_____

Perception on Mobile Health System by Antenatal Care Patients in Ilorin, North Central Nigeria

Goodluck Ngozi Onyinye Emma-Anyasodo[1], H. A. Ameen[2], Abdullahi Ahmed[3] and Idowu David Alake[4]

[1,2,4]Department of Epidemiology and Community Health, Faculty of Clinical Sciences, College of Health Sciences, University of Ilorin, Nigeria.
[3]Department of Community Medicine and Primary Care, Federal Medical Centre, Abeokuta, Nigeria.
Email: [1]*goodemma1111@yahoo.com,* [2]*hafkam2005@gmail.com,* [3]*ahmedabdelus@yahoo.com,* [4]*idowualake007@gmail.com*

_____

ABSTRACT

Access to timely and quality antenatal care remains a major development challenge in many developing economies particularly in Nigeria. The increasing proliferation of mobile technology is bringing up new opportunities for safe, accessible, coordinated and effective maternal health care. Mobile health (mHealth) is emerging as a useful tool to improve access to health especially in areas with a limited health care workforce, limited financial resources, and a high burden of disease such as in the developing world. In this paper, a descriptive cross-sectional study was carried out to assess the perception on mHealth by women attending antenatal clinics in Ilorin Metropolis of Kwara State, North Central Nigeria. This involved 450 respondents using multi-stage sampling technique. The age of the respondents ranges between 18 - 47 years with a mean age of 29.70 ±5.56 years. Slightly more than half of the respondents 252(56.0%) had secondary education, while 27(6.0%) of respondents had no formal education. Majority of the respondents (80.2%) possessed mobile phone during the course of the study and majority of the respondents (68.0%) had heard about mHealth. Regarding the perception of the respondents towards mHealth, 82.0% of the respondents had good perception about mHealth using Likert's scoring scale. Most of the respondents (83.3%) were willing to use mobile device for diagnostic process, 67.1% of the respondents were also willing to be receiving antenatal tips by phone while 248 (55.1%) of the respondents were not willing to use mHealth service as the fees gets higher. Most of the respondents (71.1%) believed mHealth enhanced privacy, 51.8% believed it is self efficient, 53.3 % agreed mHealth is culturally acceptable and 41.6% believed mHealth ensures proper time management. Data analysis was done using common calculating device for social statistics. This study showed that mobile phones would be an acceptable approach to provide pregnancy and delivery support to women attending antenatal clinics in Ilorin Metropolis since the vast majority of the pregnant women had mobile phones, had good perception towards mHealth, and were willing to use mHealth service. It is therefore recommended that mHealth implementer in Nigeria need to devise strategies of leveraging mHealth to improve maternal and new-born care.

Keywords: *Antenatal care, Pregnancy, Childbirth, mHealth, Women, Questionnaire, Mobile phone, Clinics*

_____

_____

1. INTRODUCTION

1.0 Background Information

Antenatal care (ANC) interventions have proven to be key health interventions to decrease maternal mortality. Improving maternal health outcomes require reinforcement of prevailing evidence-based practices. The World Health Organization (WHO) recommended a minimum of four ANC visits during the antenatal period. The coverage of ANC is relatively poor, therefore, nearly 40% of women develop complications following delivery and an almost 15% encounter potentially life threatening complications (Langlois et. al., 2015).The poor attendance accounts for substantial number of preventable deaths (Nurmatov et. al., 2014).

Surprisingly, many countries with limited print or internet resources have gained substantial level of cell phone penetration. The increased penetration of cell phone over the recent years has brought about the potential for mobile health to improve ANC services by addressing issues such as low literacy level, large geographical distance to services, social marginalization, unskilled human resources and poor financial resources. The increasing proliferation of mobile technology is bringing up new opportunities for safe, accessible, coordinated and effective maternal health care (World Health Organization, 2012).

During the last decade, mobile communication and computing services have penetrated our daily culture. The potential of mobile computing has also been shifted towards the delivery of health care solutions, yielding mHealth, a rapidly expanding area of research and practice (Blaya et. al, 2010).In addition, mHealth changes the face of modern healthcare by providing a wide range of functions, for improving the level of confidence and satisfaction of patients, reducing the health care costs and modernizing data acquisition and analysis for clinical trials (Gurol-Urganci et.al., 2012; Walther et. al., 2011). Mobile health changes the traditional delivery of healthcare, allowing for continuous, pervasive healthcare anytime, anywhere. With mHealth, providers, caregivers and patients have the opportunity to continuously monitor health conditions and access health information outside of the physician's office, and outside of the patient's home. mHealth interventions expand access to health information and services that promote personal wellness, preventive care, and chronic disease management, promoting efficiencies in care-management practices, and improving individual and population health outcomes.

Mobile health technology is the use of telecommunication networks and equipment for transfer of health care information between participants at different locations. Applying mobile phones in healthcare is increasingly prioritized to strengthen healthcare systems (Lund et. al., 2014).For instance, it helps provide services to remote populations and underserved communities. mHealth interventions create a means for providing individual level support to health care consumers. This improves accessibility to antenatal care by equipping them with health promotion and disease preventing health message, empowering them to make better informed health decisions (Free et. al., 2013). Mobile health (mHealth) is emerging as a useful tool to improve access to health especially in areas with a limited health care workforce, limited financial resources, and a high burden of disease such as the developing world (Mecheal, 2006).

mHealth has a positive impact on rural dwellers in respect of health care. More so, mHealth should be seen as an indispensable tool for effective health care. mHealth could serve as a major technique to change the belief among the rural dwellers which is discovered to be a barrier that inhibits the progress of health coverage to rural communities. To this end, mHealth is seen as a bridge to help the rural dwellers to cross from the dark ages to an era of enlightenment in order to enhance their awareness on prevention and control of endemic diseases, maternal and child health including family planning, the importance of safe water and basic sanitation; provision of essential drugs, appropriate treatment of common diseases, injuries and immunization against major infectious diseases (Mecheal, 2006).

The present paper is aimed at assessing the perception on mHealth among women attending antenatal clinics in Ilorin Metropolis of Kwara State, Nigeria.

1.1   Research Hypothesis

1.1.1   Null Hypothesis (H_o)
1. There was no association between monthly expenditure and access to mHealth among women attending ANC in Ilorin Metropolis.
2. There was no association between frequency of healthcare service seeking and use of mHealth as

a source of health information among women attending ANC in Ilorin Metropolis.

3. There was no association between frequency of m-health use and comfort in expressing health needs on mHealth among women attending ANC in Ilorin Metropolis.

1.1.2 Alternative Hypothesis (H₁)

1. There was an association between monthly expenditure and access to mHealth among women attending ANC in Ilorin Metropolis.

