**MAKERERE UNIVERSITY**

**An Automatic Home Health Monitoring System for Expectant Mothers (FitMaMa)**

By

BSE 18-26

EMBEDDED SYSTEM

DEPARTMENT OF NETWORKS

SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

A Project Report Submitted to the School of Computing and Informatics Technology

For the Study Leading to a Project in Partial Fulfillment of the

Requirements for the Award of the Degree of Bachelor of

Science in Software Engineering of Makerere University.

Supervisor

Dr. Swaib Kyanda

Department of Networks

School of Computing and Informatics Technology, Makerere University

kswaibk@cis.mak.ac.ug, +256-41-540628, Fax: +256-41-540620

July, 2018

# Declaration

We, group BSE 18- 26, hereby declare that the work presented is original and has never been submitted to any other university or institution of higher learning for an award. We can confirm that where we have done consultations either from published material or from the works of others, it has been attributed in this report.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **NAME** | **REGISTRATION NUMBER** | **STUDENT NO.** |
| 1 | Bakulumpagi Joseph | 11/U/16335/EVE | 211006221 |
| 2 | Mulengera Charles | 11/U/9117/PS | 211016637 |
| 3 | Kisubi Joshua | 11/U/7836/PS | 211009289 |
| 4 | Wasswa Michael | 10/U/15740/EVE | 210022740 |

Date: …………………………………………………….

# Approval

This project report titled "An Automatic Home Health Monitoring System for Expectant Mothers (FitMaMa)" has been submitted for examination with my approval as the supervisor of group

BSE 18-26.

Dr. Swaib Kyanda

Project Supervisor

Department of Networks

School of Computing and Informatics Technology

College of Computing and Information Sciences

Makerere University

Signature: ................................................... Date: ............................

## Dedication

We dedicate this work to the Almighty God, our supportive families and friends for all the love, care and sacrifices they have offered to see us through this project. We thank them for all their encouragement and support that has geared us towards achieving our professional goals and made us who we are today.

## Acknowledgements

To the Almighty God, we thank him for the love, affection and mercy he had for us throughout the development of our final year project up to the time of producing this report.

Our heartfelt gratitude goes to our supervisors; Dr. Swaib Kyanda, Mr. Motil Alex and Mrs. Mary Nsabagwa; who have been very instrumental in this project by selflessly providing their time, expert advice and guidance that has enabled us complete this project.

The support of family and friends during the period when carrying out this project cannot be left unsaid. Our parents most especially have been so amazing during this period. To all other family members and friends, words cannot fully express our gratitude to you but we sincerely appreciate you for what you have been to us throughout the whole period of our career development.

We are also sincerely grateful to our project team members for their dedication, hard work and cooperation throughout the entire academic year to see this project to completion.

## Abstract

Globally every year 529,000 maternal deaths occur, 99% of this in developing countries. Uganda has high maternal and neonatal morbidity and mortality ratios, typical of many countries in sub-Saharan Africa. Recent findings reveal maternal mortality ratio of 435:100,000 live births and neonatal mortality rate of 29 deaths per 1000 live births in Uganda; these still remain a challenge. Women in rural areas of Uganda are two times less likely to attend ANC than the urban women. Most women in Uganda have registered late ANC attendance, averagely at 5.5 months of pregnancy and do not complete the required four visits. The inadequate utilization of ANC is greatly contributing to persisting high rates of maternal and neonatal mortality in Uganda. This study was set to identify the factors associated with late booking and inadequate utilization of Antenatal Care services in upcountry areas of Uganda.

**Blog URL:** [bse18-26fitmama.simplesite.com/](http://bse18-26fitmama.simplesite.com/)

**Research paper publication URL**: https://zenodo.org/record/1288546#.WyEVEjSFNdg

## Table of contents

[Declaration i](#_Toc515229062)

[Approval ii](#_Toc515229063)

[Dedication iii](#_Toc515229064)

[Acknowledgements iv](#_Toc515229065)

[Abstract v](#_Toc515229066)

[Table of contents vi](#_Toc515229067)

[Software Design Document 1](#_Toc515229068)

[Introduction 2](#_Toc515229069)

[Purpose 2](#_Toc515229070)

[Scope 2](#_Toc515229071)

[Main Objective 2](#_Toc515229072)

[Other objectives 2](#_Toc515229073)

[Benefits 3](#_Toc515229074)

[Overview 3](#_Toc515229075)

[Reference Material 4](#_Toc515229076)

[Definitions and Acronyms 5](#_Toc515229077)

[System Overview 6](#_Toc515229078)

[System Architecture 7](#_Toc515229079)

[Architectural Design 7](#_Toc515229080)

[Decomposition Description 8](#_Toc515229081)

[Design Rationale 10](#_Toc515229082)

[Data Design 11](#_Toc515229083)

[Data Description 11](#_Toc515229084)

[Data Dictionary 12](#_Toc515229085)

[Component Design 13](#_Toc515229086)

[Human Interface Design 14](#_Toc515229087)

[Overview of User Interface 14](#_Toc515229088)

[Screen Images 14](#_Toc515229089)

[Screen Objects and Actions 15](#_Toc515229090)

[Requirements Matrix 15](#_Toc515229091)

[Implementation, testing and validation report 16](#_Toc515229092)

[Document Approval 17](#_Toc515229093)

[Introduction 18](#_Toc515229094)

[1.1 Overview of System 18](#_Toc515229095)

[Background 18](#_Toc515229096)

[1.2 Overview of document 18](#_Toc515229097)

[Requirements and system acceptance test specification 20](#_Toc515229098)

[Design and implementation process 25](#_Toc515229099)

[Development plan 25](#_Toc515229100)

[Design inputs and outputs 25](#_Toc515229101)

[Design changes 28](#_Toc515229102)

[Inspection and testing 29](#_Toc515229103)

[Test Objectives and types 29](#_Toc515229104)

[Test Results 31](#_Toc515229105)

[Installation and system acceptance test 31](#_Toc515229106)

[Performance, servicing, maintenance, and phase out 33](#_Toc515229107)

[Conclusion 34](#_Toc515229108)

[User manual 35](#_Toc515229109)

[Introduction 40](#_Toc515229110)

[Getting Started 41](#_Toc515229111)

[System Requirements 41](#_Toc515229112)

[Quick Start 41](#_Toc515229113)

[Launching the Application 42](#_Toc515229114)

[Using the Main Menu 43](#_Toc515229115)

[Checking the fetus heart rate 44](#_Toc515229116)

[Checking the blood pressure 45](#_Toc515229117)

[Checking the expectant mother heart rate 46](#_Toc515229118)

[Checking the expectant mother temperature 47](#_Toc515229119)

[Checking the fetus mobility 48](#_Toc515229120)

[Checking the expectant mother uterine contractions 49](#_Toc515229121)

[Glossary 50](#_Toc515229122)

[Findings report 51](#_Toc515229123)

[Introduction 52](#_Toc515229124)

[1. Background 52](#_Toc515229125)

[1.1. Maternal Mortality 52](#_Toc515229126)

[1.2. ANC Attendance and Utilization 52](#_Toc515229127)

[2. Methodology 55](#_Toc515229128)

[Study design 55](#_Toc515229129)

[Study setting 55](#_Toc515229130)

[Inclusion criteria 55](#_Toc515229131)

[**Exclusion criteria** 55](#_Toc515229132)

[**Sample size calculation** 55](#_Toc515229133)

[Sampling procedure 56](#_Toc515229134)

[Data handling 56](#_Toc515229135)

[Ethical approval 56](#_Toc515229136)

[3. Results 57](#_Toc515229137)

[3.1. Demographic Characteristics 57](#_Toc515229138)

[Table 1 57](#_Toc515229139)

[3.2. Awareness of Participants about ANC (Figure 1) 59](#_Toc515229140)

[3.3. Previous Place of Delivery (Table 2) 59](#_Toc515229141)

