Awareness and readiness to use telemonitoring to support diabetes care among care providers at teaching hospitals in Ethiopia: An institution-based cross-sectional study

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Research Article

Keywords: Telemonitoring, Healthcare providers, Diabetes mellitus, awareness, readiness, Ethiopia

Posted Date: January 23rd, 2021

DOI: https://doi.org/10.21203/rs.3.rs-152938/v1

Abstract

Background. Telemonitoring(TM) has great potential in the management of chronically ill patients and could help to improve the quality of the patient's life while reducing healthcare costs and care providers' overload. It is important to assess the keenness level of care providers to use and maximize benefit of using technologies in chronic care. This survey aimed to assess the awareness and readiness of care providers to support diabetes patients through TM technology.

Methods. An institution-based cross-sectional quantitative survey was conducted by using a pretested self-administered questionnaire on 423 study participants at teaching hospitals in northwest Ethiopia. Data entry and analysis were done using Epi-data version 4.6 and STATA version 14 software, respectively. The mean, percentage, and standard deviation were calculated to describe the characteristics of participants. A binary logistic regression analysis method was used to identify factors associated with awareness. The ordinal logistic regression analysis method was used to identify factors associated with readiness, however, the partial proportional odds model was fitted due to violation of the proportional assumption.

Result. A total of 406 participants (69.7%, n= 283 nurses and 30.3%, n=123 physicians) were completed survey. A high proportion of respondents owned a computer (66%) or a smartphone (80%). Overall, 38.7% of Participants have heard about TM, when it came to readiness, the majority of the study participants, 321(25.1%) and 121(65.5%) have average and low readiness towards TM, respectively. The result of regression analysis show that the participant's technical skills, access to basic technologies, and attitude were significantly associated with both outcome variables.

Conclusion. The findings of this survey revealed low awareness and readiness of participant's towards TM. However, this study suggests the need of improving participant's attitudes, access to smartphones and computers, and technical skills to fill this gap.

Introduction

Digitizing the health system is considered as a potential to improve healthcare services or possibly as an alternative in some healthcare areas such as chronic patient management [1]. According to American Telemedicine Association (ATA), **Tele-monitoring (TM) is defined as "**the process of using audio, video, and other telecommunications and electronic information processing technologies to monitor the health status of a patient from a distance" [2].

These services mainly address the care for chronically ill patients like diabetes mellitus (DM), which is a group of chronic metabolic disorders characterized by elevated blood glucose levels that are associated with significant morbidity, mortality, and high health care cost [3]. Over the past years, diabetes is becoming a public health problem in the world, affecting more than 463 million people in 2019. This global trend is also evident in Ethiopia, where more than 1.7 million people live with diabetes [4, 5].

Evidence shows that patient management has a substantial influence on the morbidity and mortality of DM and is recognized as effective in realizing blood glucose control and preventing diabetes complications [6]. In Ethiopia, however, patients have a problem in controlling their blood glucose level, the identified factors are inadequate home blood monitoring, non-adherence (non-compliance) with medications, poor lifestyle

management (nutrition and physical activity), and suboptimal patient education about the disease, and limited access to health professionals [7, 8].

In recent years, the application of different TM technologies emerges as an effective approach to solve the problems of patient education, compliance, monitoring of glucose levels, and improving provider access and controlling diabetes complications [9, 10]. Some interventional studies that are conducted in Bangladesh, Egypt, and Senegal on diabetes patients have already shown this progresses.[11-13]

Despite the great promise of TM, to date, there is a lack of programs to support diabetes or any chronic related diseases through technology in Ethiopia. However, to obtain the benefits of this technology, it is important to address factors related to the healthcare professional's readiness and awareness. There are possible deterrents discussed in the literature, which affect health professionals' awareness towards TM including attitude towards ICT, use of a computer, and computer-related training [14, 15]. In addition, individual factors such as gender, age, access to computers [14, 16, 17]. Behavioral factors like computer literacy, computer use, and self-perceived innovativeness [14, 16, 18, 19]. TM technology related factors like perception towards privacy and security [17, 20, 21]. Organizational factors such as training, technical staff, or support were found to affect the readiness of professionals [21-24].

Therefore, the current survey explored the theoretical potential for TM in the Ethiopian healthcare sector which are essential in programming efficient information technologies and facilitating their deployment.

