Vol. [3] / Issue. [2] [2025]

Awareness and understanding of Robot-Assisted Surgery and its associated factors among the general adult population in Malaysia, a cross-sectional study

Rashver Singh A/L Gurbachan Singh[1], Maheswarey A/P Sivanandan[1], Harshini Ashutosh Naik Ramanathan[1], Dev Nathan Randall[1], Murali Uthamalingam[2], Thin Mon Kyaw[3]

[1] Faculty of Medicine, Manipal University College Malaysia, Melaka, Malaysia,

[2] Department of Surgery, Faculty of Medicine, Manipal University College Malaysia, 75150, Melaka, Malaysia.,

[3] Department of Community Medicine, Faculty of Medicine, Manipal University College Malaysia, Melaka, Malaysia

Article Submitted: 8/11/2025

Article accepted: 29/12/2025

Corresponding Author: Dr. Thin Mon Kyaw

Email: dr.sofi8655@gmail.com

DOI: 10.71354/ijthpe.03.02.59

ABSTRACT

Background: Robot-Assisted Surgery (RAS) is a rapidly evolving field that integrated robotics into surgical procedures to enhance precision, minimize invasiveness, and improve patient outcomes. The study aimed to assess the awareness, knowledge, and understanding of Robot-Assisted Surgery among the general adult population in Malaysia. Method: A cross-sectional study was conducted among Malaysian adults aged 18 years and above. Data was collected using a structured, self-administered online questionnaire disseminated via social media platforms. A sample size of 337 participants was determined, and data analysis was performed using SPSS Version 30 (trial version), and Chi-square tests applied to examine associations between categorical factors, with statistical significance set at $p<0.05$. Results: A total of 337 valid responses were analyzed. The findings showed that 88.7% of respondents had heard of Robot-Assisted Surgery, primarily through social media (36.5%) and the internet (34.4%). However, misconceptions were prevalent, with 22.6% believing that robots performed surgeries autonomously while surgeons only supervised the surgeries. Awareness of the availability of Robot-Assisted Surgery in Malaysia was moderate, with 48.7% acknowledging its presence, while 41.2% remained uncertain. A significant proportion (62.3%) considered Robot-Assisted Surgery to be safe, yet 24.6% expressed uncertainty regarding its safety. Conclusion: This study highlighted that there was still a substantial gap in understanding, with persistent misconceptions influencing the public perception. Addressing these knowledge gaps through targeted educational initiatives and public awareness campaigns was crucial for fostering informed decision-making and more acceptance towards adapting to Robot-Assisted Surgery in Malaysia.

Keywords:

Awareness, Perception, Expertise in technology, Robotic surgery, Adults, Malaysia.

Vol. [3] / Issue. [2] [2025]

INTRODUCTION

The term robot was coined in 1921 by the Czech writer Karel Čapek in his play Rossom's Universal Robots (RUR). Derived from the Czech term Robota, meaning "forced labour, chore," its meaning had since evolved and may now be defined as a technological system capable of performing specific tasks automatically, according to a fixed or modifiable program. In the strict sense of the word, the robotic systems currently used in surgery were not actually robots, but instrument handling systems. The systems capable of performing such tasks remotely were called tele manipulators. These were master-slave systems that did not perform tasks automatically but obeyed the voice or hand commands of the surgeon (S. Kalan et al.,2010).

The first "robot surgeon" used on a human patient was the PUMA 200 in 1985 (Lanfranco et. al., 2011). In the 1990s, scientists developed the concept of "master–slave" robotic system, which consisted of a robot with remote manipulators controlled by a surgeon at a surgical workstation (Lanfranco et. al., 2011). Despite the lack of force and tactile feedback, technical advantages of robotic surgery, such as 3D vision, stable and magnified image, EndoWrist instruments, physiological tremor filtering, and motion scaling, had been considered fundamental to overcome many of the limitations of the laparoscopic surgery (Lanfranco et. al., 2011).

There was a need for the awareness of robotics in surgery as it was crucial for several reasons. Many Malaysians were still unfamiliar with Robot-Assisted Surgery usage. Other studies done in different countries showed that awareness was low, with many misconceptions about how robotic surgery worked. Increasing awareness could have helped build public trust and acceptance towards Robot-Assisted Surgery (Buabbas et al., 2020; Chan et al., 2022). The widespread acceptance of Robot-Assisted Surgery could have encouraged healthcare institutions to invest more into this technology. Without the public support, adoption could have been slow, limiting access to advanced surgical techniques (Buabbas et al., 2020; Chan et al., 2022).

Malaysia's multi-ethnic composition, encompassing Malays, Chinese, Indians, minority races, and indigenous groups, contributed to variations in awareness and acceptance of Robot-Assisted Surgery. Cultural beliefs, healthcare accessibility, and disparities in education shaped public perceptions and willingness to adopt robotic surgery (Chan et al., 2022). Studies suggested that individuals in urban regions, where advanced medical technologies were more readily available, demonstrated higher awareness of Robot-Assisted Surgery compared to those in rural areas, where exposure remained limited (Darlington et al., 2022).

Media exposure served as a primary source of information on Robot-Assisted Surgery, often shaping public perception. A study in Singapore found that 82% of respondents had learned about Robot-Assisted Surgery through media sources rather than healthcare professionals, leading to widespread misconceptions, including the belief that Robot-Assisted Surgery was fully automated without human control (Chan et al., 2022).

Education level and socioeconomic status also played a pivotal role in understanding Robot-Assisted Surgery. Individuals with higher levels of formal education and better access to healthcare resources tended to possess a more accurate comprehension of the benefits and limitations of robotic surgery (Darlington et al., 2022). A cross-sectional study in Southeast Asia revealed that patients' preference for Robot-Assisted Surgery was strongly influenced by their belief in superior surgical outcomes, with those perceiving better results being more likely to choose robotic surgery (OR 1.61, $P = 0.026$). Conversely, concerns over potential surgical errors significantly reduced willingness to undergo Robot-Assisted Surgery (OR 0.51, $P = 0.001$) (Chan et al., 2022).