[3.4. ANC Importance (Figure 2) 60](#_Toc515229142)

[**3.5. Opinions No ANC Booking (Figure 3)** 60](#_Toc515229143)

[**3.6. Recommended Number of ANC Visits (Figure 4)** 61](#_Toc515229144)

[**3.7. ANC Utilization (Table 3)** 61](#_Toc515229146)

[**3.8. Associations** 62](#_Toc515229147)

[3.9. Qualitative Data 63](#_Toc515229148)

[Acronyms and Operational Definitions 67](#_Toc515229149)

# Software Design Document

## Introduction

The health of a mother impacts the family and even the entire community. Her ability and access to receive necessary healthcare largely determines health outcomes for herself and her baby. Like many developing countries Uganda has high maternal mortality rates, which is often reflective of access to health care services [[1]](https://en.wikipedia.org/wiki/Maternal_health_in_Uganda#cite_note-3). According to estimates from [**UNICEF**](https://en.wikipedia.org/wiki/UNICEF), Uganda’s maternal mortality ratio, the annual number of deaths of women from pregnancy-related causes per 100,000 live births, stands at 435 after allowing for adjustments [[2]](https://en.wikipedia.org/wiki/Maternal_health_in_Uganda#cite_note-4) . Women die as a result of complications during pregnancy and childbirth. The major complications include severe bleeding, infections, unsafe abortion and obstructed labor [[3]](https://en.wikipedia.org/wiki/Maternal_health_in_Uganda#cite_note-5). **Fitmama** (Automatic home health monitoring System for expectant mothers) has the potential to reduce these health issues by providing full automatic home health monitoring of expectant mothers.

## Purpose

This document is written to specify precisely what the system being built should do and the necessary external components or systems it should connect to.

The document specifies how the system and its components are built, interact or connect with its external dependencies.

## Scope

The automatic home health monitor system for expectant mothers (**Fitmama**) is a custom application which will specifically benefit users such as Expectant mothers and their physicians/Doctors. The application will be android based and will communicate with android phones using a GSM Modem. The application will be developed using Embedded-C programming language.

## Main Objective

The main objective of this project is to develop an application (an automatic home health monitor system) for expectant mothers that would fully monitor the condition of the pregnancy and the fetus in a more efficient way.

## **Other objectives**

* To implement the application.
* To test the application.

## Benefits

* The system will reduce on the cost of frequent visits to the hospitals.
* The system will allow the Expectant mothers to receive the advices and diet prescriptions as advised by the doctor.
* The system will be capable of daily or even continuous measurement of a mother and her fetus’ vital signs.
* The system will be able to take readings such as heart rate, blood pressure, UC, and body temperature using a soft state-of-the-art fabric belt sensor, analyzing the data and then lets the user to make a decision if the health care professional should be notified or not.
* The expectant mother health monitoring system shall be a more efficient and effective capable of daily or even continuous measurement of a mother and her fetus’ vital signs.
* The expectant mother health monitoring system shall require less effort requiring minimum labour and time to operate

## Overview

Section one of these documents is an introduction and includes the description of the project, and applicable reference documents.

The remaining chapters and their contents are listed below:

1. Section 2 provides a system overview.
2. Section 3 contains the system Architecture.
3. Section 4 describes the Data Design
4. Section 5 contains the Component Design.
5. Section 6 contains the Human Interface Design.
6. Section 7 contains the Traceability Matrix.
7. And finally section 8 contains the Appendices.

## Reference Material

[1] Media Aminian and Hamid Reza Naji “A Hospital Healthcare Monitoring System Using Wireless Sensor Networks,”, Department of Computer,Science and Research branch, Islamic Azad University, Kerman, Iran and College of Electrical and Computer Engineering, Kerman Graduate University of Technology, Iran, vol 4, 2013.

[2] Darwish A, Hassanien AE (2012) Wearable and Implantable Wireless Sensor Network Solutions for Healthcare Monitoring. Sensors 12: 12375-12376.

[3] Marc Spaanderman1, Marina Velikova2 and Peter Lucas (2011).e-Mom Care: Remote Monitoring in Pregnancy Care.Department of Obstetrics and Gynecology,Radboud University Nijmegen Medical Centre.Email: [M.Spaanderman@obgyn.umcn.nl](mailto:M.Spaanderman@obgyn.umcn.nl)

[4] Microcontroller Muhammad Ali Mazadi book

[5] www.microdiditaled.com

[6] www.8052.com

[7] www.keil.com

[8] www.fsinc.com

[9] [http://developer.intel.com/design/mcs51/doc\_mcs 51.htm](http://developer.intel.com/design/mcs51/doc_mcs%2051.htm).

## Definitions and Acronyms

**UC –** Uterine Contractions

**GSM –** Global Systems for Mobile Communications.

**Arduino Uno –** A microcontroller board based on the ATmega328P (datasheet) distributed by Arduino.

**AC –** Alternating Current.

**SMS –** Short Message Service.

**LCD –** Liquid Crystal Display.

**GUI –** Graphical User Interface.

**SIM –** Subscriber Identity Module.

**TTL –** Transistor to Transfer Logic

**IoT –** Internet of things

**HBP –** High Blood Pressure

**MHR** **–** Mother Heart rate

**FHR –** Fetus Heart rate

## System Overview

The Fitmama system is meant to implement a health monitoring system to automatically read the Expectant Mother’s vital signs like (FHR, MHR and Uterine Contractions), blood pressure, and body temperature.

###### Fitmama will be built into a soft state-of-the-art fabric belt which is lightweight, elasticized, supportive, washable and irritation-free. It can be worn under normal clothing.

Wireless sensors are embedded in an independent standalone device and their primary role is to read and report the vital signs of the Expectant Mother.

This wireless sensor device is at one end connected to the Expectant Mother’s mobile device using a GSM Modem.

Communication from the medical expert mobile device to the Expectant Mother’s mobile device will be through SMS or by call.

## System Architecture

## Architectural Design

ARDUINO BOARD

Temperature Sensor

Blood pressure Sensor

Heart rate Sensor

UC sensor

LCD

Power Supply

Fetus heart rate

sensor

Fetus mobility sensor

**Fig.1: Showing a block diagram of the proposed system**

The real time implementation and design procedure of the system is discussed in this section. In the schematic block diagram, the working principle of IoT based wearable health monitoring system using Arduino is explained. Block consists of temperature sensor, pulse/heart rate sensor, pressure sensor, UC sensor and Arduino board. The sensing part will sense the temperature, pulse rate and pressure of the Expectant mothers and it sends analog signal to the microcontroller Arduino. The controller consists of in-built ADC and a GSM Modem module. Hence the analog input signal is converted into digital signal which is then transferred to cloud. In transmitting part, the information is send to the Personal computer of the doctor via an IP address. If the values are abnormal i.e., varying over a small range than the preset value, this information will be received by the doctor along with an alarm sound. Hence the doctor will send back prescription to the patient’s mobile device via SMS. If the values exceed than a critical range then the doctor will call the ambulance and this information will be sent to the relative of the patient along with an alarm.

Temperature sensor

Fetus heart rate sensor

Fetus mobility sensor

UC

Heart rate sensor

Blood pressure sensor

**ADRUINO**

LCD

**Fig.2: Showing Fitmama High Level Architecture**

## Decomposition Description

Vital Signs sensors

Android mobile device

0

Arduino processor

A

**Fig.3: Showing Fitmama Context diagram**

Expectant Mother

Normal?

