ORIGINAL ARTICLE

Identifying Public Perception, Misconceptions, Fears, and Attitudes about Robotic Surgery in Saudi Arabia

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Abstract

Introduction: Robotic surgery has now emerged as a major development in the surgical medical field. Its most important benefits include high precision, fewer stitches, and faster recovery, which has led to its rapid growth and development. However, in many societies, there is a significant segment that has fears and trepidation about these robot-based surgeries, especially among residents of the Kingdom of Saudi Arabia. This study was conducted to identify misconceptions and patients' perceptions about robot malfunctions, which prevent many from undergoing this procedure. This study appeared in areas with limited knowledge, significant fears, and differing misconceptions about robotic surgery. Most studies were conducted in hospitals or cities, which left a gap in understanding at the national level. **Objectives:** This study aimed to determine the extent of attitudes, perceptions, misconceptions, the prevalence of fears, and knowledge of the population of the Kingdom of Saudi Arabia regarding the use of robotic surgery. **Methods:** A cross-sectional survey. This study was conducted during July–December 2025, using questionnaires of the Saudi population and residents of the Kingdom via social media and community engagement. Participants were aged 18 and above. A cross-sectional survey was conducted using a structured bilingual (Arabic/English) self-administered questionnaire developed from the literature and adapted from previously validated tools. Knowledge (13 items; score 0–13), attitude/perception (7 Likert items; score 7–35), and fear/misconceptions (10 items; score 0–12) were scored, and an overall proficiency score was computed as Knowledge + Attitude + (12 − Fear), then categorized into tertiles (low/moderate/high). **Results:** A total of 445 participants were included; most were male (66.5%), nearly half were aged 18–30 years (49.9%), and over half resided in the Western region (56.2%). Regarding awareness, 72.8% had previously heard of robotic surgery, yet only 30.3% reported knowing which operations can be performed robotically, and 68.3% reported insufficient information; 82.2% believed robotic surgery is not widely available in Saudi hospitals. The mean knowledge score was 7.0 ± 2.9/13, with 61.8% classified as having moderate knowledge; the mean attitude score was 22.4 ± 5.1/35, with predominantly neutral attitudes (63.1%); and the mean fear/misconception score was 4.7 ± 2.3/12, with low fear in 53.7%. Preference and trust were cautious: 39.1% were unsure whether they would prefer robotic over traditional surgery, and 56.0% reported less trust in robotic surgery than traditional surgery; nonetheless, 61.6% agreed/strongly agreed they would choose robotic surgery if recommended by their physician. Overall proficiency was significantly associated with gender ($P = 0.002$) and region ($P = 0.014$). **Conclusion:** These findings indicate substantial informational gaps and uncertainty alongside openness to clinician-endorsed robotic-assisted surgery, underscoring the need for targeted public education and communication strategies.

Key words: Awareness, minimally invasive surgery, misconceptions, public perspectives, robotic-assisted surgery, Saudi Arabia

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INTRODUCTION

When compared to traditional procedures, robotic surgery offers improved patient outcomes, decreased invasiveness, and more precision, making it a noteworthy improvement in surgical techniques.[1] The origins of this technology can be traced back to 1986, when a team used a modified UNIMATION PUMA 200 industrial robot arm to perform the first robotic-assisted surgery (RAS), a biopsy taken from a patient with a suspected brain lesion.[2] Despite these benefits, the public still has misconceptions and fears regarding robotic surgery, especially in places such as Saudi Arabia, where knowledge is very low.[3] These misconceptions have the potential to affect patients' acceptance and choices about robotic operations, which emphasizes the importance of precisely gauging public opinion.[4] Previous research emphasizes that the main causes of these anxieties and misunderstandings are knowledge gaps and a lack of exposure to trustworthy information.[5] To improve informed decision-making, this study intends to assess the degree of misunderstandings and worries about robotic surgery that exist among Saudi citizens.[6] This will serve as the foundation for focused educational initiatives.

