ORIGINAL ARTICLE

Understanding and awareness of robotics-assisted surgery in the general population of the Jeddah Region

Nasser A. Hakami[1], Alhassan H. Hobani[2*], Hayam A. Alzahrani[3], Mohammad S. Alnejaidi[4], Abdullah Y. Asiri[5], Layan Albraik[6], Suha A. Alrumaih[7], Fahad M. Alotaibi[8], Fahad G. Alosaimi[9], Rana Z. Flimban[10], Ghida M. Aljohani[10], Abdulaziz Turki Alghamdi[11], Abdulelah F. Alahmadi[12], Abdelkhalig Hussein Elhilu[1]

ABSTRACT

Objective: This study aimed to assess the level of understanding and awareness of robotics-assisted surgery (RAS) within the general population of the Jeddah region, as public support and awareness are essential for the successful adoption of this technology.

Methodology: This cross-sectional study, conducted in Jeddah, Saudi Arabia, utilized an electronic questionnaire administered to a sample of 560 residents. Data were collected anonymously through social media.

Results: The majority of the participants (62.7%) were aware of RAS, understanding varied, with only 53.0% correctly identifying that a surgeon operates the robot from a console. Most participants (60.4%) saw RAS as similar to laparoscopic surgery, yet hesitancy was notable, as only 38.5% indicated that they would choose RAS for a surgical procedure. Key concerns included the risk of robotic malfunctions (44.7%) and potential errors (56%). Occupational status significantly influenced knowledge, with healthcare workers and medical students displaying a higher understanding ($p < 0.001$), whereas other variables, such as gender, nationality, and income, showed no significant associations.

Conclusion: This study found moderate awareness and understanding of RAS, but persistent concerns about malfunctions and errors contribute to hesitancy. Misconceptions around RAS, largely influenced by social media, highlighted the need for targeted educational initiatives by healthcare professionals to improve public knowledge and confidence in this technology.

Keywords: Robotic-assisted surgery, surgery, procedure, awareness, Saudi Arabia.

Introduction

The use of robotics in general surgery has emerged as a popular method of minimally invasive surgery (MIS). Europe and the USA have seen the most use of robots in surgery, but the evolving approach has also quickly spread to other parts of the world [1]. In robotics-assisted surgery (RAS), the surgeons use robotic systems to perform complex surgical procedures. By using these robotic systems, the surgeons can perform surgical procedures with increased precision, flexibility, and control than they would ordinarily achieve when performing surgery manually [2]. The robotic systems can achieve this increased efficiency because they enhance a three-dimensional view with depth perception, eradicate the inaccuracy caused by hand tremors, and provide a greater range of motion [3]. Typically, the robotic systems used in RAS include a camera, robotic arms, and a console.

RAS introduced several new dynamics, especially in the operating room, where the presence of a robotic system forces the redesign of the structure of the operating theater as well as the positioning of the surgical team relative to the patient [4]. The barrier placed by the robotic system changes how team members communicate and demands that they develop new nontechnical skills to enhance smooth surgical processes. Additionally, being one of the most disruptive inventions in the medical sector of the past few decades, the adoption of RAS must receive support not only from the relevant healthcare professionals but also from the public [5]. Many patients might not be aware of the technological advancements in surgical techniques, and this might affect expectations and experience of a surgical procedure [6].

In Europe and the United States, a significant proportion of the population has demonstrated adequate knowledge and awareness of the use of robotics in surgery [7,8]. For example, a study by Boys et al. [7] in the United States determined that 86% of the population was aware of RAS and 72% knew some of its benefits, such as being safer, faster, and more efficient than traditional methods. Elsewhere, a 2021 study found that while public trust in RAS in Europe varies, a considerable portion of the population was aware of RAS and its benefits [8]. In Saudi Arabia, however, there is a shortage of studies that explore the extent to which people know about these technological improvements and how they perceive these advancements. This study aimed to assess the understanding and awareness of RAS in the general population of the Jeddah region.

Subjects and Methods

This study employed a cross-sectional design to assess the understanding and awareness of RAS among the general population in Jeddah, Saudi Arabia. The primary aim was to evaluate levels of awareness, perceptions, and factors influencing RAS acceptance. The study was conducted between the period of July 2024 and September 2024.

