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Assessment of knowledge and awareness regarding Robotics-Assisted Surgery (RAS) among Saudi population: A cross sectional study

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ABSTRACT

Introduction: An increasing number of surgeries are being performed with the assistance of robots and this new technology necessitates a strong commitment on the part of healthcare providers and patients alike. The purpose of this study was to investigate the public's awareness, knowledge and perceptions of Robotic-Assisted Surgery (RAS) in Saudi Arabia. *Materials and Methods:* An online pretested questionnaire was used to collect responses from participants from different provinces of Saudi Arabia. Participants' self-reported knowledge and perceptions were recorded and based on the correct responses, knowledge levels were calculated. Data were analyzed using appropriate statistical tests by an independent biostatistician. *Results:* The knowledge level regarding RAS was found to be poor in the majority of the participants (88.8%), although 74.5% had heard about RAS. Only 33.5% knew that RAS is available in Saudi Arabia and 44.8% knew that it is similar to Laparoscopic or minimally invasive surgery. Knowledge level was significantly higher among participants with higher educational qualifications ($p<0.05$). About 41.7% believed that robots could be so accurate they would help the surgeon do a better job and approximately 9.3% had the view that robotic surgeons are less skilled than non-robotic surgeons. *Conclusion:* Knowledge and perceptions about RAS are limited among the public in Saudi Arabia. Efforts should be made to increase awareness by utilizing various virtual media platforms.

Keywords: Knowledge, perceptions, robot-assisted surgery, artificial intelligence

1. INTRODUCTION

In Europe and the United States, robot-assisted surgery (RAS), a rapidly expanding global minimally invasive surgery (MIS), has been successfully

adopted under challenging conditions, such as prostate, kidney and urinary bladder oncological surgeries (Azhar et al., 2019). Robots have been used in production industries, including the automotive sector, since the 1960s. They can repeat the same task with far more speed, precision and consistency. They are now entering the surgical realm, aiding surgeons in performing minimally invasive surgical operations as early as the turn of the century (Ahmad et al., 2017). Traditional surgery was open in its earlier forms. During the surgery, the surgeon used small, essential surgical equipment such as scalpels, scissors and forceps to complete all procedures by hand inside a large incision. Laparoscopic surgery developed and became popular in the 1980s and robots are increasingly being used in challenging surgical operations (Ahmad et al., 2017). Conversely, robots are not self-contained machines capable of carrying out simple, preprogrammed tasks (Zineddine and Arafa, 2013). Robotic surgical systems place a computer between the surgeon's hands and the tips of ultra-small equipment, with specially built programs assisting in the execution of all complex procedures through microscopic ports (Azhar et al., 2019). The approval of the Da Vinci surgical system by the US Food and Drug Administration (FDA) in 2000 promoted the development of robotic-assisted laparoscopic surgery, particularly in urology, but also in gynecology, cardiothoracic, head and neck surgery and general surgery (Lee, 2014). Since its inception in 2000, many international studies have reported on varying levels of comprehension and approval of RAS among surgeons and patients in a variety of surgical specialties, including gynecology and urology (Aldousari et al., 2021). In comparison to straight-stick laparoscopy, studies have also shown that RS offers the potential to reduce the learning curve for trainee surgeons (Mc-Dermott et al., 2020). Since the introduction of robotic systems for surgical use in 2000, the number and variety of robotic-assisted procedures (RAS) have grown significantly (Chan et al., 2022). Depending on the geographical location of practice, there appears to be significant variation in RAS availability, usage and conception. Unfortunately, RAS adoption and awareness in the Middle East are significantly lower than in Western countries (Azhar et al., 2019). Previous research has shown that robotic-assisted surgery (RAS) aids in executing precise surgical procedures, leading to shorter postoperative hospital stays and better outcomes (Buabbas et al., 2020). One of the most popular arguments for utilizing wrist-jointed instruments for intra-abdominal movements in robotic laparoscopic surgery is that it offers surgeons superior visualization in three dimensions, minimizes the need to move their arms and makes the surgical environment safer (Chan et al., 2022). The Kingdom of Saudi Arabia purchased the first da Vinci Surgical System in the Gulf Cooperation Council (GCC) region in 2003. Other GCC countries, including Qatar, the United Arab Emirates and Kuwait, established RAS programs over the next 15 years. There are several reasons for the GCC region's delayed adoption of RAS. There were few certified fellowship-trained robotic surgeons available and there were few regional robotic training facilities (Aldousari et al., 2021). The majority of previous research investigated either patients' or clinical staff's opinions toward RAS. Unfortunately, there is little research about public understanding, awareness and perceptions. As a result, we are conducting this research to assess the public understanding, awareness and perceptions of RAS.

