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# Access to mobile phone and willingness to receive mHealth services among patients with diabetes in Northwest Ethiopia: a cross-sectional study

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## ABSTRACT

**Objectives** This study aimed at determining access to mobile phone and willingness to receive mobile phone-based diabetes health services as well as identify associated factors in Northwest Ethiopia.

**Design** An institution-based cross-sectional survey was conducted from February to March 2016.

**Participants** Systematic randomly selected 423 patients with diabetes.

**Setting** University of Gondar Hospital diabetic clinic.

**Main outcome measures** The main outcome measure was willingness to receive diabetic health service via mobile phone voice call or messaging services.

**Results** Out of 423 patients with diabetes, 329 (77.8%) had access to a mobile phone. Among the latter, 232 (70.5%) were willing to receive mobile phone-based health services. The educational status of patients (adjusted OR (AOR): 2.6 (95% CI: 1.2 to 5.58)), route of medication (AOR: 3.2 (95% CI: 1.44 to 7.1)), transportation mechanism (AOR: 4.1 (95% CI: 1.2 to 13.57)), travel time to health facility (AOR: 0.3 (95% CI: 0.12 to 0.82)), current use of mobile phone as appointment reminder (AOR: 2.6 (95% CI: 1.07 to 6.49)) and locking mobile phone with passwords (AOR: 4.6 (95% CI: 1.63 to 12.95)) were significantly associated with the willingness to receive mobile phone-based diabetic health services.

**Conclusion** Access to a mobile phone and willingness to receive mobile phone-based health services were high. Educational status, route of medication, transportation mechanism, time to reach the service, using mobile phone as appointment reminder and locking mobile phone with passwords were significantly associated factors. Given the high proportion of access and willingness of patients to receive mobile phone-based health services, mHealth interventions could be helpful.

## Strength and limitation of this study

- This is the first study in Ethiopia assessing the willingness of patients with diabetes to receive a mobile phone-based diabetes health service.
- Since the study was interviewer based, the responses might have been affected by bias introduced by the interviewers.
- The study is conducted in one referral hospital based in a big town, which may affect the generalisability of the findings.

## BACKGROUND

According to the International Diabetes Federation (IDF) report, 1 in 11 adults was reported to have diabetes in 2017.[1] Diabetes is one of the leading chronic diseases in low-income and middle-income countries. More than 3.2% of the population in Africa had diabetes in 2015, of which more than two-thirds were undiagnosed. Ethiopia is one of the countries in Africa having the highest number of people with diabetes. Around 1.3 million diabetic cases were reported in 2015, which makes Ethiopia the fourth most affected country in Africa.[2 3] In 2017, IDF reported an estimated 4.8% of adults in Ethiopia to have diabetes.[1 4] Observational studies across the country reported varying prevalence levels of diabetes, from 0.34% in Debre Berhan Hospital[5] and 5% at the University of Gondar Referral Hospital[6] to 8.3% in South Eastern Amhara.[7]

Diabetes is one of the most expensive chronic diseases in the world.[8] Despite spending large amounts of resources, management of diabetes remains challenging.[9–12] Prevention of diabetes and improving self-management among people with diabetes are still few of the main priorities of diabetes. WHO planned to halt the rise in diabetes and obesity by acting on modifiable risk factors such as unhealthy diet, and physical inactivity.[13] Among people with diabetes, adherence to physical activity and nutrition recommendations and increasing the availability and accessibility of insulin are some of the key aspects of diabetes care, yet challenging.[14 15] A plethora of evidence indicated that integrating mobile health

(mHealth hereafter) to diabetes care has helped to tackle lifestyle, adherence and self-management challenges.[16–18]

To date, >7 billion people in the world have mobile phones, with 40% of them owning smart phones.[19–21] The global mobile penetration per capita has increased by almost 50%. However, the rate in Africa has only increased by 12%.[20] On average, sub-Saharan African countries have registered an average increment of 38% of per capita mobile penetration.[22 23] The growth and expansion of mobile telecommunication technology in Ethiopia was low for many years. But, it has rapidly increased from 17% in 2012 to 48.3% in 2016.[22 23] The ubiquitous access and the multitasking nature of mobile phones are great opportunities to improve chronic disease prevention, patient care and self-management.