Materials And Methods

Study design and setting

An institution-based cross-sectional study was conducted by using a quantitative approach in the Amhara region, Ethiopia from February to March 2020. The Amhara region is located in the North-Western and North Central parts of Ethiopia. It has 10 administrative zones, one special zone, 181 woredas, and 78 urban centers. Amharic is the working language of the state. The capital city of the State of Amhara is Bahir-Dar. This study was conducted at specialized teaching hospitals in the Amhara Region, namely the University of Gondar and Tibebe Ghion specialized teaching referral hospitals. Both hospitals are estimated to serve 5 million people in their catchment area, having a total of 1900 health professionals. Out of this number 1029 of them were nurses and physicians.

Sample size and procedure

The target population of this study was physicians and nurses from specialized teaching referral hospitals in the Amhara region and the sample size was determined based on the assumption of the single population proportion formula. Since there was no prior study undertaken on a similar study population, with an estimated precision of 5% and the 95% confidence interval and a non-respondent rate of 10%. Therefore, a sample of 423 physicians and nurses was taken.

The sampling method preferred for this study was simple random sampling. First, for each referral hospital, the proportional allocation of the participants was done. Then the participant was allocated proportionally to their

respective departments. Finally, the participants were selected using a simple random sampling method from each department.

Data collection instruments and pre-processing

In this survey, a structured self- administered questionnaire was used to assess the awareness and readiness of health professionals towards TM. The design and development of the survey instrument were guided by the literature review and the questionnaire which were adapted from various survey tools that had previously pilot-tested [14, 25-28]. The self-administered questionnaire consists of four sections. The first section includes socio-demographic and access to basic technology information of participants (ten items), the second section assessed behavioral factors (ten items), the third section included organizational and telemonitoring technology-related information (six items), the final section of the questionnaire consisted of one item for awareness and seventeen items for readiness assessment.

Participants' awareness of TM was assessed by a question to be answered in either "**Yes**" or "**No**": aware if the participant answered "**Yes**" to the question and unaware of the participant answered "**No**" to the question [14]. The readiness of participants was assessed by using seventeen items rated on a five-point Likert scale that ranged from "1 =strongly disagree" to "5= strongly agree,".The result was interpreted in three levels of readiness: High, moderate, low level, those who scored above 81 points categorized as high readiness, those who scored between 61and 80 categorized as moderate readiness, and those who scored below 0–60 categorized as low readiness[25, 26, 28].

In addition, a study was undertaken to assess the validity and reliability of the tools in our context, before the actual data collection, a pretest was carried out on 20 physicians and nurses who were working at Tikur-Anbesa specialized teaching hospital. Internal consistency was measured by Cronbach's alpha, with acceptable values of (>0.7.) The calculation for Cronbach's alpha in the pretest was set at 0.53 for core readiness, 0.84 for engagement readiness, and 0.7 for the structural readiness construct.

Moreover, the opinions of two experts were taken related to the importance and relativity of the content. Then, the investigator made some adjustments some to the questionnaire, from which awareness section item 5 was changed from "Have you ever used the following technology services (voice call, SMS, Email, social media, or video call) to support or monitor your patients?" to" Do you have any experience with remote monitoring/supporting of patients via (e.g. phone, SMS, Email, social media, video call)" and Instruction to questions number 4, 6 was changed from "tick all that apply" to "more than one answer is possible".

Finally, the data collection process was conducted by using four data collectors and two supervisors, after one-day training. Data back-up activities, like putting data in both hard and soft copy formats were also performed.

Statistical analysis

After the collection was done, the data were checked, cleaned, edited, and analyzed by using STATA version 14. Descriptive analyses (mean and percentage) were used to describe demographic characteristics and levels of awareness and readiness. The chi-square test was used to evaluate the statistical significance of the differences

between the responses of the participants. In addition, the binary logistic regression method was used to identify independent variables associated with the awareness of participants. Ordinal logistic regression was used to identify factors associated with readiness, but due to violation of the proportional odds assumption, the partial proportional odds model was fitted.

Furthermore, odds were used to measure the association of outcome variables with predictor variables, 95% CI, and P-value (<0.05) was calculated to evaluate statistical significance.

Operational definition

In this survey, Tele-monitoring(TM) is defined as the process of using information communication technology (ICT) to monitor/support the health status of a patient from a distance. Which refers to remote internet or Telephone-based monitoring of blood glucose, blood pressure, and other signs and symptoms of diabetes patients, and the recording devices are used by the patients in their home environment and the generated data are transferred to health care providers over the internet, telephone or mobile phone [29].