2. MATERIALS AND METHODS

A cross-sectional study was conducted on a representative sample of participants from different provinces in Saudi Arabia. A minimum sample of 874 was calculated with a confidence level of 95% and a margin of error of 5% after the application of inclusion and exclusion criteria with no gender differences. Participants aged above 18 years and who are residents of Saudi Arabia were included. Participants who worked in the health sector field and who didn't give consent were excluded. Permission to conduct the study was taken from the Research and Ethics Committee of Taif University (TU-43-554).

A self-administered questionnaire that was adopted from previous research by Buabbas et al., (2020) was used after some modification. The study was conducted from October 2022 to December 2022. The modified version was pretested on a pilot sample of 20 participants, which showed good reliability (Cronbach's α = 0.889). The online version of the questionnaire was randomly distributed to collect responses. We used convenience sampling for data collection. The first part of the questionnaire included the items that were checked for participation criteria (inclusion and exclusion criteria). Participants who satisfied the participation criteria only were allowed to answer the remaining items of the questionnaire, which included socio-demographic data and questions regarding knowledge and awareness of robotics-assisted surgery among the population in Saudi Arabia.

Data management and statistical analysis

The online responses were downloaded on a Microsoft Office Excel sheet (MS Office 2016) for Windows. After data cleaning and coding, it was then transferred to the Statistical Package of Social Science Software (SPSS) program, version 22 (IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY: IBM Corp.) for statistical analysis. An independent biostatistician was responsible for statistical analysis. Frequencies and percentages were used to represent categorical variables, while the mean and standard

deviation were used for continuous variables. Pearson's chi-square test was used to evaluate the association between categorical variables. A P value of <0.05 was considered statistically significant.

3. RESULTS

Our analysis included responses from 1879 participants from different provinces of Saudi Arabia. The socio-demographic analysis showed that 1105 (58.8%) were males, 1458 (77.6%) belonged to the 18-32 years age group, 1268 (67.5%) were single, 1182 (62.9%) had a university education, 1042 (55.5%) were students and 495 (26.3%) were from Central province of Saudi Arabia (Table 1).

Table 1 Socio-demographic characteristics (n=1879)

		Frequency	Percent
Gender	Female	774	41.2
	Male	1105	58.8
Age	18 - 32	1458	77.6
	33 - 50	371	19.7
	More than 50	50	2.7
Marital status	Single	1268	67.5
	Married	534	28.4
	Divorced	43	2.3
	Widowed	34	1.8
Education	Primary school	11	.6
	Middle school	58	3.1
	High school	543	28.9
	University	1182	62.9
	Postgraduate Study	85	4.5
Occupation	Employee	514	27.4
	Health practitioner employee	57	3.0
	Student	1042	55.5
	Housewife	121	6.4
	Retired	34	1.8
	Unemployed	111	5.9
Residence	Central Region	495	26.3
	Eastern region	245	13.0
	Southern region	403	21.4
	The northern region	353	18.8
	Western Region	383	20.4

The practices related to computer technology showed that 40.9% reported spending 6-11 hours per week on computer technology, whereas 57 (3%) didn't use any computer technology. Among those who used computer technology (n=1822), 835 (45.8%) felt that they were 'comfortable' with current computer technology and 1513 (83%) reported that their computer literacy was 'literate' (Table 2).