Over the past few decades, RAS has transformed medical practice by providing better patient outcomes, less invasiveness, and more accuracy than other options. These robotic systems, such as the da Vinci Surgical System, are being used more and more in a variety of treatments, including cardiothoracic interventions and gynecological and urological surgeries.[7] Advancements in robotic technology have made it possible to perform a wide range of surgical procedures. These modifications in the operating room lead to a new team dynamic. For example, team member communication changes as a result of the robotic system's physical barrier, which mostly focuses on verbalization.[8]

Despite the fact that RAS systems offer precision, incision reduction, and faster recovery, there are still misconceptions and anxiety among the general public. According to a 2024 study in Saudi Arabia by Arishi *et al*., found that just over half of participants were aware of RAS mainly through social media, but fears of robot malfunction (62.0%) and surgical errors (45.4%) were common, with fewer than half willing to undergo the procedure.[9] According to Al Dihan *et al*. (2024), 70.7% of patients were not aware of RAS, and 33.6% of them (n = 102) thought robots did things on their own, whereas 51% of them (n = 155) appeared to be afraid of internal injury.[10] According to AlNaim *et al*. (2024), just 16.2% of respondents were aware that a surgeon operates the robotic system, whereas 53.9% were not aware of RAS, and 48.2 mentioned cost as the main disadvantage.[6] According to Kuwaiti researchers Buabbas *et al*. (2020), 36.8% of respondents are aware of RAS, 27.1% are knowledgeable, and 47.6% are unaware of safety. In addition, 30.6% worry about a malfunction during surgery.[11]

While these findings point to consistent themes of low awareness and great concern, most studies have been restricted to urban hospitals or clinical settings. As a result, they fail to capture the broader public's understanding, especially those without direct medical experience. There is also a lack of research into the impact of media, religious beliefs, or misconceptions about the role of the surgeon versus the robot. To address these gaps, this study seeks to explore the public's knowledge, fears, and misconceptions on a national scale across Saudi Arabia. It aims to provide insights that will guide educational programs, reduce stigma, and foster informed patient decision-making regarding robotic surgery.

Objectives

The primary objective of this study is to evaluate the level of knowledge and attitude regarding RAS among the general population in Saudi Arabia. In addition, the study aimed to identify prevalent fears and misconceptions that may influence public acceptance of this surgical approach by exploring perceptions.

METHODS

Study design and setting

A cross-sectional strategy was used in this study. A self-administered questionnaire created especially for this purpose was used to gather data. The study was carried out in Saudi Arabia in different areas. Before any data were collected, ethical approval was acquired. The questionnaire was disseminated online from July to December 2025 via social media networks and community outreach avenues to guarantee widespread engagement. Both closed-ended and open-ended questions that probe participants' attitudes, knowledge, and worries about robotic surgery were part of the tool.

Subject: Participants, recruitment, and sampling procedure

The study focused on Saudi Arabian citizens in general. Convenience sampling was used, enabling internet access and volunteer participation. There were no limitations on prior medical experience, career, or educational background. Residency in Saudi Arabia and proficiency in the survey language are prerequisites for inclusion. To prevent bias, medical personnel who perform robotic surgery directly were excluded. Informed consent was acquired electronically, and participation was private and anonymous.

Sample size

Data collection began in September 2023 and ended in March 2023. A target sample of 384 patients (confidence level:

95%; margin of error: 5%) was used for data gathering. The formula $n = P(1\text{-}P) * Z\alpha_2/d^2$ with a 95% confidence level was used to estimate the sample size.

The sample size was calculated.

Z: For the chosen level of confidence (1-a), the z-value is 1.96.

P: An approximate knowledge of prevalence.

Q is equal to 50%, or 0.50, (1–0.50).

D: 0.05 is the highest allowable inaccuracy.

The minimum sample size, thus, was determined to be $n = (1.96)2 \times 0.50 \times 0.50/(0.05)\ 2 = 384$.

Inclusion and exclusion criteria

The inclusion criteria for this study are individuals aged 18 years or older, residing in Saudi Arabia at the time of data collection, able to read and understand Arabic or English, and willing to provide informed consent. Individuals younger than 18 years, non-residents of Saudi Arabia, healthcare professionals directly involved in the performance of robotic-assisted surgical procedures, and those who submitted incomplete or invalid survey responses were excluded from the study.

Method for data collection, instrument

A structured, bilingual (Arabic/English) self-administered questionnaire was used as the primary data collection tool in this study. The questionnaire was developed based on a comprehensive literature review and adapted from validated tools used in previous studies related to public awareness, attitudes, and misconceptions about robotic surgery. The final version of the questionnaire consisted of four main sections.