Physician’s mobile device

Wireless sensor device

LCD

Expectant Mother’s mobile device

End

Yes

No

Bluetooth

SMS

IoT

**Fig.4: Showing a Flowchart for various conditions of operation**

The sequence diagram is a derivative of the use case analysis and shows the interactions, relationships and methods of the objects in the systems. The remote user initiates the application via their mobile devices (Phones, PDAs, Smart Phone, IPad, and Tablets) which are connected to the remote sensor via wireless GSM Modem connection. The requests in the form of electronic pulses are sent from the wireless sensor to the mobile device which is equipped with Wireless Application Protocol (WAP) application that runs on these devices and convert it to readable format that can be transmitted via WAP gateways. The application establishes an internet connection to heath care provider web server. The web server then connects the database server through J2ME platform where the collected vital signs data are stored.



**Fig.5: Sequence diagram for the activities**

## Design Rationale

Arduino was used because it is an open source physical computing platform based on a simple input/output (I/O) board and a development environment that implements the Processing language. Arduino can be used to develop standalone interactive objects or can be connected to software on your computer. Arduino hardware is an open-source circuit board with a microprocessor and input/output (I/O) pins for communication and controlling physical objects (LED, servos, buttons, etc.). The board will typically be powered via USB or an external power supply which in turn allows it to power other hardware and sensors.

The Internet of Things (IoT) also called internet of everything. The network is formed by physical objects or "things" which are implanted with electronics, software, sensors. Things or the Objects which are connected through IoT have ability to connect with the things for data exchange with the operator or any other connected devices. IoT is an International's Global Standards Initiative. The Internet of Things allows the connected things or objects to be identified and controlled remotely across the network infrastructure. It helps in creating opportunities for more direct integration between the physical world and computer-based systems.

The main importance of this design is to show details of the system interaction, this clearly shows how analog signals flow from the sensors, converted into digital signals which are both interpreted by the microcontroller of the system and a response is returned. The architectural design is to help the system developers and manual writers to have a clear view of the system functionality and its interaction with the environment where the system is to be installed. This design is developed on an assumption that all its users are well acquainted with the English language and with full knowledge of flow chart diagrams.

## Data Design

## Data Description

The system does not have any databases but its data is stored in three kinds of memory: **Flash memory** (program space), is where the Arduino sketch is stored. **SRAM (**static random access memory) is where the sketch creates and manipulates variables when it runs. **EEPROM** (Electrically Erasable Program ROM) is memory space that programmers can use to store long-term information. Flash memory and EEPROM memory are non-volatile (the information persists after the power is turned off). SRAM is volatile and will be lost when the power is cycled. Data is to be stored and organized in this microcontroller, this has a reprogrammable flash memory that will get information from the external interfaces for example the sensors, Processes this input into a set of actions and uses the output mechanisms on the Microcontroller to do something useful. The microcontroller has a recall function or run at startup capability that enables it to restore the previous state in case of a power supply outage.

## Data Dictionary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Module | Function | Function parameters | Data type | Description |
| Temperature  module | getTemperature(); | (normal,abnormal) | float | Temperature is measured. |
| readValues(); | (degrees celsius or degrees fahrenheit) | float | Temperature values are read and recorded |
| HBP Module | getHBP(); | (high,low) | float | High Blood Pressure is measured |
| readValues(); | mmHg | float | HBP values are read and recorded from the upper to the lower limit |
| Pulse/Heart rate Module | getPulse(); | (high,low) | float | Pulse is measured. |
| readValues(); | bpm | float | Pulse values are read and recorded. |
| UC Module | getUC(); | (high,low) | float | UC is measured. |
| readValues(); | mmHg | float | UC values are read and recorded. |
| Fetus mobility Module | getFetusMobility() | (high,low) | float | Fetus Mobility is measured |
| readValues(); | hertz | float | Fetus Mobility values are read and recorded |

## Component Design

The following components make up the Fitmama Home health management system for expectant mothers and how they interact to achieve the complete system functionality

Are vital signs normal?

Read expectant mother vital signs

Connect GSM modem

Close GSM connection

Send vital signs to medical personnel

Yes

No

.

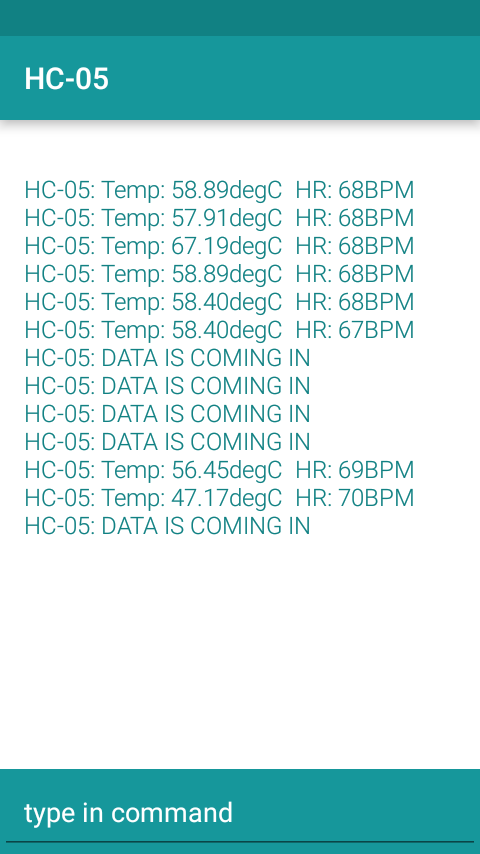
**Fig. 5: Flowchart showing Fitmama component design**

## Human Interface Design

## Overview of User Interface

The user interface has been designed to be similar to the standard android interface, a black background was chosen. The flow of the interface has been designed around the idea of flow of processes, Taking measurements using the Fitmama Portable device, initiating a GSM Modem connection between the Fitmama portable device and the patient mobile device, receiving the data and displaying the data.

## Screen Images

****

**Figure 7: Screen images.**

## Screen Objects and Actions

* Buttons - Clickable boxes that allow data manipulation and screen changes.
* Text Boxes - Allows user to input any ALPHA-NUMERIC like names and date of birth.

## Requirements Matrix

REQ 1: The system should be able to measure the required vital signs.

REQ 2: The system should be GSM Modem enabled.

REQ 3: The system should be to send files via GSM Modem

REQ 4: The system should allow the users to enter their bio data that is, the name, date of birth and age.

REQ 5: The system should store the bio data of the users.

REQ 6: The system should display the message to the user to confirm if the readings are normal or not.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Requirements | Design Components | | | |
|  | Sensor Component | GSM Modem Component | LCD Component | Memory Component |
| REQ 1 |  |  |  |  |
| REQ 2 |  |  |  |  |
| REQ 3 |  |  |  |  |
| REQ 4 |  |  |  |  |
| REQ 6 |  |  |  |  |
| REQ 7 |  |  |  |  |

# Implementation, testing and validation report

## Document Approval

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Role** | **Date** | **Signature** |
| MULENGERA CHARLES  BAKULUMPAGI JOSEPH  KISUBI JOSHUA  WASSWA MICHAEL | Developer/documenter/test /system analysts/engineer/designer  Developer/documenter/test /system  analysts/engineer/designer  Developer/ architectural designer/test engineer/system analyst/quality analysts/ documenter  Developer/test engineer/Documenter/project manager/quality analyst/ documenter/ quality engineer |  |  |
| **Dr. Swaib Kyanda** | Validation |  |  |
|  | Client |  |  |

## Introduction

## 1.1 Overview of System

## Background

An Automatic home health monitoring system for expectant mothers is a custom application which will specifically benefit pregnant women and health personnel to monitor the five vital measurements (MHR, Fetus Mobility, Uterine Contractions, blood pressure, and body temperature of an expectant mother and her fetus in a more efficient and effective way, in order to minimize on pregnancy complications and deaths. The users of the application will be the expectant mother and health personnel.

## 1.2 Overview of document

This document describes the implementation, testing and validation findings for the prepaid water billing system. It is divided into the following sections:

**Section 1.0: This section gives an overview of the document.**

It also has a detailed background review and scope of the system that explain what the system does.