Given the increasing integration of robotic technology in surgical care, public education initiatives, Robot-Assisted Surgery had been gaining momentum in Malaysia as healthcare institutions increasingly adopted advanced surgical technology to enhance precision, reduce invasiveness, and improve patient recovery outcomes. However, public awareness and understanding of Robot-Assisted Surgery remained limited, influenced by various factors such as access to healthcare, education levels, and media exposure. This highlights the key findings and gap in knowledge indicating the need for targeted awareness campaigns in Malaysia (Fauzi et al., 2023).

Current research on Robot-Assisted Surgery reveals several significant gaps that warrant attention. While there is a general awareness of Robot-Assisted Surgery, studies indicate that this awareness often lacks depth, with many individuals harboring misconceptions about technology. For instance, a study conducted in Kuwait found that only 36.8% of respondents had heard of Robot-Assisted Surgery, and among them, 47.6% were uncertain about its safety, highlighting a substantial gap in understanding (Buabbas et al., 2020). Understanding this relationship is crucial for healthcare providers to effectively communicate the benefits and risks associated with Robot-Assisted Surgery, thereby facilitating informed patient choices (Arishi et al., 2024; Moloney et al., 2020). Such efforts will inform strategies to improve awareness, education, and acceptance of this technology, ultimately leading to better patient outcomes and more informed healthcare decisions (Arishi et al., 2024). Therefore, aim of the study was to assess the awareness, knowledge, and understanding of Robot-Assisted Surgery among the general adult population in Malaysia, as well as to identify the factors that influenced their perceptions, acceptance, and willingness to undergo robot-assisted procedures.

METHODOLOGY

STUDY DESIGN, TIME SETTING AND STUDY POPULATION

The study of our research was a cross-sectional study that was carried out from February 2025 to March 2025 among the general adult population in Malaysia. The participants of our study consisted of adults residing in Malaysia aged 18 years and above, regardless of their ethnicity and nationalities.

Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(N):	1000000
Hypothesized % frequency of outcome factor in the population (p):	27.1%+/-5
Confidence limits as % of 100(absolute +/- %)(d):	5%
Design effect (for cluster surveys-DEFF):	1

Sample Size(n) for Various Confidence Levels

Confidence Level(%)	Sample Size
95%	304
80%	130
90%	214
97%	373
99%	525
99.9%	855
99.99%	1196

Equation

Sample size ***n*** **= [DEFF*Np(1-p)]/ [(d2/Z21-α/2*(N-1)+p*(1-p)]**
Results from OpenEpi, Version 3, open source calculator--SSPropor
Print from the browser with ctrl-P
or select text to copy and paste to other programs.

Figure 1. Sample Size and Confidence Levels

Vol. [3] / Issue. [2] [2025]

SAMPLE SIZE

The online platform used to calculate sample size for the research study was Open EPI sample size calculation software. With the estimated prevalence of good knowledge of Robot-Assisted Surgery (27.1%) according to the study done by Buabbas et al., 2020, a margin of error of 5%, and a 95% confidence interval, the expected sample size required for this study was 304, as shown in Figure 2 (Buabbas et al., 2020). By taking into consideration a potential non-response rate of 10%, the minimum sample size required for the study was 335 participants. A total of 339 responses were received from the distributed questionnaires. After excluding two participants aged below 18 years and one who declined participation, the final sample size included in the data analysis was 337.

SAMPLING METHOD

In our research, we employed a non-probability convenience sampling technique to gather data through a survey. We adopted this sampling technique due to its practicality and efficiency in data collection. This approach allowed us to collect relevant information efficiently by selecting participants who were readily available and willing to participate, thereby minimizing both time and resource constraints. Given the scope of our study, ensuring accessibility to respondents was a priority, and convenience sampling provided a feasible approach without compromising the study's objectives. Participants were invited to complete the survey via a link or QR code distributed across various social media channels. We considered the general adult population aged 18 years and above, encompassing various ethnicities and nationalities, who resided in Malaysia and were interested in participating. Participants were selected based on their availability and willingness to participate in the study. Exclusion criteria included individuals who did not provide informed consent, lacked experience with technology, or did not understand English (Andrade, 2021).

DATA COLLECTION

Our study, titled "Awareness and Understanding of Robot-Assisted Surgery and Its Associated Factors Among the General Adult Population in Malaysia: A Cross-Sectional Study," sought to investigate these associations among Malaysian adults. To do this, we created a detailed online self-administered questionnaire for both male and female participants, which was distributed via prominent social media sites such as Instagram, email, X (formerly known as Twitter), Telegram, WhatsApp, etc. This technique enabled us to reach a large and diverse segment of Malaysia's adult population.

RESEARCH INSTRUMENT

The data-gathering method employed a structured online questionnaire with various sections to ensure comprehensive and gender-appropriate data collection. Our questionnaire design was adapted from a previous study, with modifications to align with our research objectives. It consisted of five key sections: the first part included an informed consent form detailing the study's objectives, participant rights, and confidentiality, requiring participants to select "Agree" or "Disagree" to confirm voluntary participation. The second part gathered sociodemographic details such as age, gender, nationality, and educational background. The third section assessed participants' awareness and understanding of Robot-Assisted Surgery. In our research, good knowledge was assessed based on participants' awareness and understanding of Robot-Assisted Surgery. This was measured using a set of seven questions, with each correct response earning one point. The mean score differentiated between good and poor knowledge. A total score of at least 4 out of 7 was considered indicative of good knowledge. The fourth section explored their expertise with technology, which could influence their perception of robotic-assisted procedures. Lastly, the fifth part examined participants' perceptions and concerns regarding Robot-Assisted Surgery. This structured approach ensured a thorough understanding of factors influencing public perception while maintaining clarity and ease of response (Buabbas et al., 2020).