2. There was an association between frequency of healthcare service seeking and use of mHealth as a source of health information among women attending ANC in Ilorin Metropolis.

3. There was an association between frequency of mHealth use and comfort in expressing health needs on mHealth among women attending ANC in Ilorin Metropolis.

2. LITERATURE REVIEW

2.1 Examples of mobile applications used in Developing Countries

The following are examples of mobile applications for healthcare services that are used in developing countries:

Mom Connect
South Africa's National Department of Health pioneered a mobile health service called Mom Connect that uses the short messaging services (SMS) function to register pregnant women. Implemented in partnership with the Mobile Alliance for Maternal Action (MAMA), the initiative provides antenatal support to women registered through its system by sending them advice during and after the pregnancy –including care for their newborn babies (Western Cape Government, 2013).

The objectives of Mom Connect are:
➢ Registration of a pregnancy at government facility.
➢ Aggregating information to send stage-based personalized message to pregnant woman captured in the system.
➢ Giving women a platform to become active participants in the antenatal health delivery system through helpdesk tools and services.

Mom Connect aims to optimize mobile health technology

tools and messaging applications to sensitize expectant women on the services available to them and their unborn babies. Relatedly, Mom Connect aspires to increase access to maternal healthcare and facilitate accountability among those providing this service. The emphasis on accountability is designed to encourage ease of access, reach and quality of care given to women and their children (Western Cape Government, 2013).

Mo Tech

In 2009, a collaborative partnership between the Ghana Health Services, the University of Columbia and the Grameen Foundation saw the establishment of the "Mobile Technology for Community Health" (MoTech). Mo Tech seeks to harness the potential of mobile phone applications to cater for the health needs of pregnant women and young children in Ghana's Upper East Region- an area with high poverty levels and an endemic proliferation of diseases such as malaria, childbirth complications and high mortality rates (Grameen Foundation, 2012).

The research program was able to identify a myriad of challenges faced by local residents in accessing quality healthcare. The most notable findings that emerged from this inquiry include a heavy reliance on paper based health administration by health centres, an uncoordinated postnatal healthcare system, traditional beliefs that promote risky behaviour among patients and unavailability of accurate healthcare information for women. Appreciative of these obstacles, Mo Tech is thus modelled to overcome them and has become an integral part of Ghana's Healthcare System- especially as it relates to caring for pregnant women.

Recently, the Ondo State Government launched an initiative that is using mobile phones to save the lives of indigent pregnant women. The project tagged "ABIYE: Safe Motherhood" is supported by the World Bank. This initiative targets the reduction of maternal mortality, one of the major health challenges in Nigeria, especially in Ondo State. The program, piloted in Ifedore aims to get past the obstacles that prevent expectant mothers from low-income families from seeking help during pregnancy. To begin with, the government conducted a mass registration of pregnant women like sensitizing communities about the importance of staying healthy during pregnancy, but also raising awareness among them about the services available to them. Registered women were given cell phones with toll-free access to 'Health

Rangers' and health facilities (Ondo State Ministry of Health, http://ondostatemoh.gov.ng/abiye.php).

Mo Tech's major strength is its ability to facilitate an interactive engagement between patients and health professionals. While women with mobile phones are able to receive ailment-specific information from Mo Tech, nurses on the other hand are able to use Mo Tech phones to enter data and simultaneously receive system generated messages on patients who are defaulting on their appointments. The information generated during these processes is used for reporting purpose by district and regional health planners (Macleod et. al., 2012).

The Mo Tech software platform is given by two applications, namely Mobile Midwife and Nurses application. The former is an alert-based information service that uses text and voice message (in local languages) to remind expectant women of their antenatal care appointments and information on how they should take care of themselves. The Nurses application is a data capturing tool that allows nurses to record and keep track of the care provided to newborn babies and their mothers. Information entered into the Mo Tech software is synched with biographical patient information already held by the Ghana Health Service. This allows for reminders to be automatically activated and sent to nurses (and patients) in cases where the latter misses an appointment (Grameen Foundation, 2012).

Medic Mobile

Malawi's Ministry of Health pioneered Medic Mobile, a mHealth application that is designed to ensure that the health of pregnant women and their newborn babies in an area called Kilifi is preserved through the use of mobile phones.[45]Medic Mobile place greater emphasis on biographical data collection where a pregnant woman's name, age, potential health complication and projected delivery date are sent to a central Medic Mobile database. Medic Mobile then aggregates this information and generates appointment schedules that are used by health outreach workers to visit patients. During their scheduled visits, when health workers detect a health threat they use their mobile devices to contact health centre for possible emergency care. Medic Mobile has had immediate impact in that the number of women giving birth in health facilities has increased by more than 100% from 20 to 48 live births during the pilot phase. It has also been noted that there has been an improvement in interaction between health workers and community workers through the e-

learning opportunities offered by Medic Mobile (Medic Mobile Annual Report, 2013).

Medic Mobile operates on multiple devices some of which include desktop computer, feature phones, tablets and smart phones - making it applicable to variety of users within the health care delivery system. The short messaging function is the primary tool of engagement where patients and health workers submit information to a centralized database for health management purpose. In return, health outreach workers can use their phones to receive information on how best they can care for community members. Medic Mobile also has an in-built analytics system that allows health managers to analyze data gathered from health outreach activities.

Telemedicine in Nigeria

Telemedicine is an integrated system of health-care delivery that employs telecommunications and computer technology as a substitute for face-to-face contact between health service provider and client. It supports health-care delivery in distant remote sites and villages while connecting primary care physicians, providers, specialists and patients. It offers cheap as well as improved access to quality healthcare delivery. In Nigeria, the pilot Project was designed in a Collaboration between the National Space Research and Development Agency (NASRDA) and the Federal Ministry of Health. The sub-networks integration commenced in 2007.Remote Terminals and Mobile Buses are equipped with basic diagnosis equipment such as, Cameras: General Examination Camera ,Image & Illumination System; Diagnostic Scopes: Electronic Stethoscope , Ear Nose & Throat (ENT) Scope, Ophthalmoscope , Dermascope. Telemedicine services include: Medical services, Specialist Referral Services, Patient Remote Consultations, Remote Patient's Monitoring, Medical Education, Medical Health Records and Information Databank. The pilot project lasted six months and was a success (James et. al., 2009).

Telehealth

Telehealth is the transmission of health-related services or information over the telecommunications infrastructure. The term covers both telemedicine, which includes remote patient monitoring, and non-clinical elements of the healthcare system, such as education. Telehealth examinations can be performed by physicians, nurses or other healthcare professionals over a video conference connection to answer a patient's specific question about their condition. A telehealth visit can also be a remote

substitute for a regular physician exam or as a follow-up visit to a previous care episode (www.what is techtarget.com/definition/telehealth).