Core readiness (3 items, Cronbach's alpha [α] = 0.656, range 3–15 points) refers to the need for Tele-health services, dissatisfaction with the status quo and an expectation for change, Engagement readiness (7 items, Cronbach's alpha [α] = 0.852, range 7–35 points) refers to understanding as well as assessing the advantages and disadvantages of Telehealth service, and Structural readiness (7 items, Cronbach's alpha [α] = 0.782, range 7–35 points) focused on technical infrastructure and staff skills [18]. We defined overall readiness (17 items, Cronbach's alpha [α] = 0.876, range 17–85 points) as the intersection of core engagement and structural readiness [26].

Nurses were defined as those employees with at least a diploma certificate in the nursing profession and Physicians in this study include general practitioners, internal medicine specialists, and endocrinologists who are practicing clinical service in the study settings [22].

Ethical consideration

Ethical clearance was obtained from the ethical review board of the University of Gondar. Communication with the different official administrators of each teaching hospital was made through a formal letter obtained from the University of Gondar. Written consent was obtained from each study participant after telling the objective and benefits of the study.

Results

Socio-demographic characteristics of physicians and nurses

A total of 406 participants responded to the 423 survey questionnaires distributed. Therefore, a response rate of 95.9 % (406/423) was achieved in this study. In this survey, the majority of respondents were males, 249(61.3%). The mean age was 30.61+_6SD years and the majority of respondents were below the age of 30 years. In terms

of educational level, the majority of participants were bachelor 57.4% and medical degree 20.2% holders with a total contribution of 77.6% participants. Most of the participants, 59.4 % had working experience between 0-5 years, and only 11.8% have a working experience above 10 years (Table 1).

Access to basic technologies among physicians and nurses

Table 1 shows that 95.1% of physicians and 53.4% of nurses own a personal computer. However, only 46.2% from the 95.1% physicians and 47% from 53.4% of nurses indicated their personal computer had internet capabilities. Regarding smartphones, more than 95.1% of physicians and 73.5% of nurses own smartphones. Furthermore, from the findings, barely 16% of the total respondents indicated they did not have a social media account.

Table 1: Socio-demographic Characteristics and access to basic technologies at teaching hospitals in the Amhara region, Ethiopia, 2020.

Variables	Categories	Frequency (%)	Own computer	Computer with internet	Own smartphone	Smartphone with internet	Social-media account
Gender	Male	249	70.7	44.3	81.5	94.1	85.9
	Female	157	58.6	51.1	77.7	94.3	80.9
Age	<30	234	69.2	51.9	84.6	95.5	86.8
	>=30	172	61.6	38.7	73.8	92.2	80.2
Educational level	Medical doctor+	40	100.0	35.0	100.0	100.0	87.5
	Medical degree	82	93.9	51.9	93.9	98.7	97.6
	Master's degree	15	53.3	37.5	60.0	70.0	80.0
	Bachelor	233	53.6	46.4	72.1	92.5	79.8
	Diploma	36	50.0	55.6	86.1	94.2	77.8
Work experience	0-5	145	72.2	50.0	84.6	97.1	88.8
	6-10	128	53.8	46.0	76.9	91.1	82.1
	>10	131	64.6	29.0	64.6	83.9	64.6
Profession	Physician	123	95.1	46.2	95.1	99.1	93.5
	Nurse	283	53.4	47.0	73.5	91.4	79.9

Participant awareness for Tele-monitoring

Regarding the awareness of physicians and nurses about TM, participants have shown low awareness in general. Only 38.7 %(157/406) reported they had heard about telemonitoring. Even though there are slightly few respondents who are aware of TM technology, the majority 83.5 %(339/406) of respondents are aware of the availability of self-management tools for diabetes patients. More than 88.5% (300/339) from 83.5% of respondents who are aware of self-management tools, indicated that they recommend their patients to use different self-management tools.

As can be seen in figure 1, Regarding the specific self-management tools that are recommended, respondents reported that the most commonly recommended self-management tools were glucometer, 97.3%(292/300), blood pressure measurement 78.3%(235/300), thermometer 39%(117/300), and only 17.3%(52/300) of them recommend mobile health applications.