Informed consent section

This section provided a brief overview of the study, including its objectives, estimated completion time (5–10 min), and a clear explanation that participation was voluntary and anonymous. Participants had to indicate consent before continuing with the questionnaire.

Sociodemographic section

This section included five questions aimed at collecting background information. These questions were not scored but used for descriptive analysis and to explore correlations with knowledge, attitude, and fear responses.

Survey content section and scoring system

This section was divided into three core subsections.

Knowledge questions (13 items)

These items were designed to assess participants' knowledge of robotic surgery, including its availability in Saudi Arabia, safety, invasiveness, accuracy, and whether a human or a robot performs the surgery. One point was awarded for each correct response, with a maximum score of 13. Knowledge levels were classified as: Low (0–5), moderate (6–10), and high (11–13).

Attitude and perception statements (7 items)

These statements measured participants' trust, acceptance, and general perception of robotic surgery. Responses were based on a 5-point Likert scale (strongly disagree = 1 to strongly agree = 5). The total score ranged from 7 to 35. Attitudes were categorized as: Negative (7–16), neutral (17–26), and positive (27–35).

Fear and misconception questions (10 items)

These questions evaluated participants' misconceptions and emotional responses, such as fear, trust issues, and perceived risks. The total possible score was 12 points. Higher scores indicated more misconceptions or negative perceptions. Fear levels were classified as: Low (0–4), moderate (5–7), and high (8–12).

The overall score was computed as a composite indicator of participants' overall proficiency in robotic surgery by combining the three study domains (knowledge, attitude/perception, and fear/misconceptions) in a single metric. First, a total knowledge score was calculated by summing correct responses across the 13 knowledge items (range: 0–13), and a total attitude/perception score was calculated by summing the 7 attitude statements using the Likert scoring system specified in the questionnaire (range: 7–35). For the fear and misconception domain, responses to the 10 fear/misconception items were scored according to the proposed scoring method to generate a total fear/misconception score (range: 0–12), where higher scores indicated greater fear or misconceptions. To ensure that higher composite scores consistently reflected more favorable proficiency (i.e., better knowledge and attitudes with fewer misconceptions), the fear/misconception score was reverse-coded before aggregation using the formula Reversed Fear Score = 12 − Fear Score. The Overall Proficiency Score was then calculated as Knowledge Score + Attitude/Perception Score + Reversed Fear Score, yielding a possible range of 7–60. Finally, for analytical purposes, participants were categorized into three overall proficiency levels (low, moderate, and high) using tertile-based cutoffs derived from the distribution of the overall proficiency score in the study sample.

Pilot test

The questionnaire was distributed to 20 individuals, and asked to fill it out. This was done to test the simplicity of the questionnaire and the feasibility of the study. Data from the pilot study were excluded from the final data of the study.

Analysis and entry method

Using the "Microsoft Office Excel Software" on Windows (2021), the collected data were coded, entered, and managed using Microsoft Office Excel 2021 software installed on a Windows platform. The Statistical Package for the Social Sciences Software (SPSS) tool, version 20 (IBM SPSS Statistics for Microsoft Windows, Version 21.0), was then used to analyze the data for statistical purposes.

RESULTS

A total of 445 participants completed the questionnaire and were included in the analysis. Table 1 summarizes the sociodemographic profile. Most respondents were male (66.5%), and almost half were aged 18–30 years (49.9%). Participants were predominantly from the Western region (56.2%). Educational attainment was relatively high (50.3% bachelor's degree), and the most common monthly income categories were <1000 SAR (25.4%) and 1000–4999 SAR (23.8%).

Knowledge items are presented in Table 2. Although 72.8% had previously heard of robotic surgery, only 30.3% stated they knew which types of operations can be performed using robotic systems, and 68.3% reported they did not have enough information about robotic surgery. Most respondents (82.2%) believed robotic surgery is not widely available in Saudi hospitals. Regarding the operating process, 57.1% correctly identified that a surgeon operates the robotic system; however, 18.7% believed a computer operates it, and 23.6% were unsure. Only 27.6% recognized robotic surgery as minimally invasive, whereas 53.5% were unsure. For "select all that apply" knowledge items, the most frequently selected advantage was "more accurate results" (58.7%), and the most frequently selected disadvantage was higher cost (63.4%); option-level percentages overlap by design.

