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Physicians' knowledge and attitudes towards telesurgery and its associated factors in a resource-limited setting, Northwest Ethiopia, 2022: A facility-based cross-sectional study

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Abstract

Background: Telesurgery has become helpful in overcoming the current shortage of surgeons and reducing the barriers to timely and effective surgical intervention caused by long-distance travel, which are caused by distance, cost, complexity, and frequent hazards. However, knowledge and attitude remain challenges in the implementation of such a system.

Objective: This study aimed to assess physicians' knowledge and attitude towards telesurgery and associated factors at resource-limited setting, Northwest Ethiopia.

Method and analysis: A simple random sampling method were carried to choose study participants from each referral hospital, and data were collected using self-administered questionnaires. Descriptive and inferential statistics were applied to estimate knowledge and attitudes toward telesurgery among physicians and to identify factors associated with physician knowledge and attitudes toward telesurgery.

Study Design: cross-sectional study design.

Setting: This study was conducted at six specialized referral hospitals and two specialized and teaching referral hospitals in the Amhara region, northwest Ethiopia.

Result: Four hundred and eight (408) physicians were included for analysis, with a response rate of 96.45%. Among study participants, 47.8% and 43.1% had good knowledge and attitudes toward telesurgery, respectively. Educational status, digital literacy, Source of information, computer training, digital health training, and internet access in the organization were factors associated with a physician's knowledge of telesurgery. Moreover, physician's knowledge, technology use, educational status, computer training, computer access, and internet access in the organization were factors associated with physicians' attitudes toward telesurgery.

Conclusion and recommendation: Almost half of physicians had good knowledge, and less than half had a good attitude toward telesurgery, so healthcare policymakers should improve physicians' digital literacy, technology use, and internet access to enhance their knowledge and attitudes for future implementation. **Keywords:** Attitude, Knowledge, Physician, Telesurgery.

1. Introduction

During an outbreak or pandemic like COVID-19, there is an increased need for healthcare delivery systems to improve the accessibility of virtual care technologies like telehealth, telemedicine, telenursing, telesurgery, telecare, etc. that support affordable, high-quality, and person-centered treatment (1).

The World Health Organization defines telemedicine as the provision of health services where distance is a significant factor by all health care professionals utilizing information and communication technology for the interchange of trustworthy information for the diagnosis, treatment, and prevention of disease, research and evaluation, and the continuous education of health care professionals, all in the quest of improving people's health and the health of their coworkers (2).

Telesurgery is widely defined as the ability to perform surgery from long distances using modern surgical techniques by overcoming the obstacles of time and distance (3). This technology not only addresses the current scarcity of surgeons, but it also removes geographical restrictions, financial burdens, problems, and long-distance travel that prohibit prompt and high-quality surgical intervention. It also improves surgical accuracy and ensures the safety of surgeons (4,5).

Telesurgery is a system that connects patients and doctors (surgeons) using a wireless network and a robotic system (6). Telesurgery, which allows surgeons to give surgical care for patients from anywhere in the world, is a great way for patients to receive medical attention without having to travel outside of their local hospitals (7). The ultimate goal of telesurgery is to enable the specialist surgeon to be present virtually at the patient's bedside due to reasons like distance (for example, in remote and rural areas), special conditions (such as a battlefield or accident scene), risks that may be caused by patients to the surgical team (such as infectious diseases and radioactive contamination), or the risks posed by the surgical team that threaten the patient's health (for example, an immune deficiency in a patient) (3,5,8). According to a WHO report, the physician-to-community ratio was below the standard in Africa as compared to developed nations (2).

Globally, the rate of manpower development in surgery was not sufficient to address the fastest growing global population size. There is a global shortage of qualified surgeons and anesthetists, for which telesurgery can be a potential solution (7). In many developing countries, the shortage

of healthcare specialists has led to high mortality rates among patients suffering from various diseases (2). Because of the physician shortage, patients can't get healthcare services, which is why the death rate is increasing. Even if the patients can get the service, the required cost is high. And, when the cases are complicated, the patient must travel out of the country, which leads to high costs and wasted time.

Healthcare professionals' knowledge and attitude toward telemedicine are important factors that can influence the successful future implementation of telesurgery (9). A study performed in Egypt found that only 39% of physicians have a decent understanding of telemedicine, while 12% are unfamiliar with this strategy (10). This technology not only benefits today's shortage of surgeons, but evidence shows that telesurgery minimizes the current geographic barriers to accessing prompt, high-quality surgical care: long travel distances, a lack of experts, and a large financial burden (2,5,7). In Ethiopia, the physician-patient ratio is one physician for every 42,000 people, which shows a shortage of physicians in the field (11). The use of digital technologies like telesurgery could allow for the provision of healthcare in remote settings where physicians are scarce. Physicians' knowledge and attitude could be considered an essential requirement in the deployment of any digital health technology, including the implementation of telesurgery in the health system (10).

However, there was limited evidence on basic knowledge and attitudes toward telesurgery and determinant factors in Ethiopia. Thus, this study aims to assess the current knowledge and attitudes of physicians toward telesurgery. Therefore, this study generated evidence that could be useful for policy and practice and could initiate further studies. It could also inform decisions about curriculum development and revision for physicians' training in higher education institutions.

2. Methods

2.1. Study design, study period and Setting

An institutional-based cross-sectional study design was employed among physicians who worked at a specialized referral hospital in the Amhara region of northwest Ethiopia. This study was conducted from May 16 to July 20, 2022, at six specialized referral hospitals and two specialized and teaching referral hospitals in the Amhara region, northwest Ethiopia, namely, the University of Gondar specialized and teaching referral hospital, Dessie specialized referral hospital, Felege Hiwot specialized referral hospital, Wolo specialized referral hospital, Tibebe Gihon specialized and teaching referral hospital, Debre Birehan specialized referral hospital, Debre Tabor specialized referral hospital, and Debre Markos specialized referral hospital.

2.2. Source and Study population

All physicians who worked at six specialized referral hospitals and two specialized teaching referral hospitals in the Amhara regional state, Northwest Ethiopia, were the source population for our study. Whereas, physicians who were providers of healthcare services at those six specialized referral hospitals and at those two specialized teaching referral hospitals and who were available during the data collection period were our study population.

2.3. Inclusion and exclusion criteria

All physicians (general practitioners, residents, specialists, and subspecialists) who are working permanently at specialized referral hospitals in the Amhara Region and who were available during data collection were included in this study.

Physicians who were temporarily working in specialized referral hospitals as exchange, guest, or adjunct staff from outside the region and abroad were excluded from this study.

2.4. Sample Size Determination and Sampling Procedures

There were 8 specialized referral hospitals in the Amhara region with a total of 972 physicians. All specialized referral hospitals in this region were approached. The sample size was determined by using a single population proportion formula and considering the following assumptions: Z = standard normal deviation (Z /2 = 1.96) with a 95% confidence interval level (CI), n = final sample size, P = proportion of telesurgery knowledge and attitude, and an associated factor of 50%, since

there has been no previous study done in the same area with d = desired degree of precision (the margin of error) of 5% and the calculated sample size was 384.

$$n = \frac{(z_{\frac{a}{2}})^2 * pq}{d^2} \text{.....(1)}$$

Where, n = required sample size, d = margin of error, p = proportion of tele surgery-related knowledge, and q = 1-p.

$$n = \frac{(z_{\frac{a}{2}})^2 * p(1-P)}{d^2} = n = \frac{(1.96)^2 * 0.50(1-0.50)}{(0.05)^2} = 384 \text{ ..... (2)}$$

By assuming a 10% non-response rate, the final total sample was 423. Finally, we applied a simple random sampling method followed by proportional allocation to select appropriate study participants.

2.5. Study Variables

Dependent Variables: knowledge and attitude.

Independent Variables: Sociodemographic-related factors (Age, sex, Educational Status, Working Department, and Years of Experience), technological-related factors (Digital Literacy and Technology use), Personal or behavioral-related factors (motivation and confidence to use new technology), Sources of information about telesurgery (Training, Internet (like Social media, Journal sites), Public Media (like Radio, TV, meetings, etc.), and Colleagues), and organizational-related factors (Basic computer training, digital health-related training, trained staff available on telesurgery or any digital health-related training, Computer access in your organization, Internet access, etc.).

2.6. Data collection Tools and Procedure

A pretested and structured self-administered questionnaire was used to collect the data. The tool was adapted after reviewing different literature from previous studies (3,9–16).

Data was collected using a self-administered structured questionnaire, which had 60 questions consisting of a "Yes" or "No" question, a five-point Likert scale question, and a list of questions with five sections, such as sociodemographic, organizational, technological, personal characteristics, knowledge, and attitude-related questions.

2.7. Data Quality management

To ensure data quality, we used standardized and pretested questionnaires and gave two days of training to 12 data collectors. The pretest was done to confirm the degree to which the measuring tool produces consistency and reliability. The internal consistency of each dimension of the data collection instrument was checked using Cronbach's alpha. The pretest shows that the value of Cronbach's alpha was above 70%. According to the Cronbach alpha (α), the value of the measuring tool or questionnaires was 0.82 for knowledge and 0.83 for attitude. Continuous supervision up to the end of data collection was done to check its consistency and completeness. After data collection, questionnaires were reviewed and checked for completeness, and the data was cleaned to check for errors and missing values. All errors were identified and corrected.

2.8. Operational Definitions

Knowledge of tele surgery: This refers to the fundamental knowledge and insights that physicians have about telesurgery technology. This includes how physicians understand the meaning and benefits of telesurgery. Which was measured by nine questions and was categorized as poor and good knowledge of telesurgery (9,17,18).

Poor knowledge: If a study participant achieves a score lower than the median, they are considered to have poor knowledge of telesurgery.

Good knowledge: If a study participant achieves a score higher than the median, they are considered to have good knowledge of telesurgery.

Attitude toward telesurgery: Refers to how physicians' opinions, personal intentions, and outlook on tele-Surgery technology are expressed and how they will accept this technology if it is applied to a health facility. This was measured by nine 5-point Likert scale questions and was categorized as a poor and good attitude toward telesurgery (9,17).

Poor Attitude: If a study participant achieves a score lower than the median, they are considered to have a poor attitude toward telesurgery.

Good Attitude: If a study participant achieves a score higher than the median, they are considered to have a good attitude toward telesurgery.

2.9. Data analysis and processing Procedure

The collected data was entered into EpiData version 4.6. After producing the cleaned data, it was exported to Statistical Package for the Social Sciences (SPSS) version 26 software for further analysis. Descriptive statistics were presented through percentages, frequency tables, and graphs, and a binary logistic regression analysis was computed to identify the associated factors in both the bivariable and multivariable analyses. During the bivariate analysis, variables with a p-value less than 0.2 were candidates for the multivariate analysis.

Whereas, in multivariable analysis, variables with a p-value of less than or equal to 0.05 were considered statistically significant variables. Moreover, before bivariate and multivariate analysis, outliers and multicollinearity were checked using variable inflation factors (VIF). Based on the multicollinearity result, the VIF value is between 1.056 and 6.622, which shows that multicollinearity is not a problem because most researchers consider a VIF > 10 an indicator of multicollinearity (19). Accordingly, our results show that multi-collinearity is not an issue in our data.

The fitness of the model was checked by using the Hosmer and Lemeshow Test for both model fits (knowledge and attitude). The results of logistic binary regression revealed that the model was adequately fit to our data and that the model has a good fit with a Chi-square value of 3.081 and 4.654 for model fit for knowledge and attitude, respectively, and a p-value greater than 0.05 (p-value = 0.929 and 0.794). The full model correctly predicted 85.3% and 84.3% of the observed respondents who had good knowledge and a good attitude, respectively. Finally, we used adjusted odds ratios (AOR) with a 95% confidence interval and a p-value of 0.05 to determine factors associated with the physician's knowledge and attitude toward telesurgery.

3. Results

3.1. Socio-demographic characteristics

A total of four hundred twenty-three (423) physicians were selected from specialized referral hospitals in the Amhara Region. Four hundred eight (408) of them consented and responded to completing all questionnaires with a 96.45% response rate. Of the total 408 respondents, among those 81.4% were General Practitioners (GP), 11.5% were residents, and 7.1% were specialists. Among the study participants, 77.2% were male. The majority of the study participant age group was 24 to 34 (79.9%) and the majority of study participants had 1 to 5 years of job experience which accounted for about 52.9% (**see Table 1**).

Table 1: Socio-demographic related characteristics of physicians' tele surgery knowledge and attitude in specialized referral hospitals in Ethiopia, 2022/23 (n = 408)

Variables	Category	Frequency(n)	Percentage (%)
Age	24-34	325	79.7
	>34	83	20.3
Sex	Male	315	77.2
	Female	93	22.8
Educational Status	GP	332	81.4
	Resident	47	11.5
	Specialist	29	7.1
Working Department	IPD	77	18.9
	Gynecology	58	14.2
	OPD	60	14.7
	Pediatrics	52	12.7
	Ophthalmology	24	5.9
	Neurology	22	5.4
	Cardiology	23	5.6
	Orthopedic	24	5.9
	General Surgery	40	9.8
	Others	28	6.9
Year of Experience	<1Year	106	26.0
	1-5 Year	216	52.9
	>5 Year	86	21.1
→ **Note:** Other Working departments are**:** "**Dermatology** and **ENT**"			

3.2. Organizational characteristics

As shown in **Table 2**, of the total study participants, only one hundred thirty-three (32.6%) and one hundred two (25%), respectively, took computer training and digital health training, and one

hundred twenty-seven (31.1%) of the physicians had computer access in their organizations (**see Table 2**).

Table 2: Organizational-related factors of physicians' tele surgery knowledge and attitude in specialized referral hospitals in Ethiopia 2022/23 (n = 408)

Variables	Category	n	%
Basic computer systems training.	No	275	67.4
	Yes	133	32.6
Digital health relating training	No	306	75.0
	Yes	102	25.0
Trained staff available on Tele-surgery	No	355	87.0
	Yes	53	13.0
Computer access in your organization	No	281	68.9
	Yes	127	31.1
Internet access in the organization	No	138	33.8
	Yes	270	66.2
24-hour service of uninterrupted Electric power	No	364	89.2
	Yes	44	10.8
Availability of electric power Backup	No	351	86.0
	Yes	57	14.0

3.3. Technological related factors

As **Figure 1** shows, only 179 (43.9%) and 174 (42.60%) study participants had good digital literacy and were able to use the technology, respectively (**see Fig.1**).

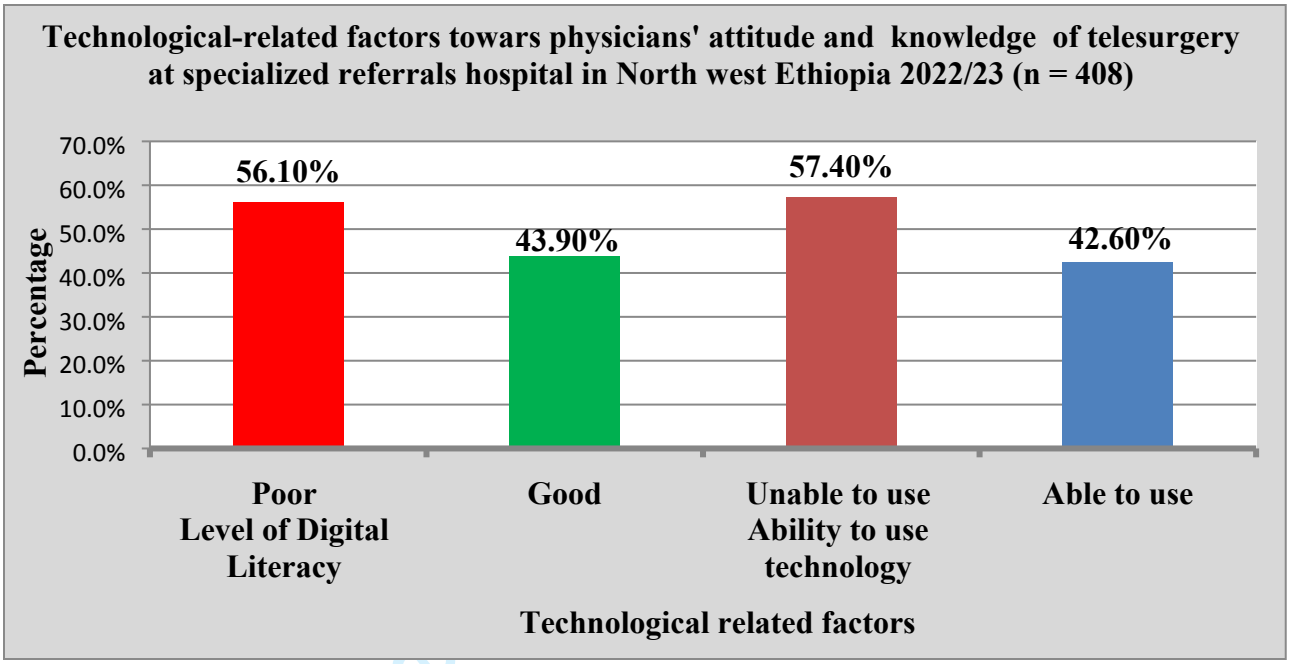

Figure 1: Technological-related factors toward physicians' attitude and knowledge

3.4. Personal Characteristics

There has been uncertainty in organizational, behavioral, technical, and all other fields among the physicians, with 50.70% were having good confidence and 44.40% of physicians were having good motivation to use new technology (**see Figure 2**, **Supplemental Figure 2**).