VALIDITY AND RELIABILITY OF THE QUESTIONNAIRE

According to the previous study conducted by Buabbas et al. (2020), the validity and reliability of the questionnaire were carefully assessed to ensure the accuracy and consistency of the data collected. The reliability of the questionnaire was measured using Cronbach's alpha, which yielded a value of 0.657, indicating an acceptable level of internal consistency. (Buabbas et al., 2020). In our study, we conducted a pilot test with 30 participants to assess the reliability and internal consistency of our adapted questionnaire. The Cronbach's alpha value obtained was 0.59, which is slightly lower than the 0.657 reported by Buabbas et al. (2020). However, it is important to consider that this study is a student research project with limited resources, a smaller sample size, and potential variations in participant demographics. While a Cronbach's alpha of 0.7 or higher is typically preferred, values around 0.6 can still be acceptable in exploratory research, pilot studies, or when dealing with diverse constructs.

DATA PROCESSING AND ANALYSIS

Data analysis was conducted using SPSS Version 30 (trial version), Epi Info Version 7.2.6 and Microsoft Excel. Descriptive statistics were used to summarize participants' demographics, awareness, experience with technology, and perceptions of Robot-Assisted Surgery. The results were presented as mean ± standard deviation or as numbers and percentages. The Chi-square test (χ^2) was applied to assess associations between categorical variables such as sociodemographic variables (e.g., gender, education level, income group), perception and experience with technology related to Robot-Assisted Surgery, and awareness of Robot-Assisted Surgery. A 95% confidence interval (95% CI) and a P-value <0.05 were considered statistically significant. The results were presented as numbers, percentages, odds ratios (95% CI), and P-values using tables, graphs, and charts for clear interpretation.

RESULT

Table 1. Demographic Characteristics of the respondents (n = 337)

Variables	n (%)
Gender	
Male	143 (42.4)
Female	194 (57.6)
Age (Completed Years)	
Young Adult (18-24 years)	229 (68.0)
Adult (25-59 years)	86 (25.5)
Old Age (>60 years)	22 (6.5)
Nationality	
Malaysian	297 (88.1)
Non-Malaysian	40 (11.9)
Ethnicity	
Malay	97(28.8)

Chinese	73(21.7)
Indian	128(38.0)
Others*	39(11.6)
Where do you live?	
Urban area	236(70.0)
Suburban area	84(24.9)
Rural area	17(5.1)
What is your highest level of education?	
No Formal Education	0(0)
Primary Education	3(0.9)
Secondary Education	56(16.6)
Tertiary Education	278(82.5)
What is your occupation status?	
Student	201(59.6)
Employed	99(29.4)
Unemployed	11(3.3)
Retired	26(7.7)
What is your income?	
B40 (<RM6,338)	121(35.9)
M40 (RM6,339-RM10,959)	134(39.8)
T20 (>RM10,959)	82(24.3)

Table 1 represents the demographic characteristics of all the respondents. Based on the analysis of the population in this study on Robot-Assisted Surgery, most respondents were between the ages of 18-24 years (68.0%), followed by adults aged 25-59 years (25.5%), and the smallest group are those above 60 years old (6.5%). In terms of gender distribution, females constituted a larger proportion of respondents at (57.6%), while males made up (42.4%). Regarding nationality, Malaysian respondents formed the majority with (88.1%), whereas non-Malaysians accounted for (11.9%), Among the ethnic groups, Indians had the highest percentage of participants at 38.0%, followed by Malays at (28.8%), Chinese at (21.7%,) and other ethnicities at (11.6%). In terms of income distribution, the M40 group represented the largest portion of respondents at (39.8%), followed by the B40 group at (35.9%), and the T20 group at (24.3%).

Vol. [3] / Issue. [2] [2025]

Table 2. Expertise with technology among the respondents (n=337)

Variables	n (%)
On average, how many hours per week do you spend using electronic devices (computers, laptops, iPads, smartphones, etc.)?	
0-5 hours	39(11.6)
6-11 hours	105(31.2)
12-17 hours	112(33.2)
18 or more hours	81(24.0)
How would you rate your comfort level with technology (computers, laptops, iPads, smartphones, etc.)?	
Not comfortable	10(3.0)
Somewhat comfortable	158(46.9)
Comfortable	169(50.1)
How do you assess your proficiency with computers?	
Not proficient	14(4.2)
Moderately proficient	216(64.1)
Proficient	107(31.8)

Table 2 presents the respondents expertise with technology. The largest proportion of respondents (33.2%) reported using electronic devices for 12–17 hours per week, followed by (31.2%) who used them for 6–11 hours, and (24.0%) who used them for 18 or more hours in a week. A smaller fraction (11.6%) spent 0–5 hours on electronic devices weekly. For the comfort level of using technology, exactly half of the respondents (50.1%) felt comfortable using devices such as computers, laptops, and smartphones, while (46.9%) were somewhat comfortable, and only (3.0%) reported being not comfortable. In terms of proficiency of using technology, the majority (64.1%) identified as moderately proficient, (31.8%) considered themselves proficient, and (4.2%) reported being not proficient in using technology. These findings shows that most respondents have moderate to high engagement with technology, with a significant portion feeling comfortable and moderately or fully proficient in computer use. This technological familiarity can influence how they will perceive and accept Robot-Assisted Surgery.

