

Mothers Intention to Use Mobile Phone Text Message Reminders for Routine Child Vaccination in Northwest, Ethiopia

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Abstract

Background: The immunization program in most developing countries including Ethiopia is challenged by lack of effective methods to track vaccination schedules. With the unprecedented penetration of mobile devices in developing world, mHealth applications are being leveraged for different disease domains. Among the different factors that affect the use of mHealth interventions is the intention of end users to use the system. In this research, we aimed to fill the evidence gap by investigating mother's intention to use text-message reminders for vaccination in north-west, Ethiopia.

Methods: A cross-sectional study was conducted among 460 mothers presenting with their infants for vaccination at a health facility from October 1 to 26, 2018. A systematic random sampling technique was applied to select study participants. Data were collected using validated instrument. Descriptive statistics were computed and binary logistic regression analyses was used to assess factors associated with the outcome variable. The regression results were reported as AORs with their 95% CIs.

Results: Of 456 mothers included for analysis, 360 (78.9%) with 95% CI: (74.9% - 82.4%) of mothers have intention to use mobile phone text message reminders for vaccination. Of these, 270 (75%) also wanted to receive the reminders a day before the vaccination due date for the child. The preferred language for receiving reminders was Amharic language (58.1%). Mothers aged 35 years and above [AOR = 0.352; 95%CI: 0.149- 0.833], secondary education and above [AOR= 4.428; 95% CI: 2.046- 9.580], mobile phone use for more than two years [AOR= 3.627; 95%CI: 1.657-7.938], perceived usefulness [AOR: 6.372; 95%CI: 3.128-12.981] and perceived ease of use [AOR: 3.847; 95%CI: 2.061- 7.180] were predictors of intention to use mobile phone text message reminders for vaccination.

Conclusion: Majority of mothers have intention to use mobile phone text message reminders for child vaccination. Mother's age, education, duration of mobile phone use, perceived usefulness, and perceived ease of use were associated with intention of mothers to use mobile phone text message reminders for vaccination. Considering these predictors and user's preference could inform the implementation strategy for use of the mHealth supported text messaging interventions in the resource limited setting of Ethiopia.

Background

Timely completion and uptake of the childhood vaccination is key to reducing the high morbidity and mortality of vaccine-preventable diseases among infants globally. However, many children still miss scheduled vaccines in the Extended Program of Immunization (EPI) or are being vaccinated after the recommended ages (1,2). Adherence to childhood vaccination schedules is a function of various factors including the information gaps both from the service supply and demand sides (3).

The immunization program is also challenged with lack of effective methods to track vaccination schedules (4). Immunization programs usually involve the use of the child health card as a tool for reminding caregivers of children of the dates of their next vaccination (5). However, it was observed that majority of the mothers who missed their vaccination appointment were due to forgetfulness and

difficulty in tracking vaccination schedules indicating a need to identify more innovative approaches (6–8).

With the continuous growth of mobile network coverage and unprecedented penetration of mobile devices, leveraging mHealth applications in health sector is becoming popular (9). By the end of 2018, 5.1 billion people around the world subscribed to mobile services, accounting for 67% of the global population (10). In the same year, the mobile subscribers in Ethiopia reached 44% (11). A study conducted on mobile phone access in Gondar city among pregnant women reported that 76.7% of mothers owned a mobile phone (12).

Mobile health (mHealth) is the use of mobile phone technology to deliver health care (13). mHealth is now extensively used in healthcare and there is a growing global trend in harnessing this technology for behavior change, disease surveillance, prevention and control of various health problems and enhancing attendance for health services. Hence, the field of mHealth, has been proposed as a potential solution to many of the challenges that developing countries face (14–22).

mHealth applications and programs make use of several aspects of mobile technology such as text messaging, voice and video services (13). Short message service (SMS) is widely applicable appointment reminder intervention to improve health care seeking behaviors considering participant characteristics such as forgetfulness and lack of knowledge (23–25). Text messaging is a potential tool for health care improvement for several reasons; applicability on almost every model of mobile phone, relatively low cost, widespread, does not require technological expertise, and widely applicable to a variety of health behaviors and conditions (26,27).

When introducing mobile phone based health services, it is critical to study the factors that influence user intention to adopt those services (28). Hence, investigating user's intention, preference and engagement is crucial (29–34) to design more effective mHealth interventions (35,36). Cultural and contextual differences should also be considered when developing text message reminder systems (28,37,38).

Although text messaging has expanded in popularity worldwide, there is limited evidence on user's intention and preference in Ethiopia, particularly in the study area. Therefore, this study aimed to assess the intention of mothers and its associated factors to use of mobile phone text message appointment reminders for routine vaccination in Gondar city, north-west, Ethiopia.

Methods

Study design and setting

A health-facility based cross sectional study was conducted from October 1 to October 26, 2018 in Gondar city administration, northwest, Ethiopia. Gondar city administration has a total of 24 Keble's (13 urban and 11 rural). The city administration had an estimated total population of 390, 644. Of which,

12,149 were under one year of age. The city administration has also a total of 23 public health facilities (one comprehensive specialized hospital, eight health centers and fourteen health posts (39).

Source and study populations

The source population consisted of mothers paired with infants attending the vaccination units at health facilities. The study population included those eligible mother-infant pairs who visited the selected health facilities during the study period.

Inclusion and exclusion criteria

Those mothers of infants who visited vaccination units of health facilities and remaining with at least one vaccination appointment were included. Mothers who resided in the study area for at least 6 months prior to the study period and who owned mobile phone were included for this particular study. Mothers whose infants had already received the last doses of vaccines were excluded from the study.