In high-income countries, mobile phones have gained popularity in diabetes prevention interventions, where they are being used to implement programmes to promote a healthy diet, regular physical activity and to prevent obesity.[24–30] They have also been used to enhance the engagement of patients to diabetic patient care as well as to reduce the number of care drop outs[31] and improve glycaemic control.[32] Because of this, mHealth particularly smart phone-based diabetes applications are rapidly transforming diabetes care in the high-income world.[32] Diabetes is considered as a major niche for mHealth interventions, yet it remains underexplored in sub-Saharan Africa.[33 34] Due to digital literacy, access and unavailability of the technology, there is a dearth of literature regarding the effectiveness and the use of mHealth interventions for improving diabetes care in sub-Saharan Africa.[33] One randomised controlled trial of a text message in sub-Saharan Africa (Senegal) reported a clinically significant reduction of glycated haemoglobin levels were achieved with the intervention.[35] A review that compared mHealth intervention between low-income and high-income countries reported that text messages are more commonly implemented than mobile apps in low-income countries.[36] Another systematic review on mHealth in Africa indicated mHealth appears to be feasible mainly on supporting follow-up and retention of patients on the chronic care continuum.[37]

In Ethiopia, there has been no report of mobile-based interventions to support diabetes prevention and care. A study in Addis Ababa reported that a patient-centred approach could augment diabetes patient care.[38] Mobile phones may facilitate the provision of patient-centred care. There are emerging efforts to use mobile phones for supporting a variety of healthcare services such as maternal health service, health promotion and disease surveillance, yet mHealth in diabetes is untapped.[39–41] A study conducted at the University of Gondar Hospital among people on antiretroviral treatment (ART) reported that a high proportion of respondents had a mobile phone and almost half were willing to receive text message medication reminders.[42] The use of mobile technology-assisted management has a great potential to improve diabetes care. For instance, in low-resource settings with limited access to healthcare, mobile phones may help provide mass health education across a wide geography. In addition, mobile phones can be used as medication and appointment reminders. However, before implementing mobile phone-based health service interventions, it is important to assess access to mobile phones and the willingness to use mobile phone-based health services. Therefore, this study aimed at determining the access to mobile phones and willingness to receive mobile phone-based health services; and identifying factors associated with willingness to receive mobile phone-based health service among persons with diabetes at the University of Gondar Referral Hospital.

## METHODS

### Study design and setting

An institution-based cross-sectional study was conducted at the University of Gondar Hospital from February to March 2016. The University of Gondar Hospital is located in Northwest Ethiopia, 727 km away from the capital, Addis Ababa. It is one of the tertiary hospitals in Ethiopia and potentially serves about 5 million people. During the study period, 700 patients with diabetes were on diabetes care follow-up at the hospital.

### Study subjects

The study population comprised patients with diabetes at the University of Gondar Hospital. Patients who were seriously ill or unable to hear and/or understand instructions were excluded from the study. The sample size was determined using a single population proportion formula, $n=Z_{(}\alpha/2_{)}^{2}pq/\delta^{2}$.[43] We assumed: n=the required sample size, Z=the value of standard normal distribution corresponding to $\alpha/2$, 1.96, p=proportion of patients with diabetes willing to be contacted via mobile phone, q=proportion of patients with diabetes NOT willing to be contacted via mobile phone and d=precision assumed as 0.05. To the knowledge of the investigators, no study has been conducted in Ethiopia to determine the willingness to receive mobile-based health service among patients with diabetes. Therefore, we assumed p (proportion of patients with diabetes willing to be contacted via mobile phone) to be 0.5. Hence, the sample size for this study was calculated to be 384. Taking 10% non-response rate into account, the final sample size was adjusted to be 423. A systematic random sampling technique was performed to select 423 patients with diabetes as respondents of this study. Respondents were selected while they were on their follow-up visits at the diabetic clinic. On the first day of the data collection, the first respondent was randomly selected. Then, every other respondent was selected and interviewed until the number of interviewed respondents reached the calculated sample size.

### Data collection procedure

Data were collected through face-to-face interviews using a structured questionnaire adapted from previous

studies.[21 42] The questionnaire (online annex 1) contains questions assessing sociodemographic characteristics, comprehensive assessment of access to mobile telecommunication technologies, willingness to receive mobile-based health services for diabetic management and preventive practices. The data collection instrument was first developed in English and then translated to Amharic and later back-translated to English by language experts to ensure consistency. To evaluate the understandability and the applicability of the questionnaire, a pretest was conducted 1 week prior to the main fieldwork. Following the analysis of the pretest study data, ambiguous or unclear questions were rephrased. Data were collected by four trained clinical nurses and onsite supervision was performed by the principal investigator. Questionnaires were evaluated on a daily basis. A timely edition of the data was also done and feedback was given to the data collectors where there were errors in the data.