Table 3. Awareness and understanding of Robot-Assisted Surgery among the respondents (n=337)

Variables	n (%)
Have you heard of Robot-Assisted Surgery?	
Yes	299(88.7)
No	38(11.3)
Where did you learn about Robot-Assisted Surgery?	
Internet	116(34.4)
Social media	123(36.5)
News	33(9.8)
Others	30(8.9)
I don't know	35(10.4)

What do you understand from the term Robotic-Assisted Surgery/surgery performed using a robot?	
The surgeon programs the robot, and the robot does the job.	57(16.9)
The robot does the surgery, while a surgeon stands by to ensure patient's safety.	76(22.6)
A surgeon sitting on a console and control the robot's arms movement.	169(50.1)
The surgeon instructs the surgical robot step by step.	14(4.2)
I don't know	21(6.2)
Is Robot-Assisted Surgery available in Malaysia?	
Yes	164(48.7)
No	34(10.1)
I don't know	139(41.2)
Do you know any person who has undergone Robot-Assisted Surgery?	
Yes	66(19.6)
No	271(80.4)
Do you consider Robot-Assisted Surgery to be safe?	
Yes	210(62.3)
No	44(13.1)
I don't know	83(24.6)
Level of awareness and understanding about Robot-Assisted Surgery	
Good	281(83.4)
Poor	56(16.6)

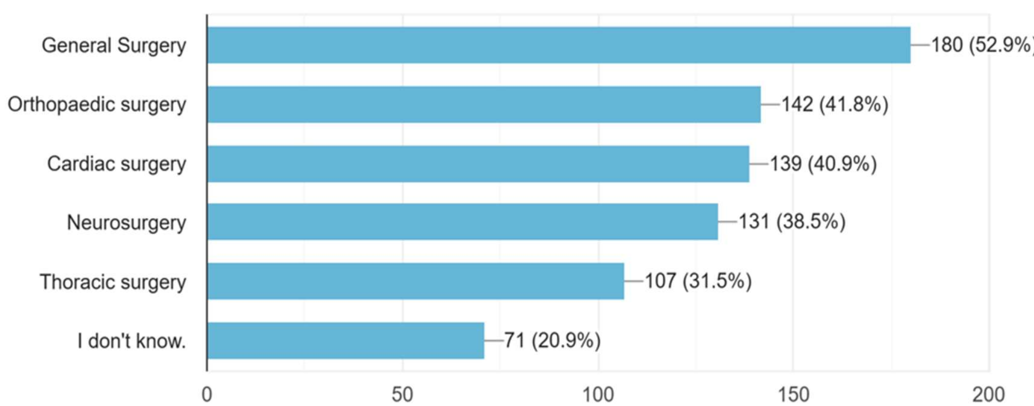

Figure 2. The medical specialties that commonly use Robot-Assisted Surgery among the respondents (n=337)

Table 3 represents the awareness and understanding of Robot-Assisted Surgery among the respondents. Based on the analysis, for the question on have you heard of Robot-Assisted Surgery, (88.7%) of respondents have heard of Robot-Assisted Surgery, while (11.3%) have not heard of Robot-Assisted Surgery. When asked the question where did you learn about Robot-Assisted Surgery, social media was the most common source, with (36.5%) of respondents learning about it via that platform. A smaller percentage (4.2%) believed the surgeon instructs the robot step by step, while (6.2%) were uncertain. The following question on whether Robot-Assisted Surgery is available in Malaysia, (48.7%) answered yes, while (10.1%) answered no. A substantial (41.2%) of respondents were uncertain. For the question on do you know any person who has undergone Robot-Assisted Surgery, (19.6%) of respondents knew someone who had undergone Robot-Assisted Surgery, while the majority (80.4%) did not. For the question on do you consider Robot-Assisted Surgery to be safe, a significant (62.3%) considered Robot-Assisted Surgery to be safe, whereas (13.1%) believed it was unsafe. Meanwhile, (24.6%) were uncertain. Overall, the level of awareness and understanding was rated as "good" among (83.4%) of respondents, while (16.6%) had a "poor" understanding of Robot-Assisted Surgery. Under figure 2: The medical specialties that commonly use Robot-Assisted Surgery among respondents. The data shows that general surgery had the highest recognition with (52.9%) selecting it. Orthopedic Surgery followed, with (41.8%) acknowledging its use in Robot-Assisted Surgery. Cardiac Surgery was (40.9%) as a field where robots are used. Neurosurgery was (38.5%) as a specialty utilizing Robot-Assisted Surgery. Thoracic Surgery was (31.5%), indicating a moderate awareness of its robotic applications. Notably, 20.9% of respondents were uncertain about which specialties commonly use Robot-Assisted Surgery, highlighting a gap in awareness.

Table 4. Perception about Robot-Assisted Surgery among the respondents (n=337)

Variables	n (%)
What type of surgery is most comparable to Robot-Assisted Surgery?	
Traditional open surgery	46 (13.6)
Laparoscopic/minimally invasive surgery	156 (46.3)
Laser surgery	46 (12.8)
Endoscopic surgery	42 (12.5)
I don't know	50 (14.8)
Would you choose Robot-Assisted Surgery if it was one of the treatment options for a surgical condition you may have?	
Yes	203 (60.2)
No	56 (16.6)
I don't know	78 (23.2)
What is your perception when you hear the term "Robot-Assisted Surgery" as a procedure compared to conventional methods of surgery?	
The procedure is LESS painful than open surgery	34 (10.1)
The procedure will have LESS complication than open surgery	70 (20.8)
The procedure is FASTER than open surgery.	82 (24.3)
The procedure is MORE painful than open surgery	4 (1.2)
The procedure will have MORE complications than open surgery	3 (0.9)
The procedure is SLOWER than open surgery	1 (0.3)
Robot malfunction during surgery is a major concern	35 (10.4)
Robot mistake causing serious complications is major concern	24 (7.1)
Robot can be so accurate it will help the surgeon do a better job.	56 (16.6)
I don't know	28 (8.3)
Do you think surgeons who use the robot are skilled compared to non-robotic surgeons?	
More skilled than non-robotic surgeons	128 (38.0)
Less skilled than non-robotic surgeons	22 (6.5)
Equally skilled as non-robotic surgeons	149 (44.2)
I don't know	38 (11.3)
Do you think hospitals offering Robot-Assisted Surgery are better than hospitals that do not offer?	
Better than hospitals that do not offer	148 (43.9)
Worse than hospitals that do not offer	16 (4.7)
Similar	127 (37.7)
I don't know	46 (13.6)