Sample size and sampling procedures

We could not find any study conducted in Ethiopia to determine the intention of mothers to use text message reminders for routine vaccination. Therefore, we did pilot study to determine the proportion of those mothers who have intention to use the text message reminders and it was found to be 77.6%. Finally, the sample size required for this particular study was calculated by considering the following assumptions; proportion of intention to use text message reminder for child vaccination as 77.6% (from pilot study), 95% CI and 4% margin of error. With this assumptions, the sample size was 418. Taking 10% non-response rate, the final sample size was 460.

All the eight health centers and the comprehensive specialized hospital in Gondar city were included for this study. The sample in each health facility were allocated proportional to the number of clients who attended vaccination schedules in the same period of the previous year. A systematic random sampling technique was applied to select the study participants.

Study variables

The outcome variable was intention to use text message reminder for vaccination. Based on the technology acceptance model; perceived ease of use and perceived usefulness were considered as predictor variables for this study (40). Additionally, the socio-demographic characteristics of mothers were included as predictors for the outcome of interest.

Intention to use mobile text message reminders was defined as the user's likelihood to use mobile phone text message reminders for child vaccination. (28,29,41–43). Perceived ease of use was defined as the extent to which a person believes that using a particular system (in this case the text message reminder) would be free from effort (28,29,41,42). Perceived usefulness was defined as the degree to which a person believes that using a particular system (in this case the text message reminder) would enhance his or her task (in this case timely vaccination of children) (28,29,41,42).

All items were measured on a 5-point likert-type scale ranging from “strongly disagree” (score 1) to “strongly agree” (score 5). Item scores for each composite variable were summated and averaged to create variable scales for data analysis (44,45). Finally the composite variables were dichotomized based on the average scores taking 3 as cut of point. Hence, those variables with average score of higher than 3 were categorized as “Yes” while those variables with average score lower than or equal to 3 were categorized as “No” (46,47).

The household socio-economic status was created by principal components analysis (PCA), including variables on asset ownership, housing characteristics and ownership of animals and farming. This was done for urban and rural households separately. Urban and rural households PCA loading scores were merged for household wealth index classification using quintiles. Finally, the merged scores for urban and rural were divided into three quintiles as poor, middle and rich households (48).

Data collection tools and procedures

Data collection instrument for this study was adapted from the scales used in the technology acceptance model (TAM) which has four major variables: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Behavioral Intention (BI) and actual use. The scales perceived usefulness and perceived ease of use were adapted from Davis’s study (42) and the scale intention to use was adapted from Venkatesh et al’s study (46) to fit the study context. During adaption, the data collection instrument underwent forward and backward translation. Face and content validity of the data collection instrument was assessed by six experts and the proposed changes from the expert panels were considered for refinement of the data collection instrument.

Then, prior to the actual data collection, pilot study was done out of the study area, in health facilities of Bahir Dar city administration with a sample size of 100. The results of the pilot study were used to assess the validity and reliability of the data collection instrument. The internal consistency for each dimension of the data collection instrument was checked using Cronbach’s alpha and scores on perceived usefulness (Cronbach alpha = 0.95), perceived ease of use (Cronbach alpha = 0.91) and intention to use text message reminders (Cronbach alpha = 0.93) were deemed acceptable.

Finally, nine data collectors and three supervisors were recruited for the actual data collection. Training was given to data collectors and supervisors on the data collection tools and procedures.

Mothers who visited the selected health facilities for their infant’s vaccination were approached for interviews. Face to face interview technique was used to collect data from eligible study participants using the validated data collection instrument.

Data processing, analysis and parameter estimation methods

The data were checked for completeness, entered into Epi-data version 3.1 and exported to STATA version 14 software for analysis. Descriptive statistics on frequencies and percentages were computed and have

been presented using graphs and tables. Binary logistic regression analysis model was used to identify the predictor variables for intention to use text message reminders for child vaccination. Those independent variables which had p-value of less than 0.2 during the bivariable logistic regression analysis were considered for the multivariable logistic regression analysis. Then, the results were reported as Adjusted Odds Ratio (AOR) with their 95% CIs.

The presence of multicollinearity was checked among independent variables using Variance Inflation Factor (VIF) at cut off point of 10. Finally, Hosmer and Lemshow goodness of fit test was used to check the model fitness (49).

Ethical considerations

Ethical approval was obtained from the University of Gondar ethical review board before the commencement of the study. Study permission was sought at all levels of governmental administration systems including health offices and health facilities. Informed written consent was obtained from each study participant. Moreover, confidentiality assurance was provided to study participants on any information provided by them and their privacy was kept during data collection.

Results

Socio-demographic characteristics

This study considered a sample size of 460 with a response rate of 99.1%. As shown in Table 1, 260 (57%) mothers belonged to an age group of 25–34 years. Majority of the mothers were currently married (90.8%), orthodox by religion (87.5%) and more than half (54.8%) of the mothers attained secondary education and above [Table 1].

Pertaining to occupation of the mothers, the largest 263 (57.7%) of the total mothers were housewife's followed by merchants 89 (19.5%). The study also indicated that vast majority (93.9%) of the mothers were resided in urban kebele's [Table 1].

