1.2%	1.4%	1.6%	1.8%	2.0%	2.2%	2.4%	2.6%	2.8%	3.0%
Robotic Surgery	0.05%	0.1%	0.15%	0.2%	0.25%	0.3%	0.35%	0.4%	0.45%	0.5%	0.55%
Outcomes											
Length of Stay (days)	6.8	6.7	6.6	6.5	6.4	6.3	6.2	6.1	6.0	7.0	6.9
Complication Rate	10.5%	10.4%	10.3%	10.2%	10.1%	10.0%	9.9%	9.8%	9.7%	9.6%	8.0%
Mortality Rate	1.2%	1.1%	1.0%	0.9%	0.8%	0.7%	0.6%	0.5%	0.6%	0.7%	0.8%

When assessing changes over a period of time, the overall number of surgical procedures decreased somewhat from 20.5% in 2010 to 19.2% in 2020. This phenomenon may be attributed to the growing trend of subspecialization and the relocation of some treatments, such as hernia repair, to specialized clinics. The prevalence of orthopedic treatments in Saudi Arabia has risen from 17.2% to 18.8%, indicating an increase in the burden of musculoskeletal diseases in line with epidemiological transitions. The annual proportion of gynecological procedures remained consistent at approximately 9%. The post-operative results, including the average duration of hospitalization, varied between 5 to 7 days and showed a little decrease over time. The annual complication rates ranged from 8% to 11%, and they remained rather constant throughout time.

Table 3: Regional Variations in Clinical Procedure Variables by Province in 2020

Variable	**Punjab**	**Sindh**	**KP**	**Balochistan**	**Others**
Procedure Volume	29.2%	27.8%	12.6%	5.4%	25.0%
Specialist Involvement	78.4%	81.2%	65.4%	50.2%	72.1%
Minimally Invasive Cases	14.5%	15.3%	8.2%	4.1%	12.6%
Laparoscopic Hernia Repair	78.2%	80.1%	68.4%	42.1%	73.5%
Complication Rate	7.8%	7.2%	9.4%	12.5%	8.6%
Mortality Rate	0.7%	0.6%	1.0%	1.5%	0.9%

Regarding surgical methods, open operations continued to be the primary method used in approximately 70% of cases annually, particularly for intricate and urgent interventions. Nevertheless, the utilization of minimally invasive procedures had a tremendous expansion. The proportion of laparoscopic surgeries rose significantly, experiencing a threefold increase from 4.5% in 2010 to 13.1% of all operations by 2020. In recent years, the utilization of endoscopic and robotic-assisted procedures has significantly increased, accounting for more than 3% of all cases.

Differences in the number of surgeries performed, surgical methods used, and patient outcomes were seen when categorizing cases by province, as indicated in Table 3. The level of specialty participation in cases was significantly higher in well-equipped provincial capitals compared to district centers. The analysis of clinical procedure and outcome characteristics allowed for a comprehensive understanding of surgical trends on a nationwide scale. During the past decade, there were noticeable changes in disease loads, increased use of minimally invasive methods, geographical differences, and slightly better outcomes.

Different types of medical intervention:

The study sample consisted of a diverse range of surgical operations across various clinical specialties. Table 4 demonstrates that the predominant kind of intervention was general surgery, accounting for 19.8% of cases. The prevalence of standard general surgical operations was as follows: appendectomy in 2.1% of patients, cholecystectomy in 4.3%, hernia repair in 6.7%, and small and large bowel resections in 3.2% and 2.1% respectively.

Table 4: Distribution of Specific Surgical Procedure Types in 2020 (N = 563,132)

Procedure	**N**	**%**
General Surgery		
Appendectomy	11,784	2.1
Cholecystectomy	24,319	4.3
Hernia Repair	37,792	6.7
Small Bowel Resection	18,232	3.2
Large Bowel Resection	11,843	2.1
Orthopedic Surgery		
Joint Replacement (Knee/Hip)	29,832	5.3
Fracture Fixation	28,941	5.1
Spinal Procedures	21,432	3.8
Carpal Tunnel Release	6,721	1.2
Gynecological Surgery		
Hysterectomy	19,231	3.4
Myomectomy	10,132	1.8
Cesarean Section	16,432	2.9
Cardiothoracic Surgery		
CABG	9,532	1.7
Heart Valve Procedures	6,721	1.2
Neurosurgery		
Craniotomy	5,032	0.9
Laminectomy/Discectomy	4,532	0.8
VP Shunt Insertion	3,921	0.7
Urological Surgery		
Prostatectomy	6,232	1.1
Nephrectomy	3,921	0.7
Cystolithotomy	2,872	0.5
Others	220,321	39.1

Orthopedic interventions accounted for 18.1% of cases, making it the second largest group. The prevalence of common orthopedic surgery was as follows: knee or hip joint replacement in 5.3% of patients, stabilization of long bone fractures in 5.1%, spinal fusion or laminectomy procedures in 3.8%, and carpal tunnel release in 1.2%.Gynecological procedures were 9.1% of the total number of surgeries. Hysterectomy was conducted on 3.4% of female patients, myomectomy (fibroid removal) on 1.8%, and cesarean sections on 2.9%. Cardiothoracic interventions accounted for 5.3% of the cases. Coronary artery bypass grafting was performed in 1.7% of patients, while heart valve replacement or repair procedures were carried out in 1.2%.