### Study variables

The primary outcome variable of this study was willingness to receive mobile phone-based health services. Mobile phone-based health service includes any form of mobile phone-based diabetes patient support via smart phone apps, text messages and voice calls. However, in this particular study, our interest was mainly to look at willingness to receive diabetes care support via text message and/or voice calls. We collectively called this as willingness to receive mobile phone-based health service. Independent variables included in the questionnaire were the following:

Sociodemographic variables: age, sex, educational status, marital status and employment status.

Environmental factors: ownership of television, radio, transportation mechanism, access to mobile phone network at home.

Behavioural factors: drinking alcohol, khat chewing, smoking, habit of sugar intake, physical activity behaviour.

Healthcare service-related factors: self-reported client satisfaction in diabetic service, perceived satisfaction on insulin supply.

Access to a mobile phone was measured using a single yes/no question, asking whether patients owned a mobile phone.

To measure willingness, respondents were asked whether they would be willing to receive a mobile phone-based diabetic health service, either through a mobile phone voice call or messaging services.

### Data quality assurance

Prior to the actual study data collection, a pretest was conducted at Felege Hiwot Referral Hospital on a 10% of the calculated sample size. The data collectors received a 2 days' training that included practical session. Feedbacks received from the data collectors were incorporated to enrich the questionnaire and adjust it to the local context. The principal investigator randomly checked 10% of the questionnaires collected each day. Anything which was unclear, missing and/or confusing was discussed with the respective data collector and corrected on the next day.

### Data processing and analysis

Data from the entire questionnaire were coded and entered using Epi Info V.7 database. Data were then exported to SPSS V.20 for analysis. Frequency and cross-tabulations were used to describe the data. The associations between characteristics of respondents and the willingness to receive mobile phone-based health services were analysed using binary and multivariable logistic regression analyses. The purposeful selection method was used to select variables having a p value of <0.2 in the bivariate logistic regression analyses. These variables were entered in the logistic regression to adjust for the effect of confounders as recommended in the previous methodological literature.[44 45] Statistical significance was declared using a p value of <0.05. ORs with 95% CIs were calculated to measure the strength of the association.

### Patient and public involvement

No patients were involved in setting the research question, defining the outcome measures, developing the design, recruitment and conduct of the study. No patients were also involved in the analysis and interpretation of the findings. In addition, there are no plans on disseminating the results to study participants or patients. The public was not also directly involved in the design of the study. However, the results of the study were disseminated to clinicians and nurses working at the diabetic clinic.

## RESULTS

### Characteristics of the respondents

A total of 423 patients with diabetes participated in the study. The majority were male, n=227; 53.7%, the mean age was 47.4 years (SD=16.6) and about two-thirds, n=261; 61.7%, were from urban areas (table 1).

More than the third-quarter of respondents (n=329, 77.8%) had access to mobile phone. The proportion of males with access to a mobile phone was higher than that of females: (n=191; 84.1% vs n=138; 70.4%, respectively). Access to a mobile phone was highest among respondents below 30 years of age (n=69; 81.2%) (table 1).

Among patients with diabetes having access to mobile, the majority (n=232, 70.5%) were willing to receive mobile phone-based health service, with the proportion being higher among females (n=99; 71.7%) than males (n=133, 69.6%) (table 1).

### Environmental, behavioural characteristics and patterns of mobile phone use

The majority of patients with diabetes, n=303; 92%, with access to a mobile phone reported being satisfied with their healthcare provider. A third, n=110; 33.4%, of them visited the diabetic follow-up clinic every 2 months, n=94; 28.6% every month, n=72; 21.9% every 3 months and n=53; 16.1% had a variable visiting frequency. Patients

Table 1 Sociodemographic characteristics of University of Gondar Hospital patients with diabetes, Gondar, Ethiopia 2016