3.5. Physicians sources of information about telesurgery

As **Fig.3** shows, different training and Internet (like journal sites, social media, etc.) were the major common sources of information about telesurgery among the study participants, accounting for 177 (43.4%) and 157 (38.5%), respectively (**see Fig.3**).

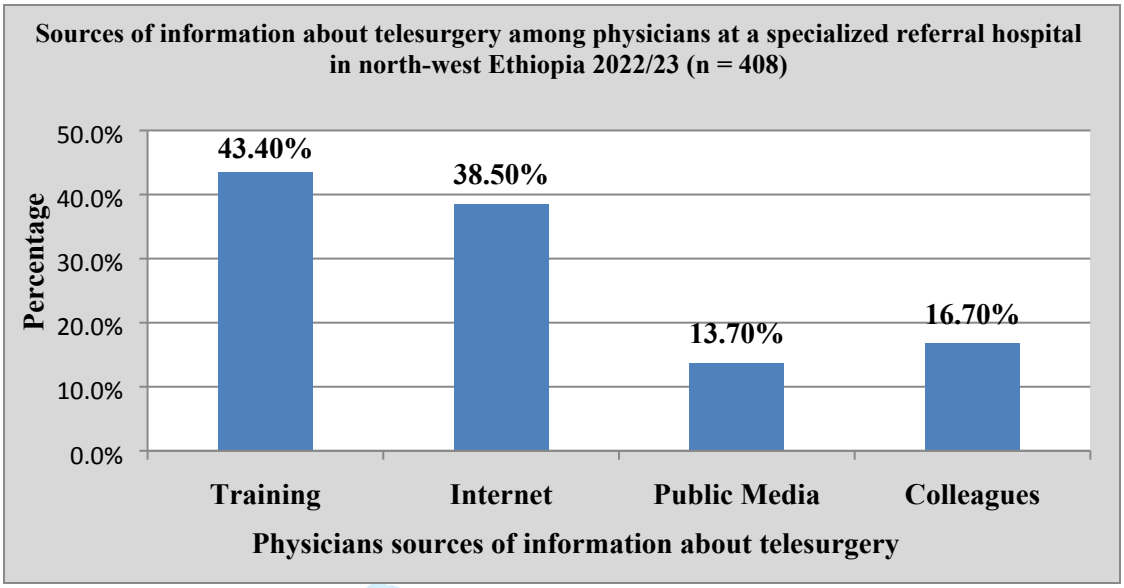

Figure 2: Sources of information about telesurgery among physicians at a specialized referral hospital in north-west Ethiopia

3.6. Physicians' knowledge and attitudes towards telesurgery

3.6.1. Physician's knowledge of tele surgery

Among study participants, one hundred ninety-five (47.8%) physicians [with a 95% CI of 43.1 to 52.7] had good knowledge about telesurgery (**see Figure 4**, **Supplemental Figure 4**).

3.6.2. Physician attitude toward tele surgery

From a total of 423 study participants (physicians), one hundred seventy-six (43.1%) [with a 95% CI of 39.7 to 48.7] had good attitudes toward telesurgery (**see Figure 5**).

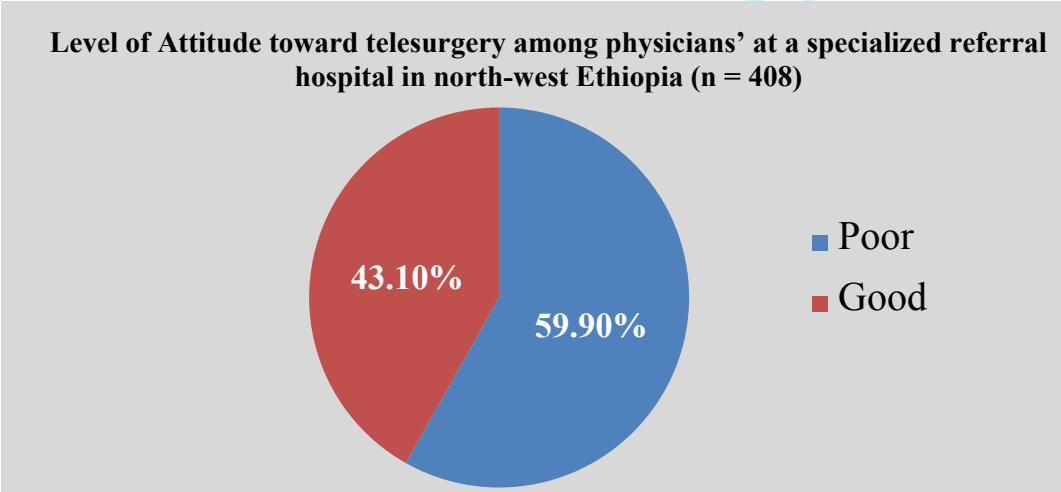

Figure 3: Level of Physician attitude towards Tele-surgery in Ethiopia 2022/23

3.7. Binary logistic regression analysis for factors associated with knowledge and attitude of telesurgery among physicians

3.7.1. Factors associated with physician knowledge of telesurgery

Binary logistic regression of multivariable analysis reveals that in addition to the age of the study participant [AOR = 2.25, 95% CI: (1.005–5.03)], educational status [AOR = 8.36, 95% CI: 1.93–36.3)] Work experience [AOR=3.1, 95% CI: (1.32-7.26) & AOR=6.34, 95% CI: (2.37-16.95)], Digital literacy [AOR=3.80, 95% CI: (2.08-6.95)], Source of information [AOR=4.25, 95% CI: (2.31-7.807) & AOR=1.90, 95% CI: (1.02-3.539)] Basic computer training [AOR = 2.23, 95% CI: 1.26–5.57] e-Health/Digital health training [AOR = 2.72, 95% CI: (2.62-8.06)], trained staff available on telesurgery or any related field [AOR = 2.12, 95% CI: (1.01-5.24)], and Internet access in the organization [AOR = 2.25, 95% CI: (1.16-4.37)] were significantly associated with physician Knowledge toward telesurgery (**see Table 3, Supplemental Table 3**).

3.7.2. Factors associated with physician attitude toward tele surgery

Binary logistic regression of multivariable analysis reveals that physicians' knowledge about telesurgery [AOR = 4.79, 95% CI: (2.34-9.79)], Job experience [AOR = 3.09, 95% CI: (1.12-8.55)], Technology use [AOR = 2.25, 95% CI: (1.16-4.38)], Educational status [AOR=4.02, 95% CI: (1.5-10.73) and AOR=7.87, 95% CI: (1.56-39.66)], e-Health/Digital Health Training [AOR = 2.50, 95% CI: (1.14-5.5)], Digital literacy [AOR = 2.82; 95% CI: 1.47–5.41], Basic computer training [AOR = 3.48, 95% CI: 1.79–6.78], Computer access [AOR = 3.32, 95% CI: 1.42–7.72], and Internet access in the organization [AOR = 2.26, 95% CI: 1.14–4.46], were significantly associated with physician attitude toward telesurgery (**see Table 4, Supplemental Table 4**).

4. Discussion

This study assessed physicians' knowledge and attitude toward telesurgery and its associated factors at a referral hospital. The conclusion of this study reveals that about half of the study participants (physicians) had good knowledge, and less than half of them had a good attitude toward telesurgery. This study revealed that 47.8% (95% CI 43.1–52.7) of the participants had good knowledge about telesurgery.

This finding is slightly similar to the studies conducted in Ethiopia (18,20) where about 45.8% of nurses had good knowledge about telenursing and about 50% of health sciences students had good knowledge about evidence-based medicine (EBM); this similarity might be due to the similarity of study period and study area, and in Saudi Arabia, 46.1% of the respondents had good knowledge of telemedicine (13). This similarity might be due to all study participants being the same; all participants are physicians, the sample size is closely similar, and most physicians had not participated in the training.

On the other hand, the current study finding was lower than the study conducted in Australia, Medical staff reported the highest rate of Robotic Assisted Surgery (RAS) knowledge (70.7%) (21), and in Malaysia Health professionals 57% has known about telesurgery (22). The difference might be due to the study settings and sample variation and technology. Moreover, this finding is higher than the previous study done in Ethiopia which reported 37.6% good knowledge of telemedicine (9), and India (41%) (23) This difference could be due to differences in a study participant, study area, sample size, scope of study model, and study participant's educational background. A previous study was conducted with 312 and 120 health professionals, respectively.

Regarding physicians' attitudes, 43.1% [95% CI: (38.5-48.0)] of the participants had a good attitude about tele surgery. This finding is lower than the study in Ethiopia (9), Australia (21), and Iran (16). This difference might be due to the difference in the study participants, study area, sample size, availability of technology, the scope of the study, and educational background of study participants and variations of study participants. This finding is higher than a study in India showed that the attitude level 30% of the respondents have a low or below the moderate level of attitude towards telemedicine, 31% possess a moderate level of attitude and 39% possess a high attitude level towards telemedicine (23).

In this finding, 48.5% of physicians agree tele surgery save time, and this finding is lower than the study in Riyadh region, Saudi Arabia, more than 90% of specialties agreed that telemedicine could save time and money (13). This difference may be due to the accessibility of technological equipment and countries' educational curriculum. In this study, 46.3% of physicians agreed that health for all is achieved through ICT-enabled health services. This finding was supported by the study in Saudi Arabia, physicians believed that ICT had a potential role in the healthcare system to become more efficient and effective (13).

Educational status, job experience, knowledge about telesurgery, digital literacy, basic computer training, internet access, e-health and digital health-related training, being able to use technology, and computer access were associated with physicians' attitudes toward telesurgery. In our study, as years of working experience increased, the level of attitude toward telesurgery increased by 75.5%. This finding supports the study of Kind Abdul-Aziz University Hospital (KAUH) in Jeddah, where senior physicians had little interest in and knowledge of telemedicine technology(15).

According to this study, having good knowledge about telesurgery increases the level of attitude toward telesurgery by 82.73%. This finding is supported by a study in Egypt showing that a good attitude correlates positively with user knowledge of telemedicine applications (10). The availability of ICT equipment like internet and computer is a factor in to use tele surgery, this finding is supported by the study done at the Tehran University of Medical Science infrastructure for the implementation of remote surgery was one of the most noticeable strengths of the implementation of remote medical technology services in the hospitals (3). The other study in Malaysia showed information systems like computer, internet, and telephone should be reliable for a better implementation of telemedicine in developing countries (22).

The study showed that physicians who have good confidence in tele surgery are 2.2 times more likely to have a good attitude towards tele surgery. This discovery of being confident is one factor for tele surgery physicians to have a good attitude.

5. Strengths and Limitations of this study

According to our findings, this is the first study in Ethiopia to assess knowledge and attitudes toward telesurgery among physicians so, it is good input for future study and implementations of

telesurgery by providing information about knowledge and attitudes of physicians toward telesurgery. This study has certain limitations. This has included only physicians working in public referral hospitals. It didn't include physicians in public primary and general hospitals as well as private hospitals, which could affect the generalizability of the findings.

6. Conclusions

The finding implied that close to half of the physicians in this study setting had a good level of knowledge, and below half of them had a good level of attitude about telesurgery applications. Sources of information, trained staff available in telesurgery or any related field, digital literacy, educational status, Job Experience, basic computer training, Digital health-related training, and the ability to use technology, computers, and Internet access in the organization were associated with physicians' knowledge and attitudes toward telesurgery.

7. Recommendation

Healthcare policymakers, the government, and other concerned bodies like higher education institutions or universities and teaching specialized referral hospitals should stress improving computer access, education, training, and enhancing physicians' levels of digital literacy, technology use, and internet access in the organization to improve physicians' telesurgery-related knowledge and attitudes for future sustainable implementation.

8. Declarations

8.1. Ethics approval and consent to participate

Ethical clearance was obtained from the Ethical review board of the University of Gondar College of Medicine and Health Science with the ethical reference number IPH/2110/2014. Informed consent was obtained from each study participant after they were informed of the objectives and benefits of the study. To maintain the confidentiality of the information provided by the study subjects, the data collection procedure was anonymous. Additionally, this study was conducted under the Declaration of Helsinki.

8.2. Patients and public Involvement

Patients or the public were not involved in the study

8.3. Consent for publication

Not applicable

9. Availability of data and materials

The data will be available upon request from the corresponding author (mekidesmolla2023@gmail.com)

10. Conflict of Interest

The authors confirm that they have no known financial or interpersonal conflicts that would have appeared to have an impact on the research presented in this study.

11. Funding

No funding was received for this study.

12. Author contributions

Mrs. MM, Dr. KD, and Mr. MA made significant contributions to the work reported, whether that was at the beginning of design, data collection, supervision, data curation, investigation, data analysis, interpretation, preparing figures, writing up the manuscript, or in all these areas. Mr. FWB has made significant contributions to this work from the beginning until the submission of this manuscript in the areas of data analysis, editing, and revision of the manuscript. Finally, all authors agreed to be held accountable for all aspects of the work and participated in writing, revising, or critically reviewing the paper.

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14. Abbreviations and acronyms

AOR: Adjusted Odds Ratio

EBM: Evidence Based Medicine

CI: Confidence Intervals

COR: Crude Odds Ratio

DDCF: Doris Dukes Charitable Foundation

GP: General Practitioner

Fig: Figure

ICT: Information and Communication Technology

IPH: Institute of Public Health

OR: Odd Ratio

RAS: Robotic Assisted Surgery

SPSS: Statistical Package for Social Science

VIF: Variance Inflation Factor

WHO: World Health Organization

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Supplemental Figure 2

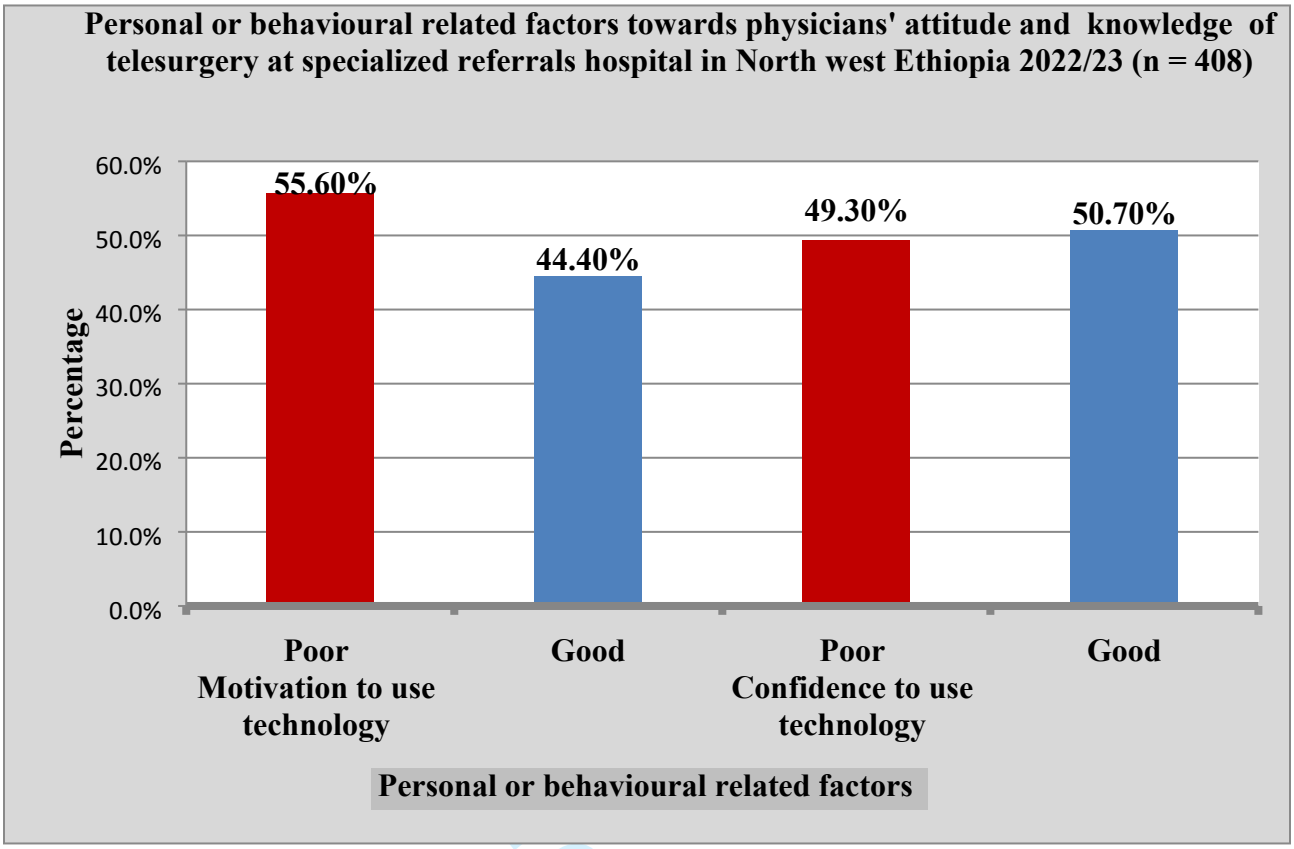

Figure 1: Level of Physicians Confidence and Motivation to use new technology in Ethiopia