Attitude and perception findings are summarized in Table 3. If offered robotic surgery, 26.1% preferred it for most or all operations, and 23.8% preferred it for some operations; however, 39.1% were unsure, and 11.0% would never prefer it. Trust was generally cautious: 56.0% reported less trust in robotic surgery than in traditional surgery, compared with 28.6% reporting more trust. Trust determinants (select-all-that-apply) were most frequently safety of the procedure (42.5%), technology reliability (42.5%), and surgeon experience (38.0%). Effectiveness perceptions were mixed, with 45.4% unsure whether robotic surgery is more effective than traditional methods (30.8% yes; 23.8% no). Notably, 68.5% agreed/strongly agreed that robotic surgery is a significant advancement in medical technology, and 61.6% agreed/strongly agreed they would choose robotic surgery if recommended by their doctor.

Fear and misconceptions are detailed in Table 4. Almost half agreed/strongly agreed that robotic surgery is risky and still experimental (47.2%), and 45.8% agreed/strongly agreed they would feel afraid if a robot were involved in their surgery. A misconception about human involvement persisted: 20.2% believed robotic surgery means no human is involved during the operation, and 22.0% were unsure. Cost concerns were prominent, with 56.0% believing robotic surgery is more expensive than regular surgery and 33.0% unsure. Uncertainty was also pronounced regarding complications: 49.9% responded "I don't know" to whether robotic surgery leads to more complications (11.9% believed it does). Despite these concerns, 70.8% would recommend robotic surgery to others, and 92.8% wanted more public awareness campaigns about robotic surgery.

Score-based classifications are summarized in Table 5. The mean knowledge score was 7.0 ± 2.9 (out of 13), with most

Table 1: Sociodemographic characteristics of participants (*n*=445)

Parameter	No.	Percentage
Gender		
Female	149	33.5
Male	296	66.5
Age group		
18–30	222	49.9
31–45	75	16.9
≥46	148	33.3
Residential area		
Southern region	28	6.3
Western region	250	56.2
Central region	86	19.3
Eastern region	38	8.5
Northern region	43	9.7
Educational qualification		
High school or less	122	27.4
Diploma	63	14.2
Bachelor	224	50.3
Postgraduate (master/doctorate)	36	8.1
Monthly income		
<1000 SAR	113	25.4
1000–4999 SAR	106	23.8
5000–9999 SAR	69	15.5
10000–14999 SAR	83	18.7
>15000 SAR	74	16.6

Table 2: Frequency distribution of knowledge questions (n=445)

Parameter	No.	Percentage
Have you ever heard of robotic surgery before?		
Yes	324	72.8
No	121	27.2
Do you know which types of surgeries can be performed using robotic systems?		
Yes	135	30.3
No	310	69.7
Is robotic surgery widely available in Saudi hospitals?		
Yes	79	17.8
No	366	82.2
Who operates the robotic surgical system?		
A surgeon	254	57.1
I don't know	105	23.6
A computer	83	18.7
A nurse	3	0.7
Is robotic surgery generally considered more precise than traditional surgery?		
Yes	225	50.6
No	43	9.7
I don't know	177	39.8
Is robotic surgery minimally invasive?		
Yes	123	27.6
No	84	18.9
I don't know	238	53.5
Is robotic surgery safe?		
Yes	193	43.4
No	64	14.4
I don't know	188	42.2
Can a robot perform surgery independently without a human?		
Yes	67	15.1
No	251	56.4
I don't know	127	28.5
Does robotic surgery require a different operating room setup than traditional surgery?		
Yes	228	51.2
No	70	15.7
I don't know	147	33.0

(*Contd*...)