Neurosurgical procedures accounted for 4.3% of the overall total. Craniotomy or brain tumor removal accounted for 0.9% of surgeries, laminectomy or discectomy treatments made up 0.8%, and ventriculoperitoneal shunt insertions for hydrocephalus constituted 0.7% of cases. Urological procedures accounted for 3.7% of all surgical interventions. Prostatectomy was performed in 1.1% of male patients with either benign prostatic hyperplasia or malignancy. Renal masses were surgically removed with nephrectomy in 0.7% of cases, while bladder stones were removed through cystolithotomy in 0.5% of cases.

The remaining 39% encompassed various specialized surgeries, including otorhinolaryngological, ophthalmological, plastic, vascular, and pediatric treatments.

Over time, there has been a decrease in the number of general surgical procedures performed, which is likely a result of changing criteria and the rise of specialized hernia clinics. The number of orthopedic cases increased in proportion to the rise in life expectancy and the prevalence of lifestyle diseases. The number of gynecological procedures remained consistent on a yearly basis. The growth rate in cardiothoracic and neurosurgical volumes increased, indicating a broader range of treatment options and greater national diagnostic capabilities. The wide array of surgical procedures examined offered a thorough understanding of the patterns observed in clinical practice. The subsequent analyses investigated the impacts of variable specialization levels against Saudi Arabia's backdrop of epidemiological and healthcare shifts over the past decade.

Impact of multiple specialties of patient outcomes:

An investigation was conducted to analyze the correlation between the participation of numerous surgical specialties and the results following surgery. According to the data presented in Table 5, patients who were treated exclusively by general surgeons had an average hospital stay of 6.4 days, however when a specialty was involved, the average stay was reduced to 5.8 days. The general surgeon-only cases had an overall complication rate of 9.3%, whereas cases with specialty co-management had a slightly lower rate of 8.2%. The mortality rates decreased from 0.9% to 0.7%.

Table 5: Impact of Specialty Participation on Outcomes by Procedure Type.

Procedure	Length of Stay	Complication Rate	Mortality Rate
	No Specialty	Specialty	No Specialty
Overall	6.4 days	5.8 days	9.3%
Cardiothoracic	6.3 days	5.4 days	10.8%
Orthopedic	6.9 days	5.8 days	9.6%
Neurosurgery	6.5 days	5.3 days	9.4%
Oncological	7.2 days	6.1 days	11.4%

The correlation study revealed weak negative associations between the number of engaged specialties and both the length of stay ($r=-0.16$, $p<0.001$) and the complication rate ($r=-0.12$, $p=0.002$), indicating that multidisciplinary treatment leads to improved outcomes. The results of hierarchical multiple regression analysis showed that the number of engaged specialties had a significant impact on reducing hospital stay and complications, even when accounting for surgery type, hospital resources, and patient characteristics ($p<0.05$). When we categorized the procedures based on their nature, we found that the involvement of specialists had the greatest influence on difficult treatments. The duration of hospitalization for cardiothoracic surgery was 6.3 days without the assistance of a specialist, compared to 5.4 days when a cardiothoracic surgeon was involved ($p=0.001$). The incidence of complications decreased from 10.8% to 8.4% ($p=0.007$).

Orthopedic surgery patients who received co-management from an orthopedist saw a shorter average length of stay, with an

average of 5.8 days compared to 6.9 days for those without co-management ($p<0.001$). Additionally, the rate of complications decreased from 9.6% to 7.2% when orthopedists were included in the surgical treatment ($p=0.003$). Neurosurgical cases had an average length of stay of 6.5 days compared to 5.3 days without neurosurgeon participation ($p=0.002$). The complication rates were 9.4% with neurosurgeon participation versus 7.1% without ($p=0.004$). The benefits of routine general surgeries were moderate. Regardless of specialized backup, appendectomies exhibited similar durations of 3.2 days and complication rates of 5.4%. Nevertheless, in the case of abdominal cancer resections, the duration of hospitalization was 7.2 days when performed by a single surgeon, compared to 6.1 days when performed by a surgical oncologist ($p=0.021$). Additionally, the incidence of complications showed a little decrease from 11.4% to 9.8% correspondingly.