The practice of using Information technologies among physicians and nurses

A slim majority of 52.7 %(214/406) of respondents are communicating with patients through either of the information technologies, phone calls, SMS, social media, email, and videoconference. The results also revealed that the highly used intercommunication method was voice calls, 96.7 %(207/214) while SMS, 59.8 %(128/214) (Table 2).

Table 2: Frequency of using information technologies to support or consult patients among participants at teaching hospitals in Amhara region 2020.

Tools	Physician n (%)	Nurse n (%)	Total
Mobile phone(voice calls)	81(39.1)	126(60.9)	207(96.7)
SMS(text messaging)	54(42.2)	74(57.8)	128(59.8)
Email	3(12)	22(88)	25(11.6)
Social media	32(49.2)	33(50.8)	65(30.3)
Videoconferencing	4(57.1)	3(42.9)	7(3.27)

***multiple response set, totals may sum up to more than 100%**

Participant readiness for Tele-monitoring

Out of total participants, only 9.4% CI: [6.7-12.3] of them have high readiness towards TM, 25.1%CI: [20.1-29.6] of participants showed moderate or average readiness while a majority of participants 65.5% CI: [60.8-70.4] shows low readiness level in this study.

Factors associated with physicians' and nurses' awareness of TM technology.

Table 3 shows the details of bivariate and multivariate logistic regression, the results of logistic regression analysis examined the association between awareness of TM and the independent variables (i.e., own a personal computer, Computer-related training, work experience, frequency of uploading and downloading the information through internet and experience in communicating with patients using information technology tools).

In the crude analysis, participants who owned a personal computer were about 2.46 times more likely to be aware of TM (OR=2.46, 95% CI=1.56-3.87) as compared to those who did not own a personal computer. Likewise, participants who download/upload information daily were 2.4 times more likely to be aware of TM (OR=2.4, 95% CI=1.93-6.258) as compared to those who never download or upload.

Furthermore, participants who had experience in supporting/communicating patients using information technology tools were about 1.75 times more likely to be aware towards (OR=1.747, 95% CI=1.164-2.62) as compared to participants who had no experience to support/communicate patients through information technology tools

On the other hand, after adjusting the individual effect of the above confounders, participants who had computer-related training (AOR=1.808, 95% CI=1.032-3.167) were more likely to be aware of TM as compared to participants who had no computer-related training. Similarly, participants who use computers daily were 2.84 times more aware likely to be aware of TM (AOR=2.84, 95% CI=1.129-7.121) than those who did not use computers daily.

Table 3: Bivariate and multivariate logistic regression factors associated with awareness of TM technologies among physicians and nurses at teaching hospitals in the Amhara region 2020.

Variable	Category	Awareness TM		Crude OR(95%CI)	AOR(95%CI)
		Yes n (%)	No n (%)		
Having a computer	Yes	122(77.7)	146(58.6)	**2.5[1.6-3.7]***	1.8[.9-3.4]
	NO	35(22.3)	103(41.4)	1	1
Computer training	Yes	70(44.6)	69(27.7)	**2.09[1.4-3.2]***	**1.8[1.0-3.2]***
	No	87(55.4)	180(72.3)	1	
Computer use	Daily	83(52.9)	101(40.6)	**3.6[1.9-7.0]***	**2.9[1.2-7.1]****
	Weekly	61(38.9)	91(36.5)	**2.9[1.5-5.8]***	2.0[.8-5.0]
	Never	13(8.3)	57(22.9)	1	
Experience in supporting using ICT tools	Yes	96(61.1)	118(47.4)	**1.7[1.2-2.6]***	**1.7[1.0-2.8]***
	No	61(38.9)	131(52.6)	1	1
Downloading/uploading through internet	Daily	65(41.4)	99(39.8)	**2.4[1.9-6.3]***	1.1[.3-3.9]
	Weekly	86(54.8)	128(51.4)	2.5[.9-6.4]	1.8[.5-6.3]
	Never	6(3.8)	22(8.8)	1	1
Work experience	<5 years	109(69.4)	132(53.0)	**2.8[1.4-5.7]***	1.8[.5-6.5]
	>10 years	11(7.0)	37(14.9)	1	1

Note: TM, Tele-monitoring *p-value≤0.05 for bivariable analysis

**** P-value <0.01 and *** P-value <0.001 for multivariable analysis, 1=reference category**

Factors associated with physicians' and nurses' readiness for TM technology using the ordinal logistic regression model.

