

# An Integrated Mobile and Web Based Approach for Promoting Antenatal and Postnatal Care Patronages and Reduction of Maternal and Neonatal Mortality Rates: A Case Study of Yobe State

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DOI: <https://doi.org/10.26438/ijcse/v9i4.16> | Available online at: [www.ijcseonline.org](http://www.ijcseonline.org)

Received: 04/Apr/2021, Accepted: 08/Apr/2021, Published: 30/Apr/2021

**Abstract**— Yobe State offers free antenatal and postnatal care services to target clients (pregnant women and nursing mothers). This free service was aimed to fulfil the MDGs fifth Goal to reduce maternal and infant mortality rates. However, the service is facing challenges of lack of patronage at the side of the clients. Researches show that, there exists a communication gap between the programme and the clients. Another problem is lack of maternal education from the clients. Some researchers have used ICT methods to solve this type of problems, however, most of the methods applied by the researchers in solving the problems are not cost-effective and skew to favour clients in urban areas. This research used the recent Information and Communication Technologies (ICT) methods to create an integrated platform that comprises Mobile and Web-Based (*iMOWBA*) to enhance the participation of clients regarding antenatal and postnatal care services. The platform provides different ways of delivering maternal awareness that include Web-based, mobile App, USSD Code and SMS. The technologies used include PHP, MYSQL, JavaScript, HTML and RapidSMS. The platform has increased the ANC services patronage from 46% to 67% of completed rounds.

**Keywords** - antenatal, neonatal, postnatal, ICT, pregnancy, Yobe.

## I. INTRODUCTION

Over the years, researches show that, pregnant women and nursing mothers are dying from some conditions that are preventable [1] and [2]. Although many countries have reduced the death rates through antenatal and postnatal care services, the rate still remains high in sub-Saharan African countries in which Nigeria is a part [3]. Antenatal care is among the world leading health intervention in pregnancies [4] and the fifth Goal of the Millennium Development Goals (MDGs) to reduce maternal mortality by three quarters between 1990 and 2015 [5], on the other hand, postnatal care provides health intervention to nursing mothers and their infants. Antenatal and postnatal care are a combination of medical and non-medical attentions given to pregnant women and nursing mothers with the aim to screening risk factors among the women involved. The objectives of screening the risk factors include identifying the pre-existing factors that could lead to increase in complications during pregnancy or delivery either to the mother or the infant as suggested by [2] and [3]. Although there are many programmes in Nigeria that aimed to reduce the rate of women and neonatal mortality, the death rate still remains high [6]. Most of the researches and programmes introduced to support service delivery of ANC and PNC in Nigeria are non-ICT based. However, in recent researches, Information and Communication Technologies (ICT) were employed to support quick and effective healthcare services delivery. Among the recent researches is the one carried out

by [7] where a web-based approach was used to integrate the antenatal and postnatal care services in the Management health Information System of hospitals in Sokoto state, Nigeria.

Antenatal and Postnatal care services are offered free of charge in Yobe State, however, lack of maternal knowledge as a result non-proper awareness makes the goal of free antenatal & postnatal services delivery functions below the designed objectives. It is therefore imperative to study the factors involving this lack of proper awareness and to apply ICT method for possible solutions.

Most of the researches conducted on antenatal and postnatal care are more on the technical and professional aspect with less attention given to the maternal education and awareness. Clients' (pregnant women and nursing mothers) patronage plays a vital role in the success of antenatal and postnatal care. In this research, attention was given to the use of ICT to create a cost-effective and timely mode of creating awareness and motivation strategies that would encourage the clients to participate in the antenatal & postnatal services. The researchers studied the determinants that result in communication gap between the clients and health workers or health centres where antenatal & postnatal services are delivered. These determinants include socioeconomic, residence in rural areas, no maternal education, maternal unemployment, long distance to health facilities and less maternal exposure to the media [4], other

factors are traditional, regional, religious beliefs and educational background. Artificial intelligence method was used to devise an integrated platform that would capture the clients and enlighten them about the importance of Antenatal & postnatal care via website, mobile App, USSD and mobile SMS.

The research studied socioeconomic factors and health information sources associated with women's use of antenatal & postnatal care services and categorized the maternal based on their ethics, region, communication skills and financial background so as to design and develop an integrated platform that would serve each client with timely, accurate and cost-effective awareness about the importance of antenatal & postnatal care.