Table 1

Socio-demographic characteristics of mothers who vaccinated their infant's in health facilities of in Gondar city administration, north-west Ethiopia, 2018 [N = 456]

Characteristics		Total (%)
Age of mother	≤ 24	138 (30.3)
	25–34	260 (57.0)
	≥35	58 (12.7)
Marital status	Married	414 (90.8)
	Others	42 (9.2)
Religion	Orthodox	399 (87.5)
	Muslim	45 (9.9)
	Others	12 (2.6)
Mother's education	No formal education	62 (13.6)
	Primary	144 (31.6)
	Secondary and above	250 (54.8)
Mother's occupation	Housewife	263 (57.7)
	Employed	60 (13.2)
	Merchant	89 (19.5)
	Others	44 (9.6)
Residence	Rural	28 (6.1)
	Urban	428 (93.9)
Family size	< 5	304(66.7)
	≥5	152 (33.3)
Household wealth Index	Poor	153(33.6)
	Middle	152 (33.3)
	Rich	151 (33.1)
Distance to health facility (in minutes)	<15Minute	192 (42.1)
	15-30Minute	213 (46.7)
	>30Minute	51 (11.2)

Mobile phone utilization

Three hundred twenty four (71.1%) of the mothers have been using mobile phones for more than two years and 232 (50.9) of the mothers were using smart phones. Mobile phone network challenges were encountered by 41 (8.9%) of the participants and 36 (7.9%) encountered a problem to keep their mobile phones charged. Regarding text message use, 415 (91%) and 398 (87.3%) of the mothers can read and send mobile text messages respectively. Pertaining to phone sharing, 56 (12.3%) shared their mobile phones to household members [Table 2].

Table 2

Mobile phone utilization of mothers who vaccinated their infant's in health facilities of Gondar city administration, north-west, Ethiopia, 2018

Characteristics		Total (%)
Duration of mobile phone use	< 1 year	54 (11.8)
	1–2 years	78 (17.1)
	> 2 years	324 (71.1)
Type of current mobile phone	Standard	232 (50.9)
	Smart	224 (49.1)
Changed phone number in the last 12 months	No	425 (93.2)
	Yes	31 (6.8)
Have additional phone number	No	411 (90.1)
	Yes	45 (9.9)
Experienced mobile network challenges	No	415 (91.1)
	Yes	41 (8.9)
Problem keeping a mobile phone charged	No	420 (92.1)
	Yes	36 (7.9)
Switch off mobile phone during day time	No	427 (93.6)
	Yes	29 (6.4)
Can read mobile text message	No	41 (9)
	Yes	415 (91)
Can send mobile text message	No	58 (12.7)
	Yes	398 (87.3)
Shared mobile phone with others in the house	No	400 (87.7)
	Yes	56 (12.3)

Intention to use text message reminders for child vaccination

In this study, 360 (78.9%) with 95% CI: (74.9% – 82.4%) of mothers intended to use text message reminders for child vaccination, if offered the opportunity. Three hundred eighty-eight (85.1%) of the mothers perceived the mobile phone based text message reminders as useful to child vaccination.

Similarly, 359 (78.7%) of the mothers perceived the mobile phone based text message reminders for child vaccination as easy to use [Figure 1].

Preference of mothers to receive text message reminders for child vaccination

Most of the mothers preferred receiving text message reminders starting the first vaccination appointment (47.8%) followed by second vaccination appointment (31.1%). Regarding the number of text messages, around two third (64.2%) preferred to receive one text message reminder per each vaccination appointment. The study also indicated that three fourth (75%) and 131 (36.4) of the mothers wanted to receive the text message reminder a day before the due date and on the due date of the vaccination appointment respectively. Regarding language preference, more than half (58.1%) of the mothers would prefer to receive text messages in local (Amharic) language while 38.9% preferred to receive the text message in both Amharic and English languages [Table 3].

Table 3

Preference of mothers to receive text message reminders for child vaccination in Gondar city administration, north-west, Ethiopia, 2018 [N = 360]

Characteristics		Total (%)
Preferred appointment to begin receiving reminders	First appointment	172 (47.8)
	Second	112 (31.1)
	Third	47 (13.1)
	Fourth	29 (8.1)
Preferred number of text messages per visit	One	231 (64.2)
	Two	115 (31.9)
	Three	14 (3.9)
Preferred date to receive text message reminders	On due date	131 (36.4)
	A day before due date	270 (75)
	Two days before due date	82 (22.8)
	Three days before due date	16 (4.4)
	Others	4 (1.1)
Preferred time of the day for receiving text message reminders	Morning (6:01am-before 12am)	86 (23.9)
	Afternoon (12am- 6 pm)	147 (40.8)
	Evening (6:01 pm-12 pm)	30 (8.3)
	Any time	97 (26.9)
Preferred language	Amharic only	209 (58.1)
	Both Amharic and English	140 (38.9)
	English only	11 (3.1)

Predictors of intention to use text message reminders for child vaccination

The bivariable analysis indicated that age, mother's education, mother's occupation, marital status, household wealth index, place of residence, duration of mobile phone use, mobile phone type, perceived ease of use and perceived usefulness were significantly associated ($p < 0.2$) with intention of mothers to use text message reminders for child vaccination. In the final multivariable logistic regression model the variables age, mother education, duration of mobile phone use, perceived ease of use and perceived usefulness were found to have statistically significant association with intention of mothers to use text message reminders for vaccination.

As shown in Table 4, mothers above 35 years of age were 65% less likely [AOR = 0.352; 95%CI: 0.149–0.833] to have intention to use text message reminders for child vaccination than those who are less than 25 years of age after controlling for other variables. Mothers who had primary education were 2.7 times more likely [AOR = 2.749; 95%CI: 1.249–6.053] and who had secondary education and above were 4.4 times more likely [AOR = 4.428; 95%CI: 2.046–9.580] to have intention to use text message reminders for child vaccination than those who had no formal education after controlling for other variables.