In this survey, ordinal logistic regression was conducted to examine the effect of predictor variables, such as owning computer, owned smartphone, computer-related training, IT support, internet access, awareness, attitude towards ICT tools, perception towards data security of TM technologies, and frequency of computer use on the readiness of participants. Table 4 shows the results of the ordinal logistic regression model. Even though five of the considered variables in the POM (proportional odds model) are found significant and the data satisfy the overall proportional odds assumption, the overall goodness of fit of the model shows a low p-value.

Therefore, to fulfill the assumption of proportional odds, Brant test was employed, after conducting the Brant test, p-values of 0.01 were found for the owned smartphone and computer-related training variables, indicating the two variables were found to violate the proportional odds assumption. The results of Brant test are shown in the last column of Table 4. This reveals that all variables except having a smartphone and computer-related training were found insignificant.

As a result, a partial proportional odds model was fitted. As can be seen in Table 5, the Partial proportional odds model (PPOM) with logit function was fitted with variables that are changing across equations, while other variables were imposed to have their effects meet Parallel-line assumption and the global Wald test for the final model indicates that the final model does not violate the proportional odds assumption.

Table 4: Result of the proportional odds model for TM readiness among physicians and nurses at teaching hospitals, 2020.

Variable	coefficient	Standard error	pvalue	Odds ratio	95% CI	Brant test p-value
Intercept 1	3.748	0.644	0.000	- -	- -	
Intercept 2	5.72	0.686	0.000	–	-	
Having a computer [No as Reference]						
Yes	0.462	0.4297	0.087	1.588	0.934-2.699	0.14
Use of computer at work[never as Reference]						0.94
Weekly	-0.585	.2162	0.132	.5568	.2601-1.191	
Daily	0.130	.4381	0.735	1.139	05360-2.420	
Having a smartphone[No as Reference]						
Yes	0.259	.4122	0.415	1.295	.6946-2.417	**0.01***
Computer related training [No as Reference]						
Yes	0.072	.26602	0.768	1.075	.6623-1.746	**0.01***
IT-support [No as Reference]						
Yes	0.462	.42546	0.084	1.588	.9397-2.685	0.27
Internet access[No as Reference]						
Yes	0.299	.3497	0.248	1.349	.8116-2.242	0.23
Heard about Tele-monitoring[No as Reference]						
Yes	0.2499	.3038	0.291	1.283	.8074-2.0418	0.91
Attitude about ICT in current health care [bad as Reference]						
Good	0.7911	.5951	0.003	2.205	1.300-3.7431	0.75
Attitude about ICT in future health care [bad as Reference]						
Good	0.7937	.8325	0.035	2.211	1.0575-4.625	0.14
Attitude about ICT for remote monitoring [bad as Reference]						
Good	1.189	1.036	0.000	3.285	1.769-6.098	0.78
Self-perceived innovativeness[not innovative as Reference]						
Innovative	1.249	1.059	0.000	3.488	1.9228-6.327	0.73

Note: TM, Tele-monitoring POM, partial proportional odds model

*p-value <0.05 and **p-value<0.01 shows violation of proportional odd assumption

Factors associated with physicians' and nurses' readiness for TM technology using a partial proportional odds model.

In this survey, variables like owning smartphone, attitude towards ICT tools in healthcare, attitude towards remote monitoring, and use of computers were positively associated with the readiness towards TM (Table 5).

The result of PPOM revealed that participants who had a favorable attitude towards remote monitoring were about 3.5 times more likely to have high readiness for TM as compared to those participants with an unfavorable attitude. Similarly, participants who had a favorable attitude to healthcare ICT tools were about 2.4 times more likely to have high readiness than those participants with an unfavorable attitude.

In addition, when high readiness and average readiness compared with low readiness level, participants who used computers daily and weekly had 1.628 and 1.55 times greater odds of having average or high readiness respectively compared with participants who never used computers. Correspondingly, the odds of having high readiness for TM were 1.65 times higher for participants who perceived themselves as innovative as compared with those who did not perceive themselves as innovative.

Furthermore, the odds of having high readiness for TM were 1.65 times higher for the participants who owned personal computers as compared with those who did not own a personal computer.

Table 5: Result of partial proportional odds model for Tele-monitoring readiness among physicians and nurses at teaching hospitals, 2020.