The responses of participants related to knowledge regarding RAS are shown in Table 3. About 666 (49.1%) gave the correct definition of RAS and about 21.4% didn't know any surgical specialties that use Robotic-Assisted Surgery. Only 33.5% knew that RAS is available in Saudi Arabia and about 307 (67.5%) think that RAS is safe. About 204 (44.8%) knew that RAS is similar to Laparoscopic/minimally invasive surgery.

The total knowledge level regarding RAS was calculated by calculating the correct response to knowledge questions. The knowledge was categorized based on the percentage of scores obtained >=75% were considered as 'good,' 60-74.9% as 'Fair' and <60% as 'Poor.' The knowledge level of the participants showed that only 84 (4.5%) demonstrated a 'good' knowledge level and the majority (88.8%) demonstrated 'poor' knowledge (Figure 1).

Table 2 Practices related to computer technology

		Frequency	Percent
Time spent on computer technology in a week	Don't use	57	3.0
	<=5	272	14.5
	6-11	768	40.9
	12-17	373	19.9
	≥18	409	21.8
How would you categorize your comfort with current technology (n=1822)	Comfortable	835	45.8
	Somewhat comfortable	859	47.1
	Not comfortable	128	7.0
How would you rate your computer literacy? (n=1822)	Competent	189	10.4
	Literate	1513	83.0
	Illiterate	120	6.6
Heard of Robotic-Assisted Surgery	No	465	25.5
	Yes	1357	74.5
Source (m=1357)	Internet	545	40.2
	Not sure	210	15.5
	Social media	602	44.4

Table 3 Knowledge related to Robotic-Assisted Surgery (n=1357)

		N	%
Definition of Robotic-Assisted Surgery/	A surgeon sitting on a console and control the robot's arms movement*	666	49.1
	The robot does the surgery, while a surgeon stands by to ensure patient's safety	236	17.4
	The surgeon instructs the surgical robot step by step	141	10.4
	The surgeon programs the robot and the robot does the job	219	16.1
	I don't know	95	7.0
Surgical specialties that use Robotic-Assisted Surgery	Cardiac surgery*	458	24.4
	General surgery*	589	31.3
	Neurosurgery*	468	24.9
	Thoracic surgery*	300	16.0
	Urology*	261	13.9
	Orthopedic surgery*	297	15.8
	I don't know	402	21.4
Is Robotic-Assisted Surgery available in Saudi Arabia?	No	162	11.9
	Yes*	455	33.5
	I don't know	740	54.5
If yes, do you know any patient who had Robotic-Assisted Surgery?	No	315	69.2
	Yes	140	30.8
Think Robotic-Assisted Surgery is safe	Yes*	307	67.5
	No	52	11.4
	I don't know	96	21.1
Type of surgery is Robotic-Assisted Surgery most similar to.	Laparoscopic/minimally invasive surgery*	204	44.8
	Traditional open surgery	64	14.1
	Laser surgery	68	14.9
	I don't know	119	26.2