After controlling for other factors, mothers who used mobile phones for more than two years were 3.6 times more likely [AOR = 3.627; 95%CI: 1.657–7.938] to have intention to use text message reminders for child vaccination as compared to those who used mobile phone for less than one year. The study also indicated that perceived ease of use has a positive and significant effect on mother's intention to use text message reminders for child vaccination. Keeping other factors constant, those who perceived the text message reminder as easy to use were 3.8 times more likely [AOR: 3.847; 95%CI: 2.061–7.180] to have intention to use text message reminders for child vaccination as compared to their counterparts. Similarly, mothers who perceived the text message reminder as useful were 6.3 times more likely [AOR: 6.372; 95%CI: 3.128–12.981] to have intention to use text message reminders for child vaccination as compared to their counterparts.

In the final multivariable model, marital status, occupation, household wealth index and the type of mobile phone mothers are currently using didn't have a statistically significant association with intention of mothers to use mobile phone text message reminders for child vaccination.

Table 4

Bivariable and multivariable regression analysis of factors associated with intention to use text message reminders for child vaccination in Gondar city, northwest, Ethiopia, 2018

Characteristics		Intention to use [N]		COR [95% CI]	AOR [95% CI]
		No	Yes		
Age of mother	≤ 24	23	115	1	1
	25–34	48	212	0.883[0.511, 1.525]	0.766 [0.379, 1.551]
	≥35	25	33	0.263 [0.132, 0.524]	0.352 [0.149, 0.833]
Mother's Education	No formal education	33	29	1	1
	Primary	29	115	4.512[2.369, 8.592]	2.749 [1.249, 6.053]
	Secondary and above	34	216	7.229[3.903, 13.386]	4.428 [2.046, 9.580]
Marital status	Married	81	333	1	1
	Others	15	27	0.437[0.222, 0.861]	0.628 [0.241, 1.635]
Mother's occupation	Housewife	60	203	1	1
	Employed	11	49	1.316[0.644, 2.690]	0.940 [0.369, 2.394]
	Merchant	11	78	2.095 [1.047, 4.194]	1.194 [0.503, 2.834]
	Others	14	30	0.633[0.315, 1.271]	0.910 [0.359, 2.305]
Household wealth index	Poor	50	103	1	1
	Middle	24	128	2.588 [1.491, 4.494]	1.272 [0.603, 2.682]
	Rich	22	129	2.846[1.618, 5.004]	1.149[0.507, 2.605]
Duration of mobile phone use	< 1 year	21	33	1	1
	1–2 years	31	47	0.964[0.474, 1.963]	1.084 [0.450, 2.611]
	> 2 years	44	280	4.049 [2.150, 7.624]	3.627 [1.657, 7.938]

Type of current mobile phone	Standard	66	166	1	1
	Smart	30	194	2.571 [1.592, 4.149]	1.407 [0.687, 2.881]
Perceived ease of use	Not easy	50	47	1	1
	Easy	46	313	7.238 [4.371, 11.986]	3.847 [2.061, 7.180]
Perceived usefulness	Not useful	37	31	1	1
	Useful	59	329	6.655 [3.832, 11.556]	6.372 [3.128, 12.981]

Multicollinearity and model fitness

Multi-collinearity test was performed for the variables included in the final multivariable model. Hence, the variable place of residence had a VIF value of 12.3 and removed from the final model due to its multicollinearity effect. The final model fitness was also assessed using Hosmer and Lemshow test. The Hosmer and Lemshow test showed that the model fits the data well (P-value of 0.905).

Discussion

In this study, mothers have high perceived usefulness, perceived ease of use and intention to use mobile phone text message reminders for their infant's vaccination. Mother's age, educational status, duration of mobile phone use, perceived ease of use and perceived usefulness were significantly associated with intention of mothers to use mobile phone-based text message reminders for child vaccination. Mothers preferred to receive mobile phone based text messages one day before the due date of vaccination and in Amharic (local) language.

This study indicated that majority of the mothers have intentions to use text message reminders for child vaccination. This finding corroborated findings from a study in Lagos Nigeria where most mothers indicated a willingness to receive reminder text messages for vaccination appointments through mobile phones (50). A willingness study on pregnant women in Gondar city also reported consistent finding where around three fourth of women were willing to receive text messages (12). However, this finding was slightly higher than a finding from another study in Nigeria (35). On the other hand, this finding is lower than a study finding from Kenya (9). The difference might be due to the difference in the ICT infrastructure and investment in digitalization across countries that can potentially be reflected among the study participants intention to use mobile technologies for health service.

In this study, older mothers were less likely to use text message reminders for child vaccination in the future that is consistent with studies conducted in Ethiopia among pregnant women (12) and ART patients (51). A study from China also indicated that young individuals are more open to new technologies (52). Evidences also indicated that younger population has higher tendency of interacting to

new technological products including mHealth with more control over ICT to adapt to the operating procedures (53,54).

Educational status of mothers was also positively associated with their intention to use mobile phone-based text message reminders for child vaccination. This finding is in accordance with other studies (6,30,50,52,55). This may be explained by the fact that educated women are likely to be aware of incoming text messages and are likely to read and act on the received messages promptly. Evidence also showed that literacy status was shown to be an issue in text message reminder system implementation that has to be addressed when text message reminder system is being planned for implementation (26). A potential drawback to implementing a mobile phone based text messaging intervention is that it requires the recipient to have an adequate level of literacy, marginalizing some population groups who could potentially benefit from the mHealth intervention (22). In our study population this could affect around 14% of women having no formal education.