**Section 2.0: Requirements and system acceptance test specification**

This subsection gives the requirements and system acceptance test showing what the system does and the objective criteria on how the computer system should be tested to ensure that the requirements are fulfilled and that the computer system performs as required in the environment in which it will be used. It includes sections in the table that serve different purposes, such sections include: Version of requirements which gives the current version of the requirements and the changes made to the require requirements, inputs, outputs, functionality, hardware control, limitations, safety of the system, default settings, version control, dedicated platform where the system will run from, special requirements, installation, service maintenance which provides documentation of service and sup­port concerning maintenance, fu­ture updates, problem solutions, requested modifications, errors and alarms.

**Section 3.0: Design and implementation process**

This section gives the full description of the System design and implementation process, which is relevant when developing new systems and handling changes subjected to existing systems. The output from this life cycle phase is a program approved and accepted for the subsequent inspection and testing phase. This section includes other sections such as the development plan, that is to say the development tools, manpower, and methods, the design outputs and outputs, it contains a table with a design output checklist which contains; implementation (coding and compilation), version identification, good programming practice, dynamic testing, utilities for validation and testing, inactive code, documentation, design changes, design change justification, and design change evaluation.

**Section 4.0: Design and implementation process**

This section gives the System inspection and testing plan and documentation of the test plan. It also contains the requirements compliance with the testing, the acceptance test specification, the approach, complexity, risks, and the intended and expected use of the computer system. It also contains other subsections that include test objectives and types, sequence of tests, configuration tests, calculation tests, regression tests, action if errors, and finally test results.

**Section 5.0: installation and system acceptance test**

The validation of the installation process ensures that all system ele­ments are properly installed in the host system and that the user obtains a safe and complete installation, especially when installing software products. It also contains other sections such as installation method, installation media, input files, installed files, supplementary files, installed components and installation qualification.

**Section 6.0: Performance, servicing, maintenance and phase out**

This section contains descriptions of Performance, servicing, maintenance, and phase out stages. In this phase, the computer system is in use and subject to the requirements for service, maintenance, performance, and support. This phase is where all activities during performance reside and where decisions about changes, upgrades, revalidation, and phase out are made. It also contains other sections such as problem/solution whereby there is detection of system problems causing operating troubles, it also talks about functional maintenance, and finally it talks about Functional expansion and performance im­provement.

**Section 7.0: Conclusions**

This section summarizes the whole project, makes remarks, and highlights several issues about the project.

# **Requirements and system acceptance test** specification

The requirements describe and specify the system completely and are the basis for the develop­ment and validation process.

**Table 1 Requirements specifications**

| Topics | **Requirements specification** |
| --- | --- |
| **Version of requirements**  Version of, and changes applied to, the requirements specification. | The requirements document version control procedure used in the project is numbering the documents from 1.1. This is the first approved version then making minor changes like formatting and diagrams clarity which are represented using the additions of 0.1 to each previous version for example 1.0,1.1,1.2.  The major changes are the ones that make the meaning of the document different. The system to be developed changes when they are changed or adjusted changing the meaning. These are mostly requirements and diagrams for the system |
| **Input**  All inputs the system will receive. Includes ranges, limits, defaults, re­sponse to illegal in­puts, etc. | ALL sensors will output analog signals which will be input to the system as voltages in the range of 0 to 5V DC. |
| **Output**  All outputs the system will produce. Includes data formats, screen presenta­tions, data storage media, print­outs, auto­mated generation of docu­ments, etc. | Temperature in degrees Celsius, Pressure in mmHg, Heart Rate in BPM (bits per minute), uterine contractions in cm/Minute, Fetal mobility in meters |
| **Limitations**  All acceptable and stated limitations in the system. | The system has several limitations to its operation. Without any of the conditions below it does not function properly   * The battery has to be in good working conditions or the system to run efficiently with minimal error. * The system can only be used by a person with a sound mind. * The expectant mother’s phone should always have subscribed SMSs to be able to send messages to the medical personnel. |
| **Safety**  All precautions taken to pre­vent overflow and malfunc­tion due to incorrect input or use. | To ensure the safety of the system the following precautions are taken into account.   * Good programming practices have been followed to prevent flows in the coding structure. * The system has a diode on power supply for reverse polarity protection. * The system has a 5V zener diode for over voltage protection. * The system has a sensor connection error detection and alert. * The LCD display is clear and the font used is big enough for easy reading. * The Fitmama system will be able to start on verification of the user’s instructions. * A user manual that has listed all the precautions to be taken for safety measures. * The system has been well developed with code well commented and segmented/ grouped logically with good indentation to prevent programmer related errors. |
| **Default settings**  All settings applied after power-up such as default input values, de­fault instru­ment or program control settings, and options selected by default. Includes infor­mation on how to manage and maintain the default settings. | * The system shall by default use English language for the first time it is installed though language customizations are to be considered for the future system versions. * The default settings for the system are not accessible to the user and can never be changed for this first version. To reset the system in case the settings dis-function, one may just need to restart it. * The device programmable once. * The device thresholds are configurable with the input buttons. |
| **Version control**  How to identify different versions of the system and to distinguish output from the indi­vid­ual versions. | * The versions of the computer system are differentiated by addition of functionality or changes made to initial existing functions/ features in relation to the initial requirements of the system with the most priority. The output from the old versions will be a bit different from the output from earlier versions in the way it is presented. * The versions of the system are identified by use of the standard version control numbering. Versions 1.0 is the initial version and minor adjustments like bug removal adds onto the version a 0.01 making it version 1.1.1, 1.1.2 and so on but adding functionality implies adding onto the version a 0.1 implying the next version will be 1.2.0. * For this particular system version is displayed on LCD at power up. |
| **Dedicated platform**  The hardware and software operating environment in which to use the system. E.g. laboratory or office computer, the actual operating system, network, third-party ex­ecuta­bles such as Microsoft® Ex­cel and Word, the actual version of the platform, etc. | * The device firmware is based on Embedded C for AVR processors. * The device is driven by a high performance 8-bit RISC AVR microcontroller from Atmel. |
| **Installation**  Installation requirements, e.g. installation kit, support, media, uninstall options, etc. | * The embedded system operating system is installed on the microcontroller and the code that we write is the operating system of the embedded system * The device is a plug and play device requiring connecting to power input in the range of 10 to 16V DC. * The SMS data transfer requires adding a GSM modem. |
| **Service and maintenance**  Documentation of service and sup­port concerning maintenance, fu­ture updates, problem solutions, requested modifications, etc. | For proper system maintenance and servicing, the following precautions have to be taken.   * The battery has to be replaced regularly. This has to be done every after 4 months. * The device shall be maintained annually following the guidelines given in the user manual. The procedures will involve dust removal, device software update using AVR MK11 programmer. * Where performance is not good, the device can be re-calibrated for performance improvement. |
| **Errors and alarms**  How to handle errors and alarms. | Press reset in case of false performance. Alternatively take device for software upgrade in case reset doesn’t help. |

# Design and implementation process

## Development plan

The system was developed using AVR Arduino V1.6.8 embedded, C++ IDE, Arduino Uno R3 board as AVR programmer, Proteus v8.6 embedded circuit design software and Microsoft visual for flowcharts and diagrams

An agile rapid prototyping method of development was used. This method involves splitting the entire project into small units and then develop and test each unit independently against the requirements, once it achieves the intended functionality, all units are merged into the proposed system.

## Design inputs and outputs

The design output must meet the design input requirements, contain or make references to acceptance criteria, and identify those char­acteristics of the design that are crucial to the safe and proper func­tioning of the product. The design output should be validated prior to releasing the system for final inspection and testing.