## II. RELATED LITERATURE ON ANTENATAL AND POSTNATAL CARE

### Introduction

This sections discusses on the definitions of terms related to antenatal and postnatal care services in general, and specifically in North-eastern Nigeria. It also gives brief description of how ICT was used by various researchers in promoting ANC and postnatal care.

Recent literatures regarding ICT and healthcare service delivery were consulted with the aim of finding the contribution of authors towards lasting solution in the healthcare sector. However, the literature left some problems unsolved (gap). The gap discovered would be bridged step-by-step as stated in the Methodology section of this Proposal.

### Antenatal Care

Antenatal Care (ANC): is the care provided by skilled health-care professionals to pregnant women and adolescent girls in order to ensure the best health conditions for both mother and baby during pregnancy. Risk identification, prevention and management are the components of ANC [8] and [9].

Presently antenatal & postnatal services are in practice in over one hundred and fifty countries including Nigeria [10]. Antenatal & postnatal are also regarded as the best method for preventing maternal and neonatal morbidity and mortality. In this case the antenatal & postnatal services are given free of charge in Yobe State, North-eastern Nigeria.

### Postnatal Care (PNC)

Postnatal Care (PNC): is the care provided by skilled health-care professionals to women from the date of giving birth to a period of six weeks.

### Antenatal and Postnatal Care in North-eastern Nigeria

Participation in ANC and postnatal care is higher in southern part of Nigeria compared with the northern part [11]. To bridge the gap, antenatal & postnatal services were made free of charge in some states in North-eastern Nigeria

including Yobe State. The initiative was designed to cover community in both rural and urban areas. However, lack of proper awareness at the site of the clients resulted in low participation.

But on return to democracy in 1999, many elected governors introduced free antenatal and postnatal care services in their states. Yobe state is among the states that started the free ANC and PNC programme.

### Related Works on ICT and Maternal Healthcare

As antenatal and postnatal care remained the leading health intervention in maternal and neonatal health [4], several research are carried out on how to promote the antenatal and postnatal care services. These researches include ICT and Non-ICT based. For example [5] emphasized on healthcare education as the leading activity to be given to clients in other to promote the patronage of ANC and PNC services. The research shows that, only 46.1% of the respondents score 50% of total knowledge score. The research recommends that, emphasis should be given on how to improve maternal knowledge about ANC and PNC. The research was not ICT-based.

The work of [12] and [10] applied ICT by designing a Mobile Devices Enable Antenatal Care in Remote Areas of Nigeria. Though the work works fine for clients with android mobile devices, it does not consider that, most of the clients in the rural areas have no android devices. As such, the work did not favour the low-income clients who constituted about 64%.

Another research was carried out by [7] where a web-based approach was used to integrate the antenatal and postnatal care services in the Management health Information System of hospital in Sokoto state, Northern Nigeria. The researchers used Web technology tools that included Dreamweaver, PHP, CSS, JavaScript, Ajax, HTML and MySQL. Each tool has its role in the design of the system. The Dreamweaver was used for coding for the system, it was chosen because of its functionalities and easy to use. MYSQL Database was used to create database that handles the records about maternal healthcare. PHP was used as a scripting language where the scripts are written to communicate with MYSQL Database. For the system to be more interactive, Ajax and JavaScript were added. However, the system can assist health workers more than the clients, because, a client must have access to the internet before benefitting the research.

In the literatures, most of the researches concentrate on promoting the health care services delivery leaving the clients in doom. There is need to have a research that can provide easy means of creating awareness on the patronage of these important services.

Table 1: summarises some literature contacted, their achievements and limitations

S/N	Research Title	Author	Achievement	Limitation
1	Integrated Antenatal and Postnatal Pregnancy Services to Hospital Management	Danlami Y. M., & Hamza, M. K. (2018)	Ease access to maternal education Using the Internet	Only Clients who own their computer and android device benefited
2	Mobile devices Enable Antenatal Care in Remote Areas of Nigeria	Souley, B., Usman, A., Abdulhamid M., Zakariyau, B. & Lookman B. (2016)	Now clients can contact Health experts and log their complain online	Clients must own a mobile phone that support Apps
3	Knowledge on Postnatal Care Among Postnatal Mothers	Timilsina, S., & Dhakal, R. (2015)	Identified the causes of lack of maternal knowledge among clients	Solution provided was cost-Effective
4	Determinants of Postnatal care non-utilization among women in Nigeria	Somefun, O. D., & Ibisomi, L., (2016)	Identified the causes of lack of immunization centres in some communities	Solution is one-sided

### eHealth

According to World Health Organization (WHO), eHealth is the use of Information and Communication Technologies (ICT) for health [13]. This comprises the use of computer and other electronic devices for healthcare service deliveries.