In this study duration of mobile phone use was found to positively affect intention of mothers in receiving text message reminders for child vaccination. Another study also indicated that offering experienced people an opportunity to get acquainted with an e-Health application will increase their intention to use e-Health in future (55). These days, as clients often use mobile phones in their daily activities for longer duration, it may reflect their intention towards the usage of their mobile phones for additional services including health care (56).

The study also found that perceived usefulness has a positive significant association with intention of mothers to use text message reminders for child vaccination. This finding is consistent with other studies where users who did not believe in the possible advantages of e-Health were less inclined to use e-Health (52,55,57,58). If the users perceived that the new system can provide useful health information and improve performance, then this usefulness will directly lead to the intention to use the proposed system (56,57,59). End users need to perceive the system as being useful or they will not attempt to use it regardless of how easy or difficult it is to use. Therefore, during system development, there is a need to ensure that the system will improve the intended health outcomes (26,56).

The findings also showed that perceived ease of use was positively associated with intention of mothers to use text message reminders for child vaccination. This finding corroborates with findings of other studies (45,52,55,57). When users have no or little previous experience of using a system, they usually pay more attention to the system's ease of use. This implies that users would be unwilling to use a new mHealth service regardless of how useful the system would be, if they perceive it to be difficult to use. Research also showed that users will stop using mHealth interventions that are not user friendly (45). Difficulty in using a new system could be solved if the user thinks that the system will be useful to them. One study reported that training users on the new mobile health technology improves perceived ease of use and, thereby, increases intention to use the actual system (45). Hence, deployment of new mHealth service may require extra guidance on how to operate and use the new system for improved implementation (26, 56).

Mobile services are mainly designed for individual users, who may have different expectations and needs in accordance with their preferences. In order to develop an effective text message reminder system for vaccination, parental preferences must be fully understood and taken into consideration (54). In this study, more than half of mothers would like to receive the text message reminders in Amharic (local) language. This finding is consistent with evidence from India (27). In contrary, from studies in Nigeria (8,30,50) and Kenya (60) majority of the mothers preferred English language for reminders on their mobile phones which could be attributed to their high literacy levels.

For successful implementation of mHealth programs, clients should be able to choose when and how frequently they would receive text messages (22). The findings of this study indicated that majority of mothers preferred to receive one text message reminder per each vaccination appointment. The optimal timing most preferred by mothers for receiving the text message reminders is the day preceding the vaccination appointment date which corroborates the findings in other studies (6,35,50). This might be due to the fact that sending text messages to mothers one day before their vaccination appointments will increase the chances of the messages being seen and help them to get prepared for their child vaccination appointments ahead of time.

The time of day at which mothers would receive text messages varied greatly. In this study afternoon is the most preferred time of the day to receive text message reminders which is consistent with another study (54). On the other hand in a study from Nigeria, about two fifths of mothers were willing to receive reminder text messages any time of the day (4).

This study also showed that marital status, mother's occupation, household wealth index and type of current mobile phone were not found to have a statistically significant association with intention of mothers' to use mobile text messages for child vaccination. In another study it was also reported that the type of mobile phone didn't have significant association with intention to use SMS reminders (12). Thus, the type of mobile phone the mother had and the differences in economic status would not be a major challenge for implementing text message reminder interventions for child vaccination. Though it didn't have significant effect in another study (12) the variable place of residence has been removed from the final model due to its multicollinearity effect.

Implications for practice and research

This study has practical implications in particular for immunization program managers. Given the high proportion of mothers who had intention to use mobile phone-based text message reminders for vaccination, incorporating mobile text messages is a promising avenue to strengthen the routine immunization program in Ethiopia. If designed appropriately by considering users preference in terms of frequency, timing and language; text message based mHealth interventions may be an innovative way for engaging users in care for improved child vaccination outcomes. The study also provides a basis for further interventional studies that can develop and assess effectiveness of mobile text messaging interventions as a tool to improve the routine immunization program in Ethiopia.

Limitations

The findings of this study should be interpreted in light of some limitations. First, we studied intention for text message based appointment reminder for those who already has mobile phone and visiting vaccination units of health facilities in north-west, Ethiopia. So, the findings may not be generalizable to the population of entire country particularly for those residing in rural areas.

As most mHealth programs focus on those with mobile phones, a potential drawback to the use of mobile phone based text-message-reminders is potential marginalization of certain populations, such as those that do not have a mobile phone. In the study area, it has been reported in another study that three-fourth of pregnant women owned a mobile phone (12) who actually are eligible for mHealth implementation. Finally, supplying mobile phones for those mothers who do not have mobile phones would not be a sustainable approach during actual implementation of mHealth interventions. However, these limitations may be reduced as mobile technology advances and mobile subscriptions grow in developing countries. In addition, further study would be helpful to assess the needs of the population that is not eligible for mHealth interventions and explore available methods to reach them. Secondly, the responses might have been affected by bias introduced by the interviewers. To reduce this bias, we trained the interviewers and standardized the interviewing procedures.

Conclusion

In this study, we found that majority of mothers have intention to use mobile phone text message reminders for child vaccination. Most of the mothers also would like to receive the text message reminders in Amharic (local) language one day before the vaccination due date. Predictors of mothers' intention to use mobile phone text message reminders include mother's age, mother's education, duration of mobile phone use, perceived ease of use and perceived usefulness of the proposed system.