| Variables | Access to mobile phone (n=423) | | Willingness to receive mobile phone-based health service (n=329) | |
|---|---|---|---|---|
| | No N (%) | Yes N (%) | No N (%) | Yes N (%) |
| Sex | | | | |
| Male | 36 (15.9) | 191 (84.1) | 58 (30.4) | 133 (69.6) |
| Female | 58 (29.6) | 138 (70.4) | 39 (28.3) | 99 (71.7) |
| Age (years) | | | | |
| <30 | 16 (18.8) | 69 (81.2) | 27 (39.1) | 42 (60.9) |
| 30–45 | 30 (27.5) | 79 (72.5) | 20 (25.3) | 59 (74.7) |
| ≥45 | 48 (21) | 181 (79.0) | 50 (27.6) | 131 (72.4) |
| Residence | | | | |
| Urban | 27 (10.3) | 234 (89.7) | 59 (25.2) | 175 (74.8) |
| Rural | 67 (41.4) | 95 (58.6) | 38 (40.0) | 57 (60.0) |
| Marital status | | | | |
| Single | 13 (21.3) | 48 (78.7) | 20 (41.7) | 28 (58.3) |
| Married | 48 (17.0) | 235 (83.0) | 66 (28.1) | 169 (71.9) |
| Separated | 4 (57.1) | 3 (42.9) | 2 (66.7) | 1 (33.3) |
| Divorced | 12 (48.0) | 13 (52.0) | 2 (15.4) | 11 (84.6) |
| Widowed | 17 (36.2) | 30 (63.8) | 7 (23.3) | 23 (76.7) |
| Educational status | | | | |
| Illiterate | 55 (38.2) | 89 (61.8) | 30 (33.7) | 59 (66.3) |
| Read and write | 25 (25.8) | 72 (74.2) | 33 (45.8) | 39 (54.2) |
| Primary | 12 (16.4) | 61 (83.6) | 17 (27.9) | 44 (72.1) |
| Secondary | 2 (3.5) | 55 (96.5) | 10 (18.2) | 45 (81.8) |
| ≥College | 0 (0.0) | 52 (100.0) | 7 (13.5) | 45 (86.5) |
| Occupation | | | | |
| Employed | 4 (4.2) | 92 (95.8) | 20 (21.7) | 72 (78.3) |
| Merchant | 6 (9.5) | 57 (90.5) | 12 (21.1) | 45 (78.9) |
| Farmer | 37 (37.0) | 63 (63.0) | 25 (39.7) | 38 (60.3) |
| Housewife | 37 (37.0) | 63 (63.0) | 21 (33.3) | 42 (66.7) |
| Others | 10 (15.6) | 54 (84.4) | 19 (35.2) | 35 (64.8) |
| Whom do you live with | | | | |
| Alone | 23 (35.9) | 41 (64.1) | 16 (39.0) | 25 (61.0) |
| With spouse | 36 (22.9) | 121 (77.1) | 41 (33.9) | 80 (66.1) |
| With family | 35 (17.3) | 167 (82.7) | 40 (24.0) | 127 (76.0) |
| Comorbidity | | | | |
| No | 72 (24.8) | 218 (75.2) | 69 (31.7) | 149 (68.3) |
| Yes | 22 (16.5) | 111 (83.5) | 28 (25.2) | 83 (74.8) |
| Comorbid disease | | | | |
| Hypertension | 17 (16.2) | 88 (83.8) | 22 (25.0) | 66 (75.0) |
| Heart disease | 3 (20.0) | 12 (80.0) | 5 (41.7) | 7 (58.3) |
| Other | 2 (15.4) | 11 (84.6) | 1 (9.1) | 10 (90.9) |
| Type of diabetes (self-report) | | | | |
| I | 17 (15.2) | 95 (84.8) | 15 (15.8) | 80 (84.2) |
| II | 46 (20.1) | 183 (79.9) | 57 (31.3) | 125 (68.7) |

Continued

Table 1 Continued

| Variables | Access to mobile phone (n=423) | | Willingness to receive mobile phone-based health service (n=329) | |
|---|---|---|---|---|
| | No N (%) | Yes N (%) | No N (%) | Yes N (%) |
| Unknown | 31 (37.3) | 52 (62.7) | 25 (48.1) | 27 (51.9) |
| Time since diagnosis | | | | |
| <6 months | 8 (21.1) | 30 (78.9) | (23.3) | 23 (76.7) |
| 6–12 months | 3 (8.1) | 34 (91.9) | 15 (44.1) | 19 (55.9) |
| >12 months | 84 (24.1) | 264 (75.9) | 75 (28.4) | 189 (71.6) |
| Diabetes follow-up time | | | | |
| <6 months | 9 (20.5) | 35 (79.5) | 8 (22.9) | 27 (77.1) |
| 6–12 months | 3 (8.3) | 33 (91.7) | 14 (42.4) | 19 (57.6) |
| >12 months | 82 (23.9) | 261 (76.1) | 75 (28.7) | 186 (71.3) |
| Route of medication | | | | |
| Injection | 33 (20.8) | 126 (79.2) | 32 (25.4) | 94 (74.6) |
| Pill | 49 (21.1) | 183 (78.9) | 57 (31.1) | 126 (68.9) |
| Both | 11 (35.5) | 20 (64.5) | 8 (40.0) | 12 (60.0) |

who reported receiving assistant or health education had a bigger proportion of willingness to receive mobile phone-based health services than those who did not (n=192; 72.2% vs n=40; 64.5%). With regard to treatment satisfaction, satisfied patients were more willing to be contacted via mobile phone than non-satisfied patients (n=221; 72.2% vs n=11; 47.8%). Nearly a third of the patients (n=100; 30.4%) had a history of missing appointments. Forgetting the appointment was the most frequently mentioned reason for missing appointments (34%), followed by illness (27%), not having permission from employers (18%), and other reasons (21%). Additionally, among those who owned mobile phones, (n=152; 80%) of those reported having a television at home were willing to receive mobile phone-based health services (table 2).