Table 4 represents the perception of respondents regarding Robot-Assisted Surgery. When asked which type of surgery is most comparable to Robot-Assisted Surgery, the majority (46.3%) identified laparoscopic/minimally invasive surgery, (13.6%) answered that it was like traditional open surgery, (12.8%) to laser surgery, and (12.5%) to endoscopic surgery. Meanwhile, (14.8%) were uncertain. Regarding personal preference, (60.2%) of respondents indicated they would opt for Robot-Assisted Surgery if it were available as a treatment option, (16.6%) would not choose it, and (23.2%) were uncertain. Perceptions of Robot-Assisted Surgery compared to conventional surgery varied. The most common belief was that Robot-Assisted Surgery is faster than open surgery (24.3%), followed by the perception that it has fewer complications (20.8%) and is less painful (10.1%). Finally, perceptions of hospitals offering Robot-Assisted Surgery were divided as (43.9%) believed such hospitals were superior, (37.7%) saw no difference. Only (4.7%) thought hospitals without Robot-Assisted Surgery were better, and (13.6%) were uncertain.

Table 5. Association of sociodemographic characteristics with awareness and understanding of Robot-Assisted Surgery among respondents by using Chi-square test (n=337)

Variables	Awareness and understanding		x^2 (df)	Odds Ratio (95% CI)	P Value
	Good	Poor			
Gender			2.911(1)	1.69 (0.92-3.11)	0.088
Male	125	18			
Female	156	38			
Age			(2)		
18-24 years	189	40	0.207	0.746(0.211-2.642)	0.649
25-59 years	73	13	0.247	0.84 (0.43-1.66)	0.619
More than 60 years	19	3	Reference		
Nationality			2.722(2)	0.37(0.11-1.26)	0.099
Non-Malaysian	3	37			
Malaysian	53	244			
Ethnicity			(3)		
Malay	15	82	0.087	1.118(0.532-2.349)	0.769
Chinese	17	56	2.75	1.855(0.888-3.876)	0.097
Indian	18	110	Reference		
Others	6	33	0.043	1.111(0.408-3.028)	0.837
Location			(2)		
Rural area	11	6	4.325	0.341(0.119-0.979)	0.038
Suburban area	71	13	0.002	1.016(0.511-2.019)	0.965
Urban	199	37	Reference		
Education			(2)		
Primary Education	2	1	Reference		
Secondary Education	50	6	1.393	4.17 (0.33-53.12)	0.238
Tertiary Education	49	229	4.805	0.11 (0.01-1.20)	0.028
Occupation			(3)		
Employed	86	13	Reference		
Retired	22	4	0.089	0.83 (0.25-2.80)	0.765

Student	163	38	1.567	0.65 (0.33-1.28)	0.211
Unemployed	10	1	0.146	1.51 (0.18-12.81)	0.703
Income Level			(2)		
B40 (<RM6338)	91	30	5.371	0.47 (0.25-0.90)	0.020
M40 (RM 6339- RM 10959)	116	18	Reference		
T20 (>RM 10959)	74	8	0.650	1.44 (0.59-3.47)	0.420

Table 5 reveals that sociodemographic factors significantly influence the awareness and understanding of Robot-Assisted Surgery among the respondents. Gender differences were observed, with males having a higher odds ratio (OR = 1.69, 95% CI: 0.92–3.11) for good awareness compared to females, though this association was not statistically significant ($x^2 = 2.911$, $p = 0.088$). Age also did not show a significant effect ($x^2 = 0.400$, $p = 0.619$), although younger adults (18–24 years) had the highest proportion of good awareness (189 respondents), followed by adults aged 25–59 years (73 respondents), and those above 60 years (19 respondents). The odds ratio for the 25–59 age group (OR = 0.84, 95% CI: 0.43–1.66) suggests no significant difference when compared to the 18–24 age group.

The location section specifically highlights the influence of geographical location on awareness levels. Based on the responses, Urban residents (199 respondents) had the highest level of awareness and served as the reference group. Suburban residents (71 respondents) showed no significant difference in awareness compared to urban residents (OR = 1.016, p = 0.965) and Rural residents (11 respondents) had significantly lower awareness levels compared to urban residents (OR = 0.341, p = 0.038), indicating a notable disparity. This suggests that individuals living in urban areas have greater exposure to healthcare innovations, likely due to better access to medical centers, digital platforms, and educational resources.

Education level did not show a statistically significant association with awareness ($x^2 = 2.217$, $p > 0.05$), although respondents with tertiary education (229 respondents) demonstrated the highest awareness compared to those with secondary education (50 respondents) and primary education (2 respondents). Occupational status also had minimal influence ($x^2 = 2.106$, $p > 0.05$), with students forming the largest group with good awareness (163 respondents), followed by employed individuals (86 respondents), retirees (22 respondents), and unemployed individuals (10 respondents). This suggests that students, possibly due to greater academic engagement and exposure to medical advancements, may be more informed about Robot-Assisted Surgery.

Income level, however, demonstrated a stronger association with awareness ($x^2 = 9.604$, $p < 0.05$). Respondents in the M40 category (RM6,339–RM10,959) had the highest proportion of good awareness (116 respondents), followed by B40 (<RM6,338) with (91 respondents) and T20 (>RM10,959) with (74 respondents). This pattern suggests that middle-income groups may have better access to healthcare information, while financial constraints in lower-income groups and differing priorities in higher-income groups may contribute to variations in awareness. These findings highlight that while gender, age, and education level may not be strong predictors of Robot-Assisted Surgery awareness, factors such as nationality, ethnicity, location, and income level play a more significant role. The disparities observed across different demographic groups underscore the need for targeted awareness campaigns to ensure equitable knowledge distribution.