Also in India, this tool was developed after studying the needs and the logistic problems related to primary healthcare of the rural tribal population of villages in India. This mobile phone-based e-Health tool was first showcased in the e-Health pavilion at the World Telecom Conference 2009 in Geneva. It helps to meet the health-care needs of the community and to overcome the challenges faced at the center by connecting the rural patient to the Medical Officer through the midwife. By establishing efficient communication between the midwife and Medical Officer, mHealth expands the Center outreach; thus facilitating timely, quality healthcare to the community under consideration (Bondale et. al., 2013).

mHealth has five major components that together use various technologies including mobile Internet, Interactive Voice Response (IVR), Indian language font rendering, and usability frameworks:
 1) Client software in the local language on a mobile phone used at the patient's end
 2) Servers in the secured data centre
 3) A doctor's console, which is viewed by a doctor/expert to suggest treatment/tests and prescribe medicines to the patients
 4) An IVR application to record the information and observations
 5) A reporting console to view various reports related to rural health in consolidated manner. The mHealth design is based on the existing government healthcare infrastructure and is influenced by rural community requirements and challenges (Bondale et. al., 2013).

The key contact with the target population is a social health activist, who is equipped with a mobile phone which has Interactive Voice Technology transcription software. The reports of the activist are available to medical and auxiliary staff (e.g., midwives) at a healthcare centre. Doctors and medical experts provide support and services at centralized locations (Bondale et. al., 2013).

The midwife at the Sub-centre provides preliminary healthcare to pregnant women and performs normal deliveries of babies. The mHealth tool can aid the midwife, as it can be integrated with the portable battery operated medical test devices for blood and urine analysis.

This facilitates inclusion of pathology test reports as part of "patient medical history." The midwife can record a voice query through the interface available to her. Wireless Internet makes it possible to upload a patient's personal information and medical history to the server. A web console gives an integrated view of patient's medical history including the midwife's voice comments about the patient's illness and symptoms to the centre doctor or Medical Officer. Through the Doctor's Console, the Medical Officer can see the patient's details with medical history and listen to the midwife's recorded voice query. The doctor would then give his/her advice in voice/text or hand-write a message using an E-pen. The image of the prescription is captured and sent over wireless Internet to the midwife's mobile phone and the midwife can then take action accordingly. If required, a specialist available at the rural hospital or in a city hospital could be contacted over the Internet and the entire case, including patient's medical history, could be referred through mHealth for expert advice. Thus, mHealth connects the social health activist in the village, the midwife at the Sub-centre, and doctors and medical officers at the Centre, and if required, doctors at a Rural Hospital or city hospital, through wireless, Internet, and web technologies (Bondale et. al., 2013).

The Senegalese mHealth initiative
In Senegal, the Ministry of Health has improved health data collection through the use of mobile technology. Community health workers in ten districts were equipped with handheld devices and data collection software, sponsored by the United Nations Foundation and the Vodafone Foundation Technology Partnership. Benefits included more frequent supervisory visits in the pilot areas, faster data collection and analysis (one district reported that data that previously took two weeks to collect on paper was collected in an hour), and the use of data by health officials to reallocate budgets (Commission on Information and Accountability for Women's and Childen's Health, http://www.who.int).

Mailafiya Health Program
This program was hatched in early 2009, when the Nigerian Federal Capital territory Millennium Development Goals Unit (FCTMDGU), health officials, and Intel Corporation began discussing ways that e-Health could be used to improve healthcare delivery in rural areas (Medic Mobile Annual Report, 2013). It initially consisted of six mobile medical teams, each composed of a doctor, a nurse, a community Health worker, and a driver. In addition to off-road trucks, basic healthcare

tools, and drug kits, each team is equipped with cost-effective intel-powered Computers and software that enable data collection into an Electronic Health record, including patient identification and patient pictures captured using the computer camera. They also carry an automated laboratory system for on-site diagnosis and treatment planning. These e-Health tools help teams improve drug dispensing, treatment follow-up and referrals. The central software component is the District Health Information System (DHIS), an open source platform already adopted in 18 countries. DHIS is a flexible platform for capturing and using health information for statistical analysis, and reporting. This program has led to a significant increase in the number of patients being seen at UHC centres within the Nigerian Federal Capital Territory (World Health Organization, http://www.who.int).

The Abiye Project

Recently, the Ondo State government launched an initiative that is using mobile phones to save the lives of indigent pregnant women. The project tagged "ABIYE: Safe Motherhood" is supported by the World Bank. This initiative targets the reduction of maternal mortality, one of the major health challenges in Nigeria, especially in Ondo State. The program, piloted in Ifedore aims to get past the obstacles that prevent expectant mothers from low-income families from seeking help during pregnancy. To begin with, the government conducted a mass registration of pregnant women like sensitizing communities about the importance of staying healthy during pregnancy, but also raising awareness among them about the services available to them. Registered women were given cell phones with toll-free access to 'Health Rangers' and health facilities (Ondo State Ministry of Health, http://ondostatemoh.gov.ng/abiye.php).

2.2 Importance of mHealth in Relation to Maternal Death

Every two minutes of the day, one woman dies somewhere in the world from complications of pregnancy and childbirth. One third of these maternal deaths take place in just two countries: India with 20% of the global total (56,000 deaths) and Nigeria with about 14% (40,000 deaths). Globally, the maternal mortality ratio is 400 per 100,000 live births (World Health Organization, 2014).

Despite ongoing efforts to improve maternal and child health in developing countries, mortality rates remain much higher than in developed countries. Women in developing regions face a lifetime risk of maternal death of 1 in 160, as compared with 1 in 3700 for women living in developed regions.[10]These inequalities are driven by many causes, one of which is limited access to preventive services. For example, in low –and middle- income countries, only about 52% of pregnant women receive the World Health Organization (WHO) recommended minimum of four antenatal visits (World Health Organization, 2012B).

However in Nigeria, the maternal mortality rate was about 1,500 per 100,000 in 2006 and currently 804 per 100,000 (Sheffman and Okonofua, 2007; Jha et. al., 2009). Available data from Oyo State revealed an average maternal mortality of 450 per 100,000 live births (Data Unit, Ministry of Health, Oyo State, 2012). Oyo South Senatorial District recorded an average of maternal mortality248 per 100,000 in 2008, 439 per 100,000 in 2009 and 462 per 100,000 live births in 2010 (Data Unit, Ministry of Health, Oyo State, 2012). In Kwara State of Nigeria; the maternal mortality rate is estimated to be 825 per 100,000 live births (Aboyeji et. al., 2007). It was found that most of the maternal deaths are as a result of avoidable causes. Those avoidable causes are primarily accountable to delay in seeking and receiving care in poor resource areas.