Almost a fifth (n=63; 19%) of those with access to a mobile phone owned a smart phone. Of these, 55 (87.3%) were willing to receive mobile phone-based health services, compared with those without a smart phone (n=177; 66.5%) (table 3).

### Factors associated with willingness to receive mobile phone-based diabetic health service

Results of the bivariate analyses indicated that educational status, with whom patients live with, route of medication, presence of radio in dwelling, transportation mechanism, time to reach the health facility, satisfaction with healthcare service, current use of mobile phone as appointment reminder and presence/absence of time or place where no calls are taken were associated with willingness to receive mobile phone-base diabetic health service. Moreover, locking mobile phone with passwords, access to mobile phone by others, current use of mobile phone for adherence and automatic appointment reminder were also significantly associated with willingness to receive mobile phone-based diabetic health services at a p value of <0.2. All of these associated factors were entered in the multivariable logistic regression analysis model to control for the effect of confounders (table 4).

The multivariable logistic regression model identified educational status (educated; 2.6 (95% CI: 1.2 to 5.6)), route of medication (pill; 3.2 (95% CI: 1.4 to 7.1)), transportation mechanism (by car; 4.0 (95% CI: 1.2 to 13.6)) and time to reach the service (<1 hour; 0.32 (95% CI: 0.12 to 0.82)) as factors significantly associated with willingness to receive mobile phone-based diabetic health services. In addition, current use of mobile phone as appointment reminder (used: 2.6 (95% CI: 1.1 to 6.5)), locking mobile phone with passwords (locked: 4.6 (95% CI: 1.6 to 12.9)) and current use of mobile phone for adherence support (used: 2.6 (95% CI: 1.07 to 6.5)) were identified to be significantly associated factors (table 4).

Educated respondents were 2.6 times more likely to be willing to use mobile phone-based health services than uneducated respondents. Patients with diabetes who take their medication in the form of a pill were 3.2 times more likely to be willing than those who take in the form of an injection. Respondents who used a car as a mode of transportation were 4.0 times more likely to be willing to receive mobile phone-based health services than those who came on foot, while those who travel <1 hour to reach the hospital were less likely to be willing compared with those who travel >1 hour. Respondents who were currently using their mobile phone as an appointment reminder were 2.64 times more likely to be willing to receive mobile phone-based health services than those who were not. Furthermore, those who lock their mobile

Table 2 Willingness to mobile health services stratified by sociodemographic characteristics among University of Gondar Hospital patients with diabetes, Gondar, Ethiopia 2016

| Variable | Willingness to receive mobile phone-based health services (n=329) | |
|---|---|---|
| | No N (%) | Yes N (%) |
| Television | | |
| No | 59 (42.4) | 80 (57.6) |
| Yes | 38 (20.0) | 152 (80.0) |
| Radio | | |
| No | 59 (40.4) | 87 (59.6) |
| Yes | 38 (20.8) | 145 (79.2) |
| Transportation mechanism | | |
| On foot | 13 (43.3) | 17 (56.7) |
| By car | 84 (28.1) | 215 (71.9) |
| Time to reach the service site | | |
| <1 hour | 60 (27.5) | 158 (72.5) |
| >1 hour | 37 (33.3) | 74 (66.7) |
| Electricity in the house | | |
| No | 32 (36.0) | 57 (64.0) |
| Yes | 65 (27.1) | 175 (72.9) |
| Mobile network access | | |
| No | 11 (50.0) | 11 (50.0) |
| Yes | 86 (28.0) | 221 (72.0) |
| Using reminder mechanisms | | |
| No | 58 (31.2) | 128 (68.8) |
| Yes | 39 (27.3) | 104 (72.7) |
| Pill box | | |
| No | 97 (29.8) | 229 (70.2) |
| Yes | 0 (0.0) | 3 (100.0) |
| Written schedule | | |
| No | 70 (27.2) | 187 (72.8) |
| Yes | 27 (37.5) | 45 (62.5) |
| Watch alarm | | |
| No | 88 (30.7) | 199 (69.3) |
| Yes | 9 (21.4) | 33 (78.6) |
| Mobile phone | | |
| No | 88 (29.5) | 210 (70.5) |
| Yes | 9 (29.0) | 22 (71.0) |
| Other reminders | | |
| No | 96 (29.8) | 226 (70.2) |
| Yes | 1 (14.3) | 6 (85.7) |
| Taking addictive substances | | |
| No | 85 (28.9) | 209 (71.1) |
| Yes | 12 (34.3) | 23 (65.7) |
| Alcohol | | |
| No | 89 (29.2) | 216 (70.8) |
| Yes | 8 (33.3) | 16 (66.7) |
| Khat chewing | | |
| No | 91 (28.8) | 225 (71.2) |
| Yes | 6 (46.2) | 7 (53.8) |
| Smoking | | |
| No | 95 (29.1) | 231 (70.9) |
| Yes | 2 (66.7) | 1 (33.3) |