### RapidSMS

This is a free and open-source framework for rapidly building mobile services for scale. RapidSMS is built with Python and Django and is designed for building robust, highly customized mobile services with web-based dashboards. RapidSMS provides a flexible platform and modular components for large-scale data collection, managing complex workflows, and automating data analysis.

### USSD

Unstructured Supplementary Service Data (USSD), sometimes referred to as "Quick Codes" or "Feature codes", is a communications protocol used by GSM cellular telephones to communicate with the mobile network operator's computers. This makes USSD more responsive than services that use SMS.

## III. METHODOLOGY

This section describes the steps-by-step methods on how the experimental aspect of the research would be conducted. It also explains the materials needed to carry out the research. Explanation on the application of Artificial Intelligence on ANC and PNC would be described. Method of data collection, processing and analysis were also stated in this section. The phases and steps about how the research would be conducted are summarized and presented in Fig. 1.

The steps are further explained as follows:

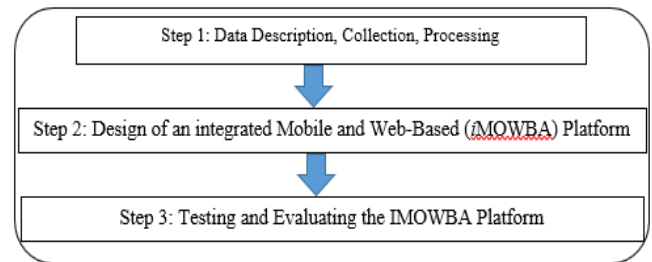


Figure 1: Phases of System Development

### Step 1: Dataset Description and Collection

This step describes the data and how the data is collected and prepared (cleaned) for analysis. There are two types of data in this research, the primary data and the secondary data.

### The Primary Data Collection Method

The primary data is the data collected directly from the clients (pregnant women and nursing mothers), this type of data was collected using two methods, that is, interview and questionnaire administration. Data from remote clients (villagers) was collected through interview method. This is to allow the research get correct information about the clients, the interview was conducted using a local language of the clients. The interview was conducted among four hundred and fifty clients (450) from Yobe states. The other method of data collection is administering of questionnaires. This has focused on urban clients who can read and write. The questionnaires were distributed to three hundred clients (300) in Yobe state.

The secondary data was obtained through ANC and PNC registers of health facilities where ANC and PNC services are carried out. The importance of secondary data is to find out the level of patronage of the free ANC and PNC clients in Yobe state. The age group of the clients as well as their residential addresses and their location from the health facility were also obtained from the registers. The secondary data also showed the clients that attended the complete rounds of ANC and PNC and those who do not. For those who do not attended the complete round, the possible causes and their possible solutions were carried out in the research. This data was collected at one (1) healthcare centres of each senatorial zone, see Fig. 2.