Considering these predictors and user's preference could inform the implementation strategy for use of the mHealth supported text messaging interventions in the resource limited setting of Ethiopia. Program planners should also consider utilizing mobile text message reminders as a strategy to increase adherence to vaccination services. Taking in to account the findings of this study, development of automated mobile phone based text message reminder system and testing its effectiveness is recommended.

Abbreviations

AOR:Adjusted Odds Ratio; CI:Confidence Interval; EPI:Expanded Program on Immunization; FMOH:Federal Ministry of Health; ICT:Information Communication Technology; mHealth:Mobile Health; PEU:Perceived Ease of Use; SMS:Short Message Service; TAM:Technology Acceptance Model; WHO:World Health Organization

Declarations

Ethics approval and consent to participate

This study obtained ethical approval from University of Gondar Institutional Ethical Review Board (ref no: O/V/P/RCS/05/060/2018). In addition, study permission was acquired at all levels and informed written consent was obtained from study participants.

Consent for publication

Not applicable

Availability of data and materials

The datasets used for this particular study will be available from the corresponding author up on reasonable request

Competing interests

The authors declare that they have no competing interests

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Author's contributions

ZAM conceived the study. KAG, MW and BT guided the design and conduct of the study. All the authors were involved in data analysis and manuscript write-up. All authors read and approved the final manuscript.

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References

1. Machingaidze S, Wiysonge CS and Hussey GD. Strengthening the Expanded Programme on Immunization in Africa: Looking beyond 2015. *PLoS Med.* 2013.
2. Patel TA and Pandit NB. Why infants miss vaccination during routine immunization sessions? Study in a rural area of Anand District, Gujarat. *Indian J Public Health.* 2011;55(4):321–3.
3. Ahlers-Schmidt CR, Chesser AK, Paschal AM and Hart TA, Williams KS, Yaghmai B, et al. Parent opinions about use of text messaging for immunization reminders. *J Med Internet Res.* 2012;14(3):1–10.

4. Oladepo O, Dipeolu IO and Oladunni O. Nigerian rural mothers' knowledge of routine childhood immunizations and attitudes about use of reminder text messages for promoting timely completion. *J Public Health Policy*. 2019.
5. FMOH. Ethiopia national expanded programme on immunization comprehensive multi- multi - year plan 2016 – 2020. Federal Ministry of Health , Addis Ababa. 2016.
6. Odinaka K, Edelu B and Achigbu K. Acceptance of mobile phone short message service for childhood immunisation reminders by Nigerian mothers. *Port Harcourt Med J*. 2018.
7. Abahussin AA and Albarrak AI. Vaccination adherence: Review and proposed model. *J Infect Public Heal*. 2016/10/30. 2016;9(6):781–9.
8. Akinrinade OT, Ajayi IO, Fatiregun AA, Isere EE and Yusuf BO. Ownership of mobile phones and willingness to receive childhood immunisation reminder messages among caregivers of infants in Ondo State, South-Western Nigeria. *SAJCH South African J Child Heal*. 2018.
9. Kazi AM, Carmichael J-L, Hapanna GW, Wangoo PG, Karanja S, Wanyama D, et al. Assessing Mobile Phone Access and Perceptions for Texting-Based mHealth Interventions Among Expectant Mothers and Child Caregivers in Remote Regions of Northern Kenya: A Survey-Based Descriptive Study. *JMIR Public Heal Surveill*. 2017;3(1):e5.
10. Global System for Mobile Communications Association. *The Mobile Economy*, 2019.
11. The World Bank. Ethiopia Digital Foundations Project. Project Information Document,2019.
12. Endehabtu B, Weldeab A, Were M, Lester R, Worku A and Tilahun B. Mobile Phone Access and Willingness Among Mothers to Receive a Text-Based mHealth Intervention to Improve Prenatal Care in Northwest Ethiopia: Cross-Sectional Study. *JMIR Pediatr Parent*. 2018;1(2):e9.
13. John R.Giudicessi, BA.Michael J.Ackerman. 2013. Text Messaging as a Tool for Behavior Change in Disease Prevention and Management. *Bone* [Internet]. 2008;23(1):1–7. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3624763/pdf/nihms412728.pdf>.
14. Lin C-L, Mistry N, Boneh J, Li H, Lazebnik R. Text Message Reminders Increase Appointment Adherence in a Pediatric Clinic: A Randomized Controlled Trial. *Int J Pediatr*. 2016.
15. WHO. mHealth New horizons for health through mobile technologies. Based on the findings of the second global survey on eHealth. 2011.
16. Nathan Georgette, Mark J. Siedner BZ. the acceptability and percieved usefulnes of weekly sms to promote HIV antiretroviral medication adherence in KwaZulu-Natal. *AIDS Behav*. 2017;20(11):2629–38.
17. Jemere AT, Yeneneh YE, Tilahun B, Fritz F, Alemu S, Kebede M. Access to mobile phone and willingness to receive mHealth services among patients with diabetes in Northwest Ethiopia: A cross-sectional study. *BMJ Open*. 2019;9(1):1–11.
18. Kebede M, Zeleke A, Asemahagn M, Fritz F. Willingness to receive text message medication reminders among patients on antiretroviral treatment in North West Ethiopia: A cross-sectional study. *BMC Med Inform Decis Mak*. 2015;15(1):1–10.