**Table 2. Design output checklist**

| Topics | **Design output** | |
| --- | --- | --- |
| **Implementation (coding and compilation)**  Development tools used to implement the system, notes on anomalies, plan for module and integration test, etc. | The development tools used to implement the system include:   * AVR Arduino V1.6.8 embedded C++ IDE was used for coding the embedded system. * Arduino Uno R3 board was used as AVR programmer * Proteus v8.6 embedded circuit design software was used for simulating the embedded system as well as drawing the circuit diagrams and schematics and Microsoft visual for flowcharts and diagrams. * The LCD is used to display the vital signs readings and indicates when the battery gets low. * Microcontroller that is attached to the breadboard is the heart of the Fitmama system. It is responsible for processing information from the sensors to the GSM modem and also setting on an alarm in case of any anomalies. * The Jumper wires are used to connect the different components together. * Breadboard is used to hold everything together. | |
| **Version identification**  How to identify versions - on screen, printouts, etc. Exam­ple “Version 1.0.0”. | The device labels will be labled as X.Y where X is the version number, Y is the version prefix | |
| **Good programming practice**  Efforts made to meet the recommendations for good programming practice... | Source code is... | Source code contains... |
| **Dynamic testing**  Step-by-step testing made dynamically during the implementation... | Comments: | |
| **Utilities for validation and testing**  Utilities implemented to assist in validation and testing and specification of the test environment. | The utilities implemented to assist in validation, testing and specification of the test environment are:   * A simulation was designed in proteus to mimic what the actual embedded system would look like after assembly * The sensors were tested individually for performance and all proved accurate. * After individual tests, the sensors were merged together for a deployment test in a real applicable environment for conformance to requirements of the system as was proposed. | |
| **Inactive code**  Inactive (dead) code left for special purposes. | Not Applicable | |
| **Documentation**  Documentation provided as output from the Design Output section. | The software design document is the design output of this section. It specifies how the system components are designed and configured to work together. This software design document describes the architecture and system design of the prepaid water billing system. People with different skill sets like the project manager, end users, system designer, programmers, system analyst, will use this document and for the system developers the document is to guide them through the design process of the project. | |

## Design changes

The Design Change section serves as an entry for all changes applied to the system, also systems being subjected to retrospective validation. Minor corrections, updates, and en­hancements that do not impact other modules of the system are regarded as changes that do not re­quire an entire revalidation. Major changes are reviewed in order to decide the degree of necessary revalidation or updating of the requirements and system acceptance test speci­fication.

# Inspection and testing

The inspection and testing of the system is planned and documented in a test plan. The ex­tent of the testing is in compli­ance with the requirements, the system acceptance test specification, the approach, complexity, risks, and the in­tended and expected use of the system.

The test plan is created during the development or reverse engineering phase and identify all elements that are about to be tested. The test plan should explicitly describe what to test, what to expect, and how to do the testing. Subse­quently it should be confirmed what was done, what was the result, and if the result was approved.

## Test Objectives and types

Description of the test in terms of what, why, and how. Module test, integration test, and system acceptance test. E.g. input, functionality, boundaries, performance, and us­ability.

| Topics | **Test plan and performance** |
| --- | --- |
| **Sequence of tests**  Test cases, test procedures, test data and expected results. | **Test cases and data**   * The device will be a wearable belt that will be tied on the expectant mother’s pregnancy below the abdomen. * The vital signs like High Blood Pressure, Temperature, Fetus mobility, Fetal Heart rate and Uterine Contractions will be tested every time the device is switched on. * If any of the vital signs has an abnormal reading, the system triggers the GSM modem to send an SMS to the physician’s mobile device for advice. * If the readings are normal then the device will be switched off and wait for another routine check. |
| **Configuration tests**  Platform, network, and inte­gration with other systems. | * The device firmware is based on Embedded C for AVR processors. * The device is driven by a high performance 8-bit RISC AVR microcontroller from Atmel. * The device will only connect to a mobile device using a GSM modem * The system will only communicate with a mobile device. |
| **Calculation tests**  To confirm that known inputs lead to specified outputs. | * Most sensors have standard equations for processing valid data and these have been used. * A parallel test with factory calibrated monitors on the same test conditions. |
| **Regression tests**  To ensure that changes do not cause new errors | * At component design, each was tested individually but this was no guarantee that the integration would be error free. * Therefore, after integration, the system was re-tested for errors and conformance to requirements and standards. * All readings are as a result of wide sample average. The system has capability to ignore all readings that are out of test range and hence can’t be processed. |
| **Action if errors**  What to do if errors are observed. | * Press the device reset button |

## 

## Test Results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test Time | Heart Rate/Bpm | Pressure Sys / mmHg | Pressure Dia/  mmHg | UC/Nm | Temperature/C |
| 08:45 | 63 | 75 | 100 | 6 | 38 |
| 09:35 | 57 | 71 | 110 | 3 | 43 |
| 02:48 | 87 | 83 | 140 | 5 | 39 |
| 03:25 | 95 | 76 | 99 | 5 | 40 |
| 04:15 | 66 | 87 | 115 | 4 | 38 |
| 04:45 | 95 | 79 | 118 | 9 | 46 |

# Installation and system acceptance test

The validation of the installation process ensures that all system ele­ments are properly installed in the host system and that the user obtains a safe and complete installation, especially when installing software products.

**Table 3. Installation summary**

| Topics | **Installation summary** |
| --- | --- |
| **Installation method**  Automatic or manual installation... | Comments: |
| **Installation media**  Media containing the in­stallation files... | Comments: |
| **Input files**  List of (relevant) files on the installation media. | Fitmama.ino Arduino file |
| **Installed files**  List of (relevant) installed files, e.g. EXE- and DLL-files, spreadsheet Add-ins and Templates, On-line Help, etc. | * Ino files |
| **Supplementary files**  Readme files, License agreements, examples, etc. | * User manual that will guide the users on how to operate the system. Online help is provided to help understand the flow of the system. * Finally, license agreements shall be provided in the next release of the system. |
| **Installed components**  Description of installed components that require validation. | * In the development phase, the microcontroller is fixed on the breadboard together with other components. It is this microcontroller that has the program that controls all the sensors and other electronic components. Its validation is vital for the performance of the system * An LCD screen is also installed on the breadboard that displays content that the user needs. |
| **Installation qualification**  How to ensure and document that each component is installed correctly. | Authorization shall be by the respective persons:   * Bakulumpagi Joseph, Kisubi Joshua, Mulengera Charles, and Wasswa Michael. * Installation tested and approved in a test environment, which included the actual environment, and according to the test plan. * Test environment included the workshop where we worked from and outside of that workshop. * User level testing was done on operators that is to say, administrators, manager, and vendor. User manuals are also provided as supporting documents |

# 

# Performance, servicing, maintenance, and phase out

In this phase the system is in use and subject to the requirements for service, maintenance, performance, and support. This phase is where all activities during performance reside and where deci­sions about changes, upgrades, revalidation, and phase out are made.

| Topics | **Performance and maintenance** |
| --- | --- |
| **Problem / solution**  Detection of system problems causing operating troubles. A first step could be to suggest or set up a well-documented temporary solution or workaround. | * Users may not be able to directly determine which test to run at a particular time. * The system is a combination of various tests and a user only has to wear the strap around the lower abdomen, start the system and all the tests run automatically. |
| **Functional expansion and performance im­provement**  List of suggestions and requests, which can improve the performance of the system. | The list shows suggestions to improve performance of the system   * A long life rechargeable battery to keep the system up for quite a longer time. |

## Conclusion

By the subsequent signatures it becomes evident that all validation activities are documented and ap­proved

| **Final approval for use** | | |
| --- | --- | --- |
| Identification: | |  |
| Responsible for validation: | |  |
| Remarks: | | |
| Date: | Signature: | |

# User manual

## Introduction

Expectant mothers are very delicate with their lives and that of their fetus.

Fitmama is a state of the art software system that provides information about the state of the expectant mother and her fetus depending on the following parameters;

* Fetus heart rate
* Blood pressure
* Expectant mother heart rate
* Expectant mother temperature
* Fetus mobility
* Uterine contractions

## Getting Started

**System Requirements**

An SMS enabled mobile phone

**Quick Start**

The expectant mother wears the belt and powers the system using the power button on the belt and it becomes ready to use i.e. taking readings.