Supplemental Figure 4

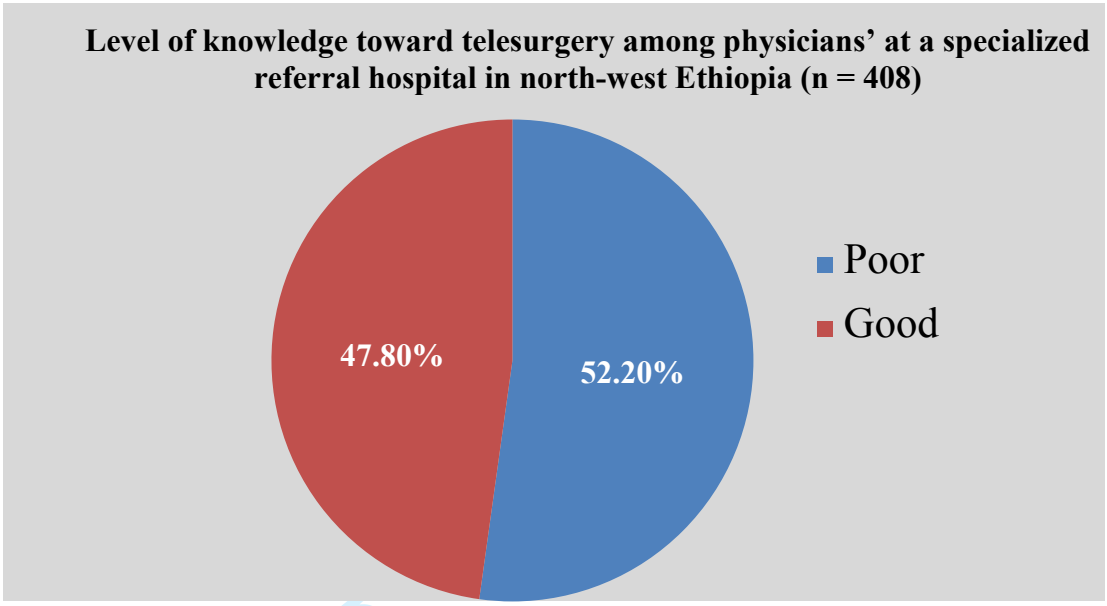

Figure 1: Level of Physician Knowledge toward telesurgery in Ethiopia

Supplemental Table 3

Table 1: Bivariate and multivariable analysis of factors associated with physician knowledge of telesurgery

Variable	Values		Knowledge		OR (95% CI)		P-value
			Poor (%)	Good (%)	COR (95% CI)	AOR (95% CI)	
Age Group	24-34Years		186 (57.2)	139 (42.8)	1	1	
	>34Years		27 (32.5)	56 (67.5%)	2.78 (1.67-4.62)*	**2.25** (1.005-5.03)*	**0.049***
Educational status	General Practitioner		199 (59.9)	133 (40.1)	1	1	
	Resident		11 (23.4)	36 (76.6)	4.9 (2.41-9.96)*	2.27 (0.89-5.78)	0.087
	Specialist		**3 (10.3)**	**26 (89.7)**	**12.97 (3.85-43.7)***	**8.36 (1.93-36.3)***	**0.005***
Working Experience		<1year	90 (84.9)	16 (15.1)	1	1	
		1-5years	**101 (46.8)**	**115 (53.2)**	**6.41 (3.5-11.61)***	**3.1 (1.32-7.26)***	**0.009***
		>5Years	**22 (25.6)**	**64 (74.4)**	**16.36 (7.97-33.6)***	**6.34 (2.37-16.95)***	**0.001***
Digital Literacy		Poor	169 (73.8)	60 (26.2%)	1	1	
		Good	**44 (24.6)**	**135 (75.4)**	**8.64 (5.51-13.55)***	**3.80 (2.08-6.95)***	**0.001***
Source of info.	Professional training	No	170 (73.6)	61 (26.4)	1	1	
		Yes	**43 (24.3)**	**134 (75.7)**	**8.69 (5.5-13.64)***	**4.25 (2.31-7.807)***	**0.001***
	Internet (Social media, etc.)	No	158 (63.2)	92 (36.8)	1	1	
		Yes	**55(35.0)**	**102 (65.0)**	**3.19 (2.1-4.83)***	**1.90 (1.02-3.539)***	**0.043***
Basic computer training		No	176 (64.0)	99 (36.0	1	1	
		Yes	**37 (27.8)**	**96 (72.2)**	**4.61 (2.94-7.25)***	**2.23 (1.26-5.57)***	**0.006***
e-Health/Digital health training		No	187 (61.1)	119 (38.9)	1	1	
		Yes	**26 (25.5)**	**76 (74.5)**	**4.59 (2.78-7.58)***	**2.72 (2.62-8.06)***	**0.002***
Trained staff available on telesurgery		No	193 (54.4)	162 (45.6)	1	1	
		Yes	**20 (37.7)**	**33 (62.3)**	**1.97 (1.09-3.56)***	**2.12 (1.01-5.24)***	**0.007***
Internet in access in the organization		No	103 (74.6)	35 (25.4)	1	1	
		Yes	**110 (40.7)**	**160 (59.3)**	**4.28 (2.72-6.74)***	**2.25 (1.16-4.37)***	**0.017***

Note: AOR = Adjusted Odd Ratio, **COR** = Curd Odd Ratio, ***** = P-value < 0.05 & ** = P-value < 0.01**

Supplemental Table 4

Table 1: Bivariate and multivariable analysis of factors associated with physician attitude towards telesurgery

Variable	Values	Attitude		OR (95% CI)		P-value
		Poor (%)	Good (%)	COR (95% CI)	AOR (95% CI)	
Age Group	24-34Years	193 (59.4)	132 (40.6)	1	1	
	>34Years	39 (47.0)	44 (53.0)	1.65 (1.0-2.68)*	0.46 (0.20-1.06)	0.068
Educational status	General Practitioner	217 (65.4)	115 (34.6)	1	1	
	Resident	**12 (25.5)**	**35 (74.5)**	**5.5 (2.75-11.01)***	**4.02 (1.5-10.73)***	**0.005**
	Specialist	**3 (10.3)**	**26 (89.7)**	**16.35 (4.85-55.2)***	**7.87 (1.56-39.66)***	**0.012**
Job experience	<1year	88 (83.0)	18 (17.0)	1	1	
	1-5years	117 (54.2)	99 (45.8)	4.14 (2.3-7.34)	0.93 (0.39-2.23)	0.876
	>5Years	**27 (31.4)**	**59 (68.6)**	**10.68 (5.40-21.12)**	**3.09 (1.12-8.55)***	**0.036**
Digital Literacy	Poor	178 (77.7)	51 (22.3)	1	**1**	
	Good	**54 (30.2)**	**125 (69.8)**	**8.1 (5.17-12.62)***	**2.82 (1.47-5.41)***	**0.002**
Technology use	Unable to use	160 (68.4)	74 (31.6)	1	1	
	Able to use	**72 (41.4)**	**102 (58.6)**	**3.06 (2.04-4.61)***	**2.25 (1.16-4.38)***	**0.017**
Motivation	Poor	150 (66.1)	77 (33.9)	1	1	
	Good	82 (45.3)	99 (54.7)	2.35 (1.57-3.51)*	1.199 (0.59-2.4)	0.617
Confidence	Poor	131 (65.2)	70 (34.8)	1	1	
	Good	101 (48.8)	106 (51.2)	1.96 (1.32-2.92)*	0.845 (0.42-1.69)	0.632
Basic computer training	No	198 (72.0)	77 (28.0)	1	1	
	Yes	**34 (25.6)**	**99 (74.4)**	**7.49 (4.68-11.98)***	**3.48 (1.79-6.78)***	**0.000**
e-Health/Digital health training	No	205 (67.0)	101 (33.0)	1	1	
	Yes	**27 (26.5)**	**75 (73.5)**	**5.64 (3.42-9.3)***	**2.50 (1.14-5.5)***	**0.02**
Trained staff available on telesurgery	No	208 (58.6)	147 (41.4)	1	1	
	Yes	24 (45.3)	29 (54.7)	1.7 (0.96-3.06)	1.29 (0.57-2.93)	0.5
Computer access in the organization	No	188 (66.9)	93 (33.1)	1	1	
	Yes	**44 (34.6)**	**83 (65.4)**	**3.8 (2.451-5.9)***	**3.32 (1.42-7.72)***	**0.0**
Internet in access in the organization	No	112 (81.2)	26 (18.8)	1	1	
	Yes	**120 (44.4)**	**150 (55.6)**	**5.4 (3.3-8.79)***	**2.26 (1.14-4.46)***	**0.019**
Knowledge	Poor	177 (83.1)	36 (16.9)	1	1	
	Good	**55 (28.2%)**	**140 (71.8)**	**12.5 (7.78-20.13)***	**4.79 (2.34-9.79)***	**0.0001**

Note: AOR = Adjusted Odd Ratio, **COR** = Curd Odd Ratio, * = **P-value < 0.05** & ** = **P-value < 0.01**

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	I
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	II
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3
Bias	9	Describe any efforts to address potential sources of bias	3-4
Study size	10	Explain how the study size was arrived at	3-4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	3-4
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11

		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13-14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Physicians' knowledge and attitudes towards telesurgery and its associated factors in a resource-limited setting, Northwest Ethiopia, 2022

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Physicians' knowledge and attitudes towards telesurgery and its associated factors in a resource-limited setting, Northwest Ethiopia, 2022

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Abstract

Background: Telesurgery has become helpful in overcoming the current shortage of surgeons and reducing the barriers to timely and effective surgical intervention caused by long-distance travel, which are caused by distance, cost, complexity, and frequent hazards. However, knowledge and attitude remain challenges in the implementation of such a system.

Objective: This study aimed to assess physicians' knowledge and attitude towards telesurgery and associated factors at resource-limited setting, Northwest Ethiopia.

Method and analysis: A simple random sampling method was carried to choose study participants from each referral hospital, and data were collected using self-administered questionnaires. Descriptive and inferential statistics were applied to estimate knowledge and attitudes toward telesurgery among physicians and to identify factors associated with physician knowledge and attitudes toward telesurgery.

Study Design: cross-sectional study design.

Setting: This study was conducted at six specialized referral hospitals and two specialized and teaching referral hospitals in the Amhara region, northwest Ethiopia.

Result: Four hundred and eight (408) physicians were included for analysis, with a response rate of 96.45%. Among study participants, 47.8% and 43.1% had good knowledge and attitudes toward telesurgery, respectively. Educational status, digital literacy, Source of information, computer training, digital health training, and internet access in the organization were factors associated with a physician's knowledge of telesurgery. Moreover, physician's knowledge, technology use, educational status, computer training, computer access, and internet access in the organization were factors associated with physicians' attitudes toward telesurgery.

Conclusion and recommendation: Almost half of physicians had good knowledge, and less than half had a good attitude toward telesurgery, so healthcare policymakers should improve physicians' digital literacy, technology use, and internet access to enhance their knowledge and attitudes for future implementation. **Keywords:** Attitude, Knowledge, Physician, Tele surgery.

Strength and Limitation of this study

- ✓ This study is the first to assess physicians' knowledge and attitude toward telesurgery in Ethiopia. It might serve as a basis for future studies in the area within the country.
- ✓ This study includes all types of physicians, such as General Practitioners (GPs), residents, and specialists (including surgeons, pediatricians, and ophthalmologists), with the aim of raising awareness among physicians and sharing knowledge regarding tele-surgery technology for the future implementation of tele-surgery in the country.
- ✓ This study's results contribute to the Ethiopian health policy plan and strategy by highlighting the current level of physicians' knowledge and attitudes toward tele-surgery, for future implementation.
- ✓ While this study was conducted in a specialized and referral hospital in the Amhara region, its findings may only be generalized to similar institutions within the region.
- ✓ Since this study is an institutional-based cross-sectional study, the cross-sectional nature of the study design prevents us from proving any causal relationship between physicians' knowledge and attitude and their associated factors.

Introduction

During an outbreak or pandemic like COVID-19, there is an increased need for healthcare delivery systems to improve the accessibility of virtual care technologies, such as telehealth, telemedicine, telenursing, telesurgery, telecare, etc., that support affordable, high-quality, and person-centered treatment [1].

Telesurgery is widely defined as the ability to perform surgery from long distances using modern surgical techniques by overcoming the obstacles of time and distance [2]. This technology not only addresses the current scarcity of surgeons but also eliminates geographical restrictions, financial burdens, and problems associated with long-distance travels that hinder prompt and high-quality surgical intervention. Furthermore, it enhances surgical accuracy and ensures the safety of surgeons [3, 4].

Telesurgery is a system that connects patients and doctors (surgeons) using both wired and wireless networks, along with a robotic system. Enabling surgeons to provide surgical care to patients from anywhere in the world, telesurgery is a remarkable way for patients to receive medical attention without needing to travel beyond their local hospitals [5]. [6]. The ultimate goal of telesurgery is to enable the specialist surgeon to be virtually present at the patient's bedside [2, 4, 7]. This is especially crucial in situations like:

- Distance: for example, in remote and rural areas.
- Special conditions: such as a battlefield or accident scene.
- Risks caused by patients to the surgical team: like infectious diseases and radioactive contamination.
- Risks posed by the surgical team that threaten the patient's health: for instance, an immune deficiency in a patient.

Due to a shortage of healthcare specialists in many developing countries, there is a high mortality rate among patients with various diseases. The scarcity of physicians results in limited access to healthcare services, contributing to an increasing death rate [8].[6]. . Healthcare professionals' knowledge and attitude toward telemedicine are important factors that can influence the successful future implementation of telesurgery [9]. A study conducted in Egypt found that only 39% of physicians have a decent understanding of telemedicine, while 12% are unfamiliar with this strategy [10]. This technology not only benefits today's shortage of surgeons, but evidence shows that telesurgery minimizes the current geographic barriers to accessing prompt, high-quality surgical care: long travel distances, a lack of experts, and a large financial burden [4, 6, 8].

In Ethiopia, the physician-patient ratio is one physician for every 42,000 people, which shows a shortage of physicians in the field [11]. The use of digital technologies like telesurgery could allow for the provision of healthcare in remote settings where physicians are scarce.

Physicians' knowledge and attitude could be considered an essential requirement in the deployment of any digital health technology, including the implementation of telesurgery in the health system [10].

However, limited evidence existed on basic knowledge and attitudes toward telesurgery and determinant factors in Ethiopia. Thus, this study aims to assess physicians' current knowledge

and attitudes toward telesurgery, providing valuable insights. The findings could prove useful for policymaking, informing practice, and initiating further studies. Additionally, the results may guide decisions about curriculum development and revision for physicians' training in higher education institutions.

Methods

1.1. Study design, study period and Setting

An institutional-based cross-sectional study design was employed among physicians working at a specialized referral hospital in the Amhara region of northwest Ethiopia. The study was conducted from May 16 to July 20, 2022, at eight locations, including six specialized referral hospitals and two specialized and teaching referral hospitals in the Amhara region. These locations are the University of Gondar specialized and teaching referral hospital, Dessie specialized referral hospital, Felege Hiwot specialized referral hospital, Wolo specialized referral hospital, Tibebe Gihon specialized and teaching referral hospital, Debre Birehan specialized referral hospital, Debre Tabor specialized referral hospital, and Debre Markos specialized referral hospital.

1.2. Source and Study population

The source population for our study comprised all physicians who worked in specialized and referral hospitals, as well as specialized teaching referral hospitals, in the Amhara regional state of Northwest Ethiopia. . While these physicians were available during the data collection period in those specialized referral hospitals, the specialized teaching and referral hospitals in the region were considered our study population.

1.3. Inclusion and exclusion criteria

All physicians, including general practitioners, residents, specialists, and subspecialists, who were permanently employed at specialized referral hospitals in the Amhara Region and available during data collection, were included in this study. However, physicians who were temporarily working in specialized referral hospitals as exchange, guest, or adjunct staff from outside the region and abroad were excluded.