The potential barriers to efficient mHealth outcome among pregnant women depend on the accessibility of mobile phones, socio-economic status and educational background of the pregnant women (Aboyeji et. al., 2007). Delay seeking antenatal care is accountable to concerns like lack of information about the existence of care, socioeconomic and infrastructure challenges, the level of empowerment of women in patriarchal socio-cultural settings. The challenges are responsible for maternal mortality and poor maternal health.

A study by Lund et.al., (2012) done in Zanzibar among women of reproductive age found a difference in the mHealth intervention effect between women of urban and rural residence i.e. 82% of urban women in the intervention group delivered with skilled attendance contrary to 43% of rural women. It was also mentioned that the insignificant impact of mHealth intervention in rural women is due to the factors like transportation, the proximity of health centre from the users and information availability.[16]Similarly, there is a regional difference in ANC attendance in Ethiopia with 70% of urban women making more than 4 visits, unlike rural women where only 44% attended four visits or more (Fedha, 2004). This

_____

difference was linked with women's literacy status and stated that women in urban areas have more access to education and are literate to read SMS reminders than people in the rural areas (Fedha, 2004). Besides limited access to mobile phones, mHealth interventions challenged rural populations with problems like electricity to charge mobile phones and higher levels of illiteracy, resulting in difficulties in reading text messages (Lund et.al., 2012).

3. METHODOLOGY

3.1 Study Design, Population and Sample Size Determination

The study was a descriptive cross-sectional study using quantitative method of data collection. The study population comprised of women attending antenatal clinic in Ilorin Metropolis. The sample size was calculated using a list of standard formulas, specifically, using Fisher's formula (Jung, 2013; Charan and Biswas, 2013).
To calculate the sample size when population is less than 10,000, we use:

$$n_f = \frac{n}{1+\frac{n}{N}}$$

where:
n_f = desired sample size when target population size is less than 10,000
N = the estimated population size
n = minimum sample size when target population is greater than 10,000.

In this research, N = 4725 and n = 384, therefore n_f = 355
To compensate for non response, 10% of the original size was added.

$$n_s = n_f/0.9$$

where:
n_s= sample size to compensate for attrition
n_f = original calculated sample size
355/0.9 =394

However, final sample size of 450 was used to increase the power of the study.

3.2 Sampling Technique

A multi-stage sampling technique was adopted as follows:

Stage 1- Selection of health facilities

The 3 public secondary health facilities in the state were selected for the study, namely; General Hospital, Civil Service Hospital and Sobi Specialist Hospital. A proportionate allocation was used to determine the number of questionnaires that were administered in each hospital. It was calculated depending on the total number of registered women for antenatal in each hospital from January to June 2018.

The number of questionnaires to be administered in each hospital was calculated as follows:
n = (Number of women in each hospital x sample size for the study)/Total population of women in all of the hospitals

Table 1 shows the total number of women who registered for antenatal care in each of the three hospitals and the number of administered questionnaires in each hospital.

Stage 2 – Selection of respondents
In each hospital, systematic random sampling technique was used to select respondents for the sample study using the total number of women who attend the antenatal clinic in each hospital at the time of the study as the sampling frame.

$$Sampling\ interval = \frac{Sampling\ frame}{Sample\ size}$$

The first respondents was randomly selected within the sampling interval, while subsequent respondents were selected using the sampling interval until the desired sample size for each hospital was completed. Where a respondent declined participation, the next person on the sampling frame was enlisted until the desired size for each hospital was attained.

3.3 Preparation for Data Collection

Advocacy visits were paid to the Head of the Department of Obstetrics and Gynaecology of the selected hospitals in Ilorin metropolis, intimating them with the research and soliciting for their support. Four trained research assistants were employed to aid with the administration of questionnaires. The tool of data collection was pretested in Offa General Hospital, Offa. This was carried out using 10% of the sample size at Offa General Hospital, Offa to determine the validity of the questionnaires.

3.4 Data Collection Instrument

A semi – structured interviewer administered questionnaire was used to obtain information from the participants on the perception of the use of mHealth among women attending antenatal clinic in Ilorin Metropolis. The questionnaire was validated and adjusted to suit the environment where this study was carried out. The questionnaire was developed by the researcher and structured to have five sections: section 1, 2, 3, 4and 5. Section 1 was for gathering respondent's socio-demographic data. Section 2 was use to collect data on the use of mobile phones and awareness of mHealth among women attending antenatal clinic in Ilorin Metropolis. Section 3 was used to collect data on the perception of women towards mHealth which was structured as a four – point, Likert's –type response format. Section 4 was used to collect data on the attitude of women towards mHealth which was structured as a four –point, Likert's –type response format. The four- point response format of "Strongly Agree", "Agree", "Disagree" and "Strongly Disagree" quantified as 3, 2, 1, and 0respectively was used. Section 5 was used to collect data on the willingness of women attending antenatal clinic to use mHealth.

3.5   Data Collection Procedure

Four trained research assistants participated in the data collection in the study after a detailed explanation as to the purpose of the study was given to all the eligible respondents. Data collection was done within three (3) weeks, each week for hospital. Data was collected with the use of the interviewer - administered questionnaire early in the morning before the commencement of lectures from 7:30am to 8:30am in their various units. The reason was due to transport issues they encounter going back home after their consultation in the afternoon.

3.6   Ethical Consideration

Ethical approval was obtained from the Ethical Review Committee of Faculty of Clinical Sciences through Department of Epidemiology and Community Health with reference number UIL/UERC/16/68KF003. Verbal informed consent was sought and obtained from each of the participants with anonymity and confidentiality of the information obtained was assured and maintained.

3.7   Data Analysis

Data collected was checked daily for correctness and completeness. Then it was coded and analyzed using common calculating device for social statistics. Inferential statistics to test for associations between categorical variables was done using Chi-square test for qualitative variables. Summary of the statistics was presented using frequency tables, charts, means and rates. Logistic regression analysis was done to identify independent factors for perception, attitude and willingness of pregnant women towards mHealth in Ilorin Metropolis. Level of statistical significance was set at $p < 0.05$ at confidence level of 95% for all inferential analysis.