	Comparisons					
Variable	**Low readiness for TM) Vs.(average and high readiness**			**Low readiness & average vs. high readiness for TM**		
	B1 value	**OR1**	**p-**	**B2 value**	**OR2**	**p-**
Coefficient	-3.9498	-	0.000	-4.731	-	0.000
Having a computer [No as Reference]						
Yes	0.44887	1.64975	0.024	0.44887	1.64975	0.964
Use of computer at work[never as Reference]						
Weekly	0.2160	1.5517	0.019	0.2160	1.5517	0.019
Daily	0.4515	1.628	0.032	0.4515	1.628	0.032
Having a smartphone[No as Reference]						
Yes	0.40962	1.2702	0.860	0.4096	1.2702	0.034
Computer related training [No as Reference]						
Yes	0.3099	1.1658	0.543	0.15857	0.42433	0.102
IT-support [No as Reference]						
Yes	0.4404	1.61857	0.062	0.4404	1.618557	0.383
Internet access[No as Reference]						
Yes	0.34933	1.32788	0.413	0.34933	1.32788	0.296
Heard about Tele-monitoring[No as Reference]						
Yes	0.3006	1.2575	0.338	0.3006	1.25754	0.49
Attitude about ICT in current health care [bad as Reference]						
Good	0.6060	2.2276	0.003	1.7108	3.0627	0.045
Attitude about ICT in future health care [bad as Reference]						
Good	0.90752	2.36617	0.025	0.9075	2.3661	0.025
Attitude about ICT for remote monitoring [bad as Reference]						
Good	1.1261	3.4959	0.000	1.261	3.4959	0.000
Self-perceived innovativeness[not innovative as Reference]						
Innovative	1.1609	3.8048	0.000	0.8041	1.7103	0.254

Discussion

To our knowledge, there is a lack of studies that have been conducted in Ethiopia to assess the awareness and readiness of health professionals' for the implementation of e-health applications in inpatient care**.** This paper attempt to address this knowledge gap.

According to this analysis, about 38.7% of participants have heard about TM, which is a low level of awareness. This could be due to no specific courses are provided about telemedicine or TM for clinical staff and graduates of clinical fields have not been highly trained in this regard. This result was consistent with the study done in Saudi Arabia, 33% heard about Tele-dentistry [30]. However, the result is higher than the study in Iran 20.1% [31]. A possible explanation may be due to the study period (the study was conducted about 4 years ago).

This survey showed that awareness was significantly associated with computer-related training, technical skill, experience in supporting patients using ICT tools, and work experience (p-value<0.05). Table 3 shows that participants who had good technical skills had a higher awareness in TM (AOR=2.8, (95% CI) :(1.13, 7.12), implying that participants' technical skill could have a positive correlation with their internet access, usages, and availability of infrastructure. This finding is in line with other research studies which indicate ICT skill could have increased awareness [32].

Computer-related training was found to significantly associate with having awareness of TM. Participants who have previous computer-related training were more aware of TM (p-value=0.021). The possible reason for this could be computer-related training were more likely to increase participant familiarity in using technologies [33].

In this survey, the participant's core, engagement, and structural readiness were assessed as a proxy to measure overall readiness. About, 65.5% of participants had low readiness, which indicates there are barriers to successful use of TM among these respondents [34]. Also, 25.1% of participants showed an average or moderate readiness towards TM. This result is slightly lower than a study conducted in Nigeria, which reveals 33% of average readiness [35]. On the other hand, both results are lower than a study done on Austrian professionals to assess their readiness towards using TM technologies for diabetic patient management and found out 58.2% of them have average readiness levels [36]. This might be due to well-organized infrastructure at the clinical practice site and availability technological guideline which promote the use of ICT tools for patient care. Furthermore, only 9.4% of participants showed high readiness for TM in our survey. This low level of participant readiness is quite distinguishable from the high level of readiness (41%) among nurses in the U.S [37]. This substantial difference could be the result of infrastructural differences and the difference in measurements used in the studies.

In the analysis, ordinal logistic regression was fitted on possible explanatory variables but, due to the violation of proportional odds assumption by two explanatory variables partial proportional odds model was fitted, which relaxes the proportional assumption for these two variables. Among all possible explanatory variables fitted into the partial proportional odds model, self-perceived innovativeness, attitude towards ICT tools in healthcare, attitude towards remote monitoring, access to a smartphone, and computer were significantly associated with TM readiness.