Table 2: (*Continued*)

Parameter	No.	Percentage
What do you think about how the robot works in general surgery?		
The doctor guides the robot step by step	141	31.7
The doctor uses robot arms	107	24.0
I don't know	89	20.0
The doctor programs the robot, and the robot performs	61	13.7
The robot performs surgery, and doctor ensures safety	47	10.6
What are the advantages of general robotic surgery from your point of view?*		
More accurate results	261	58.7
Fewer complications	95	21.3
Makes it easier for the doctor	213	47.9
Faster recovery	76	17.1
I don't know	77	17.3
What are the disadvantages of general robotic surgery from your point of view?		
Its cost is higher	282	63.4
Longer surgery time	58	13.0
Difficult to perform	90	20.2
No difference with traditional surgery	16	3.6
I don't know	128	28.8
Do you think you have enough information about general robotic surgery?		
Yes	75	16.9
No	304	68.3
I don't know	66	14.8

*Percentages can sum to >100% because participants may select multiple options

participants classified as having moderate knowledge (61.8%), whereas 28.1% had low knowledge and 10.1% had high knowledge. The mean attitude score was 22.4 ± 5.1 (out of 35), and participants were predominantly classified as neutral (63.1%), followed by positive (23.8%) and negative (13.0%) attitudes. The mean fear/misconception score was 4.7 ± 2.3 (out of 12), and 53.7% were classified as low fear/misconception. To provide an interpretable composite indicator, an overall proficiency score was computed as Knowledge + Attitude + (12 − Fear). The overall proficiency score ranged from 19 to 55 and was categorized into tertiles: Low (≤33; 37.8%), moderate (34–40; 29.4%), and high (≥41; 32.8%).

Figure 1 visually summarizes the distributions of knowledge levels, attitude and perception levels, fear/misconception

Table 3: Frequency distribution of attitude and perception questions (*n*=445)

Parameter	No.	Percentage
If you were offered general robotic surgery, would you prefer it over traditional surgery?		
Yes, all operations	63	14.2
Yes, most operations	53	11.9
Yes, some operations	106	23.8
Not sure	174	39.1
Never	49	11.0
How much do you trust robotic surgery compared to traditional surgery?		
Much less trust	108	24.3
Somewhat less trust	141	31.7
No difference	69	15.5
Somewhat more trust	100	22.5
Much more trust	27	6.1
What factors influence your trust in robotic surgery?*		
Safety of the procedure	189	42.5
Technology reliability	189	42.5
Surgeon's experience	169	38.0
Patient testimonials	97	21.8
Media coverage	31	7.0
Others	5	1.1
I don't know	60	13.5
Do you believe robotic surgery is more effective than traditional surgery?		
Yes	137	30.8
No	106	23.8
Not sure	202	45.4
I believe robotic surgery is a significant medical advancement that should be supported		
Strongly agree	183	41.1
Agree	122	27.4
Neutral	118	26.5
Disagree	16	3.6
Strongly disagree	6	1.3
I would choose robotic surgery if recommended from my physician		
Strongly agree	133	29.9
Agree	141	31.7
Neutral	122	27.4
Disagree	32	7.2
Strongly disagree	17	3.8

(*Contd...*)

Table 3: (*Continued*)

Parameter	No.	Percentage
Believe the main reason robotic surgery is underutilized is a lack of awareness		
Strongly agree	145	32.6
Agree	135	30.3
Neutral	124	27.9
Disagree	32	7.2
Strongly disagree	9	2.0

*Percentages can sum to >100% because participants may select multiple options

Table 4: Frequency distribution of fear and misconception questions (*n*=445)

Parameter	No.	Percentage
I think robotic surgery is risky and still experimental		
Strongly agree	66	14.8
Agree	144	32.4
Neutral	160	36.0
Disagree	66	14.8
Strongly disagree	9	2.0
I would be afraid if a robot were involved in my surgery		
Strongly agree	70	15.7
Agree	134	30.1
Neutral	142	31.9
Disagree	87	19.6
Strongly disagree	12	2.7
I think robotic surgery has a high chance of failure		
Strongly agree	37	8.3
Agree	42	9.4
Neutral	230	51.7
Disagree	123	27.6
Strongly disagree	13	2.9
I trust robotic surgery more if it is performed in private hospitals		
Strongly agree	42	9.4
Agree	41	9.2
Neutral	199	44.7
Disagree	125	28.1
Strongly disagree	38	8.5
I believe robotic surgery is only for rich people		
Strongly agree	32	7.2
Agree	71	16.0

(*Contd...*)

Table 4: (*Continued*)