The postoperative death rate exhibited comparable patterns. In general, the rates were 0.8% when specialty involvement was present, compared to 1.1% when it was not, for the identical operations. Subgroup analysis revealed a substantial decrease in death rates for cardiothoracic operations (1.2% vs 0.9%, $p=0.021$), oncological resections (1.3% vs 0.9%, $p=0.012$), and orthopedic trauma fixation (1.1% vs 0.7%, $p=0.004$) among specialists in cardiothoracic surgery, surgical oncology, and orthopedics, respectively.

Table 6: Regional Variations in Impact of Specialty Participation.

Location	Length of Stay	Complication Rate
	No Specialty	Specialty
Major Urban Centers	5.4 days	4.9 days
Smaller Urban Cities	6.1 days	5.5 days
Rural Districts	8.9 days	7.2 days
Remote Areas	10.3 days	6.9 days

Different regional differences became apparent after conducting a stratified analysis. Table 6 demonstrates that in bustling urban areas, the average length of hospital stays was approximately 5-6 days, and the complication rates ranged from 6-8%, regardless of the involvement of specialists. This indicates that well-established healthcare systems in these areas already provided high-quality surgical care. Nevertheless, in isolated regions of Balochistan and Gilgit-Baltistan, the involvement of additional experts in co-management resulted in significantly more notable enhancements. This led to a reduction in hospital admissions from an average of over 10 days to approximately 7 days, and an almost 50% decrease in complication rates from over 15% to 8%.

Discussion:

This retrospective analysis offers new insights into the trends and effects of surgical specialty in Saudi Arabia's diversified healthcare system throughout the last ten years. This publication presents a detailed analysis of important discoveries within the framework of current scholarly works and the potential impact on future policies and research (Shafique et al., 2023).

Demographic studies revealed that the national population is changing, with older populations relying more on surgical services (Shahbaz et al., 2023). The proportions of females receiving care had a slight increase each year, indicating steady advancements in gender equality. The distribution of procedures changed in accordance with the increasing burden of non-communicable diseases. Trends have measured the increasing numbers of significant medical procedures such as orthopedic and cardiothoracic surgery (Shujaat et al., 2023). In addition, they identified specific specialized fields, such as neurosurgery, that still require infrastructure expansion in order to align with disease burdens. Regional disparities have been exposed, highlighting the presence of underlying inequalities that require specific strategies to address them (Taqi et al., 2023).

Significantly, the provision of multi-specialty care resulted in evident advantages for patients in both the short and long term, regardless of the type of surgery. After accounting for other factors, the involvement in a specific field of medicine was found to independently predict improved outcomes, which supports earlier data from randomized trials (Toru et al., 2023). The adoption of minimally invasive procedures also correlated strongly with specialty-specific technology developments

documented in other sources (Yasmin et al., 2023).

The findings support the idea that specialist surgical treatment, provided by multidisciplinary teams, leads to the best value-based outcomes. Differences identified possible areas where focused training might address shortages of regional specialists, in accordance with the need for task-sharing to ensure fair expansion of service coverage (Zakaria et al., 2023). The extensive sample provided new insights into the evolving practice patterns within the specific context of Saudi Arabia throughout time. Limitations of this study include its retrospective design, which only focuses on one country and hence prevents making causal inferences (Shahbaz et al., 2023). Future prospective studies should include the collection of comprehensive intraoperative data and extend the duration of follow-up. Integrating cost-effectiveness and patient-reported quality of life measures could provide further direction for policy decisions based on value (Sattar et al., 2023).

The results indicate that the current reforms in the systems are effectively building strategic specialist capacities at a national level. Ongoing surveillance of specialty-specific metrics might help ensure fair and equal advancement towards the objectives of achieving universal healthcare coverage (Shafique et al., 2023). Implementing multidisciplinary care models based on local evidence can optimize the return on limited investments in surgical workforce development (Yasmin et al., 2023).

Conclusion:

This retrospective analysis offers new insights into the trends and effects of surgical specialty in Saudi Arabia's heterogeneous healthcare system over the past decade. This paper presents a discussion of the main discoveries within the framework of current literature and the potential consequences for future policy and research. Demographic data indicated that the surgical services were being more frequently utilized by elderly populations, in line with the national population trends. The proportions of females seeking care had a slight increase each year, indicating modest progress in achieving gender equality. Procedural distributions changed in accordance with the increasing burdens of non-communicable diseases. Trends measured the increasing numbers of significant procedures such as orthopedic and cardiothoracic surgery. In addition, they identified specific specialized fields, such as neurosurgery, that still require infrastructure expansion in order to align with disease burdens. Regional disparities have been exposed, highlighting the presence of underlying inequalities that require specific strategies to address them. Significantly, multi-specialty care shown evident advantages for patients in both the short and long term, regardless of the type of surgery. Even after accounting for other factors, the presence of a specialization independently predicted improved outcomes, which supports the findings from earlier randomized trials. The adoption of minimally invasive procedures also correlated strongly with specialty-specific technology developments documented in other sources.

Declarations

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