The study targeted adult residents of Jeddah, Saudi Arabia, of all genders, aged 18 years and above. Inclusion criteria required participants to be residents of Jeddah, willing to participate, and capable of completing an online survey independently. Those who were unable to respond to the questionnaire, those who lived outside the Jeddah region, and those who were aged below 18 years were excluded.

The sample size was determined using a 95% confidence level and a 5% margin of error, calculated with the formula: $n = P(1–P) * Za^2/d^2$. This resulted in an estimated sample size of 384. However, the sample was increased to 560 to improve reliability. A non-probability convenience sampling method was used to recruit participants based on their willingness and availability.

The questionnaire used in this study was adapted from a previous study that aligned with study objectives [9].

Data was gathered through an anonymous electronic questionnaire administered via Google Forms, and distributed on social media platforms such as WhatsApp, Telegram, and X. The survey included multiple-choice

Table 1. *Social demographic characteristics of the participants.*

Variables	Category	Frequency (Percentage) N (%)
Age	(mean ± SD)	29.789 ± 9.816
Gender	Female	330 (58.9)
	Male	230 (41.1)
Nationality	Saudi	513(91.6)
	Non-Saudi	47(8.4)
Educational level	Primary school	5(0.9)
	Intermediate school	7(1.3)
	Secondary school	106 18.9)
	University and post-graduate	442(78.9)
Occupational status	Healthcare worker	76 (13.6)
	Non-healthcare worker	165 (29.5)
	Students in the medical field	157 (28)
	Student in a non-medical field	47 (8.4)
	Not working	115 (20.5)
Income level	<5,000	215 (38.4)
	5,000–9,999	114 (20.4)
	10,000–15,000	99 (17.7)
	More than 15,000	132 (23.6)
Do you have health insurance?	Yes	168 (30)
	No	392 (70)

Table 2. *Participants' technological gadgets use behavior (n = 560).*

Questions	Category	Frequency (Percentage) N (%)
On average, how many hours per week do you spend using digital devices (such as computers, tablets, and smartphones)?	0 to 5	31 (5.5)
	6 to 11	161 (28.7)
	12 to 17	194 (34.6)
	18 and more	174 (31.1)
How comfortable are you with using current technology (such as computers, smartphones, and tablets)?	Not comfortable	26 (4.6)
	Somewhat comfortable	213 (38)
	Comfortable	321 (57.3)
How would you rate your computer literacy?	Illiterate	10 (1.8)
	Literate	211 (37.7)
	Competent	339 (60.5)

Table 3. Participants' awareness and understanding of RAS.

Questions	Category	Frequency (Percentage) N (%)
Have you ever heard of RAS?	Yes	351 (62.7)
	No	209 (37.3
If yes, from which resource? (n = 351)	Social media	253 (72.1)
	Magazines	6 (1.7)
	Doctors	82 (23.4)
	Friends and relatives	10 (2.8)
What do you understand from the term RAS /surgery performed using a robot? (n = 351)	The surgeon programs the robot, and the robot does the job	49 (14.0)
	The robot does the surgery, while a surgeon stands by to ensure the patient's safety	60 (17.1)
	A surgeon sits on a console and controls the robot's arm movements	186 (53.0)
	The surgeon instructs the surgical robot step by step	29 (8.3
	I don't know	27 (7.7)
Is RAS available in Saudi Arabia? (n = 351)	Yes	147 (41.9)
	No	34 (9.7)
	Uncertain	170 (48.4)
If yes, do you know any patients who had RAS? (n = 351)	Yes (Inside KSA)	39 (11.1)
	Yes (Outside KSA)	166 (47.3)
	No	146 (41.6)
Do you think RAS is safe?(n = 351)	Yes	191 (54.4)
	No	160 (45.6)

questions on demographics, awareness, understanding, and perceptions of RAS, taking approximately 3–5 minutes to complete. Questions covered key areas such as familiarity with RAS, sources of information, perceived risks, and likelihood of choosing RAS for a procedure. The questionnaire's validity was evaluated, achieving satisfactory Cronbach's alpha values above 0.7 for reliability. The assessment consisted of five questions. Participants who answered at least three out of five questions correctly were categorized as having good knowledge. Those who scored fewer than three correct answers were considered to have limited awareness.