1.4. Sample Size Determination and Sampling Procedures

There were 8 specialized referral hospitals in the Amhara region with a total of 972 physicians. All specialized referral hospitals in this region were approached. The sample size was determined by using a single population proportion formula and considering the following assumptions: Z = standard normal deviation (Z /2 = 1.96) with a 95% confidence interval level

(CI), n = final sample size, P = proportion of telesurgery knowledge and attitude, and an associated factor of 50%, since there has been no previous study done in the same area with d = desired degree of precision (the margin of error) of 5% and the calculated sample size was 384.

$$n = \frac{(z_{\frac{a}{2}})^2 * pq}{d^2} \text{.....(1)}$$

Where, n = required sample size, d = margin of error, p = proportion of tele surgery-related knowledge, and q = 1-p.

$$n = \frac{(z_{\frac{a}{2}})^2 * p(1-P)}{d^2} = n = \frac{(1.96)^2 * 0.50(1-0.50)}{(0.05)^2} = 384 \text{ ..... (2)}$$

By assuming a 10% non-response rate, the final total sample was 423. Finally, we applied a simple random sampling method followed by proportional allocation to select appropriate study participants.

1.5. Study Variables

Dependent Variables: knowledge and attitude.

Independent Variables: Sociodemographic-related factors (Age, sex, Educational Status, Working Department, and Years of Experience), technological-related factors (Digital Literacy and Technology use), Personal or behavioral-related factors (motivation and confidence to use new technology), Sources of information about telesurgery (Training, Internet (like Social media, Journal sites), Public Media (like Radio, TV, meetings, etc.), and Colleagues), and organizational-related factors (Basic computer training, digital health-related training, trained staff available on telesurgery or any digital health-related training, Computer access in your organization, Internet access, etc.).

1.6. Data collection Tools and Procedure

A pretested and structured self-administered questionnaire was used to collect the data. The tool was adapted after reviewing different literature from previous studies [2, 9-16].

Data was collected using a self-administered structured questionnaire, which had 60 questions consisting of a "Yes" or "No" question, a five-point Likert scale question, and a list of questions

with five sections, such as sociodemographic, organizational, technological, personal characteristics, knowledge, and attitude-related questions.

1.7. Data Quality management

To ensure data quality, we used standardized and pretested questionnaires and provided two days of training to 12 data collectors. The pretest was conducted to confirm the degree to which the measuring tool produces consistency and reliability. The internal consistency of each dimension of the data collection instrument was checked using Cronbach's alpha. The pretest shows that the value of Cronbach's alpha was above 70%. According to Cronbach's alpha (α), the value for the measuring tool was 0.82 for knowledge and 0.83 for attitude. Continuous supervision up to the end of data collection was conducted to check its consistency and completeness. After data collection, questionnaires were reviewed and checked for completeness, and the data were cleaned to identify and correct errors and missing values. All errors were identified and corrected.

1.8. Operational Definitions

Knowledge of telesurgery encompasses the fundamental understanding and insights that physicians possess about telesurgery technology, including how they perceive its meaning and benefits. This knowledge was assessed using nine questions and categorized as either poor or good knowledge of telesurgery [9, 17, 18].

Poor knowledge: If a study participant achieves a score lower than the median, they are considered to have poor knowledge of telesurgery [9, 17, 18].

Good knowledge: If a study participant achieves a score higher than the median, they are considered to have good knowledge of telesurgery [9, 17, 18].

Attitude toward telesurgery: Refers to how physicians' opinions, personal intentions, and outlook on tele-Surgery technology are expressed and how they will accept this technology if it is applied to a health facility. This was measured by nine 5-point Likert scale questions and was categorized as a poor and good attitude toward telesurgery [9, 18].

Poor Attitude: If a study participant achieves a score lower than the median, they are considered to have a poor attitude toward telesurgery [9, 18].

Good Attitude: If a study participant achieves a score higher than the median, they are considered to have a good attitude toward telesurgery [9, 18].

1.9. Data analysis and processing Procedure

The collected data was entered into EpiData version 4.6. After producing the cleaned data, it was exported to Statistical Package for the Social Sciences (SPSS) version 26 software for further analysis. Descriptive statistics were presented through percentages, frequency tables, and graphs, and a binary logistic regression analysis was computed to identify the associated factors in both the bivariable and multivariable analyses. During the bivariate analysis, variables with a p-value less than 0.2 were candidates for the multivariate analysis.

Whereas, in multivariable analysis, variables with a p-value of less than or equal to 0.05 were considered statistically significant variables. Moreover, before bivariate and multivariate analysis, outliers and multicollinearity were checked using variable inflation factors (VIF). Based on the multicollinearity result, the VIF value is between 1.056 and 6.622, which shows that multicollinearity is not a problem because most researchers consider a VIF > 10 an indicator of multicollinearity [19]. Accordingly, our results show that multi-collinearity is not an issue in our data.

The fitness of the model was checked by using the Hosmer and Lemeshow Test for both model fits (knowledge and attitude). The results of logistic binary regression revealed that the model was adequately fit to our data and that the model has a good fit with a Chi-square value of 3.081 and 4.654 for model fit for knowledge and attitude, respectively, and a p-value greater than 0.05 (p-value = 0.929 and 0.794). The full model correctly predicted 85.3% and 84.3% of the observed respondents who had good knowledge and a good attitude, respectively. Finally, we used adjusted odds ratios (AOR) with a 95% confidence interval and a p-value of 0.05 to determine factors associated with the physician's knowledge and attitude toward telesurgery.

1.10. Patients and public Involvement

Patients or the public were not involved in the study

Results

1.11. Socio-demographic characteristics

A total of four hundred twenty-three (423) physicians were selected from specialized referral hospitals in the Amhara Region. Four hundred eight (408) of them consented and responded to completing all questionnaires with a 96.45% response rate. Of the total 408 respondents, among those 81.4% were General Practitioners (GP), 11.5% were residents, and 7.1% were specialists. Among the study participants, 77.2% were male. The majority of the study participant age group was 24 to 34 (79.9%) and the majority of study participants had 1 to 5 years of job experience which accounted for about 52.9% (**see** Table 1).

Table 1: Socio-demographic related characteristics of physicians' tele surgery knowledge and attitude in specialized referral hospitals in Ethiopia, 2022/23 (n = 408)

Variables	Category	Frequency(n)	Percentage (%)
Age	24-34	325	79.7
	>34	83	20.3
Sex	Male	315	77.2
	Female	93	22.8
Educational Status	GP	332	81.4
	Resident	47	11.5
	Specialist	29	7.1
Working Department	IPD	77	18.9
	Gynecology	58	14.2
	OPD	60	14.7
	Pediatrics	52	12.7
	Ophthalmology	24	5.9
	Neurology	22	5.4
	Cardiology	23	5.6
	Orthopedic	24	5.9
	General Surgery	40	9.8
	Others	28	6.9
Year of Experience	<1Year	106	26.0
	1-5 Year	216	52.9
	>5 Year	86	21.1
→ **Note:** Other Working departments are**:** "**Dermatology** and **ENT**"			

1.12. Organizational characteristics

As shown in Table 2, of the total study participants, only one hundred thirty-three (32.6%) and one hundred two (25%), respectively, took computer training and digital health training, and one

hundred twenty-seven (31.1%) of the physicians had computer access in their organizations (**see** Table 2).

Table 2: Organizational-related factors of physicians' tele surgery knowledge and attitude in specialized referral hospitals in Ethiopia 2022/23 (n = 408)

Variables	Category	n	%
Basic computer systems training.	No	275	67.4
	Yes	133	32.6
Digital health relating training	No	306	75.0
	Yes	102	25.0
Trained staff available on Tele-surgery	No	355	87.0
	Yes	53	13.0
Computer access in your organization	No	281	68.9
	Yes	127	31.1
Internet access in the organization	No	138	33.8
	Yes	270	66.2
24-hour service of uninterrupted Electric power	No	364	89.2
	Yes	44	10.8
Availability of electric power Backup	No	351	86.0
	Yes	57	14.0

1.13. Technological related factors

As **Error! Reference source not found.** shows, only 179 (43.9%) and 174 (42.60%) study participants had good digital literacy and were able to use the technology, respectively (**see** Figure1).

1.14. Personal Characteristics

There has been uncertainty in organizational, behavioral, technical, and all other fields among the physicians, with 50.70% were having good confidence and 44.40% of physicians were having good motivation to use new technology.

1.15. Physicians sources of information about telesurgery

As **Error! Reference source not found.** shows, different training and Internet (like journal sites, social media, etc.) were the major common sources of information about telesurgery among the study participants, accounting for 177 (43.4%) and 157 (38.5%), respectively (**see** Figure2).

1.16. Physicians' knowledge and attitudes towards telesurgery

1.16.1. Physician's knowledge of tele surgery

Among study participants, one hundred ninety-five (47.8%) physicians [with a 95% CI of 43.1 to 52.7] had good knowledge about telesurgery.

1.16.2. Physician attitude toward tele surgery

From a total of 423 study participants (physicians), one hundred seventy-six (43.1%) [95% CI of 39.7 - 48.7] had good attitudes toward telesurgery (**see** Figure3).

1.17. Binary logistic regression analysis for factors associated with knowledge and attitude of telesurgery among physicians

1.17.1.Factors associated with physician knowledge of telesurgery

Binary logistic regression of multivariable analysis reveals that in addition to the age of the study participant [AOR = 2.25, 95% CI: (1.005–5.03)], educational status [AOR = 8.36, 95% CI: 1.93–36.3)] Work experience [AOR=3.1, 95% CI: (1.32-7.26) & AOR=6.34, 95% CI: (2.37-16.95)], Digital literacy [AOR=3.80, 95% CI: (2.08-6.95)], Source of information [AOR=4.25, 95% CI: (2.31-7.807) & AOR=1.90, 95% CI: (1.02-3.539)] Basic computer training [AOR = 2.23, 95% CI: 1.26–5.57] e-Health/Digital health training [AOR = 2.72, 95% CI: (2.62-8.06)], trained staff available on telesurgery or any related field [AOR = 2.12, 95% CI: (1.01-5.24)], and Internet access in the organization [AOR = 2.25, 95% CI: (1.16-4.37)] were significantly associated with physician Knowledge toward telesurgery.

1.17.2. Factors associated with physician attitude toward tele surgery

Binary logistic regression of multivariable analysis reveals that physicians' knowledge about telesurgery [AOR = 4.79, 95% CI: (2.34-9.79)], Job experience [AOR = 3.09, 95% CI: (1.12-8.55)], Technology use [AOR = 2.25, 95% CI: (1.16-4.38)], Educational status [AOR=4.02, 95% CI: (1.5-10.73) and AOR=7.87, 95% CI: (1.56-39.66)], e-Health/Digital Health Training [AOR = 2.50, 95% CI: (1.14-5.5)], Digital literacy [AOR = 2.82; 95% CI: 1.47–5.41], Basic computer training [AOR = 3.48, 95% CI: 1.79–6.78], Computer access [AOR = 3.32, 95% CI: 1.42–7.72], and Internet access in the organization [AOR = 2.26, 95% CI: 1.14–4.46], were significantly associated with physician attitude toward telesurgery.

Discussion

This study assessed physicians' knowledge and attitude toward telesurgery and its associated factors at a referral hospital. The conclusion of this study reveals that about half of the study participants (physicians) had good knowledge, and less than half of them had a good attitude toward telesurgery. This study revealed that 47.8% (95% CI 43.1–52.7) of the participants had good knowledge about telesurgery.

This finding is slightly similar to the studies conducted in Ethiopia [17, 20] where about 45.8% of nurses had good knowledge about telenursing and about 50% of health sciences students had good knowledge about evidence-based medicine (EBM); this similarity might be due to the similarity of study period and study area, and in Saudi Arabia, 46.1% of the respondents had good knowledge of telemedicine [13]. This similarity might be due to all study participants being the same; all participants are physicians, the sample size is closely similar, and most physicians had not participated in the training.

On the other hand, the current study finding was lower than the study conducted in Australia, Medical staff reported the highest rate of Robotic Assisted Surgery (RAS) knowledge (70.7%) [21], and in Malaysia Health professionals 57% has known about telesurgery [22]. The difference might be due to the study settings and sample variation and technology. Moreover, this finding is higher than the previous study done in Ethiopia which reported 37.6% good knowledge of telemedicine [9], and India (41%) [23] This difference could be due to differences in a study participant, study area, sample size, scope of study model, and study participant's educational background. A previous study was conducted with 312 and 120 health professionals, respectively.

Regarding physicians' attitudes, 43.1% [95% CI: (38.5-48.0)] of the participants had a good attitude about tele surgery. This finding is lower than the study in Ethiopia [9], Australia [21], and Iran [16]. This difference might be due to the difference in the study participants, study area, sample size, availability of technology, the scope of the study, and educational background of study participants and variations of study participants. This finding is higher than a study in India showed that the attitude level 30% of the respondents have a low or below the moderate level of

attitude towards telemedicine, 31% possess a moderate level of attitude and 39% possess a high attitude level towards telemedicine [23].

In this finding, 48.5% of physicians agree that telesurgery can save time, and 46.3% of physicians agree that ICT-enabled health services can improve the accessibility of healthcare. This finding is supported by a study conducted in Saudi Arabia, which emphasizes the potential role of ICT in the healthcare system to become more efficient and effective. The majority of physicians in the study also agreed that telemedicine could save both time and money [13].

Computer and e-Health or digital health-related training positively affected the attitudes of physicians toward telesurgery. Taking computer and e-Health or digital health-related training increased the level of physicians' attitudes by 77.68% and 71.43%, respectively. This finding supports a study in Saudi Arabia, which reported that a lack of suitable training and consultation between information technology experts and clinicians affects physicians' perceptions in adopting telemedicine technology [13].

According to this study, having good knowledge about telesurgery increases the level of attitude toward telesurgery by 82.73%. This finding is supported by a study in Egypt showing that a good attitude correlates positively with user knowledge of telemedicine applications [10]. The availability of ICT equipment like internet and computer is a factor in to use tele surgery, this finding is supported by the study done at the Tehran University of Medical Science infrastructure for the implementation of remote surgery was one of the most noticeable strengths of the implementation of remote medical technology services in the hospitals [2]. The other study in Malaysia showed information systems like computer, internet, and telephone should be reliable for a better implementation of telemedicine in developing countries [22].

The study showed that physicians who have good confidence in tele surgery are 2.2 times more likely to have a good attitude towards tele surgery. This discovery of being confident is one factor for tele surgery physicians to have a good attitude.

Strengths and Limitations of this study

According to our findings, this is the first study in Ethiopia to assess knowledge and attitudes toward telesurgery among physicians so; it is good input for future study and implementations of

telesurgery by providing information about knowledge and attitudes of physicians toward telesurgery. This study has certain limitations. This has included only physicians working in public referral hospitals. It didn't include physicians in public primary and general hospitals as well as private hospitals, which could affect the generalizability of the findings.

Conclusions

The finding implied that close to half of the physicians in this study setting had a good level of knowledge and below half of them had a good level of attitude about telesurgery applications. Sources of information, trained staff available in telesurgery or any related field, digital literacy, educational status, Job Experience, basic computer training, Digital health-related training, and the ability to use technology, computers, and Internet access in the organization were associated with physicians' knowledge and attitudes toward telesurgery.

Recommendation

Healthcare policymakers, the government, and other concerned bodies like higher education institutions or universities and teaching specialized referral hospitals should stress improving computer access, education, training, and enhancing physicians' levels of digital literacy, technology use, and internet access in the organization to improve physicians' telesurgery-related knowledge and attitudes for future sustainable implementation.

Declarations

1.18. Ethics approval and consent to participate

Ethical clearance was obtained from the Ethical review board of the University of Gondar College of Medicine and Health Science with the ethical reference number IPH/2110/2014. Informed consent was obtained from each study participant after they were informed of the objectives and benefits of the study. To maintain the confidentiality of the information provided by the study subjects, the data collection procedure was anonymous. Additionally, this study was conducted under the Declaration of Helsinki.

1.19. Consent for publication

Not applicable

Availability of data and materials

The data will be available upon request from the corresponding author (mekidesmolla2023@gmail.com)

Conflict of Interest

The authors confirm that they have no known financial or interpersonal conflicts that would have appeared to have an impact on the research presented in this study.

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No funding was received for this study.

Author contributions

Mrs. MM, Dr. KD, and Mr. MA made significant contributions to the work reported, whether that was at the beginning of design, data collection, supervision, data curation, investigation, data analysis, interpretation, preparing figures, writing up the manuscript, or in all these areas. Mr. FWB has made significant contributions to this work from the beginning until the submission of this manuscript in the areas of data analysis, editing, and revision of the manuscript. Finally, all authors agreed to be held accountable for all aspects of the work and participated in writing, revising, or critically reviewing the paper.