19. Domek GJ, Contreras-Roldan IL, O'Leary ST, Bull S, Furniss A, Kempe A, et al. SMS text message reminders to improve infant vaccination coverage in Guatemala: A pilot randomized controlled trial. *Vaccine*. 2016/03/31. 2016;34(21):2437–43.
20. Hotenzia, Wakadhaa Subhash C, Werea EV, Rubina A, Obora D, Levineb OS, Gibsonb DG, et al. The feasibility of using mobile-phone based SMS reminders and conditional cash transfers to improve timely immunization in rural Kenya. *Vaccine*. 2012.
21. Higgs ES, Goldberg AB, Labrique AB, Cook SH, Schmid C, Cole CF, et al. Understanding the role of mhealth and other media interventions for behavior change to enhance child survival and development in low-and middle-income countries: An evidence review. *Journal of Health Communication*. 2014.
22. Cormick G, Kim NA, Rodgers A, Gibbons L, Buekens PM, Belizán JM, et al. Interest of pregnant women in the use of SMS (short message service) text messages for the improvement of perinatal and postnatal care. *Reprod Health*. 2012;9(1):1–7.
23. Albino S, Tabb KM, Requena D, Egoavil M, Pineros-leano MF, Zunt JR, et al. Perceptions and Acceptability of Short Message Services Technology to Improve Treatment Adherence amongst Tuberculosis Patients in Peru: A Focus Group Study. 2014;9(5):1–6.
24. Brown VB, Oluwatosin A, Ogundeji MO. Experiences, perceptions and preferences of mothers towards childhood immunization reminder/recall in Ibadan, Nigeria: a cross-sectional study. *Pan Afr Med J*. 2015;20:243.
25. Kalan R, Wiysonge CS, Ramafuthole T, Allie K, Ebrahim F, Engel ME. Mobile phone text messaging for improving the uptake of vaccinations: A systematic review protocol. *BMJ Open*. 2014;4(8):1–5.
26. Manakongtreecheep K. SMS-reminder for vaccination in Africa: research from published, unpublished and grey literature. *Pan Afr Med J*. 2017;27(Supp 3):23.
27. Datta SS, Ranganathan P, Sivakumar KS. A study to assess the feasibility of text messaging service in delivering maternal and child healthcare messages in a rural area of Tamil nadu, India. *Australas Med J*. 2014;7(4):175–80.
28. Gao S, Krogstie J, Siau K. Developing an instrument to measure the adoption of mobile services. *Mob Inf Syst*. 2011.
29. Karkonasasi K, Yu-n C, Mousavi SA. Intention to Use SMS Vaccination Reminder and Management System among Health Centers in Malaysia: The Mediating Effect of Attitude. 2011.
30. Ibraheem RM, Akintola MA. Acceptability of reminders for immunization appointments via mobile devices by mothers in Ilorin, Nigeria: A cross-sectional study. *Oman Med J*. 2017.
31. Chao CM. Factors determining the behavioral intention to use mobile learning: An application and extension of the UTAUT model. *Front Psychol*. 2019.
32. Lepère P, Touré Y, Bitty-Anderson AM, Boni SP, Anago G, Tchounga B, et al. Exploring the patterns of use and acceptability of mobile phones among people living with HIV to improve care and treatment: Cross-sectional study in three francophone West African Countries. *JMIR mHealth uHealth*. 2019.

33. Aranda-Jan CB, Mohutsiwa-Dibe N, Loukanova S. Systematic review on what works, what does not work and why of implementation of mobile health (mHealth) projects in Africa. BMC Public Health. 2014.
34. Zaunbrecher BS, Kowalewski S, Ziefle M. The willingness to adopt technologies: A cross-sectional study on the influence of technical self-efficacy on acceptance. Lect Notes Comput Sci (including Subser Lect Notes Artif Intell Lect Notes Bioinformatics). 2014;8512 LNCS(PART 3):764–75.
35. Ibraheem RM, Akintola MA, Abdulkadir MB, Adeboye MA, Mohammad MJ. A comparative analysis of mothers ' preference for specific type of phone-derived reminders for routine immunization appointments in Ilorin , Nigeria. J Med Trop 2018;20:42-8.
36. Vital Wave Consulting. mHealth in Ethiopia: Strategies for a New Framework. 2011;1–65;
37. El-Wajeeh M, H. Galal-Edeen PG, Mokhtar DH. Technology Acceptance Model for Mobile Health Systems. IOSR J Mob Comput Appl. 2014;1(1):21–33.
38. Bastawrous A, Armstrong MJ. Mobile health use in low-and high-income countries: An overview of the peer-reviewed literature. J R Soc Med. 2013;106(4):130–42.
39. Gondar City Health Department . Gondar city administration health office report, 2018.
40. Lee Y, Kozar KA, Larsen KRT. The Technology Acceptance Model: Past, Present, and Future. Commun Assoc Inf Syst. 2003;12(March).
41. Sek YW, Lau SH, Teoh KK, Law CY, Parumo S Bin. Prediction of user acceptance and adoption of smart phone for learning with Technology Acceptance Model. J Appl Sci. 2010.
42. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Q Manag Inf Syst. 1989.
43. Amoroso DL, Hunsinger S. Measuring the Acceptance of Internet Technology by Consumers Measuring the Acceptance of Internet Technology by Consumers. 2009;3:48–81.
44. Venkatesh V, Davis FD. A Model of the Antecedents of Perceived Ease of Use: Development and Test. Decis Sci. 1996.
45. Park DY, Goering EM, Head KJ, Bartlett Ellis RJ. Implications for Training on Smartphone Medication Reminder App Use by Adults With Chronic Conditions: Pilot Study Applying the Technology Acceptance Model. JMIR Form Res. 2017;1(1):e5.
46. Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: Toward a unified view. MIS Q Manag Inf Syst. 2003.
47. Gagnon MP, Orruño E, Asua J, Abdeljelil A Ben, Emparanza J. Using a modified technology acceptance model to evaluate healthcare professionals' adoption of a new telemonitoring system. Telemed e-Health. 2012.
48. Shea Oscar Rutstein and Kiersten Johnson. The DHS Wealth Index. DHS Comparative Reports No. 6. Calverton, Maryland: ORC Macro. 2004.
49. D. Hosmer and S. Lemeshow . Applied Logistic Regression. Second Edition. 2000.