Data were coded and analyzed using IBM Statistical Package for Social Sciences software version 27. Descriptive statistics were used to summarize participant responses: continuous variables, such as age, were presented as means and standard deviations, while categorical variables were reported as counts and frequencies. The chi-square test was employed to assess associations between RAS knowledge and sociodemographic variables, with statistical significance set at $p < 0.05$.

Results

A total of 560 participants were included in the study. Females represented 58.9%. Most participants were Saudi nationals (91.6%) and had a university or post-graduate

Table 4. Participants' responses on surgical specialties that apply RAS (n = 351).

Variables	Category	
	Yes	No
	N (%)	N (%)
General surgery	148 (42.2)	203 (57.8)
Orthopaedical surgery	184 (52.4)	167 (47.6)
Neurosurgery	134 (38.2)	217 (61.8)
Urology surgery	170 (48.4)	181 (51.6)
Thoracic surgery	156 (44.4	195 (55.6)
Cardiac surgery	141 (40.2)	210 (59.8)
I don't know	236 (67.2)	115 (32.8)

education (78.9%). Occupationally, 13.6% were healthcare workers and 28% were students in the medical field. Income levels showed 38.4% earning below 5,000 Saudi Riyals and a majority (70%) do not have health insurance (Table 1).

Most participants regularly use computer technology, with 34.6% using it for 12–17 hours per week. Comfort with technology was generally high, as 57.3% describe themselves as comfortable. Regarding computer literacy, 60.5% identified as competent (Table 2).

Furthermore, 62.7% of participants were aware of RAS, primarily through social media (72.1%) and doctors (23.4%). Understanding of RAS operation varies: 53% correctly identified that a surgeon controls the robot's arms from a console, while 7.7% admit they do not know how it works. Awareness of RAS availability in Saudi Arabia was mixed, with only 41.9% believing it is accessible. Regarding safety, 54.4% consider RAS safe, highlighting a potential need for greater public

information on RAS safety and functionality (Table 3). As far as the familiarity with RAS across different specialties was concerned, it was shown that orthopedic surgery was the most recognized, with 52.4% of participants aware of its application, followed by urology (48.4%) and thoracic surgery (44.4%) (Table 4). Most participants (60.4%) view RAS as similar to laparoscopic/MIS. Concerns about robotic malfunctions were prominent, with 57.3% seeing it as a major issue. A majority (61.5%) would not

Table 5. Participants' perceptions of RAS (n = 351).

Questions	Category	Frequency (Percentage) N (%)
What type of surgery is RAS most similar to?	Traditional open surgery	37 (10.5)
	Laparoscopic/MIS	212 (60.4)
	Laser surgery	38 (10.8)
	I don't know	64 (18.2)
Robot malfunction during surgery: select the appropriate option	Has never occurred	29 (8.3)
	Has occurred	94 (26.8)
	Unsure	228 (65)
Would you consider choosing RAS as a treatment option if it were available for a surgical condition you might have?	Yes	135 (38.5)
	No	216 (61.5)
Which of the following concerns do you have about RAS? Select all that apply	The robot malfunctions, causing internal damage during the surgery	157 (44.7)
	The robot does the wrong operation on you	188 (53.6)
	Others	
What comes to mind when you hear the term " RAS " as a procedure in comparison to traditional surgical methods?	The procedure causes LESS pain compared to open surgery	187 (53.3)
	The procedure is likely to result in fewer complications compared to open surgery	158 (45)
	The procedure is FASTER than open surgery	146 (41.6)
	The procedure is MORE painful than open surgery	179 (51)
	The procedure will have MORE complications than open surgery	187 (53.6)
	The procedure is SLOWER than open surgery	170 (48.4)
	Malfunctions of surgical robots present a significant concern during operations	201 (57.3)
	Robot mistakes causing serious complications are a major concern	197 (56.1)
	Robots can achieve such high levels of precision that they assist surgeons in performing procedures with enhanced accuracy	166 (47.3)
	I don't know	206 (58.7)
Do you believe surgeons who perform robotic-assisted procedures are more or less skilled than those who operate without robotic assistance?	More proficient than their non-robotic counterparts	177 (50.4)
	Less skilled in comparison to surgeons who do not use robotic assistance	26 (7.4)
	Similar to non-robotic surgeons	85 (24.2)
	Uncertain	63 (17.9)
How do hospitals that offer RAS compare to those that do not - are they better or worse?	Superior to hospitals that do not provide this service	250 (71.2)
	Worse than hospitals that do not offer	21 (6.0)
	Similar	80 (22.8)