phones with a password were 4.6 times more likely to be willing than those who did not.

However, with whom patients live with, perceived satisfaction with the healthcare provider, the presence of radio in dwelling and availability of time or place where no calls are taken were not significantly associated with willingness to receive mobile phone-based health services among patients with diabetes at the University of Gondar Referral Hospital.

## DISCUSSION

The purpose of this study was to determine access to mobile phones and the willingness to receive mobile phone-based health services and associated factors among patients with diabetes at the University of Gondar Referral Hospital. The results of the study show that access to mobile phones among patients with diabetes at the University of Gondar Hospital is high, 77.8%. From those respondents who had access to mobile phones, majority (70.5%) were willing to receive mobile phone-based health services. Educational status, route of medication, transportation mechanism, time to reach the service, current use of mobile phone as an appointment reminder, locking mobile phone with passwords were significantly associated with willingness to receive mobile phone-based health services among patients with diabetes at the University of Gondar Referral Hospital.

Access to mobile phones in this study (77.8%) is slightly higher than in a previous study conducted at the University of Gondar Referral Hospital ART clinic (76.2%),[42] and in Kenya (74%).[46] The difference might be due to the socioeconomic difference between HIV/AIDS and patients with diabetes and the difference in the timing of the study. While access to mobile phones in the current study is consistent with the report on Honduras chronic patients (78%),[21] it is however lower than that in a study from the USA, 83%.[47] The difference is possibly due to the differences in socioeconomic, Information Communication Technology (ICT) development index

**Table 3** Willingness to receive mobile phone-based health services stratified by pattern of mobile phone use among University of Gondar Hospital patients with diabetes, Gondar, Ethiopia, 2016

| Variable | Willingness to receive mobile phone-based health services (n=329) | |
|---|---|---|
| Type of mobile phone | | |
| Smart | 8 (12.7) | 55 (87.3) |
| Non-smart | 89 (33.5) | 177 (66.5) |
| Use mobile phone as appointment reminder | | |
| No | 76 (32.5) | 158 (67.5) |
| Yes | 21 (22.3) | 73 (77.7) |
| Use mobile phone as medication reminder | | |
| No | 78 (33.8) | 153 (66.2) |
| Yes | 19 (19.6) | 78 (80.4) |
| Preferred mode of communication | | |
| Voice call | 85 (27.6) | 223 (72.4) |
| Text message | 14 (25.0) | 42 (75.0) |
| Email | 4 (26.7) | 11 (73.3) |
| How often do you have your mobile phone with you? | | |
| Always | 73 (26.3) | 205 (73.7) |
| Sometimes | 21 (60.0) | 14 (40.0) |
| Seldom | 3 (30.0) | 7 (70.0) |
| Never | 0 (0.0) | 6 (100.0) |
| Mobile phone lost, damaged or stolen in the past | | |
| No | 77 (34.4) | 147 (65.6) |
| Yes | 20 (19.0) | 85 (81.0) |
| Have additional phone number | | |
| No | 81 (28.8) | 200 (71.2) |
| Yes | 16 (33.3) | 32 (66.7) |
| Switch off mobile phone during day time | | |
| No | 89 (30.2) | 206 (69.8) |
| Yes | 8 (23.5) | 26 (76.5) |
| There are times or places where I do not take calls | | |
| No | 76 (33.6) | 150 (66.4) |
| Yes | 21 (20.4) | 82 (79.6) |
| Do not answer unknown calls | | |
| No | 71 (30.7) | 160 (69.3) |
| Yes | 26 (26.5) | 72 (73.5) |
| Lock phone with password | | |
| No | 82 (34.5) | 156 (65.5) |
| Yes | 15 (16.5) | 76 (83.5) |
| Mobile phone used and accessed by others | | |
| No | 79 (35.4) | 144 (64.6) |
| Yes | 18 (17.0) | 88 (83.0) |
| Mobile phone shared with another person | | |
| No | 76 (29.8) | 179 (70.2) |
| Yes | 21 (28.4) | 53 (71.6) |
| Able to read and send text message using mobile | | |
| No | 81 (38.4) | 130 (61.6) |
| Yes | 16 (13.8) | 102 (86.2) |
| Delete text message without reading it | | |
| No | 13 (13.5) | 83 (86.5) |
| Yes | 3 (13.6) | 19 (86.4) |
| Likelihood of text message to be seen by others | | |
| Very high | 2 (20.0) | 8 (80.0) |
| High | 3 (6.4) | 44 (93.6) |
| Lower | 8 (22.2) | 28 (77.8) |
| Very low | 5 (18.5) | 22 (81.5) |
| Use internet on the phone | | |
| No | 83 (33.2) | 167 (66.8) |
| Yes | 14 (17.7) | 65 (82.3) |
| Use social network pages such as Facebook on the phone | | |
| No | 84 (32.3) | 76 (67.7) |
| Yes | 13 (18.8) | 56 (81.2) |
| Email | | |
| No | 91 (30.2) | 210 (69.8) |
| Yes | 6 (21.4) | 22 (78.6) |
| Google | | |
| No | 88 (28.9) | 217 (71.1) |
| Yes | 9 (37.5) | 15 (62.5) |
| Mobile-based support could be helpful in your adherence | | |
| No | 61 (82.4) | 13 (17.6) |
| Yes | 36 (14.1) | 219 (85.9) |