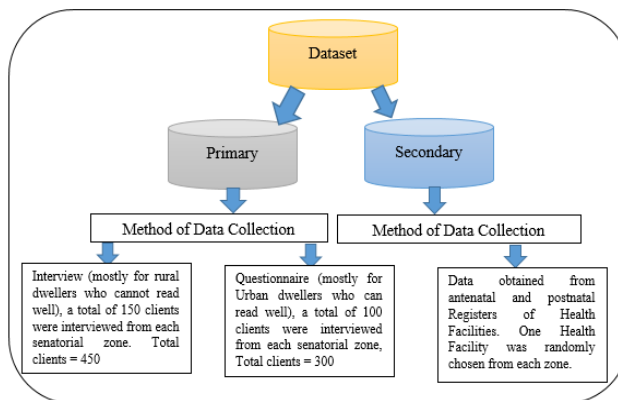


Figure 1: Dataset Description and Collection Methods Used

## Step 2: Materials and Methods Required for Developing the iMOWBA

The second step comprised the materials required to achieve the objectives. These materials are categorized according to their usage. The web-based and mobile App platforms were implemented using tools and technologies that include VSCode (short form for Visual Studio Code) as a text editor that enabled the writing of codes for the system. It is a good tool used for writing codes with a lot of functionalities that make web programming easy, while XAMP Server comprises bundle of servers for Windows and Linux operating systems. Other tools included are MySQL Database which makes the system with dynamic futures for web application and for records of client's antenatal visits, postnatal and vaccination of infants, login credentials and any other relevant data. PHP, CSS, JavaScript, Ajax, HTML are also included for easy web development and fashions especially for the front end.

### Existing System

As mentioned in the literature, there exist two recent researches on the use of ICT to improve the maternal healthcare services, the work of [7] which focused on integrating the antenatal services into the hospital management information system and that of [12] which focused on mobile device enabled antenatal care system. The former focused on incorporating the activities of ANC and PNC services into the health management information system of hospitals in Sokoto state. The work has eased access to the ANC data and services so easily. It also minimizes data error, inconsistency and lost. There was also a provision of e-resources about the importance of ANC and PNC to the life of the women and their children. Unfortunately, the main contribution of the research is the ease of service delivery especially to urban dwellers and those women with computer or android devices. This means that clients with financial difficulties would not benefit the projects.

### Proposed System Architecture

The proposed system architecture is presented in Fig.3. The system development life cycle was followed in designing and implementing the proposed system.

As seen in the Fig.3, the ANC centre (the health centre) provides the ANC and PNC services. The clients would first visit the health centre for registration followed by booking. Then the client would see a doctor for the commencement of the ANC service. After which clients are then enrol into iMOWBA platform via admin who is working together with the health worker or the health worker himself. Clients can receive lectures about the importance of ANC and PNC from the healthcare centre, then the iMOWBA platform would be used by the clients when at home. The clients can also enlighten their communities based on the lectures they received.

The data about the clients are kept in the clinic register saved on the iMOWBA platform.

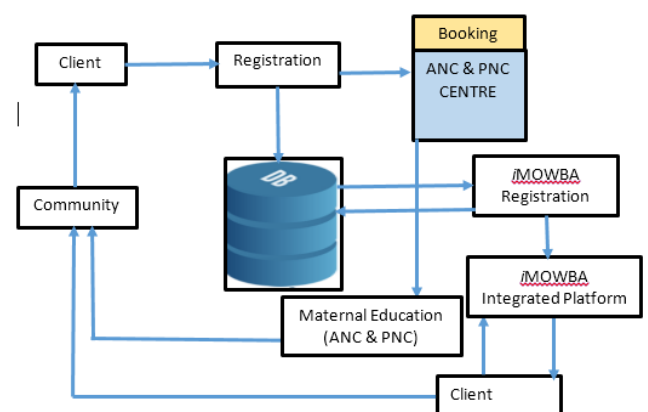


Figure 2: Architecture for Proposed iMOWBA

### System Design

The system was designed using strategies for hardware/software platform on which the system will run, the persistent data management strategy, the global control flow, the access control policy and the handling of boundary conditions. The result of the system design is a clear description of these strategies. Such as subsystem decomposition and a deployment diagram representing the hardware/software mapping of the system.

### Interface Design

The interface designed used for the implementation of the Online Antenatal and Postnatal Care Services awareness for iMOWBA are divided into input interface and output interface as shown below:

#### The Input Interface Design

The input interface accepts the data about the client that would be used for accessing the iMOMBA platform and for creating the database. Variables used include the client name, age, address, occupation of client and of husband, religion and educational background.

#### The Output Interface Design

The output interfaces produce the information entered from the input design page, which can either be a web page or a mobile App containing all the relevant information.

Another output interface is that of the USSD menu while SMS services would be provided periodically.