Table 6. *The association between social demographic variables and participants' total knowledge on RAS.*

Variables	Category	Total knowledge score Poor N (%)	Total knowledge score Good N (%)	p-value
Gender	Female	261 (60.3)	69 (54.3)	0.231
	Male	172 (39.7)	58 (45.7)	
Nationality	Saudi	399 (92.1)	114 (89.8)	0.394
	Non-Saudi	34 (7.9)	13 (10.2)	
Educational level	Primary school	4(0.9)	1 (0.8)	0.045
	Intermediate school	4 (0.9)	3 (2.4)	
	Secondary school	92 (21.2)	14 (11.0)	
	University and post-graduate	333(76.9)	109 (85.8)	
Occupational status	Healthcare worker	41 (9.5)	35 (27.6)	<0.001*
	Non-healthcare worker	136 (31.4)	29 (22.8)	
	Students in the medical field	114 (26.3)	43 (33.9)	
	Student in a non-medical field	43 (9.9)	4(3.1)	
	Not working	99 (22.9)	16 (12.6)	
Income level	<5,000	164 (37.9)	51(40.2)	0.120
	5,000–9,999	93(21.5)	21 (16.5)	
	10,000–15,000	82 (18.9)	17 (13.4)	
	More than 15,000	94 (21.7)	38 (29.9)	
Do you have health insurance?	Yes	123 (28.4)	45 (35.4)	0.129
	No	310 (71.6)	82 (64.6)	

The asterisk values indicate statistical significance at *p* < 0.005.

choose RAS as a treatment option. Perceptions of the procedure vary: 53.3% believed it is less painful than open surgery and 53.6% worry about increased complications. Regarding surgeon skills, 50.4% saw robotic surgeons as more skilled than those performing traditional surgery. Hospitals offering RAS were generally viewed positively, with 71.2% perceiving them as better than those without the technology (Table 5).

Data has been presented as counts and frequencies

A significant association between occupational status and knowledge score (*p* < 0.001) was indicated. Healthcare workers and students in the medical field demonstrated higher knowledge, with 27.6% and 33.9%, respectively, scoring well, compared to other occupational groups. The educational level also showed a marginally significant association with knowledge (*p*-value = 0.045), with university and post-graduate participants scoring higher, though this was not as strong as the association with occupational status. Other variables, such as gender, nationality, income level, and health insurance status, did not have statistically significant associations with knowledge level (all *p*-values >0.05), suggesting that being in a medical occupation is a key factor in higher knowledge about the technology (Table 6).

Discussion

In the recent past, RAS has emerged as a groundbreaking advancement in surgical technology, offering precision and efficiency [1]. Understanding and acceptance of RAS among the general population can significantly impact its adoption and effectiveness in clinical practice. The study aimed to assess the understanding and awareness of RAS among the general population in the Jeddah region of Saudi Arabia. A majority of participants, 351 (62.7%), had heard of or were aware of RAS, indicating a relatively high level of awareness within this population. This finding aligns with similar research conducted in the United States, where 86% of participants were aware of RAS [7]. Another study conducted in Singapore by Chan et al. [6] found that 53% of participants were familiar with RAS, further supporting the findings of this study.

Regarding the understanding of RAS, the study found that slightly more than half of the participants, 186 (53.0%), correctly identified RAS as a procedure in which a surgeon operates from a console to control the robot's arm movements, with only 54.4% believing it to be safe. This suggested a moderate level of awareness among the study's participants. This finding contrasts with a study by Iran et al. [10] where only 32.5% of participants recognized that a surgeon controls the robot's

movements during surgery, indicating a lower level of understanding of RAS. Similarly, a study conducted in Kuwait by Buabbas et al. [5] found that only 27.1% of participants fully understood RAS. The higher level of understanding observed in this study might be attributed to the fact that many participants were university or postgraduate students, potentially contributing to a stronger familiarity with technology.

The results further explored participants' perceptions of the type of surgery they believed to be most similar to RAS. A majority, 212 (60.4%), identified laparoscopic surgery as the closest comparison, which aligns with findings from a study by Al Dihan et al. [11] where 64.4% of participants also considered laparoscopic surgery similar to RAS. Similarly, a study by Boys et al. [7] conducted in the United States among the general population found that 78.0% of participants viewed laparoscopic surgery as closely resembling RAS.