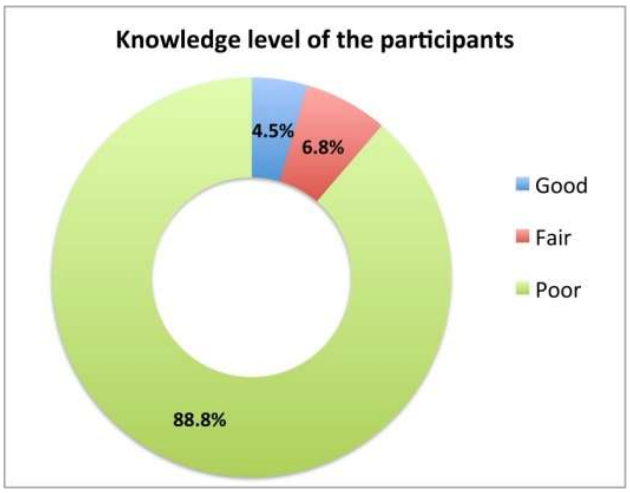

Figure 1 Knowledge level of participants regarding Robotic-Assisted Surgery

The relationship between "knowledge level and participants" socio-demographic characteristics is given in Table 4. The analysis showed that the Gender, Age and Marital status of the patients didn't show any statistically significant relationship with knowledge level ($p>0.05$). However, participants who had higher education qualifications such as university and post-graduate levels of education had demonstrated significantly more 'good' knowledge levels than others ($p<0.05$). It was also found that participants from the northern region showed a comparatively more "good knowledge level" than other regions ($p<0.05$).

Table 4 Relationship of knowledge level with socio-demographic characteristics (n= 1357)

			Knowledge level			Total	P value
			Good	Fair	Poor		
Gender	Female	N	39	55	497	591	0.860
		%	6.6%	9.3%	84.1%	100.0%	
	Male	N	45	72	649	766	
		%	5.9%	9.4%	84.7%	100.0%	
Age	18 – 32	N	63	92	855	1010	0.505
		%	6.2%	9.1%	84.7%	100.0%	
	33 – 50	N	16	31	259	306	
		%	5.2%	10.1%	84.6%	100.0%	
	More than 50	N	5	4	32	41	
		%	12.2%	9.8%	78.0%	100.0%	
Marital status	Divorced	N	0	2	31	33	0.583
		%	0.0%	6.1%	93.9%	100.0%	
	Married	N	29	42	358	429	
		%	6.8%	9.8%	83.4%	100.0%	
	Single	N	54	82	731	867	
		%	6.2%	9.5%	84.3%	100.0%	
	Widowed	N	1	1	26	28	
		%	3.6%	3.6%	92.9%	100.0%	
Educational level	Primary school	N	0	1	6	7	0.016*
		%	0.0%	14.3%	85.7%	100.0%	
	Middle school	N	0	1	30	31	
		%	0.0%	3.2%	96.8%	100.0%	
	High school	N	12	25	333	370	
		%	3.2%	6.8%	90.0%	100.0%	
	University	N	67	93	727	887	
		%	7.6%	10.5%	82.0%	100.0%	

	Postgraduate	N	5	7	50	62	
		%	8.1%	11.3%	80.6%	100.0%	
Region	Central Region	N	17	30	291	338	0.006*
		%	5.0%	8.9%	86.1%	100.0%	
	Eastern region	N	9	18	132	159	
		%	5.7%	11.3%	83.0%	100.0%	
	Southern region	N	14	25	296	335	
		%	4.2%	7.5%	88.4%	100.0%	
	The northern region	N	31	30	203	264	
		%	11.7%	11.4%	76.9%	100.0%	
	Western Region	N	13	24	224	261	
		%	5.0%	9.2%	85.8%	100.0%	

We also evaluated the relationship between knowledge level and computer literacy and current computer technology's comforts (Table 5). Participants who reported that their computer literacy was 'competent' significantly demonstrated a comparatively more 'good' knowledge level ($p<0.05$). No statistically significant association was observed between knowledge level and comforts of current computer technology ($p>0.05$).

Table 5 Relationship of knowledge level with computer literacy and Comfortness of current computer technology (1857)

			Knowledge level			Total	P value
			Good	Fair	Poor		
How would you rate your computer literacy?	Competent	N	17	22	115	154	0.004
		%	11.0%	14.3%	74.7%	100.0%	
	Illiterate	N	2	9	62	73	
		%	2.7%	12.3%	84.9%	100.0%	
	Literate	N	65	96	969	1130	
		%	5.8%	8.5%	85.8%	100.0%	
How would you categorize your comfort with current technology (i.e., computers, cell phones)?	Comfortable	N	47	52	545	644	0.310
		%	7.3%	8.1%	84.6%	100.0%	
	Not comfortable	N	5	11	78	94	
		%	5.3%	11.7%	83.0%	100.0%	
	Somewhat comfortable	N	32	64	523	619	
		%	5.2%	10.3%	84.5%	100.0%	