Table 6. Association between experience with technology with awareness and understanding of Robot-Assisted Surgery among respondents by using Chi-square test (n=337)

Variables	Awareness and understanding		x^2 (df)	OR (95% CI)	P Value
	Good	Poor			
Expertise of Technology					
How many hours per week using electronic devices			1.039(3)		
0-5 hours	33	6	0.052	1.12(0.41-3.05)	0.819
6-11 hours	90	15	0.294	1.23(0.59-2.56)	0.587
12-17 hours	93	19	*Ref*		
18 or more hours	65	16	0.246	0.83(0.40-1.73)	0.620
Comfort level with technology			(2)		
Not Comfortable	9	1	0.14	1.49(0.18-12.30	0.710
Somewhat comfortable	127	31	1.71	0.68(0.38-1.22)	0.190
Comfortable	145	24	*Ref*		
Proficiency with computers			(2)		
Not proficient	13	1	0.13	3.23(0.41-25.38)	0.239
Moderately proficient	173	43	*Ref*		
Highly proficient	12	95	0	0.03(0.02-0.06)	0.001

OR=Odds Ratio, 95%CI= 95% Confident Interval

Table 6 explores the relationship between respondents' technological experience, their perception of Robot-Assisted Surgery, and their overall awareness and understanding of the procedure. The odds ratios for different time brackets (0–5 hours, 6–11 hours, 12-17 hours and 18 or more hours) were close to 1, and the (p>0.05), indicating no statistically significant association. Similarly, the comfort level with technology did not show a strong correlation with awareness ($p = 0.19$), and neither did proficiency with computers, except for those categorized as "highly proficient" ($p < 0.001$), where there was a strong negative association (OR = 0.03, 95% CI: 0.02–0.06). This suggests that while basic technological skills may contribute to awareness, highly proficient individuals may not necessarily have a higher awareness of Robot-Assisted Surgery.

Table 7. Association between experience with perception with awareness and understanding of Robot-Assisted Surgery among respondents by using Chi-square test (n=337)

Variables	Awareness and understanding		x^2 (df)	OR (95% CI)	P Value
	Good	Poor			
Perception of Robot-Assisted Surgery					
Type of surgery is most comparable to Robot-Assisted Surgery			73.78(4)		
Traditional open surgery	45	1	0.19	3.41(0.43-27.1	0.218
Laparoscopic/minimally invasive surgery	145	11	*Ref*		
Laser Surgery	34	9	7.18	0.29(0.11-0.75)	0.001
Endoscopic Surgery	35	7	3.70	0.38(0.13-1.05)	0.050
I don't know	22	28		0.06(0.03- 0.13)	0.001

Would you choose Robot-Assisted Surgery if it was one of the treatment options for a surgical condition you may have			(2)		
Yes	170	34	63.601	9.444(5.213-17.111)	0.001
No	9	49	6.233	0.347(0.148-0.811)	0.013
I don't know	27	51	*Ref*		
Perception when you hear the term "Robot-Assisted Surgery" as a procedure compared to conventional methods of surgery			(9)		
The procedure is LESS painful than open surgery	33	1	0.11	1.48(0.15-14.76)	0.738
The procedure will have LESS complications than open surgery	67	3	*Ref*		
The procedure is FASTER than open surgery	73	9	2.32	0.36(0.09-1.40)	0.130
The procedure is MORE painful than open surgery.	3	1	3.18	0.13(0.01-1.75)	0.075
The procedure will have MORE complications than open surgery.	2	1	4.69	0.089(0.00-1.29)	0.030
The procedure is SLOWER than open surgery.	0	1	16.99	0	0.001
Robot malfunction during surgery is a major concern.	25	10	12.69	0.11(0.03-0.44)	0.001
Robot mistakes causing serious complications is a major concern.	18	6	8.86	0.13(0.03-0.59)	0.001
Robot can be so accurate it will help the surgeon do a better job.	50	6	1.94	0.37(0.08-1.56)	0.164
I don't know	10	18	42.76	0.02(0.00-0.10)	0.001
Surgeons who use the robot are more skilled compared to non-robotic surgeons			(3)		
More skilled than non-robotic surgeons	112	16	1.50	0.61(0.28-1.35)	0.221
Less skilled than non-robotic surgeons	13	9	19.2	0.13(0.05-0.36)	0.001
Equally skilled as non-robotic surgeons	137	12	*Ref*		
I don't know	19	19	38.52	0.08(0.04-0.21)	0.001
Hospitals offering Robot-Assisted Surgery are better than hospitals that do not			(3)		
Better than hospitals that do not offer	135	13	*Ref*		
Worse than hospitals that do not offer	11	5	7.46	0.21(0.06-0.70)	0.006
Similar	110	17	1.49	0.62(0.29-1.33)	0.222
I don't know	25	21	33.0	0.11(0.05-0.26)	0.001

OR=Odds Ratio, 95%CI= 95% Confident Interval

According to table 7, a highly significant association ($p < 0.001$) was found between the respondents' perception of what type of surgery is most comparable to Robot-Assisted Surgery and their level of awareness. Those who identified laparoscopic/minimally invasive surgery as the closest equivalent had the highest odds of good awareness. Conversely, those who selected laser surgery ($p < 0.001$) or who were unsure ($p < 0.001$) had significantly lower awareness, suggesting a potential gap in understanding the nature of Robot-Assisted Surgery. Preference for undergoing Robot-Assisted Surgery was also strongly associated with awareness ($p < 0.001$). Respondents who indicated they would choose Robot-Assisted Surgery had significantly higher odds (OR = 9.44, 95% CI: 5.21–17.11) of good awareness. In contrast, those who outright rejected Robot-Assisted Surgery had significantly lower odds (OR = 0.35, 95% CI: 0.15–0.81, $p = 0.013$), indicating that a lack of awareness may contribute to hesitancy or rejection of the technology.