### How the Proposed System Works

The proposed system works in these ways: The Urban clients whom are cumbersome with the computer systems, and are equally using smartphones can be at the greatest advantage to the *iMOWBA*, this is because they will make use of both web-based application and the android mobile phones in order to gain access to the current issues regarding the maternal healthcare. Both Rural and Urban women that does not use computer and an android phone will be receiving their lectures regarding maternal healthcare issues with the help of the keypad mobile phones. This will be achieved by sending a periodic SMS and USSD at certain interval of time reminding about the time for maternal healthcare lectures, thereby they become conscious of the time for their ANC or PNC services.

## IV. EXPERIMENTAL RESULT

After implementing the methodology described in the previous section, the result was the integrated platform called *iMOWBA* platform (that is, integrated Mobile & Web-based) platform for the awareness of ANC patronage. The interface of *iMOWBA* platform Home Page is shown in Fig4:



Figure 3: : *iMOWBA* Home Page

### SYSTEM EVALUATION

The integration Mobile and Web-Based (*iMOWBA*) to one platform for the promotion antenatal and postnatal care services was successfully done. The platform was tested at 15 health facilities for the period of five (months) and it has provided the maximum services it has designed to provide. In five (5) months, the use of *iMOWBA* has risen the patronage of ANC services from 46% to 67% of those who complete their required rounds.

### Pregnancy order number

Table 1 below shows the frequency distribution of the order number of pregnancy, it shows that out of 150 respondents, 36(24.0%) have their first pregnancy experience while 51(34.0%) are pregnant for the second time. The table also shows 41respondents (27.3%) as those having third pregnancy, while 11 respondents say they are carrying the fourth pregnancy, these women represent 7.3% of the sample size. The same figure goes to women with the fifth pregnancy and above. According to WHO,

women carrying more than fourth pregnancy need extra attention during their antenatal care.

Table 2: Frequency Distribution of the Order of Pregnanc

Response	Frequency	Percentage	Cumulative %
First	36	24.0	24.0
Second	51	34.0	58.0
Third	41	27.3	85.3
Fourth	11	7.3	92.7
Fifth+	11	7.3	100.0
Total	150	100	

The graph below shows the bar charts representing the frequency of the patronage of pregnant women based on order number of pregnancy.

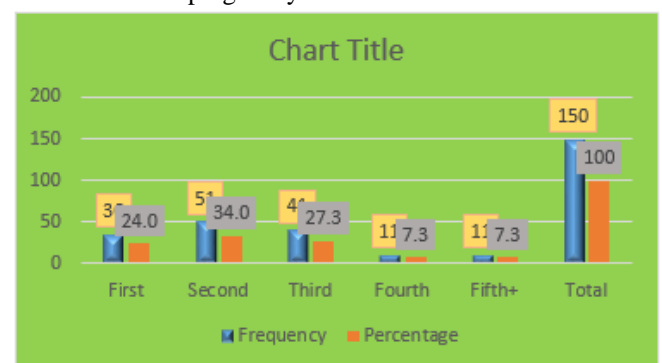


Figure 4: Showing the Frequency and Percentage of Pregnancy Order

## V. SUMMARY AND CONCLUSION/RECOMENDATIONS

### 5.1 Summary

The research has improved the patronage of clients toward accessing the free antenatal and postnatal care services provided by Yobe state government. The percentage coverage of ANC was 46% before the design of *iMOWBA*, it has now risen to 67% in five months. The researchers designed and implemented an integrated Mobile and Web-based Application (*iMOWBA*) platform that aided in disseminating awareness about the importance of antenatal and postnatal care services.

### 5.2 Conclusion

There is no doubt that the use of *iMOWBA* has increase the patronage of the both Rural and Urban clients, this is in return has increase the percentage of those who completes their rounds. It would be concluded that, the application of recent technologies in ICT to promote healthcare service delivery is real and absolute. Therefore, the contribution of ICT in health promotion is a researchable area that needs more attention collectively and individually. By and large the following recommendations are made based results obtained:



- The nearby government of these areas should continue to give free maternal healthcare to both Urban and Rural communities.
- Government should create awareness regarding enrolling women on iMOWBA in both Rural and Urban areas on Radios, TVs and using social media platforms.
- Rural areas with no mobile network should be install.
- Workshops and training should organise on timely by government in conjunction with the health workers to improve awareness on ANC & PNC.

## VI. ACKNOWLEDGEMENT

This research work was sponsored by the Federal Government of Nigeria through the Tertiary Education Trust Fund (TETFund).

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