Parameter	No.	Percentage
Neutral	157	35.3
Disagree	150	33.7
Strongly disagree	35	7.9
Robotic surgery means no human is involved during the operation.		
True	90	20.2
False	257	57.8
I don't know	98	22.0
Robotic surgery is more expensive than regular surgery		
True	249	56.0
False	49	11.0
I don't know	147	33.0
I believe robotic surgery leads to more complications		
True	53	11.9
False	170	38.2
I don't know	222	49.9
I would recommend robotic surgery to others		
Yes	315	70.8
No	130	29.2
I want more public awareness campaigns about robotic surgery in Saudi Arabia		
Yes	413	92.8
No	32	7.2

Table 5: Distribution of participants by score categories (*n*=445)

Parameter	No.	Percentage
Knowledge level		
Low	125	28.1
Moderate	275	61.8
High	45	10.1
Attitude and perception level		
Negative	58	13.0
Neutral	281	63.1
Positive	106	23.8
Fear and misconception level		
Low	239	53.7
Moderate	158	35.5
High	48	10.8
Participant's overall score level (Knowledge + Attitude + reversed Fear)		
Low	168	37.8
Moderate	131	29.4
High	146	32.8

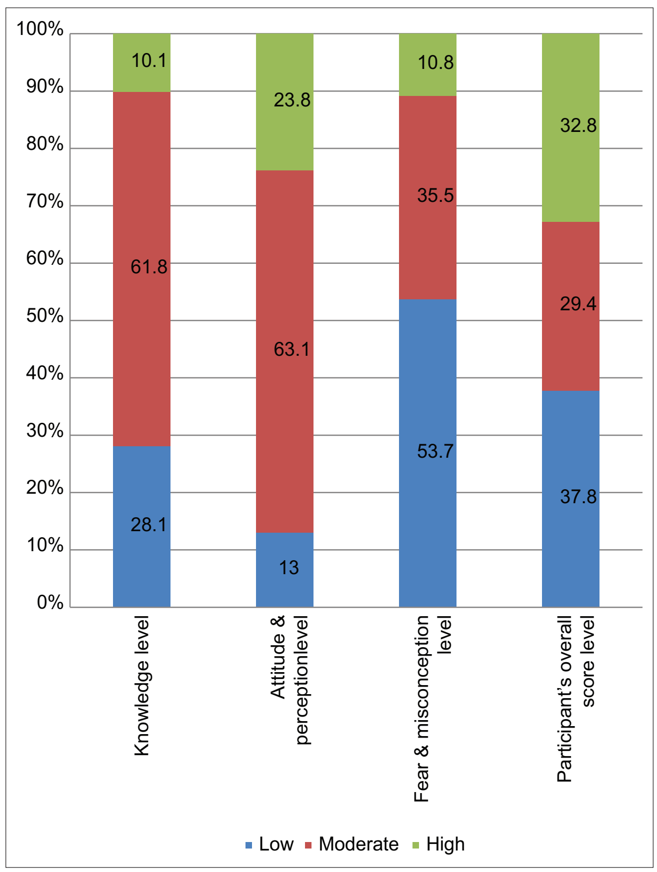

Figure 1: Distribution of participants by score categories (*n*=445)

levels, and participants' overall score levels, highlighting that moderate knowledge predominated while misconceptions and uncertainty remained substantial.

Table 6 presents Chi-square analyses of associations between sociodemographic variables and overall score categories. Overall proficiency category was significantly associated with gender (P = 0.002) and region of residence (P = 0.014), but was not significantly associated with age group (P = 0.072), educational qualification (P = 0.224), or monthly income (P = 0.295). Within-category distributions indicated that males constituted a larger share of the high proficiency group (75.3%) compared with females (24.7%). Regional differences were also observed, with the Western region representing the majority of all three proficiency groups, particularly the high category (55.5% of the high).