Just as with the data collection instrument, Likert's –type response format was used in scoring the perception of respondents towards mHealth. Perception of respondents towards mHealth was graded and scored as follows (highest score was 21):

1. Good perception: 11-21
2. Poor perception: 0 -10

Also, Likert's –type response format was used in scoring the attitude of respondents towards mHealth. Attitude of respondents about mHealth was graded and scored as follows (highest score was 18):

1. Positive attitude: 10-18
2. Negative attitude: 0-9

4. RESULTS

The results of the paper are presented in this section.

The age of the respondents ranges between 18 - 47 years with a mean age of 29.70±5.56 years. Slightly more than one third of the respondents (32.7%) were between 25 - 29 years age group, Majority of the respondents 373 (82.9%) were Yoruba by tribe, 34 (7.6%) were Hausa, 34 (7.6%) were Igbo while the remaining 9(2.0%) belong to other ethnic groups such as Fulani and Nupe.

More than half (54.0%) of the respondents were of the Islamic faith while the remaining 207(46.0%) were Christians. Almost all of the respondents 429 (95.3%) were married, with 4.2% of the respondents single, while 2(0.4%) were widowed.

Slightly more than half of the respondents 252(56.0%) had secondary education, while 27(6.0%) of respondents had no formal education. Almost half of the respondents 229 (49.1%) were traders, while 18.7% were civil servants and 64(14.2%) of the respondents were unemployed. Slightly more than half of the respondents

(51.8%) earned below ₦10,000 monthly with only 4.4% of the respondents earned more than ₦50,001 on monthly basis. Most of the respondents (62.7%) attended antenatal clinic twice with 12.7% attended three or more times on a monthly basis.

Majority of the respondents (80.2%) possessed cellphone during the course of the study while 19.8% of the respondents do not have a cellphone. Among the 80.2% of the respondents who possessed cellphone, most of the respondents 242(67.0%) make use of internet connected phones. Also, majority of the respondents (64.9%) correctly choose the definition of mHealth.

Three hundred and six respondents (68.0%) were aware and have heard about mHealth before while the remaining 144(32.0%) of them had never heard of mHealth.

Almost all of the respondents (90.4%) agreed that mHealth helps in achieving focused antenatal care, 88.2% agreed it is easy to learn while 47.7% of the respondents disagreed that mHealth responds promptly to emergency obstetric complications.

Majority of the respondents (82.0%) had good perception towards mHealth while 83 (18.0%) of the respondents had poor perception towards mHealth.

Association between socio-demographic characteristics and perception of respondents towards mHealth showed significant relationship with level of education, occupation, monthly income and frequency of visit to health centre of the respondents while marital status and age group of the respondents showed no significant difference.

5. DISCUSSION

The mean age of women attending antenatal clinics in this study was 29.70 ± 5.56. Yoruba was the most populous among the respondents (82.9%), possibly due to the fact that this study was carried out in Yoruba dominated area. Next to the Yorubas were the Hausas and Igbos. This finding was similar with the study done in Ile-Ife where majority of the respondents (82.1%) were Yorubas, 7.9% and 5.7% were Igbo and Hausa respectively (Odetola et. al., 2017).

Majority of the respondents (80.2%) possessed mobile phones during the course of the study. Mobile phones have become a visible part of lives of millions throughout the world. Mobile phone service is provided through a network structure that enables access in places where most other technologies are not available. Interactions with information and communications technology and adaptations in behaviour particularly as they pertain to public health, health service delivery, and the social determinants of health in developing countries have yet to be systematically assessed (Byomine and Mmaige, 2015).

The rapidly growing presence of mobile phones offers paradigm shift and a unique opportunity in the provision of maternal health services. This results in reduced maternal deaths as mobile phones can be used by health care providers in hospitals, clinics, or on home visits for surveillance, monitoring health status and easing obstetric emergency situations (Byomine and Mmaige, 2015). It was suggested that mobile phones interventions can improve quality of maternal health care by creating awareness on the demand side of service delivery. Mobile phones enabled for internet use was possessed by more than half of the respondents (67.0%), this was similar to 68.0% of respondents in a study carried out in Peru (Fitzpatrick and Vineski, 1993) and was lower to 95.2% of respondents obtained from a study carried out in Ido-Ekiti, Nigeria (Adebara et. al., 2017).

This study showed that general perception towards mHealth among women attending antenatal clinics in Ilorin Metropolis was high. This was similar to a study carried out by Odetola and his colleagues in Ile-Ife where 87.3% of the respondents had good perception of the benefits of mHealth for providing maternal health information (Odetola et. al, 2017). Respondents who had a positive perception about the use of mobile phone for disseminating maternal health information had higher odds of accessing a health institution for delivery compared to those who had poor perception about the use of mobile health technology.

Since the majority of the women owned mobile phones and had a good perception about using mHealth for maternal health information, pregnant women in Ilorin Metropolis could benefit from mHealth programme if implemented. This finding was similar to the study done in Argentina where a high perception towards mHealth was obtained (Cormick et. al., 2012). Association between socio-demographic characteristics and perception of respondents towards mHealth showed significant relationship with level of education, occupation, monthly income and frequency of visit to health centre of the respondents while marital status and age group of the respondents showed no significant difference.

Also, implementation of mHealth would provide a free and easy communication linkage between the pregnant women and the health workers. It improves lifestyle interventions among pregnant women and encourages medication adherence among pregnant women which in turn improves the maternal health of reproductive aged women. Nyamtema et. al. (2012) found that in rural Tanzania 20% of severe maternal morbidities were attributed to substandard antenatal care which indicates that a significant proportion of adverse pregnancy outcome could be reduced by improving this programme. The use of mobile health would improve facility utilization and maternal health and generally improved health services for pregnant women.

6. CONCLUSION

This study showed that mobile phones would be an acceptable approach to provide pregnancy and delivery support to women attending antenatal clinics in Ilorin Metropolis. This is due to the fact that the vast majority of the pregnant women interviewed possessed a mobile phone and regard it as a desired means of communication.

Majority of the women attending antenatal clinics in Ilorin Metropolis had good perception about mHealth, thus this will help to facilitate successful adoption of mHealth services and also help to identify potential obstacles of the program.

The following are the recommendations:
1. mHealth implementer in Nigeria needs to devise strategies of leveraging mHealth for maternal and new-born care, particularly in this under resourced health ecosystem. There should be sensitization, awareness of the populace about the use of mHealth technology, this will encourage the development of innovative mHealth solutions and harmonize the regulation between the delivery of traditional health care services and mobile health.

2. Government should embark on innovative methods of strengthening the healthcare system for maternal and newborn health as well as new approaches like mHealth technology which is capable of reaching the hard-to-reach populations to support Nigeria efforts towards desirable global maternal and child health targets against the year 2030.