When we assessed participants' perceptions related to RAS, it was found that about 41.7% believed that robot can be so accurate it will help the surgeon do a better job. About 32.3% believed that robot malfunction during surgery is a major concern and 26.5% had the view that robot mistakes causing serious complications is a major concern. It was reported by 41.6% of the participants that they would choose RAS if it was one of the treatment options for a surgical condition they have. About 42.5% of the participants had the view that robotic surgeons are more skilled compared to non-robotic surgeons, whereas as only 9.3% believed that they are less skilled compared to non-robotic surgeons. More than half of the participants had the view that hospitals that offer RAS are better than hospitals that do not offer these procedures (Table 6).

Table 6 Perceptions related to Robotic-Assisted Surgery use (n=1357)

	Responses	N	%
Perception when you hear the term "Robotic-Assisted Surgery" as a procedure compared to conventional methods of surgery	Robot malfunction during surgery is a major concern	438	32.3
	The procedure is less painful than open surgery.	255	18.8
	The procedure will have less complications than open surgery	188	13.9
	The procedure is faster than open surgery.	446	32.9
	Robot mistakes causing serious complications is a major concern	359	26.5

	Robot can be so accurate it will help the surgeon do a better job.	566	41.7
	The procedure will have more complications than open surgery	91	6.7
	The procedure is slower than open surgery	95	7.0
	I don't know	280	20.6
Choose Robotic-Assisted Surgery if it was one of the treatment options for a surgical condition.	Yes	564	41.6
	No	383	28.2
	I don't know	410	30.2
Surgeons who use the robot are more or less skilled compared to non-robotic surgeons.	Less skilled compared to non-robotic surgeons	126	9.3
	More skilled compared to non-robotic surgeons	577	42.5
	Similar skills to non-robotic surgeons	460	33.9
	I don't know	194	14.3
Hospitals that offer Robotic-Assisted Surgery are better or worse compared to hospitals that do not.	Better than hospitals that do not offer	704	51.9
	Worse than hospitals that do not offer	71	5.2
	Uncertain	381	28.1
	I don't know	201	14.8

4. DISCUSSION

Surgical technology continues to advance rapidly and robots are increasingly being employed to perform complex surgeries across a wide range of specialties, including urology, gynecology, cardiothoracic surgery and colorectal surgery (Azhar et al., 2019; Platis and Zoulias, 2014). Robotic-assisted surgery (RAS) has been proved in previous research to assist in conducting precise surgical procedures with greater effectiveness and short postoperative hospital stays (Novara et al., 2012; Porpiglia et al., 2018; Porpiglia et al., 2013; Zhang et al., 2019). The integration of RAS necessitates a clear understanding and willingness from both the healthcare organization and the public to use the robots for various surgical procedures. The findings of our study showed that about 74.5% of our participants had heard about RAS and only 33.5% of them knew that it is available in Saudi Arabia. The awareness found in our study is higher than the one by Buabbas et al., (2020) in Kuwait, which reported that only one-third of the participants heard about RAS and one-third of them knew that it is available in their country. Another study done in the USA reported that about 86% have heard of RAS, where more than half of the participants in this study had a health care background (Boys et al., 2016). However, the knowledge level observed in our study was not satisfactory, where only 4.5% demonstrated good knowledge. Only 44.8% of the participants in our study thought that RAS is similar to Laparoscopic or minimally invasive surgery (MIS). This is in contrast to a previous study, which reported higher awareness and a majority of the participants believed that it is similar to MIS (Zineddine and Arafa, 2013). We observed a higher knowledge about RAS among participants who had higher educational qualifications, which means that individuals with lesser educational qualifications need more dissemination of information through various sources to improve their awareness regarding RAS. At the same time, it should be made aware to the patients that an open surgeon may be better trained and certified than an MIS surgeon. Depending on the surgeon's experience and training, he or she may be able to do open, laparoscopic or robotic procedures.