The GSM modem is activated on the system in case there is need to communicate with the mobile handset of the medical personnel or expectant mother caretaker

## Launching the Application

To launch the application, the expectant mother wears the belt and powers the system using the power button on the belt and it becomes ready to use i.e. taking readings.

## Using the Main Menu

Choose one of the following options to check the status of the expectant mother and her fetus:

* Fetus heart rate

To check the heart rate of the fetus the expectant mother is carrying

* Blood pressure

To check the blood pressure of the expectant mother

* Expectant mother heart rate

To check the heart rate of the expectant mother

* Temperature

To check the temperature of the expectant mother

* Fetus mobility

To check the movements of the fetus in the expectant mother’s womb

## Checking the fetus heart rate

The expectant mother wears the belt and presses start button on the belt and then the device displays the fetus’ heart rate readings.

When the heart rate is between 52 – 110 vpm, then it is normal and anything less or greater than the range values the system triggers the GSM modem and the SMS sent mobile medical personnel device to receive these values

FHR: 52.45 BPM

**Fig.1: Showing the fetus heart rate screen**

## Checking the blood pressure

The expectant mother wears the belt and presses start button on the belt and then the device displays the blood pressure readings.

When the blood pressure is between 110 – 75 mmHg, then it is normal and anything less or greater than the range values, the system triggers the GSM modem and the SMS sent mobile medical personnel device to receive these values

BP: 95 MMHG

**Fig.2: Showing the Expectant mother’s blood pressure on the screen**

## Checking the expectant mother heart rate

The expectant mother wears the belt and presses start button on the belt and then the device displays the expectant mother’s heart rate readings.

When the heart rate is between 52 – 110 bpm, then it is normal and anything less or greater than the range values, the system triggers the GSM modem and the SMS sent mobile medical personnel device to receive these values

MHR: 89.45 BPM

**Fig.3: Showing the expectant mother’s heart rate on the screen**

# 

## Checking the expectant mother temperature

The expectant mother wears the belt and presses start button on the belt and then the device displays the expectant mother’s temperature readings.

When the temperature 350C – 390C, then it is normal and anything less or greater than the range values, the system triggers the GSM modem and the SMS sent mobile medical personnel device to receive these values

TEMP: 38.4 DEG CEL

**Fig.4: Showing the expectant mother’s body temperature on the screen**

## Checking the fetus mobility

The expectant mother wears the belt and presses start button on the belt and then the device displays the fetus mobility readings.

When the vibrations are detected, then it is normal and anything less or greater than the range values, the system triggers the GSM modem and the SMS sent mobile medical personnel device to receive these values

FM: 25 VPM

**Fig.5: Showing the Fetus mobility in expectant mother’s womb on the screen**

## Checking the expectant mother uterine contractions

The expectant mother wears the belt and presses start button on the belt and then the device displays the expectant mother uterine contractions readings.

When the contractions are detected, then it is normal and otherwise the system triggers the GSM modem and the SMS sent mobile medical personnel device to receive these values

UC: 30.41 NPM

**Fig.6: Showing Uterine contractions for the Expectant mother on the screen**

## Glossary

FHR: Fetus Heart Rate

VPM: Vibrations Per Minute

BP: Blood Pressure

MMHG: Millimeters of Mercury

MHR: Expectant Mother Heart rate

TEMP: Temperature

FM: Fetus Mobility

UC: Uterine Contractions

NPM: Newtons Per Metre

SMS: Short Message Service

# 

# Findings report

## Introduction

Globally every year 529,000 maternal deaths occur, 99% of this in developing countries. Uganda has high maternal and neonatal morbidity and mortality ratios, typical of many countries in sub-Saharan Africa. Recent findings reveal maternal mortality ratio of 435:100,000 live births and neonatal mortality rate of 29 deaths per 1000 live births in Uganda; these still remain a challenge. Women in rural areas of Uganda are two times less likely to attend ANC than the urban women. Most women in Uganda have registered late ANC attendance, averagely at 5.5 months of pregnancy and do not complete the required four visits. The inadequate utilization of ANC is greatly contributing to persisting high rates of maternal and neonatal mortality in Uganda. This study was set to identify the factors associated with late booking and inadequate utilization of Antenatal Care services in upcountry areas of Uganda.

**Introduction**

Globally every year 529,000 maternal deaths occur, 99% of this in developing countries. Uganda has high maternal and neonatal morbidity and mortality ratios, typical of many countries in sub-Saharan Africa. Recent findings reveal maternal mortality ratio of 435:100,000 live births and neonatal mortality rate of 29 deaths per 1000 live births in Uganda; these still remain a challenge. Women in rural areas of Uganda are two times less likely to attend ANC than the urban women. Most women in Uganda have registered late ANC attendance, averagely at 5.5 months of pregnancy and do not complete the required four visits. The inadequate utilization of ANC is greatly contributing to persisting high rates of maternal and neonatal mortality in Uganda. This study was set to identify the factors associated with late booking and inadequate utilization of Antenatal Care services in upcountry areas of Uganda.

**Method**

Cross-sectional study design with mixed methods of interviewer administered questionnaires, focus group discussions and key informant interviews. Data was entered using Epidata and analyzed using Stata into frequency tables using actual tallies and percentages. Ethical approval was sought from SOM-REC MakCHS under approval number “#REC REF 2012-117” before conducting the study.

**Results**

A total of four hundred one were enrolled with the majority being in the age group 20 – 24 years (mean age, 25.87 ± 6.26). Health workers played a great role (72.04%), followed by the media (15.46%) and friends (12.50%) in creating awareness about ANC. A significant number of respondents went to TBAs with reasons such as “near and accessible”, “my husband decided”, and “they are the only people I know”. 37.63% of the respondents considered getting an antenatal Card as an importance of ANC. 71 (19.67%) respondents gave a wrong opinion (late) on booking time with reasons like demands at work, no problems during pregnancy, advised by friends, just to get a card, long distance and others didn’t know. Almost half of the respondents never knew the recommended number of visits. Religion, occupation, level of education, and parity were found to influence place of ANC attendance, number of ANC visits and booking time. Husbands were necessary to provide financial support, accompany their wives ANC clinic, and ensure that they complete the visits. But their response was poor due to: fear of routine investigations and constrained economically.

**Conclusion**

The study findings show the actual rural setting of ANC services attendance and utilization. Much sensitization has to be done specifically in these rural areas to empower pregnant women and their husbands as to improve ANC attendance and utilization.

**Keywords:**Antenatal Care, ANC, Utilization, Attendance

## 1. Background

## 1.1. Maternal Mortality

Like many developing countries Uganda has high maternal mortality rates, which is often reflective of access to health care services [[1]](https://en.wikipedia.org/wiki/Maternal_health_in_Uganda#cite_note-3). According to estimates from [**UNICEF**](https://en.wikipedia.org/wiki/UNICEF), Uganda’s maternal mortality ratio, the annual number of deaths of women from pregnancy-related causes per 100,000 live births, stands at 435 and neonatal mortality rate of 29 deaths per 1000 live births[[2]](https://en.wikipedia.org/wiki/Maternal_health_in_Uganda#cite_note-4) . Women die as a result of complications during pregnancy and childbirth. The major complications include severe bleeding, infections, unsafe abortion and obstructed labor [[3]](https://en.wikipedia.org/wiki/Maternal_health_in_Uganda#cite_note-5).

## 1.2. ANC Attendance and Utilization

Countries with good indicators in maternal and infant mortality have pregnancy related complications identified and managed early, however according to Uganda Bureau of Statistics (UBOS) the overall one time antenatal attendance in Uganda was found at 94% with women in rural areas being twice less likely to attend ANC than the urban women.