3. Information literacy training on mHealth technology

use, for both health care professionals and patients, should be a priority for health care policy markers when implementing the national health care information strategy.

4. Hospitals need to start packaging general health pregnancy information for onward broadcast to expectant women while at the same time encouraging the latter to submit any questions that they may have on the information delivered.

ACKNOWLEDGEMENT

REFERENCES

1. Aboyeji, A. P; Ijaiya, M; and Adegboya, A. F. (2007). Maternal mortality in a Nigerian Teaching Hospital: A Continuing Tragedy. *Tropical Doctor*, 37(2), 83-5.

2. Adebara, O. V; Adebara, O. I; Olaide, R, and Gabriel, O. E. (2017). Knowledge, Attitude and Willingness to mHealth Technology among Doctors at a Semi-urban Tertiary Hospital in Nigeria. *Journal of Advances in Medicine and Medical Research*, 22(8), 1-10.

3. Amusa, Morufu and Oluwade, Bamidele (2019), Perception of Nigerians on the Use of Information Technology in Managing Counterfeit Drugs I: Prevention of Counterfeiting, *African Journal of Management Information System*, Vol. 1, Issue 1, pp. 31-48.

4. Amusa, Morufu and Oluwade, Bamidele (2019), Perception of Nigerians on the Use of Information Technology in Managing Counterfeit Drugs II: Detection of Counterfeiting, *African Journal of Management Information System*, Vol. 1, Issue 1, pp. 49-64.

5. Amusa, Morufu and Oluwade, Bamidele (2020), A Historical Background of Some Basic ICT Tools used in Counterfeit Drug Control, *African Journal of Computing & ICT*, Vol. 13, Nos. 1, pp. 52-61.

6. Anyasodo-Emma, Goodluck Ngozi Onyinye (2019), *Perception, Attitude and Willingness to Use mHealth among Women Attending Antenatal Clinics in Ilorin Metropolis, Kwara State*, Masters in Community Health (Mcomm. H) Dissertation, College of Health Sciences, University of Ilorin, Nigeria.

7. Blaya, J. A., Fraster, H. S. and Holt, B. E. (2010) Health Technologies Show Promise in Developing Countries. *Health Aff* (Milliwood), 29:244 -257.

8. Bondale, N; Kimbahune, S; and Pande, A. (2013). mHEALTH - PHC: An ICT Tool for Primary Healthcare in India. *IEEE Technology and Society Magazine*. Fall 2013.

9. Byomine, G. and Maige, G. (2015). *A Model for Mobile Phone Adoption in Maternal Healthcare*. Mekerere University Business School, Kampala, Uganda. IIMC International Information Management Corporation, 978-1-905824-51-9.

10. Charan, Jaykaran and Biswas, Tamoghna (2013), 'How to Calculate Sample Size for Different Study Designs in Medical Research?'. Indian Journal of Psychological Medicine, 35(2), pp. 121-126. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC 3775042

11. Cormick, G; Kim, N. A. and Rodgers, A. (2012). Interest of Pregnant Women in the Use of SMS (short message service) Text Messages for the Improvement of Perinatal and Postnatal Care. *Reprod Health*, 9(9).

12. *Commission on Information and Accountability for Women's and Children's Health. Opportunities for Innovation in Information and Communication Technologies*. http://www.who.int. Accessed on the 4th of November 2018.

13. Data Unit, Ministry of Health, Oyo State, Nigeria, p.5.

14. Fedha, T. (2004). Impact of Mobile Telephone on Maternal Health Service Care: A Care of Ngoro Division. *Open Journal of Preventive Medicine*. 4(5), 365-376. https://doi.org/10.4236/.jpm.2014.45044.

15. Fitzpatrick, K. and Vineski, E. (1993). The Role of Cordless Phones in Improving Patient Care. *Physicians Assist*, 17(6):87-92.

16. Free, C; Philip, G; Galli, L, Watson, L; Felix, L, et al. (2013). The Effectiveness of Mobile Health Technology–Based Health Behaviour Change or Disease Management Interventions for Health Care Consumers: A systematic Review. *PLos Med*. 10(1).

17. Grameen Foundation. Mobile Technology for Community Health in Ghana: *What it is and what Grameen Foundation has Learned so far*. 2012. Available at https://grameenfoundation.box.com/shared/static /5020C8ste2hjkxekff8.pdf. [Accessed on 7th May 2018].

18. Gurol-Urganci, I; de Jongh, T; Vodopivec – Jamsek, V; Car, J; Atun, R. (2012). Mobile Phone Messaging for Communicating Results of Medical Investigations (Renew). *The Cochtane Library*, Issue 6.

19. James, K. G; Odimayomi, P. K; and Shaba, A. H. (2009). *Telemedicine Development in Nigeria*. A presentation at the National Space Research and Development Agency, Nigeria http://www.un-spider.org/sites/default/files/james_3rd_ws-bonn_23_10_09.pdf <last accessed in June 2020>

20. Jha, A. K; Bates, D. W; Jenter, C; Orav, E. J; Zheng, J. and Cleary, P. S. R. (2009). Electronic Health Records: Use, Barriers and Satisfaction among Physicians who care for Black and Hispanic Patients. *Journal of Evaluation in Clinical Practices*, 15(1), 158-63.

21. Jung, Sin-Ho (2013), 'Stratified Fisher's Exact Test and Its Sample Size Calculation', *Biometrical Journal*, Vol. 56, Issue 1, pp. 129-140.

22. Langlois, E. V; Miskurka, M; Zunzunegui, M. V;

Ghaffar, A; Ziegler, D; Karp, I. (2015). Inequities in Postnatal Care in Low and Middle-Income Countries: A Systematic Review and Meta- Analysis. *Bull World Health Organ*. 93(4), 259-70.

23. Lund, S; Hemed, M; Nielsen, B. B; Said, A; Said, K. and Makungu, M. H. (2012). Mobile Phones as a Health Communication Tool to Improve Skilled Attendance at Delivery in Zanzibar: A Cluster–Randomized Controlled Trial. *BJOG: An International Journal of Obstetrics and Gynaecology,* 119(10), 1256-1264. https://doi.org/10.1111/j.1471-0528.

24. Lund, S. N; Birgitte, B. H; Maryam, B. M; Said, A. and Khidya, S. (2014). Mobile Phones Improve Antenatal Care Attendance in Zanzibar: A Cluster Randomized Controlled Trial. *BMC pregnancy and childbirth. PubMed*., 14(14), 29.