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Abbreviations and acronyms

AOR: Adjusted Odds Ratio

EBM: Evidence Based Medicine

CI: Confidence Intervals

COR: Crude Odds Ratio

DDCF: Doris Dukes Charitable Foundation

GP: General Practitioner

Fig: Figure

ICT: Information and Communication Technology

IPH: Institute of Public Health

OR: Odd Ratio

RAS: Robotic Assisted Surgery

SPSS: Statistical Package for Social Science

VIF: Variance Inflation Factor

WHO: World Health Organization

Figures Caption

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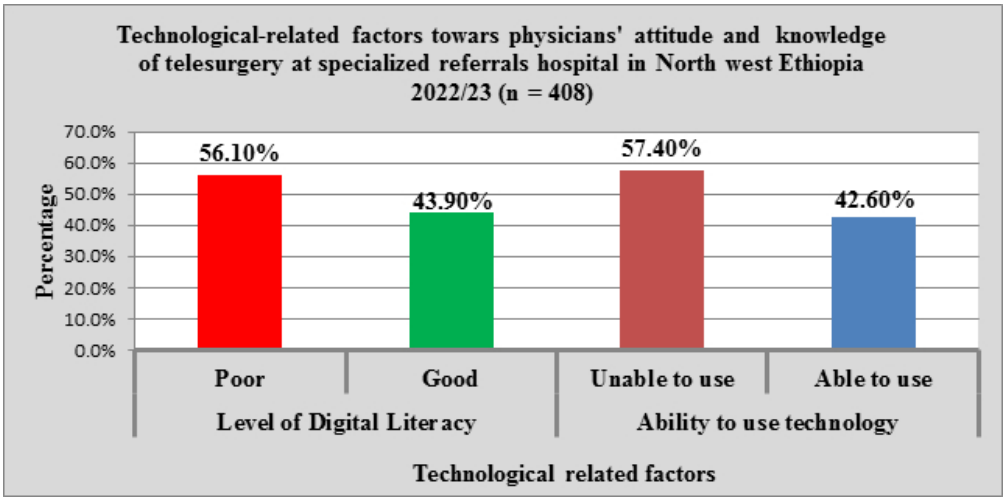

Figure1: Technological-related factors toward physicians' attitude and knowledge

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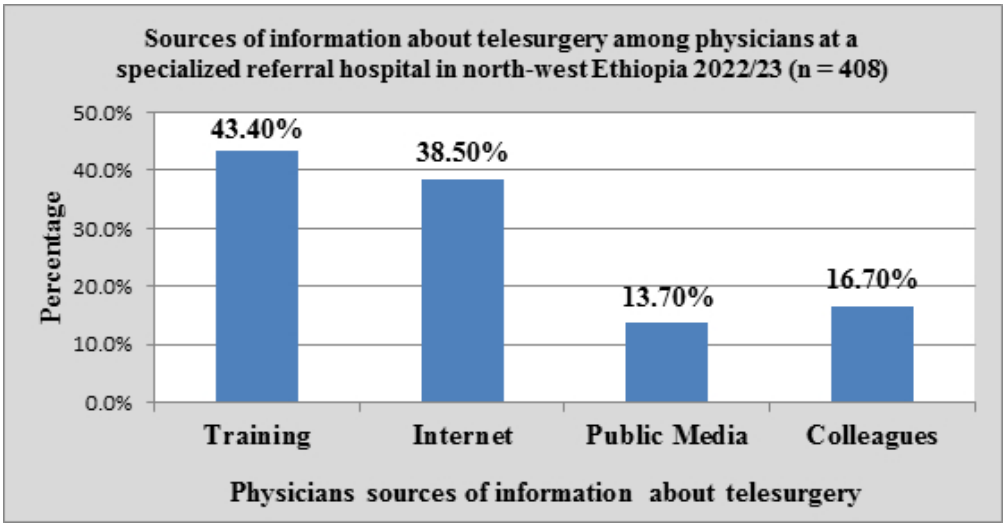

Figure2: Sources of information about telesurgery among physicians at a specialized referral hospital in north-west Ethiopia

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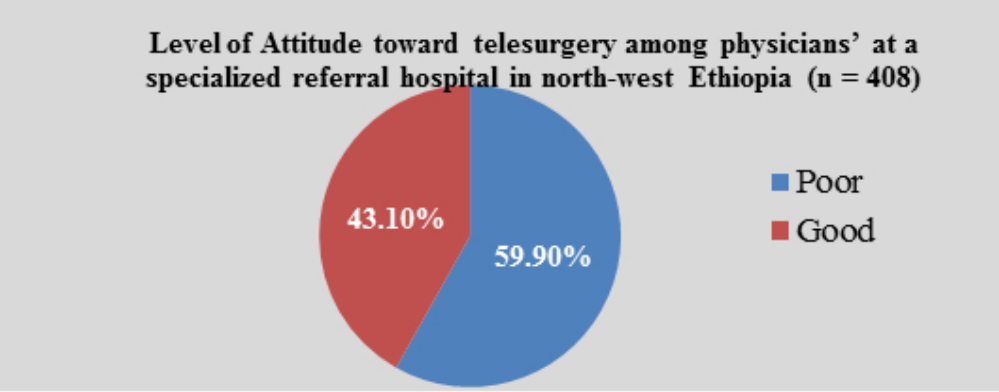

Figure3: Level of Physician attitude towards Tele-surgery in Ethiopia 2022/23

140x55mm (96 x 96 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	I
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	II
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3
Bias	9	Describe any efforts to address potential sources of bias	3-4
Study size	10	Explain how the study size was arrived at	3-4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	3-4
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11

		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13-14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Supplemental Figures

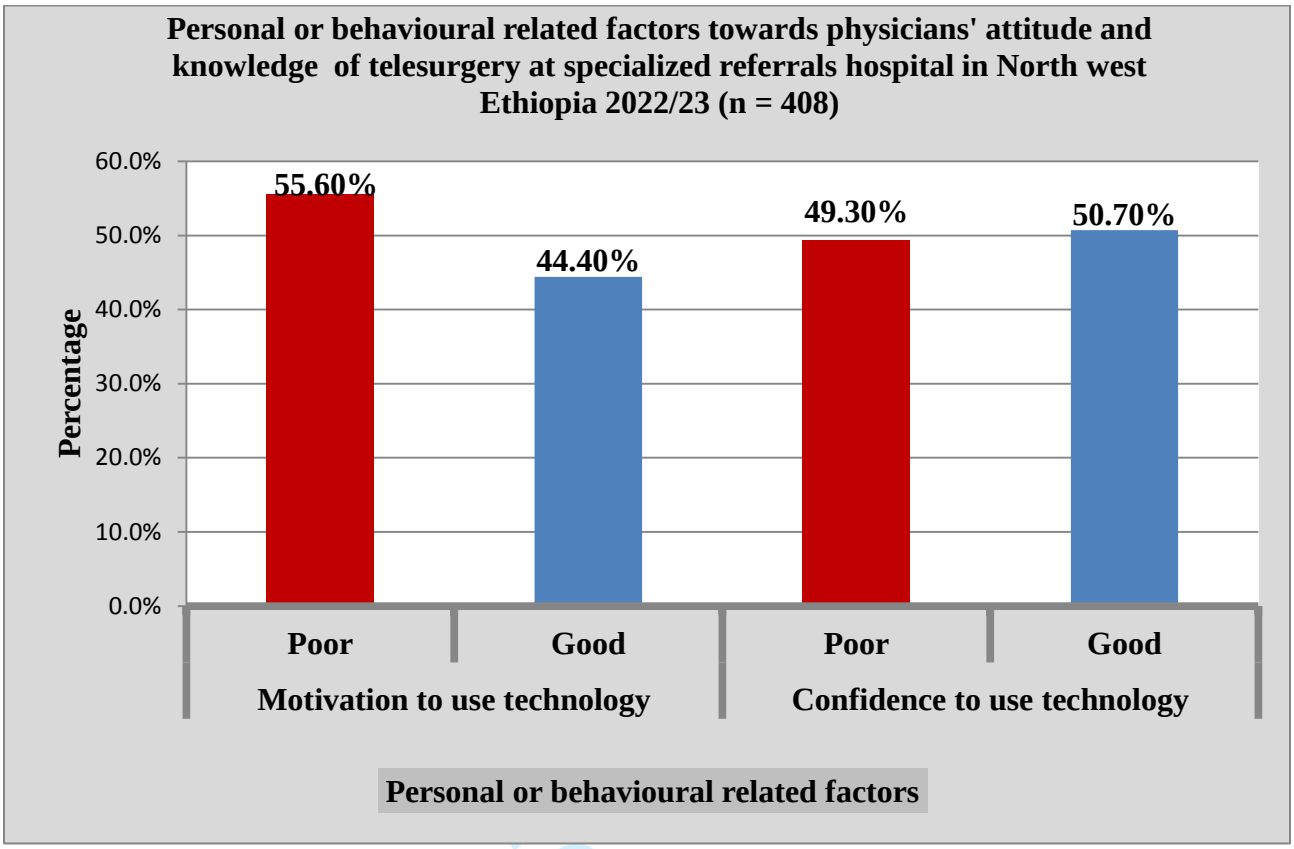

Figure 1: Level of Physicians Confidence and Motivation to use new technology in Ethiopia

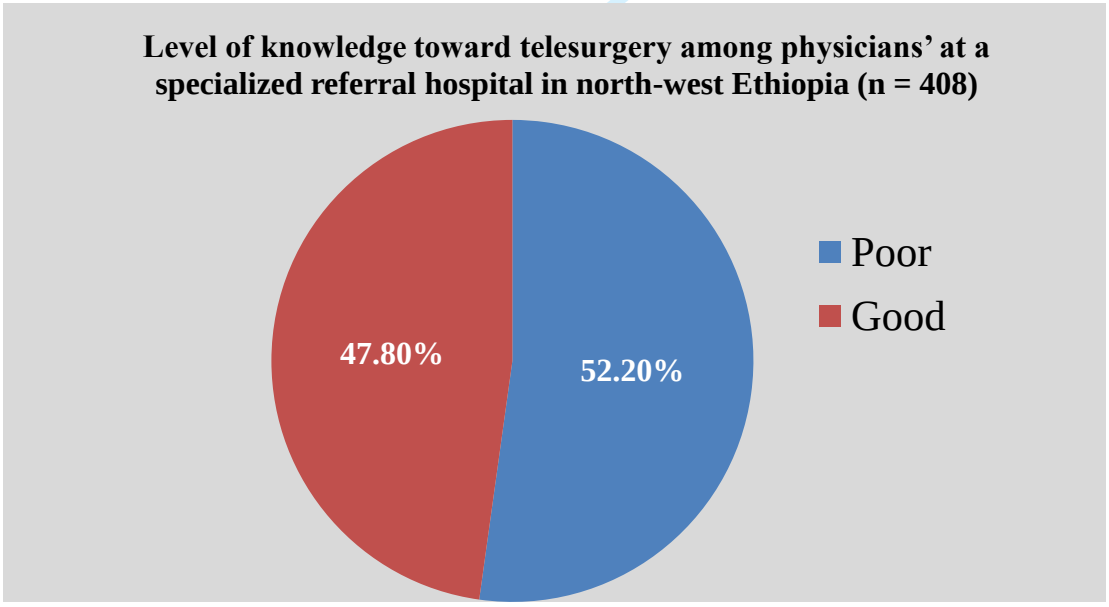

Figure 2: Level of Physician Knowledge toward telesurgery in Ethiopia

Supplemental Tables

Table 1: Bivariate and multivariable analysis of factors associated with physician knowledge of telesurgery

Variable	Values		Knowledge		OR (95% CI)		P-value
			Poor (%)	Good (%)	COR (95% CI)	AOR (95% CI)	
Age Group	24-34Years		186 (57.2)	139 (42.8)	1	1	
	>34Years		27 (32.5)	56 (67.5%)	2.78 (1.67-4.62)*	**2.25** (1.005-5.03)*	**0.049***
Educational status	General Practitioner		199 (59.9)	133 (40.1)	1	1	
	Resident		11 (23.4)	36 (76.6)	4.9 (2.41-9.96)*	2.27 (0.89-5.78)	0.087
	Specialist		**3 (10.3)**	**26 (89.7)**	**12.97 (3.85-43.7)***	**8.36 (1.93-36.3)***	**0.005***
Working Experience		<1year	90 (84.9)	16 (15.1)	1	1	
		1-5years	**101 (46.8)**	**115 (53.2)**	**6.41 (3.5-11.61)***	**3.1 (1.32-7.26)***	**0.009***
		>5Years	**22 (25.6)**	**64 (74.4)**	**16.36 (7.97-33.6)***	**6.34 (2.37-16.95)***	**0.001***
Digital Literacy		Poor	169 (73.8)	60 (26.2%)	1	1	
		Good	**44 (24.6)**	**135 (75.4)**	**8.64 (5.51-13.55)***	**3.80 (2.08-6.95)***	**0.001***
Source of info.	Professional training	No	170 (73.6)	61 (26.4)	1	1	
		Yes	**43 (24.3)**	**134 (75.7)**	**8.69 (5.5-13.64)***	**4.25 (2.31-7.807)***	**0.001***
	Internet (Social media, etc.)	No	158 (63.2)	92 (36.8)	1	1	
		Yes	**55(35.0)**	**102 (65.0)**	**3.19 (2.1-4.83)***	**1.90 (1.02-3.539)***	**0.042***
Basic computer training		No	176 (64.0)	99 (36.0	1	1	
		Yes	**37 (27.8)**	**96 (72.2)**	**4.61 (2.94-7.25)***	**2.23 (1.26-5.57)***	**0.006***
e-Health/Digital health training		No	187 (61.1)	119 (38.9)	1	1	
		Yes	**26 (25.5)**	**76 (74.5)**	**4.59 (2.78-7.58)***	**2.72 (2.62-8.06)***	**0.002***
Trained staff available on telesurgery		No	193 (54.4)	162 (45.6)	1	1	
		Yes	**20 (37.7)**	**33 (62.3)**	**1.97 (1.09-3.56)***	**2.12 (1.01-5.24)***	**0.007***
Internet in access in the organization		No	103 (74.6)	35 (25.4)	1	1	
		Yes	**110 (40.7)**	**160 (59.3)**	**4.28 (2.72-6.74)***	**2.25 (1.16-4.37)***	**0.017***

Note: AOR = Adjusted Odd Ratio, **COR** = Curd Odd Ratio, * = **P-value < 0.05** & ** = **P-value < 0.01**

Table 2: Bivariate and multivariable analysis of factors associated with physician attitude towards telesurgery

Variable	Values	Attitude		OR (95% CI)		P-value
		Poor (%)	Good (%)	COR (95% CI)	AOR (95% CI)	
Age Group	24-34Years	193 (59.4)	132 (40.6)	1	1	
	>34Years	39 (47.0)	44 (53.0)	1.65 (1.0-2.68)*	0.46 (0.20-1.06)	0.068
Educational status	General Practitioner	217 (65.4)	115 (34.6)	1	1	
	Resident	**12 (25.5)**	**35 (74.5)**	**5.5 (2.75-11.01)***	**4.02 (1.5-10.73)***	**0.005**
	Specialist	**3 (10.3)**	**26 (89.7)**	**16.35 (4.85-55.2)***	**7.87 (1.56-39.66)***	**0.012**
Job experience	<1year	88 (83.0)	18 (17.0)	1	1	
	1-5years	117 (54.2)	99 (45.8)	4.14 (2.3-7.34)	0.93 (0.39-2.23)	0.876
	>5Years	**27 (31.4)**	**59 (68.6)**	**10.68 (5.40-21.12)**	**3.09 (1.12-8.55)***	**0.030**
Digital Literacy	Poor	178 (77.7)	51 (22.3)	1	**1**	
	Good	**54 (30.2)**	**125 (69.8)**	**8.1 (5.17-12.62)***	**2.82 (1.47-5.41)***	**0.002**
Technology use	Unable to use	160 (68.4)	74 (31.6)	1	1	
	Able to use	**72 (41.4)**	**102 (58.6)**	**3.06 (2.04-4.61)***	**2.25 (1.16-4.38)***	**0.017**
Motivation	Poor	150 (66.1)	77 (33.9)	1	1	
	Good	82 (45.3)	99 (54.7)	2.35 (1.57-3.51)*	1.199 (0.59-2.4)	0.617
Confidence	Poor	131 (65.2)	70 (34.8)	1	1	
	Good	101 (48.8)	106 (51.2)	1.96 (1.32-2.92)*	0.845 (0.42-1.69)	0.632
Basic computer training	No	198 (72.0)	77 (28.0)	1	1	
	Yes	**34 (25.6)**	**99 (74.4)**	**7.49 (4.68-11.98)***	**3.48 (1.79-6.78)***	**0.0001**
e-Health/Digital health training	No	205 (67.0)	101 (33.0)	1	1	
	Yes	**27 (26.5)**	**75 (73.5)**	**5.64 (3.42-9.3)***	**2.50 (1.14-5.5)***	**0.02**
Trained staff available on telesurgery	No	208 (58.6)	147 (41.4)	1	1	
	Yes	24 (45.3)	29 (54.7)	1.7 (0.96-3.06)	1.29 (0.57-2.93)	0.53
Computer access in the organization	No	188 (66.9)	93 (33.1)	1	1	
	Yes	**44 (34.6)**	**83 (65.4)**	**3.8 (2.451-5.9)***	**3.32 (1.42-7.72)***	**0.005**
Internet in access in the organization	No	112 (81.2)	26 (18.8)	1	1	
	Yes	**120 (44.4)**	**150 (55.6)**	**5.4 (3.3-8.79)***	**2.26 (1.14-4.46)***	**0.019**
Knowledge	Poor	177 (83.1)	36 (16.9)	1	1	
	Good	**55 (28.2%)**	**140 (71.8)**	**12.5 (7.78-20.13)***	**4.79 (2.34-9.79)***	**0.0001**

Note: AOR = Adjusted Odd Ratio, **COR** = Curd Odd Ratio, ***** = **P-value < 0.05 & **** = **P-value < 0.01**

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Physicians' knowledge and attitudes towards telesurgery and its associated factors in a resource-limited setting, Northwest Ethiopia, 2022: A cross-sectional study design

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Abstract

Background: Telesurgery has become helpful in overcoming the current shortage of surgeons and reducing the barriers to timely and effective surgical intervention caused by long-distance travel, which are caused by distance, cost, complexity, and frequent hazards. However, knowledge and attitude remain challenges in the implementation of such a system.