Hesitancy toward the use of RAS was prevalent, with only 38.5% of participants indicating they would choose this technology as a treatment option for surgical conditions. Concerns about potential errors and malfunctions in RAS were also notable: 56% of participants were worried about the risk of the robot performing the wrong operation, and 44.7% expressed concern about the possibility of robot malfunction causing internal damage during surgery. Additionally, a similar study was carried out by Lira and Kowalski [12] who found that more than half of the participants, 51%, were concerned about malfunctions of the robots during surgery.

There was a statistically significant relationship between occupational status and participants' knowledge of RAS ($p < 0.001$), with healthcare workers and medical students demonstrating higher knowledge levels compared to other groups. The educational level also showed a marginally significant association with knowledge (p-value = 0.045), with university and post-graduate participants scoring higher. Other sociodemographic variables, including gender, income level, and nationality, did not show statistically significant associations with knowledge of RAS ($p > 0.05$). This finding aligns with previous studies, which similarly found no significant relationship between gender and knowledge in medical fields [13]. Surprisingly, the educational level also did not show any statistically significant relationship (p-value = 0.192); this might be due to the fact that a majority of the participants in this particular study were of the same education level. However, there was a statistically significant relationship between the occupation of the participants and total knowledge on RAS. Possible explanations for the significant relationship might be explained by the fact that different professionals, especially the medics, have varied knowledge in the medical field compared to other specialties [14].

Nonetheless, the study was marred by a few limitations. One of it being the use cross-sectional design, which restricted the ability to establish causal relationships between variables. Additionally, because data was collected through online surveys, the study relied on participants to provide accurate responses independently, without an opportunity for verification, which might have introduced bias.

Conclusion

This study revealed a moderate level of awareness and understanding of RAS. Although there was general awareness of RAS, significant concerns about potential errors and malfunctions persist, contributing to hesitancy in its adoption as a preferred treatment option. The data also revealed varied misconceptions surrounding RAS, which might impact its embracement as a remedy among this particular population. There is a need for health practitioners to conduct seminars and educational training to enlighten people more on RAS, as from the findings, it is evident that most of the information comes from social media, which at times might delude the intended message.

List of Abbreviations
MIS   Minimally invasive surgery
RAS   Robotics-assisted surgery

Conflicts of interest
The authors declare that there is no conflict of interest regarding the publication of this article.

Consent to participate
Informed consent was obtained from all the participants.

Ethical approval
The study was approved by the Jazan Health Ethics Committee, with Reference number REC-44/04/369. Dated: 15-11-2022.

Author details
Nasser A. Hakami[1], Alhassan H. Hobani[2], Hayam A. Alzahrani[3], Mohammad S. Alnejaidi[4], Abdullah Y. Asiri[5], Layan Albraik[6], Suha A. Alrumaih[7], Fahad M. Alotaibi[8], Fahad G. Alosaimi[9], Rana Z. Flimban[10], Ghida M. Aljohani[10], Abdulaziz Turki Alghamdi[11], Abdulelah F. Alahmadi[12], Abdelkhalig Hussein Elhilu[1]
1. Surgery Department, College of Medicine, Jazan University, Jazan, Saudi Arabia
2. College of Medicine, Jazan University, Jazan, Saudi Arabia
3. College of Medicine, Batterjee Medical College, Jeddah, Saudi Arabia
4. College of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia
5. College of Medicine, King Khalid University, Abha, Saudi Arabia
6. College of Medicine, Alfaisal University, Riyadh, Saudi Arabia
7. Department of Family Medicine, Riyadh Second Health Cluster, Riyadh, Saudi Arabia
8. College of Medicine, Imam Mohammad Ibn Saud Islamic University, Riyadh, Saudi Arabia

9. College of Medicine, King Abdulaziz Specialist Hospital, Taif, Saudi Arabia

10. College of Medicine, Fakeeh College of Medical Sciences, Jeddah, Saudi Arabia

11. College of Medicine, King Faisal University, Al-Ahsa, Saudi Arabia

12. College of Medicine, Taibah University, Al-Madinah al-Munawwarah, Saudi Arabia

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