Awareness levels were influenced by perceptions of Robot-Assisted Surgery compared to conventional surgery. Respondents who believed Robot-Assisted Surgery has fewer complications than open surgery served as the reference group. Those who perceived Robot-Assisted Surgery as more painful ($p = 0.075$) or more prone to complications ($p = 0.03$) had significantly lower odds of good awareness, suggesting that misconceptions about surgical risks and pain levels may contribute to poorer understanding. Concerns about robot malfunction and mistakes during surgery were also significantly associated with awareness ($p < 0.001$). Respondents who were worried about robotic errors had lower odds of good awareness (OR = 0.13, 95% CI: 0.03–0.59), possibly reflecting a knowledge gap regarding the safety and reliability of robotic systems.

Perception about the skill level of robotic surgeons was also significantly linked to awareness ($p < 0.001$). Respondents who believed robotic surgeons were equally skilled as non-robotic surgeons had the highest awareness, those who believed robotic surgeons were less skilled had significantly lower odds of good awareness (OR = 0.13, $p < 0.001$). Similarly, perceptions about hospitals that offer Robot-Assisted Surgery influenced awareness levels ($p < 0.001$). Those who believed hospitals with Robot-Assisted Surgery were superior had higher awareness, whereas those who thought hospitals without Robot-Assisted Surgery were better (OR = 0.21, $p = 0.006$) or who were unsure (OR = 0.11, $p < 0.001$) had significantly lower awareness. This indicates that Robot-Assisted Surgery is closely tied to perceived institutional credibility and trust in robotic technology.

DISCUSSION

This study assessed the awareness, knowledge, and understanding of Robot-Assisted Surgery among the general adult population in Malaysia. The findings revealed encouraging levels of awareness, but persistent misconceptions underscore a significant knowledge gap that warrants attention. While most respondents were aware of RAS, many lacked accurate understanding of its operational principles, particularly the surgeon's role in controlling robotic instruments. Such misconceptions are consistent with findings from previous studies in Singapore and Kuwait, where large portions of the public also believed that robots independently performed surgery (Buabbas et al., 2020). However, misconceptions remain prevalent, particularly regarding robotic autonomy, which is consistent with the findings from Singapore, where (43.6%) of respondents falsely believed that robots perform surgery autonomously (Chan et al., 2022).

The high awareness observed in Malaysia compared with other countries may be attributed to the nation's growing healthcare infrastructure and the increasing presence of robotic surgery programs in tertiary hospitals. However, awareness alone does not equate to understanding. The reliance on social media as the main source of information raises concerns, as online content often lacks medical accuracy and may perpetuate misinformation. If these misconceptions persist, the public could develop unrealistic expectations or unwarranted fears toward RAS, potentially influencing treatment decisions and acceptance of innovative medical technologies (Buabbas et al., 2020; Chan et al., 2022).

The study also identified sociodemographic disparities influencing awareness and acceptance. Urban residents and individuals with tertiary education demonstrated higher awareness, likely reflecting better access to information and exposure to advanced healthcare systems. These findings align with studies in Saudi Arabia, where awareness was significantly influenced by education level and urban residency (Arishi et al., 2024). Addressing such disparities is essential to ensure equitable health education and prevent digital and informational divides between urban and rural populations.

Additionally, education level was significantly associated with awareness of Robot-Assisted Surgery, with majority of respondents having tertiary education, correlating with a better understanding of the technology. A Saudi Arabian study similarly found that higher education levels were linked to improved comprehension of Robot-Assisted Surgery (Arishi et al., 2024). However, gender differences were not statistically significant ($p = 0.088$), contradicting studies from Saudi Arabia, where males exhibited higher awareness due to greater exposure to technology (Arishi et al., 2024).

From a broader public health perspective, insufficient understanding of RAS could hinder its integration into Malaysia's healthcare system. Continued lack of awareness may lead to patient hesitancy, delayed acceptance of minimally invasive technologies, and slower institutional adoption due to limited public demand. Moreover, misinformation could fuel ethical and safety concerns that may erode confidence in medical professionals using robotic systems. Conversely, improving public literacy about RAS could enhance patient engagement, foster trust in healthcare innovations, and encourage evidence-based decision-making.

The findings also underscored the importance of strategic educational interventions. Collaboration between healthcare providers, academic institutions, and media platforms could play a pivotal role in disseminating accurate information about RAS. Integrating awareness programs into community health campaigns or hospital outreach activities could further demystify robotic technology and clarify its safety, surgeon involvement, and benefits.

Future research should incorporate interventional and longitudinal designs to assess the effectiveness of targeted awareness initiatives and to examine how public understanding evolves as RAS becomes more prevalent. Moreover, policy-level support for integrating robotic surgery into medical education and national health awareness programs would strengthen the foundation for sustainable implementation.

In summary, this study highlighted a critical opportunity to bridge the gap between awareness and understanding of RAS in Malaysia. Without proactive measures, the persistence of misinformation could limit public confidence and slow the advancement of technologically driven healthcare. Strengthening education, communication, and outreach was therefore essential to ensure that Malaysia's transition into robotic-assisted healthcare is both informed and inclusive.

STRENGTHS AND LIMITATIONS

This study had some limitations, including its cross-sectional design, which may limit the ability to establish causal relationships between awareness of RAS (Robot-Assisted Surgery) and associated factors. Longitudinal studies would be necessary to determine causal links and potential long-term effects. Furthermore, the study relied on self-reported data, which may introduce recall bias and subjective variations in pain perception. Participants may have overestimated or underestimated their awareness, knowledge and perception of RAS, leading to potential measurement inaccuracies. Additionally, the potential confounders such as occupational status (eg: medical specialties) and experience in using technology were not extensively controlled, which might have influenced the findings. Future studies could incorporate a more comprehensive assessment of these variables.