DISCUSSION

The present study aimed to evaluate knowledge and attitudes regarding RAS among the general population in Saudi Arabia and to identify fears and misconceptions that may influence acceptance. Among 445 respondents, knowledge was

Table 6: Association between sociodemographic variables and overall score category (*n*=445)

Parameters	Overall score category			Total	*P*-value
	Low	Moderate	High		
Gender					
Female	72	41	36	149	0.002
	42.9%	31.3%	24.7%	33.5%	
Male	96	90	110	296	
	57.1%	68.7%	75.3%	66.5%	
Age group					
18–30	70	74	78	222	0.072
	41.7%	56.5%	53.4%	49.9%	
31–45	33	22	20	75	
	19.6%	16.8%	13.7%	16.9%	
≥46	65	35	48	148	
	38.7%	26.7%	32.9%	33.3%	
Residential area					
Southern region	17	6	5	28	0.014
	10.1%	4.6%	3.4%	6.3%	
Western region	81	74	95	250	
	48.2%	56.5%	65.1%	56.2%	
Central region	34	27	25	86	
	20.2%	20.6%	17.1%	19.3%	
Eastern region	18	15	5	38	
	10.7%	11.5%	3.4%	8.5%	
Northern region	18	9	16	43	
	10.7%	6.9%	11.0%	9.7%	
Educational qualification					
High school or less	45	39	38	122	0.224
	26.8%	29.8%	26.0%	27.4%	
Diploma	25	17	21	63	
	14.9%	13.0%	14.4%	14.2%	
Bachelor	90	58	76	224	
	53.6%	44.3%	52.1%	50.3%	
Postgraduate (master/doctorate)	8	17	11	36	
	4.8%	13.0%	7.5%	8.1%	
Monthly income					
<1000 SAR	45	37	31	113	0.295
	26.8%	28.2%	21.2%	25.4%	
1000–4999 SAR	35	33	38	106	
	20.8%	25.2%	26.0%	23.8%	
5000–9999 SAR	23	16	30	69	
	13.7%	12.2%	20.5%	15.5%	
10000–14999 SAR	39	22	22	83	
	23.2%	16.8%	15.1%	18.7%	
>15000 SAR	26	23	25	74	
	15.5%	17.6%	17.1%	16.6%	

P-value was considered statistically significant if ≤0.05

predominantly moderate (mean 7.0 ± 2.9 out of 13; 61.8% moderate, 28.1% low, 10.1% high), and attitudes were largely neutral (mean 22.4 ± 5.1 out of 35; 63.1% neutral). Fear/misconception scores were generally low (mean 4.7 ± 2.3 out of 12; 53.7% low), but numerous individual items showed high uncertainty, which is important for patient counseling and informed decision-making.

A consistent theme was the disconnect between general awareness and understanding of action. While it was found that 72.8% had heard of robotic surgery, only 30.3% were aware of the operations that could be performed robotically, and 68.3% said they did not have enough information. Similar "heard of it but don't know details" patterns have been reported from populations in Saudi Arabia. Arishi *et al*. reported significant public exposure to RAS and social media as a precedent, leading source of information when knowledge was incomplete.[9] Likewise, AlNaim *et al*. found the derated levels of public knowledge and reported that many respondents had no idea about the presence and availability of robotic surgery in hospitals.[6] Perceived availability was also low in our sample, with 82.2% saying robotic surgery is not widely available in Saudi hospitals, which could represent true regional variation in access but could also indicate limited visibility of existing services in the general public.

Misconceptions about surgeon control and robots' autonomy were of particular importance because they are plausibly risk-magnifying. In our sample, 57.1% knew that a surgeon operates the robotic system, but 18.7% thought that a computer operates it, and 23.6% were unsure. 15.1% thought that a robot can perform surgery independently without a human, and 28.5% were unsure. These misunderstandings are consistent with the international findings according to which the term "robotic" can be interpreted as autonomous. In the UK, low median knowledge and misconceptions regarding surgeon control and robot independence have been reported[1] by Brar *et al*. Earlier work also showed that autonomy and "machine error" are concerns of the public, even in countries that have long-running robotic programs.[12]

Uncertainty was found for fundamental procedural characteristics. Only 27.6% chose RAS as minimally invasive, and 53.5% chose "I don't know." This is of clinical relevance as minimally invasive framing tends to set expectations with regard to post-operative pain and recovery time, and misinterpretation can lead to expectations that are unrealistic or anxiety that can be avoided. Knowledge gaps may remain even in the clinical setting: Chan *et al*. found that 45.9% of outpatients attending general surgery had heard of robotic surgery, and greater awareness was correlated with higher levels of education and better perception scores; however, overall understanding was variable.[4] Together, these findings highlight that it may not be enough to expose people to the healthcare system to correct misconceptions without explicit education to do so.