Adoption of RAS in Saudi Arabia could be attributed to multiple factors, including the robot's high price, maintenance, surgeons' knowledge and skills and the public's willingness. Improved visualization and refined motor movements, as well as greater ergonomics, are cited by surgeons in favor of RAS. These technical factors have encouraged some surgeons to use RAS for many surgical procedures. RAS has successfully handled the drawbacks of standard laparoscopic and thoracoscopic surgery, hence enabling the minimally invasive execution of complex and sophisticated surgical operations with enhanced precision (Ballantyne, 2002; Lönnerfors et al., 2015). However, research comparing robotic and non-robotic MIS procedures in gynecology, general surgery, otolaryngology and thoracic surgery has demonstrated limited or no substantial increase in outcomes with RAS, despite the fact that RAS is increasingly used in these fields as well (Ballantyne, 2002; Flores and Alam, 2008; Morino et al., 2004; Shibata et al., 2015). Hospitals' aggressive marketing of surgical innovation may have also contributed to the dramatic increase in RAS. In a technologically advanced society, there may be a notion that innovative technology and hospitals that embrace change are fundamentally superior; as a result, patient demand for RAS may be a major factor in a competitive healthcare system (Jones and Sethia, 2010). In our study, it was observed that participants who had competent literacy in computer technology had significantly improved knowledge related to RAS. This could be explained by the fact participants with higher levels of education and skills in information technology were able to receive the most up-to-date information about contemporary medical technology from credible sources, resulting in a greater understanding of RAS.

Patient trust is a key factor in health-related decision-making, especially when there is a significant degree of risk and ambiguity involved in surgery (Torrent-Sellens et al., 2021). Nearly two-thirds of the participants believed that RAS is safe. People who express concern about the safety of this procedure should know that malfunction is very rare in such procedures. Evidence shows that the majority of robot malfunctions occur before the initiation of the operation, with an incidence of 0.5–2.6% (Kaushik et al., 2010; Zorn et al., 2007). In order to minimize any misperceptions and safety concerns regarding RAS, surgeons should have careful preoperative discussions with patients explaining the potential benefits and risks related to such a procedure. In our study, only 33.5% knew that RAS is available in Saudi Arabia. This could be attributed to the fact that some participants have restricted access to health care facilities that offer RAS due to a lack of referrals. The lack of use of visual and social media tools to educate patients about robotic technology and its availability is evident in our study findings. It's been well documented how media can be used to address misconceptions and offer accurate information about RAS's availability, safety and comparative advantages over other surgical techniques (Dixon et al., 2019; Randell et al., 2019). Despite this, physicians play a critical role in educating patients about the benefits of this new technology.

One of the strengths of this study is its larger sample size, which covered most of the provinces in Saudi Arabia. However, our study has some limitations, which need to be addressed before interpreting the findings. We used a convenience sampling technique, which may not give a true representation of the Saudi population. Secondly, we used a self-reported online questionnaire that could have resulted in recall bias and social desirability bias.

5. CONCLUSION

The knowledge regarding Robotic-Assisted Surgery in this study was found to be moderate to low, even though the majority of the participants had higher awareness. Robotic surgery is at its infancy stage in Saudi Arabia and it is undergoing rapid transformation. Proper utilization of visual and social media platforms is necessary to improve the knowledge and minimize the misconceptions regarding Robotic-Assisted Surgery. These findings can guide implementation decisions and assist healthcare organizations in planning and preparing to integrate robotic-assisted surgery into everyday practice.

Author contributions

The author Khalid Alzahrani was the principal investigator who was responsible for concepts and design and final review of manuscript. Rami Algethami, Moayyad Alotbi and Abeer Alsulaimani were responsible for data collection. Layla Alkhaldi and Zouhor Atallah Alhossaini were responsible for drafting of manuscript.

Ethical Approval

The Research and Ethics Committee of Taif Univeristy approved this study (TU-43-554).

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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