25. Macleod, B; Philips, J; Stones, A. E; Walyi, A. and Awoonor-Williams, J. K. (2012). The Architecture of a Software System for Supporting Community-based Primary Health-Care with Mobile Technology: The Mobile Technology for Community Health (MoTeCH) Initiative in Ghana, *Online J Public Health Inform* 4(1): doi: 10.5210/ojphi.v4i1.3910.

26. Mecheal, P. N. (2006) *Exploring Health- related Uses of Mobile Phones. An Egyptian Case Study*. PhD Thesis, London School of Hygiene and Tropical Medicine

27. *Medic Mobile annual report* (2013). Available at www.medicmobile.org. [Accessed on 7th May 2018]

28. Nurmatov, U. B; Lee, S. H; Nwaru, B. I; Mukherjee, M. and Pagliari, C. (2014). The Effectiveness of mHealth Interventions for Maternal, Newborn and Child Health in Low and Middle Income Countries: Protocol for a Systematic Review and Meta-Analysis. *J Glob Health*, 4(1), 010407.

29. Nyamtema, A. S; Bartsch-de, J. A; Urassa, D. P; Hagen, J. P. and Roosmalen, J. V. (2012), The Quality of Antenatal Care in Rural Tanzania: What is Behind the Number of Visits? *BMC Pregnancy Childbirth*, 12(1), 70.

30. Odetola, T. D; Ayamolomo, L. B and Ayamolomo, S. J. (2018). Childbearing Women's Perception about the Use of mHealth for Maternal Health Information in Rural Communities, Ile-Ife, Nigeria. *Journal of the International Society for TeleMedicine and Ehealth*, 6:e9.

31. *Ondo State Ministry of Health. Abiye Safe Motherhood.* http://ondostatemoh.gov.ng/abiye.php.[Retrieved on May 8th 2018].

32. Sheffman, J. and Okonofua, F. (2007). The State of Political Priority for Safe Motherhood in Nigeria. *BJOG*. 114: 127-33.

33. Walther, B; Hossin, S; Townend, J; Abernethy, N; Parker, D. and Jeffries, D. (2011). Comparison of Electronic Data Capture (EDC) with the Stand Data Capture Method for Clinical Trial Data. *PLos One*, 6(9), e25348.

34. Western Cape Government. Maternal Health care services (2013). *New project connects Expectant Moms to Government Health Services.* Accessed at http://westerncape.gov.za/general-publication/new-project-connects-expectant-moms-government-health-services [Accessed on 7th May, 2018]

35. World Health Organization (2012A). *World Health Statistics 2012*. Geneva, Switzerland: World Health Organization.

36. World Health Organization (WHO) (2012B). *Antenatal Care: Situation, World Health organization*, Geneva, Switzerland. http://www.who.int/gho/maternal_health/reproductive_health/antenatal-care-text/en/.

37. World Health Organization (2014). *Trends in Maternal Mortality: 1990 to 2013*. .http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2013/en/.

38. World Health Organization. *Increasing Healthcare delivery by 270% to underserved communities using a scalable ICT solution. Digital health for developing nations.*

Vol. 2, Issue 3, July 2020, pp. 12 - 30

Emma-Anyasodo and Ameen (2020). Perception on Mobile Health System by Antenatal Care Patients in Ilorin, North Central Nigeria

http://www.who.int .Accessed on the 30th of October 2018

39. What is Telehealth. what is techtarget.com/definition/telehealth <Accessed on the 4th of November 2016>

40. www.laico.org

41. www.ey.com

APPENDIX
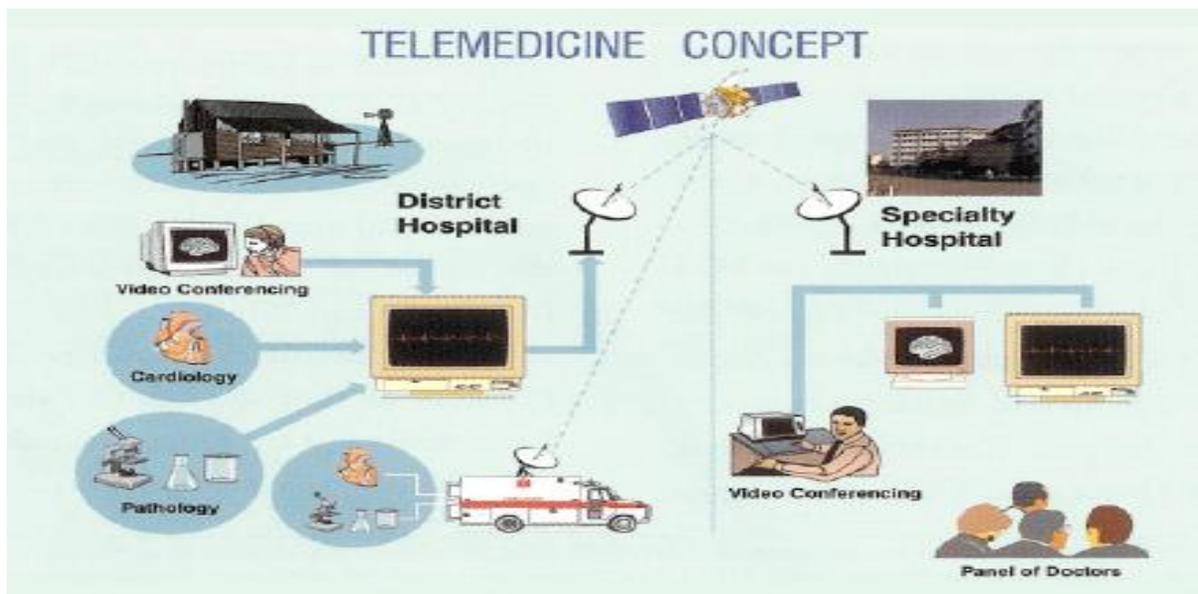
Figure 1: Telemedicine Concept (www.laico.org)
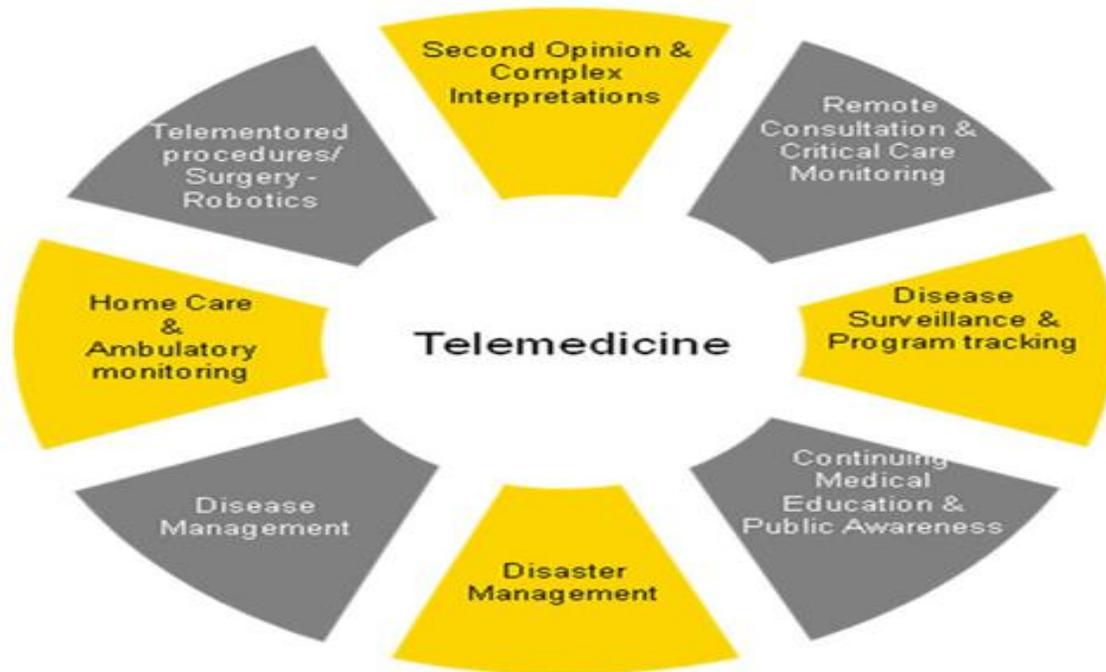
Figure 2: Applications of Telemedicine (www.ey.com)