Perceived benefits and drawbacks within our cohort both reflected optimism and cost sensitivity. Number of responses – "More accurate results" was the criterion most often chosen (58.7%), but higher cost was the criterion perceived as the dominant disadvantage (63.4%). Similar benefit-cost framing has been described in other places. In Kuwait, Buabbas *et al*. found that accuracy was a commonly perceived advantage and cost was the dominant perceived disadvantage.[11] In a Saudi clinical sample, Al Dihan et al. found that many respondents thought that robotic surgery is more expensive and that there were many misconceptions about the way in which robotic surgery is performed, despite generally positive expectations.[10] Our result adds to this evidence by demonstrating that cost concerns also coexist with informational uncertainty: One-third of the sample were not sure if robotic surgery is costlier, which suggests that monetary apprehension may be partly due to a lack of transparency regarding pricing, coverage, and hospital pathways.

Attitudes to RAS for the present study were cautious, not with resistance. When given the choice of robotic surgery, 26.1% would prefer it for most or all operations, 23.8% would prefer it for some operations, 39.1% were unsure, and 11.0% would never prefer it. 56.0% felt less trust in RAS than in traditional surgery. Yet receptiveness to professional guidance was clear: 61.6% would select RAS if recommended by their physician, and respondents cited safety, reliability of technology, and experience of the surgeon as being the top factors in shaping trust. These determinants are consistent with survey findings of the centrality of clinician credibility and perception of safety in acceptance.[1,12] Importantly, 68.5% agreed that RAS is a significant medical advance, and this implies that neutrality may be based on uncertainty rather than rejection.

Fear and risk perception findings help put this wariness trust into additional context. Almost half agreed with the fact that robotic surgery is risky and is still in the experimental stage (47.2%), and 45.8% said they were afraid if a robot was involved. A misconception on human involvement remained: 20.2% thought robotic surgery involves no human being during the surgery, and 22.0% were unsure. At the same time, there was a high number of neutrality and "I don't know" answers, also for perceived challenges, where 49.9% were unsure. This pattern is suggestive that it may be the case that fear is not so much driven by fixed negative beliefs, but by low confidence and incomplete information, which is potentially modifiable. A recent mixed-methods systematic review concluded that structured education programs generally improve knowledge and awareness and are associated with high satisfaction, whereas misconceptions remain a major barrier to acceptance.[13]

The significant need for information in our sample shows there is a real need for intervention. Despite the lack of certainty and concern, 70.8% would recommend robotic surgery to others, and 92.8% wanted public awareness campaigns; nearly two-thirds agreed that lack of awareness is one of the key reasons for the lack of utilization. Given the finding that social media was ranked as a major information source in related Saudi surveys,[9] accurate clinician-led digital communication, hospital-based informational resources, and standardized pre-operative counseling may be especially effective. Educational content should explicitly address surgeon control, the non-autonomous nature of existing platforms, expected recovery pathways, potential risks, and financial considerations, and emphasize surgeon training and institutional quality assurance due to the highest prevalence of these trust determinants in our cohort.

There are a number of limitations that should be considered. The cross-sectional design does not allow for inferring causality in the relationships of knowledge, fear, and preference. The online convenience sample may be over-representative of younger people and digitally connected people, limiting the generalizability to groups that have less access to the internet. Finally, all the measures were self-reported, and the high rate of "I don't know" responses may reflect a combination of real uncertainty and differences in item interpretation.

CONCLUSION

In this national sample, public familiarity with robotic surgery was common, but actionable knowledge was limited, and uncertainty remained high: Most participants reported insufficient information and perceived low availability of robotic surgery in Saudi hospitals. Attitudes were largely neutral, and trust was cautious, with many unsure about preferring robotic over traditional surgery; however, a majority expressed willingness to choose robotic surgery if recommended by a physician and to recommend it to others, suggesting that clinician counseling and credible communication are pivotal. Overall proficiency varied by gender and region, indicating the value of geographically and demographically tailored awareness initiatives.

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ETHICAL APPROVAL

The study was fully explained to all participants, and it was emphasized that participation was voluntary. Written informed consent was obtained from each participant before enrollment. All collected information was securely stored and used exclusively for research purposes.

INFORMED CONSENT

Written informed consent was obtained from all study participants.

DATA AND MATERIALS AVAILABILITY

All data generated or analyzed during this study are included in this published article.

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