This study showed that participants who owned a personal computer were found to have better readiness in TM. This finding is in line with other studies that indicate a positive correlation between computer access and

professionals readiness [19, 31]. According to this study, another important behavioral factor that affects TM readiness was the attitude of participants. Participants who had a favorable attitude towards ICT were 2.4 times more likely to have high readiness compared to participants with an unfavorable attitude towards ICT. This is in line with the findings of a study that found that a positive attitude was related to e-health readiness among health care providers.

Declarations

Data availability

The dataset generated or analyzed during this survey is included in this article and its supplementary information files.

Conflict of interests

The authors declare that they have no conflict of interests.

Funding

Not available.

Acknowledgment

We would like to thank the University of Gondar, for its support during the study. We also thank all data collectors and survey respondents for their contributions.

List of abbreviation

AOR: Adjusted odds ratio; CI: Confidence Interval; DM: Diabetes Mellitus; ICT: -information Communication Technology; IDF: International Diabetes Federation; OR: Odds ratio; POM: Proportional Odd Model; PPOM: Partial Proportional Odds Model; SMS: Short message service; TM: Tele-monitoring.

Ethics approval and consent to participate

Ethical approval to conduct the study was obtained from the University of Gondar ethical review board. Communication with the different official administrators of each teaching hospital was made through a formal letter obtained from the University of Gondar. The purpose of the study was explained to every physician and nurse and their written consent was taken before the study.

Author's contributions

BT, TM, and AY contributed during the process of proposal development. BT handled the data collection process. BT, TM, and AY involved during data analysis and write up.BT prepared the draft. Then TM and AY revised the draft of the paper. All authors provided input into drafts and approved the final draft of the manuscript.

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Figures

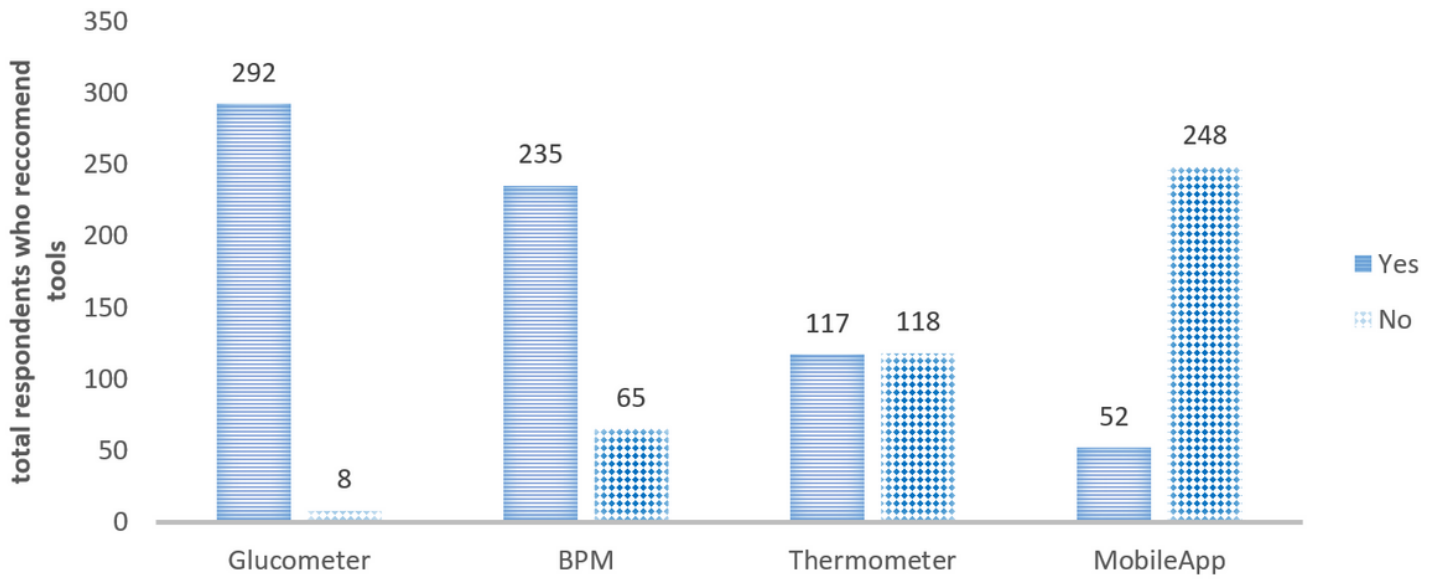

Figure 1

most commonly recommended self-management tools by physicians and nurses at two teaching hospitals in Amhara region, 2020.