According to the report only 8% of rural women in Uganda received ANC from a doctor. Regionally Southwestern Women were more likely to receive skilled care (20%), than Eastern women (3%), while only 2% of the women in Karamoja were reported to seek the same. It was reported that women in Uganda tend to seek antenatal care very late, 37% attending for the first time at 6 months or more [[2](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R2)].

Globally, developing countries still face a challenge of poorly implemented ANC programs with irregular clinical visits and long waiting times plus poor feedback to the women [[3](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R3)]. A study in Hadiya zone, Ethiopia found that majority of the mothers who attended ANC did not receive adequate number of visits and initiated the visits later than recommended by the World Health Organization [[4](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R4)].

A similar study done in Nigerian teaching hospital found that Nigerian women tended to obtain care late in pregnancy, and about one third the care was inadequate with almost half (47 percent) of women attending the ANC clinic in the third trimester [[5](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R5)].

The ANC Service utilization in Ethiopia was significantly influenced by maternal age, where mothers aged between 25 – 29 years were less likely to utilize ANC service than women who were 35 years and older. Positive husband attitude towards ANC was also significantly related to ANC service utilization [[4](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R4)] [[6](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R6)].

Mothers’ level of education influenced the use of ANC for which Mothers with primary educational level were more likely to attend ANC than women who are unable to read and write. This study further revealed that availability of women’s time is important as women spend more time on their multiple responsibilities for care of children, collecting water or fuel, cooking, cleaning, and trade than on their own health [[7](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R7)]. In Hadiya; Ethiopia, Family size was a strong determinant of ANC service utilization with greater household size limiting the use of ANC service [[4](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R4)].

A study done by Simkhada B., *et al.* also included maternal education, husband’s education, marital status, availability, cost, household income, women’s employment, media exposure and having a history of obstetric complications. But not leaving out Cultural beliefs, Parity and ideas about pregnancy. Whilst women of higher parity tend to use antenatal care less [[8](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R8)].

Another study done in Ibadan, Nigeria revealed that Women who were Muslims or other religions were more than 2 times likely to attend ANC clinic than women who were Christians. The same study showed that Women who were 25 years and older utilized ANC more than women who were below 25 years of age which agrees with study made in Bangladesh [[9](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R9)] [[10](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R10)].

A study done in rural Local Government Area in Ogun State, Nigeria, identified that women preferred TBAs for various reasons which included: cheap easily accessible culturally acceptable services and more compassionate care than orthodox health workers, and for some it was the only maternity they knew. However some respondents acknowledged that complications could arise from TBA care [[11](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R11)]–[[13](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R13)].

In many countries, TBAs are an important source of social and cultural support to women during childbirth and due to economic constraints, and the difficulty in posting trained professionals to rural areas; many women continue to deliver with TBAs [[14](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R14)]–[[17](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R17)].

A study done in rural Uganda revealed ANC attendance being irregular with few women appreciating the fact that ANC attendance was to monitor both the growth of the baby and the health status of the woman. This study also identified Parity as significantly influencing ANC attendance, but level of education, religion and marital status did not.

Several factors influenced Ugandan women ANC seeking behavior which included: perceived high cost of (ANC services, conducting a delivery and treatment), and perceived inadequacy of services provided by the formal health system [[18](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R18)]. Another study in India economic disparity along with cultural belief and restrictions determined care seeking behavior and utilization of health care, resulting in slow decline of child mortality rate [[19](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R19)]. The recent Uganda Maternal Health review revealed that access to the basic antenatal care services has significantly declined [[20](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R20)].

The ministry of health, Uganda in adherence of WHO recommends a simplified antenatal care of four visits; First visit: occurring in the first trimester, between (10 – 20) week of pregnancy, Second visit: scheduled close to week 26 (20 – 28) of pregnancy, Third visit: occurring in or around week 32 (28 – 36) of pregnancy, and lastly Fourth visit (final visit): taking place between weeks 36 and 38 (>36) of pregnancy [[3](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R3)] [[21](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R21)].

This study was set to identify the factors associated with late booking and inadequate utilization of Antenatal Care services in upcountry areas of Uganda. With specific objectives: to describe the knowledge, attitude and practices of women regarding ANC booking; to identify the socio-demographic, obstetric and cultural factors associated with late booking; to describe the knowledge, attitude and practices of women regarding utilization of ANC; to identify the socio-demographic, obstetric and cultural factors associated inadequate utilization of ANC services.

## 2. Methodology

## Study design

This was a cross sectional study using mixed methods approach. Interviewer administered questionnaires, focus group discussions and key informant interviews were employed to capture the required information.

## Study setting

Participants were randomly selected from pregnant women attending ANC Clinic at the selected COBES sites until the required number was attained. Data was collected from. These were: Dokolo Health Centre IV in the north, Rwashamaire Health Centre IV in the south west, Kayunga Hospital in central, and Budadiri Health Centre IV in the east.

Dokolo Health Centre IV is located in northern region of Uganda, Budadiri Health Centre IV is located in eastern region of Uganda, Kayunga district Hospital is located in central region of Uganda, and Rwashamaire Health Centre IV is located in Ntungamo district in western region of Uganda.

## Inclusion criteria

Pregnant women attending ANC clinic at the study site that consented to the study.

**Exclusion criteria**

Pregnant women who were too sick to participate in the study.

**Sample size calculation**

Sample size, *n* was calculated using Kirsh and Leslie formula:

Where:

* *t* = confidence level at 95% (standard value of 1.96);
* *p* = 41% women had late booking for ANC;
* *m* = margin of error at 5% (standard value of 0.05).

*n* = 371.713216; ~372. However, for convenience we enrolled 100 participants from each site [[22](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R22)]–[[24](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R24)].

## Sampling procedure

A systematic random sampling was done using the ANC clinic attendance register, selecting every third pregnant woman. Qualitative data was obtained through FGDs with randomly selected pregnant women attending the ANC clinic and KIs with two TBAs and two health workers at the ANC clinic.

## Data handling

Quantitative data obtained using a questionnaire was entered onto computer using EpiData 3.1 software by double entry, followed by data cleaning and validation. Data was exported to stata, statistically analyzed and summarized in frequency tables using actual tallies and percentages. Qualitative data initially was analyzed to identify themes and categories.

## Ethical approval

This study was approved by Makerere University School of Computing and Informatics Technology.

## 3. Results

Four hundred one respondents were enrolled with one hundred (24.94%) at Dokolo health center IV, one hundred (24.94%) at Budadiri health center IV, one hundred and two (25.44%) at Kayunga district hospital and ninety nine (24.69%) at Rwashamaire health center IV.

## 3.1. Demographic Characteristics

As can be seen from [Table 1](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/table/T1/), majority were within 20 – 24 years, with mean age of 25.87 ± 6.26. Predominantly, the respondents were primary school dropouts.