Objective: This study aimed to assess physicians' knowledge and attitude towards telesurgery and associated factors at resource-limited setting, Northwest Ethiopia.

Method and analysis: A simple random sampling method was carried to choose study participants from each referral hospital, and data were collected using self-administered questionnaires. Descriptive and inferential statistics were applied to estimate knowledge and attitudes toward telesurgery among physicians and to identify factors associated with physician knowledge and attitudes toward telesurgery.

Study Design: cross-sectional study design.

Setting: This study was conducted at six specialized referral hospitals and two specialized and teaching referral hospitals in the Amhara region, northwest Ethiopia.

Result: Four hundred and eight (408) physicians were included for analysis, with a response rate of 96.45%. Among study participants, 47.8% and 43.1% had good knowledge and attitudes toward telesurgery, respectively. Educational status, digital literacy, Source of information, computer training, digital health training, and internet access in the organization were factors associated with a physician's knowledge of telesurgery. Moreover, physician's knowledge, technology use, educational status, computer training, computer access, and internet access in the organization were factors associated with physicians' attitudes toward telesurgery.

Conclusion and recommendation: Almost half of physicians had good knowledge, and less than half had a good attitude toward telesurgery, so healthcare policymakers should improve physicians' digital literacy, technology use, and internet access to enhance their knowledge and attitudes for future implementation.

Keywords: Attitude, Knowledge, Physician, Tele surgery.

Strength and Limitation of this study

- ✓ Provides novel insights, understanding, and knowledge in surgical procedures through the introduction of telesurgery.
- ✓ Includes various types of physicians (GPs, residents, specialists) to raise awareness and share knowledge on tele-surgery technology.
- ✓ Contributes to Ethiopian health policy by highlighting physicians' knowledge and attitudes toward tele-surgery for future implementation.
- ✓ Findings are limited to similar institutions within the Amhara region.
- ✓ Institutional-based and cross-sectional design prevents establishing causal relationships between physicians' knowledge/attitude and associated factors.

1. Introduction

During an outbreak or pandemic like COVID-19, there is an increased need for healthcare delivery systems to improve the accessibility of virtual care technologies, such as telehealth, telemedicine, telenursing, telesurgery, telecare, etc., that support affordable, high-quality, and person-centered treatment [1].

Telesurgery is widely defined as the ability to perform surgery from long distances using modern surgical techniques by overcoming the obstacles of time and distance [2]. This technology not only addresses the current scarcity of surgeons but also eliminates geographical restrictions, financial burdens, and problems associated with long-distance travels that hinder prompt and high-quality surgical intervention. Furthermore, it enhances surgical accuracy and ensures the safety of surgeons [3,4].

Telesurgery is a system that connects patients and doctors (surgeons) using both wired and wireless networks, along with a robotic system. Enabling surgeons to provide surgical care to patients from anywhere in the world, telesurgery is a remarkable way for patients to receive medical attention without needing to travel beyond their local hospitals [5,6]. The ultimate goal of telesurgery is to enable the specialist surgeon to be virtually present at the patient's bedside [1–3]. This is especially crucial in situations like:

- Distance: for example, in remote and rural areas.

- Special conditions: such as a battlefield or accident scene.
- Risks caused by patients to the surgical team: like infectious diseases and radioactive contamination.
- Risks posed by the surgical team that threaten the patient's health: for instance, an immune deficiency in a patient.

Due to a shortage of healthcare specialists in many developing countries, there is a high mortality rate among patients with various diseases. The scarcity of physicians results in limited access to healthcare services, contributing to an increasing death rate [4,6] . Healthcare professionals' knowledge and attitude toward telemedicine are important factors that can influence the successful future implementation of telesurgery [5] . A study conducted in Egypt found that only 39% of physicians have a decent understanding of telemedicine, while 12% are unfamiliar with this strategy [7]**.** This technology not only benefits today's shortage of surgeons, but evidence shows that telesurgery minimizes the current geographic barriers to accessing prompt, high-quality surgical care: long travel distances, a lack of experts, and a large financial burden [1,4,6].

In Ethiopia, the physician-patient ratio is one physician for every 42,000 people, which shows a shortage of physicians in the field [8]. The use of digital technologies like telesurgery could allow for the provision of healthcare in remote settings where physicians are scarce.

Physicians' knowledge and attitude could be considered an essential requirement in the deployment of any digital health technology, including the implementation of telesurgery in the health system [7].

However, limited evidence existed on basic knowledge and attitudes toward telesurgery and determinant factors in Ethiopia. Thus, this study aims to assess physicians' current knowledge and attitudes toward telesurgery, providing valuable insights. The findings could prove useful for policymaking, informing practice, and initiating further studies. Additionally, the results may guide decisions about curriculum development and revision for physicians' training in higher education institutions.

2. Methods

2.1. Study design, study period and Setting

An institutional-based cross-sectional study design was employed among physicians working at a specialized referral hospital in the Amhara region of northwest Ethiopia. The study was conducted from May 16 to July 20, 2022, at eight locations, including six specialized referral hospitals and two specialized and teaching referral hospitals in the Amhara region. These locations are the University of Gondar specialized and teaching referral hospital, Dessie specialized referral hospital, Felege Hiwot specialized referral hospital, Wolo specialized referral hospital, Tibebe Gihon specialized and teaching referral hospital, Debre Birehan specialized referral hospital, Debre Tabor specialized referral hospital, and Debre Markos specialized referral hospital.

2.2. Source and Study population

The source population for our study comprised all physicians who worked in specialized and referral hospitals, as well as specialized teaching referral hospitals, in the Amhara regional state of Northwest Ethiopia. . While these physicians were available during the data collection period in those specialized referral hospitals, the specialized teaching and referral hospitals in the region were considered our study population.

2.3. Inclusion and exclusion criteria

All physicians, including general practitioners, residents, specialists, and subspecialists, who were permanently employed at specialized referral hospitals in the Amhara Region and available during data collection, were included in this study. However, physicians who were temporarily working in specialized referral hospitals as exchange, guest, or adjunct staff from outside the region and abroad were excluded.

2.4. Sample Size Determination and Sampling Procedures

There were 8 specialized referral hospitals in the Amhara region with a total of 972 physicians. All specialized referral hospitals in this region were approached. The sample size was determined by using a single population proportion formula and considering the following assumptions: Z = standard normal deviation (Z /2 = 1.96) with a 95% confidence interval level (CI), n = final sample size, P = proportion of telesurgery knowledge and attitude, and an associated factor of 50%, since

there has been no previous study done in the same area with d = desired degree of precision (the margin of error) of 5% and the calculated sample size was 384.

$$n = \frac{(z_{\frac{a}{2}})^2 * pq}{d^2} \text{.....(1)}$$

Where, n = required sample size, d = margin of error, p = proportion of tele surgery-related knowledge, and q = 1-p.

$$n = \frac{(z_{\frac{a}{2}})^2 * p(1-P)}{d^2} = n = \frac{(1.96)^2 * 0.50(1-0.50)}{(0.05)^2} = 384 \text{ ..... (2)}$$

By assuming a 10% non-response rate, the final total sample was 423. Finally, we applied a simple random sampling method followed by proportional allocation to select appropriate study participants.

2.5. Study Variables

Dependent Variables: knowledge and attitude.

Independent Variables: Sociodemographic-related factors (Age, sex, Educational Status, Working Department, and Years of Experience), technological-related factors (Digital Literacy and Technology use), Personal or behavioral-related factors (motivation and confidence to use new technology), Sources of information about telesurgery (Training, Internet (like Social media, Journal sites), Public Media (like Radio, TV, meetings, etc.), and Colleagues), and organizational-related factors (Basic computer training, digital health-related training, trained staff available on telesurgery or any digital health-related training, Computer access in your organization, Internet access, etc.).

2.6. Data collection Tools and Procedure

A pretested and structured self-administered questionnaire was used to collect the data. The tool was adapted after reviewing different literature from previous studies [3,5,7–13] .

Data was collected using a self-administered structured questionnaire, which had 60 questions consisting of a "Yes" or "No" question, a five-point Likert scale question, and a list of questions with five sections, such as sociodemographic, organizational, technological, personal

characteristics, knowledge, and attitude-related questions (see S1: Supplemental-File-Questionnaire).

2.7. Data Quality management

To ensure data quality, we used standardized and pretested questionnaires and provided two days of training to 12 data collectors. The pretest was conducted to confirm the degree to which the measuring tool produces consistency and reliability. The internal consistency of each dimension of the data collection instrument was checked using Cronbach's alpha. The pretest shows that the value of Cronbach's alpha was above 70%. According to Cronbach's alpha (α), the value for the measuring tool was 0.82 for knowledge and 0.83 for attitude. Continuous supervision up to the end of data collection was conducted to check its consistency and completeness. After data collection, questionnaires were reviewed and checked for completeness, and the data were cleaned to identify and correct errors and missing values. All errors were identified and corrected.

2.8. Operational Definitions

Knowledge of telesurgery encompasses the fundamental understanding and insights that physicians possess about telesurgery technology, including how they perceive its meaning and benefits. This knowledge was assessed using nine questions and categorized as either poor or good knowledge of telesurgery [5,14,15].

Poor knowledge: If a study participant achieves a score lower than the median, they are considered to have poor knowledge of telesurgery [5,14,15] .

Good knowledge: If a study participant achieves a score higher than the median, they are considered to have good knowledge of telesurgery [5,14,15] .

Attitude toward telesurgery: Refers to how physicians' opinions, personal intentions, and outlook on tele-Surgery technology are expressed and how they will accept this technology if it is applied to a health facility. This was measured by nine 5-point Likert scale questions and was categorized as a poor and good attitude toward telesurgery [5,15] .

Poor Attitude: If a study participant achieves a score lower than the median, they are considered to have a poor attitude toward telesurgery [5,15] .

Good Attitude: If a study participant achieves a score higher than the median, they are considered to have a good attitude toward telesurgery [5,15].

2.9. Data analysis and processing Procedure

The collected data was entered into EpiData version 4.6. After producing the cleaned data, it was exported to Statistical Package for the Social Sciences (SPSS) version 26 software for further analysis. Descriptive statistics were presented through percentages, frequency tables, and graphs, and a binary logistic regression analysis was computed to identify the associated factors in both the bivariable and multivariable analyses. During the bivariate analysis, variables with a p-value less than 0.2 were candidates for the multivariate analysis.

Whereas, in multivariable analysis, variables with a p-value of less than or equal to 0.05 were considered statistically significant variables. Moreover, before bivariate and multivariate analysis, outliers and multicollinearity were checked using variable inflation factors (VIF). Based on the multicollinearity result, the VIF value is between 1.056 and 6.622, which shows that multicollinearity is not a problem because most researchers consider a VIF > 10 an indicator of multicollinearity [16]. Accordingly, our results show that multi-collinearity is not an issue in our data.

The fitness of the model was checked by using the Hosmer and Lemeshow Test for both model fits (knowledge and attitude). The results of logistic binary regression revealed that the model was adequately fit to our data and that the model has a good fit with a Chi-square value of 3.081 and 4.654 for model fit for knowledge and attitude, respectively, and a p-value greater than 0.05 (p-value = 0.929 and 0.794). The full model correctly predicted 85.3% and 84.3% of the observed respondents who had good knowledge and a good attitude, respectively. Finally, we used adjusted odds ratios (AOR) with a 95% confidence interval and a p-value of 0.05 to determine factors associated with the physician's knowledge and attitude toward telesurgery.

2.10. Patients and public Involvement

Patients or the public were not involved in the study

3. Results

3.1. Socio-demographic characteristics

A total of four hundred twenty-three (423) physicians were selected from specialized referral hospitals in the Amhara Region. Four hundred eight (408) of them consented and responded to completing all questionnaires with a 96.45% response rate. Of the total 408 respondents, among those 81.4% were General Practitioners (GP), 11.5% were residents, and 7.1% were specialists. Among the study participants, 77.2% were male. The majority of the study participant age group was 24 to 34 (79.9%) and the majority of study participants had 1 to 5 years of job experience which accounted for about 52.9% (**see Table 1**).

Table 1: Socio-demographic Characteristics of Physicians' Tele-surgery Knowledge and Attitude in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n = 408)

Variables	Category	Frequency(n)	Percentage (%)
Age	24-34	325	79.7
	>34	83	20.3
Sex	Male	315	77.2
	Female	93	22.8
Educational Status	GP	332	81.4
	Resident	47	11.5
	Specialist	29	7.1
Working Department	IPD	77	18.9
	Gynecology	58	14.2
	OPD	60	14.7
	Pediatrics	52	12.7
	Ophthalmology	24	5.9
	Neurology	22	5.4
	Cardiology	23	5.6
	Orthopedic	24	5.9
	General Surgery	40	9.8
	Others	28	6.9
Year of Experience	<1Year	106	26.0
	1-5 Year	216	52.9
	>5 Year	86	21.1
→ **Note:** Other Working departments are**:** "**Dermatology** and **ENT**"			

3.2. Organizational characteristics

As shown in Table 2, of the total study participants, only one hundred thirty-three (32.6%) and one hundred two (25%), respectively, took computer training and digital health training, and one hundred twenty-seven (31.1%) of the physicians had computer access in their organizations (**see** Table 2).

Table 2: Organizational-related Factors of Physicians' Tele-surgery Knowledge and Attitude in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n = 408)

Variables	Category	n	%
Basic computer systems training.	No	275	67.4
	Yes	133	32.6
Digital health relating training	No	306	75.0
	Yes	102	25.0
Trained staff available on Tele-surgery	No	355	87.0
	Yes	53	13.0
Computer access in your organization	No	281	68.9
	Yes	127	31.1
Internet access in the organization	No	138	33.8
	Yes	270	66.2
24-hour service of uninterrupted Electric power	No	364	89.2
	Yes	44	10.8
Availability of electric power Backup	No	351	86.0
	Yes	57	14.0

3.3. Technological related factors

As **Figure1** shows, only 179 (43.9%) and 174 (42.60%) study participants had good digital literacy and were able to use the technology, respectively (**see Figure1**).

3.4. Personal Characteristics

There has been uncertainty in organizational, behavioral, technical, and all other fields among the physicians, with 50.70% were having good confidence and 44.40% of physicians were having good motivation to use new technology (**see** S2: Supplemental materials figures).

3.5. Physicians sources of information about telesurgery

As **Figure2** shows, different training and Internet (like journal sites, social media, etc.) were the major common sources of information about telesurgery among the study participants, accounting for 177 (43.4%) and 157 (38.5%), respectively (see **Figure2**).

3.6. Physicians' knowledge and attitudes towards telesurgery

3.6.1. Physician's knowledge of tele surgery

Among study participants, one hundred ninety-five (47.8%) physicians [with a 95% CI of 43.1 to 52.7] had good knowledge about telesurgery (**see** S2: Supplemental materials figures).

3.6.2. Physician attitude toward tele surgery

From a total of 423 study participants (physicians), one hundred seventy-six (43.1%) [95% CI of 39.7 - 48.7] had good attitudes toward telesurgery (see **Figure3**).

3.7. Binary logistic regression analysis for factors associated with knowledge and attitude of telesurgery among physicians

3.7.1. Factors associated with physician knowledge of telesurgery

Binary logistic regression of multivariable analysis reveals that in addition to the age of the study participant [AOR = 2.25, 95% CI: (1.005–5.03)], educational status [AOR = 8.36, 95% CI: 1.93–36.3)] Work experience [AOR=3.1, 95% CI: (1.32-7.26) & AOR=6.34, 95% CI: (2.37-16.95)], Digital literacy [AOR=3.80, 95% CI: (2.08-6.95)], Source of information [AOR=4.25, 95% CI: (2.31-7.807) & AOR=1.90, 95% CI: (1.02-3.539)] Basic computer training [AOR = 2.23, 95% CI: 1.26–5.57] e-Health/Digital health training [AOR = 2.72, 95% CI: (2.62-8.06)], trained staff available on telesurgery or any related field [AOR = 2.12, 95% CI: (1.01-5.24)], and Internet access in the organization [AOR = 2.25, 95% CI: (1.16-4.37)] were significantly associated with physician Knowledge toward telesurgery (see S3: Supplemental materials tables).