Advanced statistical methods such as logistic regression or multivariate analysis should be used to control confounders and provide stronger evidence of associations.

RECOMMENDATIONS

Future researchers should focus on the intervention studies that measure the effectiveness of educational programs in improving public understanding of Robot-Assisted Surgery. Public awareness campaigns should be expanded beyond urban areas to reach rural and suburban populations. Furthermore, longitudinal studies are needed to assess how awareness influences patient decision-making over time. Government policies should focus on making Robot-Assisted. Training initiatives could improve surgeons' skills and confidence in robotic procedures, ultimately leading to greater patient trust and wider acceptance of Robot-Assisted Surgery in Malaysia.

CONCLUSION

This study on Robot- Assisted Surgery highlighted the high awareness but persistent misconceptions about Robot-Assisted Surgery in Malaysia. While most respondents were aware of this advanced surgical technique, misconceptions regarding how it operates, safety concerns and surgeon involvement remain a significant barrier towards its acceptance. The urban-rural disparity and education-related differences suggested that access to healthcare information and exposure to advanced medical technology play a crucial role in shaping the public's perception. Despite growing awareness, public hesitancy remained a challenge, with concerns about surgical complications, robot malfunctions and surgeon competency influencing perceptions. By implementing the targeted public awareness campaigns, integrating robotic surgery training into medical education, and developing clear national guidelines for its practice, Malaysia can improve public understanding and acceptance of this evolving surgical technology. As Robot-Assisted Surgery continued to advance, future research should focus on identifying effective strategies to bridge the knowledge gap, address patient concerns, and enhance accessibility for all population groups.

ACKNOWLEDGEMENT

We would like to express our sincere gratitude and appreciation towards all participants in our study. Furthermore, we would also like to thanks to Prof Adinegara Lutfi Abas and Research Ethics Committee, Faculty of Medicine, Manipal University College Malaysia for approving our research. Moreover, we would like to warmly express our appreciation towards and all the lecturers for providing their invaluable guidance, comments and suggestions throughout the course of the project.

CONFLICT OF INTEREST

There was no conflict of interest in this study.

FUNDING

There is no funding support in this study.

REFERENCES

Aldousari, S. A., Buabbas, A. J., Yaiesh, S. M., Alyousef, R. J., & Alenezi, A. N. (2021). Multiple perceptions of robotic-assisted surgery among surgeons and patients: A cross-sectional study. Journal of Robotic Surgery, 15(4), 529–538. https://doi.org/10.1007/s11701-020-01136-w.

AlNaim, A. A., AlNaim, N., Al Nasser, F., Albash, L., Almulhim, M., & Albinsaad, L. (2024). Public's perception and knowledge of using robotics in general surgery in Eastern Region, Saudi Arabia. Annals of African Medicine, 23(3), 299–306. https://doi.org/10.4103/aam.aam_182_23.

Buabbas, A. J., Aldousari, S., & Shehab, A. A. (2020). An exploratory study of public awareness about robotics-assisted surgery in Kuwait. BMC Medical Informatics and Decision Making, 20(140). https://doi.org/10.1186/s12911-020-01167-1.

Chan, K. S., Kwan, J. R., & Shelat, V. G. (2022). Awareness, perception, knowledge, and attitude toward robotic surgery in a general surgical outpatient clinic in Singapore, Asia. Journal of Clinical and Translational Research, 8(3), 224–233. https://doi.org/10.18053/jctres.08.202203.011.

Ergin, E., Karaarslan, D., Şahan, S., & Çınar Yücel, Ş. (2022). Artificial intelligence and robot nurses: From nurse managers' perspective: A descriptive cross-sectional study. Journal of Nursing Management, 30(8), 3853–3862. https://doi.org/10.1111/jonm.13646.

Ghezzi, T. L., & Corleta, O. C. (2016). 30 years of robotic surgery. World Journal of Surgery, 40(10), 2550–2557. https://doi.org/10.1007/s00268-016-3543-9.

Gleneagles Hospital Kuala Lumpur. (n.d.). Innovative Surgical Excellence: da Vinci® Xi System at Gleneagles Hospital KL. https://gleneagles.com.my/kuala-lumpur/facilities-services/innovative-surgical-excellence-da-vinci-xi-system-at-gleneagles-hospital-kl.

Kumar, R., & Pandey, A. K. (2011). A study on the awareness and acceptance of robotic surgery among patients and healthcare professionals in a tertiary care hospital. Journal of Robotic Surgery, 5(3), 215–219. https://doi.org/10.1016/j.jrob.2011.05.004.

Lanfranco, A. R., Castellanos, A. E., Desai, J. P., & Meyers, W. C. (2011). Robotic surgery: A current perspective. Journal of Minimal Access Surgery, 7(1), 1-10. https://doi.org/10.1016/j.jamcollsurg.2011.02.009

McBride, K., Steffens, D., Duncan, K., & Solomon, M. J. (2019). Staff attitude towards the implementation of robotic surgery categorized according to specialty [Figure]. Knowledge and attitudes of theatre staff prior to the implementation of robotic-assisted surgery in the public sector. PLOS ONE, 14(3), e0213840. https://doi.org/10.1371/journal.pone.0213840.

Mohd Shahrol, S. N., & Salim, S. A. (2024). A foresight study on the adoption of robotic surgery in Malaysia. Research in Management of Technology and Business, 5(1), 543–562. https://publisher.uthm.edu.my/periodicals/index.php/rmtb/article/view/16090.

Pantai Hospital Kuala Lumpur. (n.d.). Robotic surgery. https://www.pantai.com.my/kuala-lumpur/robotics

Sunway Medical Centre. (n.d.). Robotic surgery & minimally invasive surgery centre. https://www.sunwaymedical.com/en/centres-of-excellence/robotic-surgery-mis-centre