and infrastructure development between the USA and Honduras and Ethiopia[21 42]

The proportion of respondents with access to mobile phones who were willing to receive mobile phone-based health services observed in this study (70.5%) is higher than that reported in the previous study conducted at the University of Gondar Referral Hospital among patients on ART. In the latter, only 50.5% of the patients were willing to receive text message medication reminders.[42] The difference may be due to the discrepancy in the study period, perceived stigma and discrimination and the difference in the literacy rate of the study populations. Perceived stigma and discrimination is lower among patients with diabetes than patients on ART, which probably makes patients with diabetes to have a higher willingness to be contacted via their private mobile phones. Furthermore, traditionally, patients with diabetes in low-income and middle-income countries

Table 4 Bivariate and multivariate analyses of factors associated with willingness to receive mobile phone-based health services among University of Gondar Referral Hospital patients with diabetes, Gondar, Ethiopia, 2016

| Variable | Willingness | | Crude OR (95% CI) | Adjusted OR (95% CI) |
|---|---|---|---|---|
| | Yes | No | | |
| Educational status | | | | |
| No education | 98 | 63 | 1 | 1 |
| Educated | 134 | 34 | 2.534 (1.549 to 4.143) | 2.59 (1.2 to 5.58)* |
| Whom do you live with | | | | |
| Live alone | 25 | 16 | 1 | 1 |
| With spouse | 80 | 41 | 1.249 (0.601 to 2.596) | 0.52 (0.14 to 1.92) |
| With parents | 127 | 40 | 2.032 (0.988 to 4.179) | 1.95 (0.65 to 5.9) |
| Route of medication | | | | |
| Injection | 126 | 57 | 1 | 1 |
| Pill | 106 | 40 | 1.884 (1.169 to 3.037) | 3.2 (1.44 to 7.1)* |
| Presence of radio | | | | |
| No | 87 | 59 | 1 | 1 |
| Yes | 145 | 38 | 2.588 (1.591 to 4.21) | 2.02 (0.94 to 4.35) |
| Transportation mechanism | | | | |
| On foot | 17 | 13 | 1 | 1 |
| By car | 215 | 84 | 0.527 (0.247 to 1.124) | 4.07 (1.2 to 13.57)* |
| Time to reach the service | | | | |
| >1 hour | 74 | 37 | 1 | 1 |
| <1 hour | 158 | 60 | 0.67 (0.41 to 1.11) | 0.32 (0.12 to 0.82)* |
| Satisfied with the healthcare provider | | | | |
| Not satisfied | 15 | 11 | 1 | 1 |
| Satisfied | 217 | 86 | 1.85 (0.817 to 4.189) | 3.71 (0.99 to 13.96) |
| Use mobile phone as appointment reminder | | | | |
| No | 158 | 76 | 1 | 1 |
| Yes | 73 | 21 | 1.67 (0.958 to 2.919) | 2.64 (1.07 to 6.49)* |
| Time or place no calls are taken | | | | |
| No | 150 | 76 | 1 | 1 |
| Yes | 82 | 21 | 1.98 (1.14 to 3.44) | 0.498 (0.21 to 1.18) |
| Lock phone with passwords | | | | |
| No | 155 | 82 | 1 | 1 |
| Yes | 76 | 15 | 5.075 (2.567 to 10.03) | 4.6 (1.63 to 12.95)* |
| Others access the mobile phone | | | | |
| No | 144 | 79 | 1 | 1 |
| Yes | 88 | 18 | 2.68 (1.51 to 4.77) | 1.88 (0.84 to 4.23) |
| Automatic appointment reminder | | | | |
| No | 109 | 30 | 1 | 1 |
| Yes | 123 | 67 | 0.51 (0.31 to 0.84) | 1.71 (0.83 to 3.51) |