3.7.2. Factors associated with physician attitude toward tele surgery

Binary logistic regression of multivariable analysis reveals that physicians' knowledge about telesurgery [AOR = 4.79, 95% CI: (2.34-9.79)], Job experience [AOR = 3.09, 95% CI: (1.12-8.55)], Technology use [AOR = 2.25, 95% CI: (1.16-4.38)], Educational status [AOR=4.02, 95% CI: (1.5-10.73) and AOR=7.87, 95% CI: (1.56-39.66)], e-Health/Digital Health Training [AOR = 2.50, 95% CI: (1.14-5.5)], Digital literacy [AOR = 2.82; 95% CI: 1.47–5.41], Basic computer training [AOR = 3.48, 95% CI: 1.79–6.78], Computer access [AOR = 3.32, 95% CI: 1.42–7.72], and Internet access in the organization [AOR = 2.26, 95% CI: 1.14–4.46], were

significantly associated with physician attitude toward telesurgery (see S2: Supplemental materials tables).

4. Discussion

This study assessed physicians' knowledge and attitude toward telesurgery and its associated factors at a referral hospital. The conclusion of this study reveals that about half of the study participants (physicians) had good knowledge, and less than half of them had a good attitude toward telesurgery. This study revealed that 47.8% (95% CI 43.1–52.7) of the participants had good knowledge about telesurgery.

This finding is slightly similar to the studies conducted in Ethiopia [14,17] where about 45.8% of nurses had good knowledge about telenursing and about 50% of health sciences students had good knowledge about evidence-based medicine (EBM); this similarity might be due to the similarity of study period and study area, and in Saudi Arabia, 46.1% of the respondents had good knowledge of telemedicine [10]. This similarity might be due to all study participants being the same; all participants are physicians, the sample size is closely similar, and most physicians had not participated in the training.

On the other hand, the current study finding was lower than the study conducted in Australia, Medical staff reported the highest rate of Robotic Assisted Surgery (RAS) knowledge (70.7%) [18], and in Malaysia Health professionals 57% has known about telesurgery [19]. The difference might be due to the study settings and sample variation and technology. Moreover, this finding is higher than the previous study done in Ethiopia which reported 37.6% good knowledge of telemedicine [5] and India (41%) [20]. This difference could be due to differences in a study participant, study area, sample size, scope of study model, and study participant's educational background. A previous study was conducted with 312 and 120 health professionals, respectively.

Regarding physicians' attitudes, 43.1% [95% CI: (38.5-48.0)] of the participants had a good attitude about tele surgery. This finding is lower than the study in Ethiopia [5], Australia [18], and Iran [13]. This difference might be due to the difference in the study participants, study area, sample size, availability of technology, the scope of the study, and educational background of study participants and variations of study participants. This finding is higher than a study in India

showed that the attitude level 30% of the respondents have a low or below the moderate level of attitude towards telemedicine, 31% possess a moderate level of attitude and 39% possess a high attitude level towards telemedicine [20].

In this finding, 48.5% of physicians agree that telesurgery can save time, and 46.3% of physicians agree that ICT-enabled health services can improve the accessibility of healthcare. This finding is supported by a study conducted in Saudi Arabia, which emphasizes the potential role of ICT in the healthcare system to become more efficient and effective. The majority of physicians in the study also agreed that telemedicine could save both time and money [10].

Computer and e-Health or digital health-related training positively affected the attitudes of physicians toward telesurgery. Taking computer and e-Health or digital health-related training increased the level of physicians' attitudes by 77.68% and 71.43%, respectively. This finding supports a study in Saudi Arabia, which reported that a lack of suitable training and consultation between information technology experts and clinicians affects physicians' perceptions in adopting telemedicine technology [10].

According to this study, having good knowledge about telesurgery increases the level of attitude toward telesurgery by 82.73%. This finding is supported by a study in Egypt showing that a good attitude correlates positively with user knowledge of telemedicine applications [7]. The availability of ICT equipment like internet and computer is a factor in to use tele surgery, this finding is supported by the study done at the Tehran University of Medical Science infrastructure for the implementation of remote surgery was one of the most noticeable strengths of the implementation of remote medical technology services in the hospitals [3]. The other study in Malaysia showed information systems like computer, internet, and telephone should be reliable for a better implementation of telemedicine in developing countries [19].

The study revealed that physicians with high confidence in tele-surgery are 2.2 times more likely to exhibit a positive attitude toward tele-surgery. This discovery of confidence emerges as a significant factor influencing the attitude of tele-surgery physicians. This finding is consistent with studies conducted in Indonesia [21], Malaysia [22], and China [23], emphasizing that confidence has a positive influence on individual attitudes towards accepting digital health technology such as telenursing, telemedicine, and e-health. This correlation may be attributed to the importance of

individual confidence as a factor that positively impacts attitudes toward the advancement of digital health technology use.

Additionally, the study found a positive correlation between computer access in the organization and physicians' attitudes. Access to computers within the organization resulted in a 69.32% increase in physicians' attitudes. This finding is consistent with studies conducted in Iran [24], China [23], Canada [25]. The observed increase can be attributed to the essential role computers play in facilitating the proper utilization of digital health. Therefore, the availability of computer access within the organization can enhance physicians' attitudes towards telesurgery, fostering a greater sense of familiarity and comfort with digital health.

In contrast, this study found no significant relationship between backup power, 24-hour electricity supply, and physicians' attitudes towards telesurgery. This contradicts studies conducted in Australia [26] and Iran [24] which were reported electricity supply is fundamental to the basic function and advancement of digital health technology, including telemedicine and in-home medical devices. It has been reported that electricity supply is fundamental to the basic function and advancement of digital health technology, including telemedicine and in-home medical devices. This discrepancy highlights significant differences in electricity access among countries, with Australia and Iran boasting universal access (100%) [27] in contrast to Ethiopia's lower penetration rate of 54.2% [28].

5. Strengths and Limitations of this study

According to our findings, this is the first study in Ethiopia to assess knowledge and attitudes toward telesurgery among physicians so; it is good input for future study and implementations of telesurgery by providing information about knowledge and attitudes of physicians toward telesurgery. This study has certain limitations. This has included only physicians working in public referral hospitals. It didn't include physicians in public primary and general hospitals as well as private hospitals, which could affect the generalizability of the findings.

6. Conclusions

The finding implied that close to half of the physicians in this study setting had a good level of knowledge and below half of them had a good level of attitude about telesurgery applications.

Sources of information, trained staff available in telesurgery or any related field, digital literacy, educational status, Job Experience, basic computer training, Digital health-related training, and the ability to use technology, computers, and Internet access in the organization were associated with physicians' knowledge and attitudes toward telesurgery.

7. Recommendation

Healthcare policymakers, the government, and other concerned bodies like higher education institutions or universities and teaching specialized referral hospitals should stress improving computer access, education, training, and enhancing physicians' levels of digital literacy, technology use, and internet access in the organization to improve physicians' telesurgery-related knowledge and attitudes for future sustainable implementation.

8. Declarations

8.1. Ethics approval and consent to participate

Ethical clearance was obtained from the Ethical review board of the University of Gondar College of Medicine and Health Science with the ethical reference number IPH/2110/2014. Informed consent was obtained from each study participant after they were informed of the objectives and benefits of the study. To maintain the confidentiality of the information provided by the study subjects, the data collection procedure was anonymous. Additionally, this study was conducted under the Declaration of Helsinki.

8.2. Consent for publication

Not applicable

9. Availability of data and materials

The data will be available upon request from the corresponding author (mekidesmolla2023@gmail.com)

10.Conflict of Interest

The authors confirm that they have no known financial or interpersonal conflicts that would have appeared to have an impact on the research presented in this study.

11.Funding

No funding was received for this study.

12.Author contributions

Mrs. MM, Dr. KD, and Mr. MA made significant contributions to the work reported, whether that was at the beginning of design, data collection, supervision, data curation, investigation, data analysis, interpretation, preparing figures, writing up the manuscript, or in all these areas. Mr. FWB has made significant contributions to this work from the beginning until the submission of this manuscript in the areas of data analysis, editing, and revision of the manuscript. Finally, all authors agreed to be held accountable for all aspects of the work and participated in writing, revising, or critically reviewing the paper.

13.Acknowledgments

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14.Abbreviations and acronyms

AOR: Adjusted Odds Ratio

EBM: Evidence Based Medicine

CI: Confidence Intervals

COR: Crude Odds Ratio

DDCF: Doris Dukes Charitable Foundation

GP: General Practitioner

Fig: Figure

ICT: Information and Communication Technology

IPH: Institute of Public Health

OR: Odd Ratio

RAS: Robotic Assisted Surgery

SPSS: Statistical Package for Social Science

VIF: Variance Inflation Factor

WHO: World Health Organization

15.Figures Caption

Figure1: Technological-related Factors Influencing Physicians' Attitude and Knowledge in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n = 408).

Figure2: Sources of Information about Telesurgery among Physicians in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n = 408).

Figure3: Level of Physician Attitude towards Tele-surgery in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n = 408).

16.Supportive Supplementary Materials

S1: Supplemental-File-Questionnaire

S2: Supplemental materials figures

S3: Supplemental materials tables

17.References

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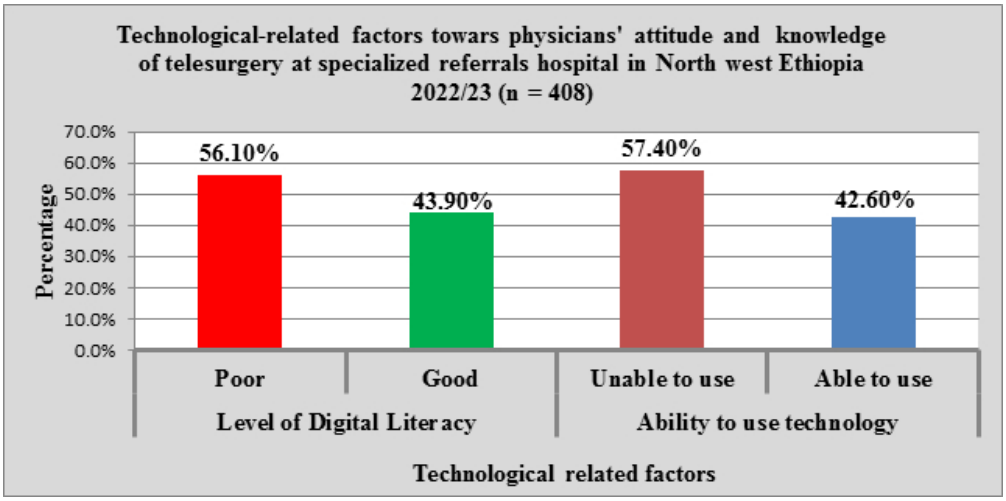

Figure1: Technological-related Factors Influencing Physicians' Attitude and Knowledge in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n = 408).

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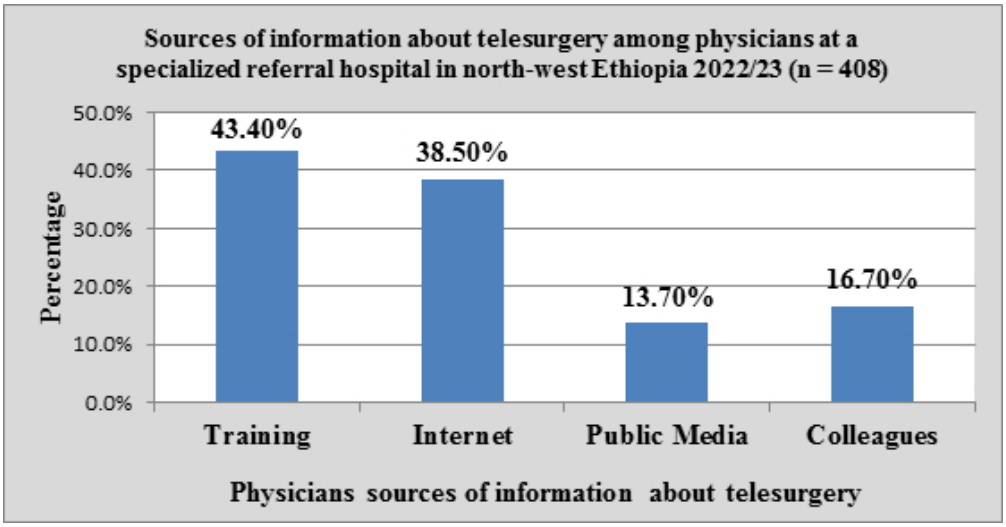

Figure2: Sources of Information about Telesurgery among Physicians in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n = 408).

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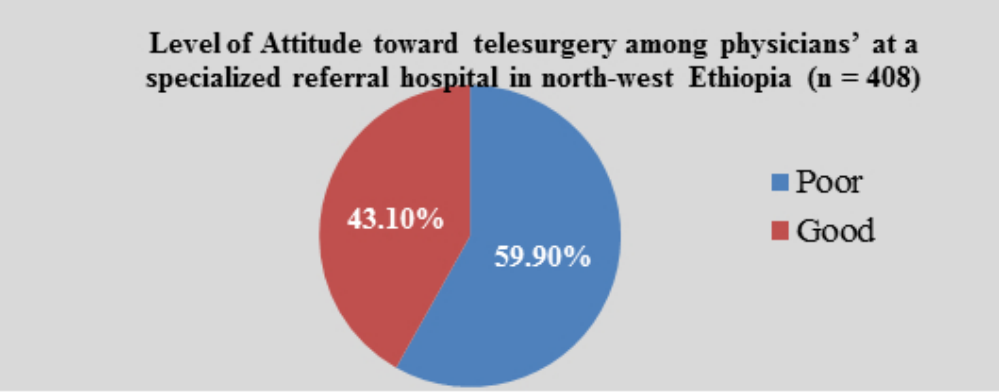

Figure3: Level of Physician Attitude towards Tele-surgery in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n = 408).

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University of Gondar

College of Medicine and Health Sciences

Institute of Public Health

Title: knowledge and Attitude towards Tele-surgery and its associated factors among physicians at Amhara Region Specialized Referral Hospitals

Informed consent statement

I am from Gondar University, College of medicine and other Health Science, School of Public Health to conduct research. The aim of the study is the assessment of the knowledge and Attitude towards Tele-surgery and its Associated Factors among Physicians at Amhara region Specialized Referral Hospitals. I kindly request you to give me your attention to explain to you about the study and study participant. You are chosen to participate in this study and your anonymous answers will be used only for research purposes. To effectively attain the purpose of the research I request you to give a genuine response to each question.. Your answers are completely confidential. It is your full right to refuse, to answer any or all of the questions. Study questionnaires will take a maximum of 20 minutes. If they have any question, you can contact with and ask at any time you want.

Phone No :0927687162

Certificate of consent

I understand that the findings of this research will be disseminated to Hospital management and decision-makers that will be useful as an input for the next actual use of Tele-surgery service among health professionals and sustainable utilization of Tele-surgery service. I voluntarily consent to participate in this study.

I agree ☐ I disagree ☐

If you agree signify here &lets begin.