50. Balogun MR, Sekoni AO, Okafor IP, Odukoya OO, Ezeiru SS, Ogunnowo BE, et al. Access to information technology and willingness to receive text message reminders for childhood immunisation among mothers attending a tertiary facility in Lagos, Nigeria. *SAJCH South African J Child Heal*. 2012;6(3):76–80.
51. Kebede M, Zeleke A, Asemahagn M, F. F. Willingness to receive text message medication reminders among patients on antiretroviral treatment in North West Ethiopia:a cross-sectional study. *BMC Med Inf Decis Mak*. 2015.
52. Deng Z, Hong Z, Ren C, Zhang W, Xiang F. What predicts patients' adoption intention toward mhealth services in China: Empirical study. *JMIR mHealth uHealth*. 2018;6(8):1–14.
53. Zhao Y, Ni Q, Zhou R. What factors influence the mobile health service adoption? A meta-analysis and the moderating role of age. *Int J Inf Manage*. 2018;43(October 2017):342–50.
54. Annika M. Hofstetter a Celibell Y. Vargas a, Allison Kennedy c, Ken Kitayama a, Melissa S. Stockwell b. Parental and provider preferences and concerns regarding text message reminder/recall for early childhood vaccinations. *Prev Med (Baltim)*. 2013.
55. De Veer AJE, Peeters JM, Brabers AEM, Schellevis FG, Rademakers JJDJM, Francke AL. Determinants of the intention to use e-health by community dwelling older people. *BMC Health Serv Res*. 2015;15(1):1–9.
56. Puhan MA, Chandra D, Mosenifar Z, Ries A, Make B, Hansel NN, et al. Trust, Perceived Risk, Perceived Ease of Use and Perceived Usefulness as Factors Related to mHealth Technology Use. *Study Heal Technol Inf*. 2017;37(4):784–90.
57. Tao D. Intention to use and actual use of electronic information resources: further exploring Technology Acceptance Model (TAM). *AMIA Annu Symp Proc*. 2009;2009:629–33.
58. Liébana-Cabanillas F, de Luna IR, Montoro-Ríosa F. Intention to use new mobile payment systems: A comparative analysis of SMS and NFC payments. 2017;30(1):892–910. Available from: <http://doi.org/10.1080/1331677X.2017.1305784>.
59. Alloghani M, Hussain A, Al-Jumeily D, Abuelma'Atti O. Technology Acceptance Model for the Use of M-Health Services among Health Related Users in UAE. *Proc - 2015 Int Conf Dev eSystems Eng DeSE 2015*. 2016;213–7.
60. Kharbanda EO, Stockwell MS, Fox HW, Rickert VI. Text4health: A qualitative evaluation of parental readiness for text message immunization reminders. *Am J Public Health*. 2009.

Figures

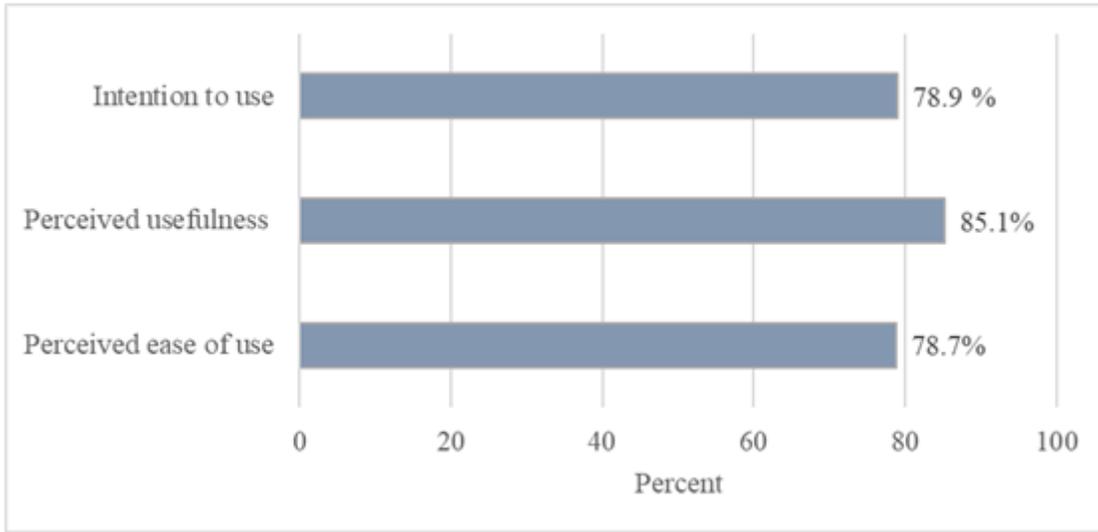


Figure 1

Intention, perceived usefulness and perceived ease of use in using text message reminders for vaccination, Gondar city administration, northwest, Ethiopia [N=456]