*Statistically significant (p <0.05).

tend to be from a higher socioeconomic class and more educated in comparison to patients with HIV/AIDS, which could possibly make them more likely to be willing to receive mobile phone-based health service.[48 49] Willingness to receive mobile phone-based diabetic health service was also higher than studies from Japan (50%),[50] and the USA (56.7%),[51] but lower than a study from Honduras chronic patients (>80%).[21] The difference might be due to the difference in the ICT development index and digital divide across countries that can potentially be reflected among the study participants.[22 23]

In this study, being educated is positively associated with willingness to receive mobile phone-based health services. This is in line with findings of the study conducted among patients on ART at the same hospital,[42] and with those of the Honduras study conducted among chronic patients.[21] The observed association is probably due to the fact that improved educational status is likely to lead to an increase in awareness about diabetic management, and to have better access to a mobile phone and mobile network.[49]

The current study shows that those taking medication in the form of a pill were more willing to receive mobile phone-based health services than those taking injectable insulin. This finding contradicts findings of a study from the USA.[52] The contradiction might be due to the fact that patients on non-insulin treatment in our study were having adherence problems, which resulted in them being more interested in using mobile phone-based health services.[53] In addition, forgetting medication might be higher among people who take pills than injections. This might have influenced their interest in receiving mobile phone-based health services.

In line with the study done in Honduras among chronic patients,[21] patients who reported using a car as a transportation mechanism were more likely to be willing to receive mobile phone-based health services than those who travel on foot. This may be because those who have access to improved transportation services might be in better socioeconomic conditions[54 55] and may have a better access to mobile phone network coverage and have reduced digital divide challenges,[50 56] which in turn might positively influence their decision to be willing to receive mobile phone-based health services.[54]

In this study, patients who travel <1 hour to receive health services are less likely to be willing to receive mobile phone-based health services compared with those who travel more than an hour. This contradicts with findings of the study done among patients on ART at the same setting, the University of Gondar Hospital.[42] This may be because patients who travel less time may prefer to consult their clinician face-to-face as they have a lower cost of transportation.[42] In addition, patients who travel less time might have a lower perceived expectation from technology than a face-to-face consultation.

Current use of mobile phones as an appointment reminder in this study is positively associated with willingness to receive mobile phone-based health services, which is in line with the study done in Honduras among chronic patients.[21] The positive association is probably due to the patients' improved awareness of the importance of mobile phones for diabetes care.[50 55 57]

The positive association between locking the mobile phone with a password and willingness to receive mobile phone-based health services observed in this study is in line with findings of the study among patients on ART done at the University of Gondar Hospital.[42] The association might be due to the perceived privacy and security protection of the information stored in their mobile phone offered by the use of the passwords.[58]

This study reports a large proportion of willingness to receive mobile phone-based health services. However, the study has limitations and we call for careful interpretation of the findings. First, the responses might have been affected by bias introduced by the interviewers. To reduce this bias, we trained the interviewers to standardise the interviewing procedures. Second, the study was conducted in one of the largest referral hospitals in Ethiopia based in a mid-size town. This affected the rural population to be under-represented in the study. Only one-third of the study participants owning mobile phones were from rural areas. One may argue this affects the generalisability of the study to all people with diabetes in Ethiopia. However, stratified analysis to compare willingness among respondents from rural and urban residence still shows a high (60%) willingness among rural residents, although it is lower than urban residents. Therefore, it looks feasible to introduce a text message and/or voice call-based mHealth interventions that may help patients tackle behavioural, self-management and adherence challenges.

## CONCLUSION

Access to mobile phones was found to be high. Among respondents who had access to mobile phones, willingness to receive mobile phone-based health services was also high. Educational status, route of medication, transportation mechanism, time to reach the service, current use of mobile phone as an appointment reminder and lock phone with passwords were significantly associated with willingness to receive mobile phone-based health services. Based on this result, implementing a mobile phone-based health services such as self-monitoring and adherence support, behavioural counselling and interventions targeting to improve the knowledge of patients to solve problem areas in diabetes might change the livelihood of patients with diabetes.

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