Respondent Signature_____ Date_____

SECTION 1: Socio Demographic Information related questions

No.	Question	Respondent Answer	
Q1	Name of the institution you are working in _____		
Q2	Your sex	1. Male	2. Female
Q3	Age in years		
Q4	Educational status	1. GP 2. Resident 3. Specialist	4. Sub_Specialist 5. Other
Q5	What is your current working department	1,General Surgery 2,Pediatrics 3,Gynecology 4, Orthopedic 5, Ophthalmology	6, IPD 7, Neurology 8, Cardiology 9, OPD 10,Other (Dermatology and ENT)
Q6	How long have you been employed in your current position?	1. < 1 Year 2. 1-5 years.	3. 6-10 years 4. more than a 10 Years

Section 2: Physicians Knowledge toward Tele-surgery related questions

Q7	Have you ever heard about Tele-surgery?		0. No	1. Yes	
Q8	Have you ever seen Tele-surgery system?	0. No	1. Yes		
Q9	Have you ever seen or heard about any tele-surgery system applied to a surgical procedure?	0. No	1. Yes		
Q10	If yes, for Q9 which Tele-surgery technology do you know?		1. Tele robotic surgery 2.Tele assisted surgery	3. Both 4. Basic Consent	
Q11	I know the effect of Tele-surgery on Healthcare quality?			0. No	1. Yes
Q12	Do you know about tele-surgery infrastructure?			0. No	1. Yes
Q13	Do you know which surgical procedures are suitable for telesurgery and how to apply them?			0. No	1. Yes

Q14	I know the benefits of tele-surgery in saving clinicians time and reducing unnecessary transportation costs?	0. No	1. Yes
Q15	If say yes, for Q7 what was your source of information? (Multiple answers are possible).	1. Training 2,Internet	3,Media 4,colleagues,

Section 3: Physicians attitude toward Tele-surgery related questions

Please answer the following sections according to the following order:

1. Strongly Disagree, 2.Disagree. 3. Neutral. 4. Agree. 5. Strongly Agree.

	I believe that Tele-surgery may ….					
Q16	Do belive that Health for all can be easily achieved through ICT enabled technology	1	2	3	4	5
Q17	It Facilitate diagnosis and treatment	1	2	3	4	5
Q18	It increase communication among health care profassional	1	2	3	4	5
Q19	It enables me to accomplish my task more quickly.	1	2	3	4	5
Q20	In my opinion, Tele-surgery is compatible with all aspects of my work.	1	2	3	4	5
Q21	Using tele_surgery fits well into my work style	1	2	3	4	5
Q22	It saves my time when I use it	1	2	3	4	5
Q23	It should be implemented in all the Hospitals	1	2	3	4	5
Q24	I am interested in getting training on tele_surgery	1	2	3	4	5

Section 4: Organizational Related questions

No.	Questions	Response	
		No	Yes
Q25	Dose your organization provide basic computer skill training?	0	1
Q26	Dose your organization provide provide/facilitate telehealth or digital health relating training?	0	1
Q27	Is there a trained staff available on telehealth or other digital health relating technology?	0	1
Q28	Is there Computer access in your organization?	0	1
Q29	Is there Internet access in your organization?	0	1
Q30	Does your organization has Uninterrupted Electric power	0	1
Q31	Does your organization has Electric power Backup	0	1

SECTION 5: Technology related questions

S.N	Digital Literacy	0	1
Q32	Do you have computer skills?	No	Yes
Q32.1	If you say "Yes" for question 32 Which level of computer skill do you have?	1. Basic	2. Advanced
Q33	Do you use Computer/laptop/ smartphone in work place?	No	Yes
Q33.1	Activities perform with your Computer/Laptop and smart phone? (Multiple answers are possible).	1. Internet accesses 2. Entertainment	3. Microsoft office 4. Other
Q34	Can you open a browser easily?	No	Yes
Q35	Have you ever visited the Health care systems on the internet?	No	Yes
Use of technology			
Q36	Have you ever communicate with other physician by using digital technology like internet, phone, Video conferencing etc.?	No	Yes
Q36.1	If you say "Yes" for Q36 What was reason for communication with other physicians?(Multiple answers possible)	1. Sharing experience 2. e-learning and knowledge sharing 3. For assisted purpose 4. Others	
Q37	Have you ever visited the Tele_surgery system on the internet?	No	Yes
Q38	What kind of phone do you have?	1. Basic phone 2. Feature phone 3. Smart phone	
Q39	Is your phone capable of connecting to the internet?	No	Yes
Q39.1	If you say "Yes" for Qfor what purpose do you use your phone? (multiple Answer possible)	1. To find health-related information 2. Entertainment 3. To find technological information 1. For Educational purpose	

SECTION 6: Personal or Behavioral Related questions

Confidence			
Q41	How do you rate your agreement on confidence to perform tele-surgery?	1,Not good 2,Good	3,Very good
Q42	I'm interested to communicate with physician over video conferencing?	1. Yes	2. No
Q43	Has telemedicine changed your confidence in providing medical care?	1. Yes positive way 2. Yes negative way	3. No
Q44	How confident do you feel in handling the tele-surgery in general?	1. Confident 2. Not confident	
Q45	If you answer is not confident in which fields, do you feel uncertain?	1. Technical 2. Organizational 3. Behavioral	4.Other
Motivation question			

Q46	Does the use of tele-surgery technology by other country profassionals have positive impact to adopte it to our country?	1. Yes	2. No
Q47	If tele-surgery services are not limited by location or time do you think that it can be motivate you to use the system?	1. Yes	2. No
Q48	If Tele-surgery saves more time and money than offline medical services do you thik it motivates to use the system?	1. Yes	2. No
Q49	Do you agree that tele-surgery is easy to use (User friendly)?	1. Yes	2. No
Q50	Dose your level of motivation to use tele-surgery is good ?	1. Yes	2. No
Q51	If you have ever taken atraning on tele_surgery does it motivate to use the system?	1.Yes	2.No

Thank you a lot!!!

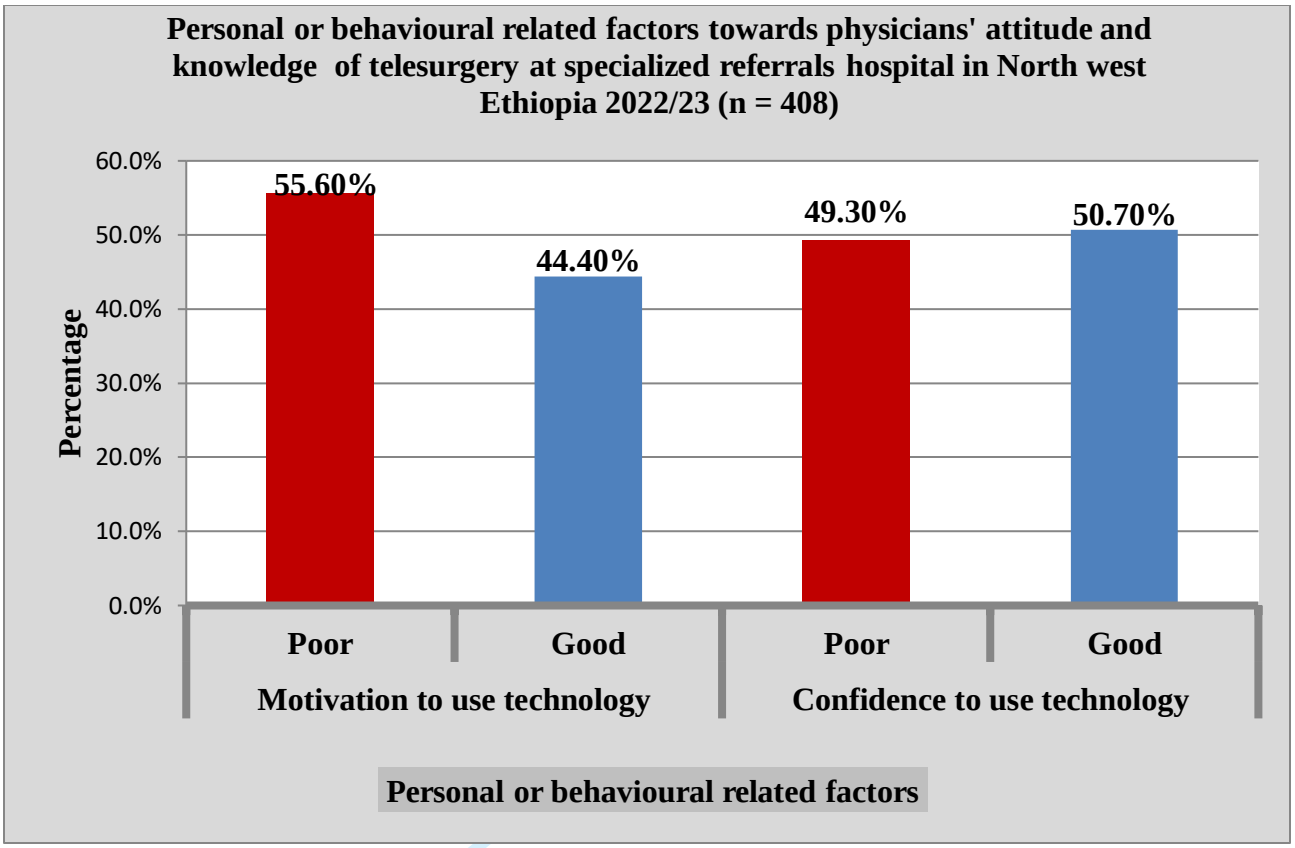

Figure 4: Level of Physicians Confidence and Motivation to use new technology among Physicians' in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n=408)

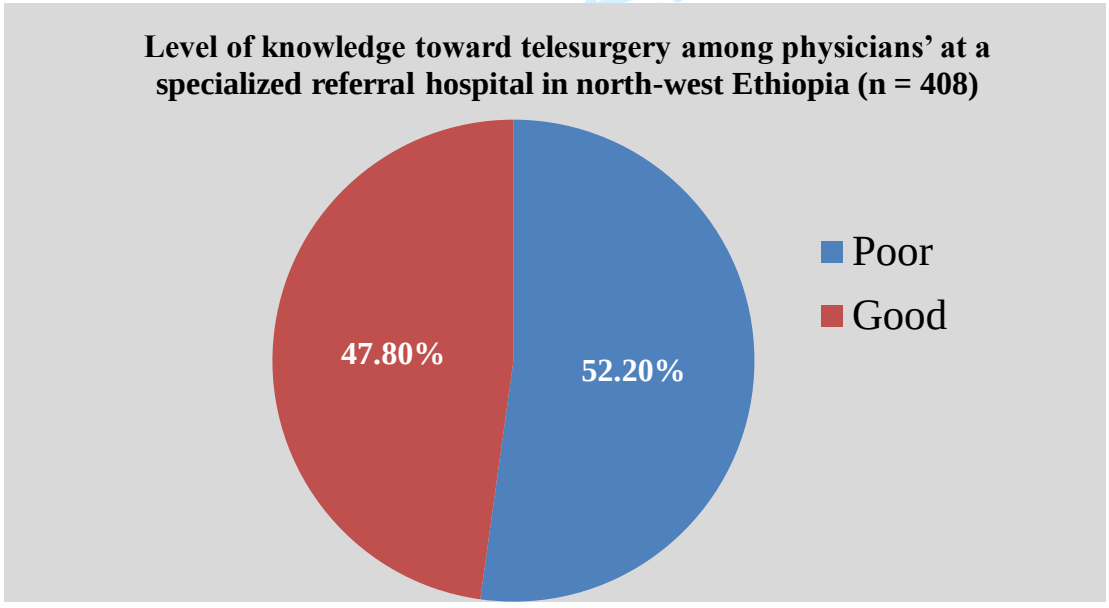

Figure 5: Level of Physician Knowledge toward telesurgery in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n=408)

Supplemental Tables

Table 3: Bivariate and multivariable analysis of factors associated with physician knowledge of telesurgery in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n=408)

Variable	Values	Knowledge		OR (95% CI)		P-value
		Poor (%)	Good (%)	COR (95% CI)	AOR (95% CI)	
Age Group	24-34Years	186 (57.2)	139 (42.8)	1	1	
	>34Years	27 (32.5)	56 (67.5%)	2.78 (1.67-4.62)*	**2.25** (1.005-5.03)*	**0.049***
Educational status	General Practitioner	199 (59.9)	133 (40.1)	1	1	
	Resident	11 (23.4)	36 (76.6)	4.9 (2.41-9.96)*	2.27 (0.89-5.78)	0.087
	Specialist	**3 (10.3)**	**26 (89.7)**	**12.97 (3.85-43.7)***	**8.36 (1.93-36.3)***	**0.005***
Working Experience	<1year	90 (84.9)	16 (15.1)	1	1	
	1-5years	**101 (46.8)**	**115 (53.2)**	**6.41 (3.5-11.61)***	**3.1 (1.32-7.26)***	**0.009***
	>5Years	**22 (25.6)**	**64 (74.4)**	**16.36 (7.97-33.6)***	**6.34 (2.37-16.95)***	**0.001***
Digital Literacy	Poor	169 (73.8)	60 (26.2%)	1	1	
	Good	**44 (24.6)**	**135 (75.4)**	**8.64 (5.51-13.55)***	**3.80 (2.08-6.95)***	**0.001***
Source of info. Professional training	No	170 (73.6)	61 (26.4)	1	1	
	Yes	**43 (24.3)**	**134 (75.7)**	**8.69 (5.5-13.64)***	**4.25 (2.31-7.807)***	**0.001***
Internet (Social media, etc.)	No	158 (63.2)	92 (36.8)	1	1	
	Yes	**55(35.0)**	**102 (65.0)**	**3.19 (2.1-4.83)***	**1.90 (1.02-3.539)***	**0.043***
Basic computer training	No	176 (64.0)	99 (36.0	1	1	
	Yes	**37 (27.8)**	**96 (72.2)**	**4.61 (2.94-7.25)***	**2.23 (1.26-5.57)***	**0.006***
e-Health/Digital health training	No	187 (61.1)	119 (38.9)	1	1	
	Yes	**26 (25.5)**	**76 (74.5)**	**4.59 (2.78-7.58)***	**2.72 (2.62-8.06)***	**0.002***
Trained staff available on telesurgery	No	193 (54.4)	162 (45.6)	1	1	
	Yes	**20 (37.7)**	**33 (62.3)**	**1.97 (1.09-3.56)***	**2.12 (1.01-5.24)***	**0.007***
Internet in access in the organization	No	103 (74.6)	35 (25.4)	1	1	
	Yes	**110 (40.7)**	**160 (59.3)**	**4.28 (2.72-6.74)***	**2.25 (1.16-4.37)***	**0.017***

Note: AOR = Adjusted Odd Ratio, **COR** = Curd Odd Ratio, * = **P-value < 0.05 & ** = P-value < 0.01**

Table 4: Bivariate and multivariable analysis of factors associated with physician attitude towards telesurgery in Specialized Referral Hospitals, Amhara Region, Northwest Ethiopia (2022/23) (n=408)

Variable	Values		Attitude		OR (95% CI)		P-value
			Poor (%)	Good (%)	COR (95% CI)	AOR (95% CI)	
Age Group	24-34Years		193 (59.4)	132 (40.6)	1	1	
	>34Years		39 (47.0)	44 (53.0)	1.65 (1.0-2.68)*	0.46 (0.20-1.06)	0.068
Educational status	General Practitioner		217 (65.4)	115 (34.6)	1	1	
	Resident		**12 (25.5)**	**35 (74.5)**	**5.5 (2.75-11.01)***	**4.02 (1.5-10.73)***	**0.005**
	Specialist		**3 (10.3)**	**26 (89.7)**	**16.35 (4.85-55.2)***	**7.87 (1.56-39.66)***	**0.012**
Job experience	<1year		88 (83.0)	18 (17.0)	1	1	
	1-5years		117 (54.2)	99 (45.8)	4.14 (2.3-7.34)	0.93 (0.39-2.23)	0.876
	>5Years		**27 (31.4)**	**59 (68.6)**	**10.68 (5.40-21.12)**	**3.09 (1.12-8.55)***	**0.030**
Digital Literacy	Poor		178 (77.7)	51 (22.3)	1	**1**	
	Good		**54 (30.2)**	**125 (69.8)**	**8.1 (5.17-12.62)***	**2.82 (1.47-5.41)***	**0.00**
Technology use	Unable to use		160 (68.4)	74 (31.6)	1	1	
	Able to use		**72 (41.4)**	**102 (58.6)**	**3.06 (2.04-4.61)***	**2.25 (1.16-4.38)***	**0.01**
Motivation	Poor		150 (66.1)	77 (33.9)	1	1	
	Good		82 (45.3)	99 (54.7)	2.35 (1.57-3.51)*	1.199 (0.59-2.4)	0.617
Confidence	Poor		131 (65.2)	70 (34.8)	1	1	
	Good		101 (48.8)	106 (51.2)	1.96 (1.32-2.92)*	0.845 (0.42-1.69)	0.632
Basic computer training	No		198 (72.0)	77 (28.0)	1	1	
	Yes		**34 (25.6)**	**99 (74.4)**	**7.49 (4.68-11.98)***	**3.48 (1.79-6.78)***	**0.0001**
e-Health/Digital health training	No		205 (67.0)	101 (33.0)	1	1	
	Yes		**27 (26.5)**	**75 (73.5)**	**5.64 (3.42-9.3)***	**2.50 (1.14-5.5)***	**0.02**
Trained staff available on telesurgery	No		208 (58.6)	147 (41.4)	1	1	
	Yes		24 (45.3)	29 (54.7)	1.7 (0.96-3.06)	1.29 (0.57-2.93)	0.53
Computer access in the organization	No		188 (66.9)	93 (33.1)	1	1	
	Yes		**44 (34.6)**	**83 (65.4)**	**3.8 (2.451-5.9)***	**3.32 (1.42-7.72)***	**0.00**
Internet in access in the organization	No		112 (81.2)	26 (18.8)	1	1	
	Yes		**120 (44.4)**	**150 (55.6)**	**5.4 (3.3-8.79)***	**2.26 (1.14-4.46)***	**0.019**
Knowledge	Poor		177 (83.1)	36 (16.9)	1	1	
	Good		**55 (28.2%)**	**140 (71.8)**	**12.5 (7.78-20.13)***	**4.79 (2.34-9.79)***	**0.0001**

Note: AOR = Adjusted Odd Ratio, **COR** = Curd Odd Ratio, ***** = **P-value < 0.05 & **** = **P-value < 0.01**

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	I
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	II
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3
Bias	9	Describe any efforts to address potential sources of bias	3-4
Study size	10	Explain how the study size was arrived at	3-4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	3-4
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11

		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13-14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.