Table 1: Total Number of Women Who Registered for Antenatal Care and the Number of Administered Questionnaire in each of the Three Visited Hospitals

S/N	HOSPITAL	TOTAL NUMBER OF WOMEN WHO REGISTERED FOR ANTENATAL CARE	NUMBER OF ADMINISTERED QUESTIONNAIRE
1	General Hospital	2552	243
2	Civil Service Hospital	1134	108
3	Sobi Specialist Hospital	1039	99
	TOTAL	4725	450

_____

Table 2: Socio-demographic characteristics of respondents

N=450

Variables	Frequency	Percentage
Age Groups		
<20	4	0.9
20 – 24	80	17.8
25 – 29	147	32.7
30 – 34	133	29.6
35 – 39	57	12.7
40 – 44	27	6.0
45 – 49	2	0.4
Mean ± SD (Range)	**29.70 ± 5.56**	**(18 – 47)**
Tribe		
Yoruba	373	82.8
Hausa	34	7.6
Igbo	34	7.6
Others	9	2.0
Religion		
Christianity	207	46.0
Islam	243	54.0
Marital Status		
Married	429	95.4
Single	19	4.2
Widowed	2	0.4
Level of Education		
None	27	6.0

Primary	78	17.3
Secondary	252	56.0
Tertiary	93	20.7
Occupation		
Artisan	81	18.0
Civil Servants	84	18.7
Trader	221	49.1
Unemployed	64	14.2
Average monthly income		
≤ 10,000	233	51.8
10001 – 50000	197	43.8
≥ 50,001	20	4.4
Frequency of visit to health centre monthly		
Once	111	24.7
Twice	282	62.7
Three or more times	57	12.7

Table 3: Use of mobile phone and knowledge of mHealth among respondents

Variables	Yes (%)	No (%)
Possession of cell phone	361 (80.2)	89 (19.8)
Correctly choose mHealth definition	292 (64.9)	158 (35.1)
n=361		
Usage of internet on cell phone	242 (67.0)	119 (33.0)

_____

Table 4: Awareness of mHealth among respondents

Awareness	Frequency	Percentage (%)
Yes	306	68.0
No	144	32.0

Table 5: Perception of respondents about the use of mHealth for maternal health information

Variables	Frequency (%)			
	Strongly Agreed	**Agreed**	**Disagreed**	**Strongly Disagree**
mHealth is easy to learn	200(44.4)	197(43.8)	50(11.1)	3(0.67)
mHealth is flexible to interact with	108(24.0)	271(60.2)	65(14.4)	6(1.3)
mHealth enhance effectiveness in patient care	1(0.2)	77(17.1)	301(66.9)	71(15.8)
mHealth helps in achieving FANC	208(46.2)	199(44.2)	43(9.6)	0(0.0)
mHealth helps in pregnancy and birth preparedness	116(25.7)	201(44.7)	121(26.9)	12(2.7)
mHealth responds promptly to emergency obstetric complication	98(21.8)	137(30.5)	200(44.4)	15(3.3)
mHealth accomplishes tasks more quickly	88(19.5)	314(69.8)	40(8.9)	8(1.8)

Table 6a: Association between socio-demographic characteristics and perception of respondents towards mHealth

Variables	Perception		χ^2	P
	Poor (%)	Good (%)		
Age Groups			5.195	0.519
<20	2 (50.0)	2 (50.0)		
20 – 24	12 (15.0)	68 (85.0)		
25 – 29	25 (17.0)	122 (83.0)		
30 – 34	27 (20.3)	106 (79.7)		
35 – 39	13 (22.8)	44 (77.2)		
40 – 44	4 (14.8)	23 (85.2)		
45 – 49	0 (0.0)	2 (100.0)		
			2.701	0.259
Marital Status				
Married	77 (17.9)	352 (82.1)		
Single	6 (31.6)	13 (68.4)		
Widowed	0 (0.0)	2 (100.0)		
			48.135	**< 0.001**
Level of Education				
None	16 (59.3)	11 (40.7)		
Primary	19 (24.4)	59 (75.6)		
Secondary	46 (18.3)	206 (81.7)		
Tertiary	2 (2.2)	91 (97.8)		
			26.668	**< 0.001**
Occupation				
Artisan	4 (4.9)	77 (95.1)		
Civil Servants	7 (8.3)	77 (91.7)		
Trader	60 (27.1)	161 (72.9)		

Table 6b: Association between socio-demographic characteristics and perception of respondents towards mHealth

Variables	Perception		χ^2	P
	Poor (%)	Good (%)		
Average monthly income			24.969	**< 0.001**
≤ 10,000	63 (27.0)	170 (73.0)		
10001 – 50000	20 (10.2)	177 (89.8)		
≥ 50,001	0 (0.0)	20 (100.0)		
			33.455	**< 0.001**
Frequency of visit to health centre monthly				
Once	6 (5.4)	105 (94.6)		
Twice	75 (26.6)	207 (73.4)		
Three or more times	2 (3.5)	55 (96.5)		