# Table 1

Demographic characteristics of participants in a multi-center study on attendance and utilization of ANC in upcountry areas of Uganda, 2012.

| **Variable** | **Frequency** | **Percentage (%)** |
| --- | --- | --- |
| **Age** | | |
| <20 | 53 | 13.22 |
| 20 – 24 | 146 | 36.41 |
| 25 – 29 | 86 | 21.45 |
| 30 – 34 | 63 | 15.71 |
| >34 | 53 | 13.22 |
| **Tota**l | **401** | **100** |
|  | | |
| **Marital status** | | |
| Married | 352 | 88 |
| Single | 48 | 12 |
| **Total** | **400** | **100** |
|  | | |

|  |  |  |
| --- | --- | --- |
| **Religion** | | |
| Roman catholic | 184 | 49.07 |
| Anglican | 117 | 31.20 |
| SDA | 20 | 5.33 |
| Moslem | 54 | 14.40 |
| **Total** | **375** | **100** |
|  | | |
| **Education level** | | |
| None | 33 | 8.38 |
| Primary | 229 | 68.12 |
| Secondary | 112 | 28.43 |
| Tertiary | 20 | 5.08 |
| **Total** | **394** | **100** |
|  | | |
| **Parity** | | |
| Prime | 59 | 15.61 |
| Multiparous | 319 | 84.39 |
| **Total** | **378** | **100** |
|  | | |
| **Occupation** | | |
| Peasant | 268 | 74.24 |
| Civil servants | 20 | 5.54 |
| Self employed | 73 | 20.22 |
| **Total** | **361** | **100** |

## 3.2. Awareness of Participants about ANC ([Figure 1](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/figure/F1/))

An external file that holds a picture, illustration, etc.
Object name is nihms693695f1.jpg

[**Figure 1**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/figure/F1/)**: Shows percentage of participants aware of the value of t ANC.**

Health workers played a great role in creation of awareness (two hundred nineteen, 72.04% of the respondents). The media and friends also played a role with forty seven (15.46%) and thirty eight (12.50%) of the respondents respectively.

## 3.3. Previous Place of Delivery (Table 2)

| **Place of delivery** | **Frequency** | **Percentage (%)** |
| --- | --- | --- |
| Health facility | 300 | 87.21 |
| Home | 33 | 9.59 |
| TBA | 11 | 3.20 |

[**Table 2**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/table/T2/) **: A table showing place of delivery for the previous pregnancy.**

Though the majority of the respondents had delivered from health facility, a considerably high proportion delivered from home and TBA with reasons that included: fear of hospital mode of delivery, encouraged by mother, husband’s decision, and no pregnancy problems. However some seemed interested in delivering at the health facility but were hindered by: loss of antenatal card, abrupt onset of labor, lack of transport, bad weather like too much rain, distance, and onset of labor at night.

## 3.4. ANC Importance ([Figure 2](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/figure/F2/))

[An external file that holds a picture, illustration, etc.
Object name is nihms693695f2.jpg](https://www.ncbi.nlm.nih.gov/core/lw/2.0/html/tileshop_pmc/tileshop_pmc_inline.html?title=Click%20on%20image%20to%20zoom&p=PMC3&id=4450446_nihms693695f2.jpg)

[**Figure 2**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/figure/F2/)**: Shows participants perception of ANC importance.**

Of the majority that considered ANC important, nine (2.47%) thought it was important only to get antenatal Card.

**3.5. Opinions No ANC Booking (**[**Figure 3**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/figure/F3/)**)**

An external file that holds a picture, illustration, etc.
Object name is nihms693695f3.jpg

[**Figure 3**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/figure/F3/)**: Shows the opinion of participants on ANC booking.**

Much as majority of the respondents had a correct opinion, a good number gave a wrong opinion with reasons such as: work, have no problems during pregnancy, heard from friends, just to get a card, long distance, and to be checked for malaria. Also a considerable number of respondents did not know.

**3.6. Recommended Number of ANC Visits (**[**Figure 4**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/figure/F4/)**)**

**An external file that holds a picture, illustration, etc.
Object name is nihms693695f4.jpg**

[**Figure 4**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/figure/F4/) **: Shows the opinion of participants on recommended number of ANC visits.**

Although the majority of the respondents thought that the recommended number of ANC visits was four, some respondents gave a wrong opinion and others did not know.

**3.7. ANC Utilization (**[**Table 3**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/table/T3/)**)**

| **Variable** | **Frequency** | **Percentage (%)** |
| --- | --- | --- |
| **Prophylaxis for malaria (Fansidar)** | | |
| Yes | 359 | 94.97 |
| No | 19 | 5.03 |
| **Total** | **378** | **100.00** |
|  | | |
| **Prophylaxis for anemia** | | |
| Yes | 325 | 94.20 |
| No | 20 | 5.80 |
| **Total** | **345** | **100.00** |
|  | | |
| **Prophylaxis for intestinal parasites** | | |
| Yes | 297 | 89.46 |
| No | 35 | 10.54 |
| **Total** | **332** | **100.00** |
|  | | |
| **Sleep under mosquito net** | | |
| Yes | 344 | 87.76 |
| No | 48 | 12.24 |
| **Total** | **392** | **100.00** |
|  | | |
| **Received Tetanus toxoid vaccination** | | |
| Yes | 351 | 90.46 |
| No | 37 | 9.54 |
| **Total** | **388** | **100.00** |

[**Table 3**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/table/T3/) **: Shows utilization of some ANC components of ANC.**

Much as majority of the respondents received prophylaxis for malaria, anemia and intestinal worms, some never knew why they did so. 12% (48/392) respondents did not sleep under mosquito nets with reasons such as; mosquito nets being expensive, inconveniencing (suffocates, smells bad and makes them feel hot) while for some the nets were torn. Some of the respondents did not receive Tetanus toxoid vaccination with reasons like: never knew that they had to get it, and poor attitude of health workers “they behave badly”.

**3.8. Associations**

In our study, religion influenced place of ANC attendance with most of the religious respondents attending from the health facility. Occupation of the respondents also influenced the Place of attendance of ANC with all civil servants attending from a health facility.

The level of education also influenced place of ANC attendance with those at tertiary level attending at the health facility, it also influenced place of delivery. Parity significantly influenced place of delivery with most multiparous women delivering from health facility and almost half of the prime gravidas delivering from TBAs’ homes.

More grand multiparous respondents compared to those who were not, delivered from their homes. Occupation also influenced number of ANC visits with almost all civil servants completing the four visits and close to half of those self-employed not completing. Parity also influenced number of ANC visits with about half of the prime gravidas not completing the four visits.

Furthermore, booking was found to be influenced by occupation and level of education with the highest proportion of self-employed and secondary level education booking late.

## 3.9. Qualitative Data

**1) Attitude of women towards ANC**

The attitude towards ANC is becoming positive due to better outcomes in health of the baby and the mother, though some still consider home deliveries as status quo. Some considered ANC as government policy so they attended in order to fulfill their obligation. For it was considered a waste of time due to protocol and delays at ANC clinics.

**2) Role of different stakeholders**

The main stakeholders identified here were: Health workers (thought to offer ANC services, Mobilize mothers for ANC, provide mosquito nets, and health education), Husbands (thought to be relevant in: financial support, accompaniment of mothers to ANC clinic, and ensuring adherence to ANC).

However husbands respond poorly due to: fear of disclosure for STIs during routine investigations, constrained economic status, and for some cultures, males think they are not supposed to be involved leaving mostly their old mothers to intervene.

**3) Late booking**

Late booking was thought to follow: absence of complications, long Distance and terrain, some are restricted by their husbands and shame especially teenagers who are shy and timid.

**4) Number of ANC visits**

There was no specific response, as they thought anytime they felt a problem they go to ANC clinic and with absence of problems, only once just to get the ANC card.

**5) Incomplete ANC visits**

Incomplete ANC visits were attributed to: long distance, some are satisfied by first visits (1st and 2nd), preoccupied by garden work.

**6) Failure to comply and adhere to advice and prophylactic treatment**

Poor compliance and adherence to prophylactic medication was thought to be due to: morning sickness, large size tablets like fansidar, and use of native medicines like “mumbwa” a local concoction made of clay and herbs.

**4. Discussion**

As predicted by other studies elsewhere, majority of the respondents’ sensitization (72.04%) was by health workers; if health workers are encouraged and empowered, this would make ANC awareness better. Visiting TBAs for pregnancy care was supported with reasons like: near and accessible, husband’s decision, and the only ones known. These were similar to findings in rural Local Government Area in Ogun State, Nigeria [[11](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R11)].

Delivery at home or TBA was supported with reasons such as; fear of mode of delivery at hospital, encouraged by mother, husband’s decision, and lack of problems during pregnancy. These were similar to findings elsewhere but were more supported by the social and cultural support given by TBAs during child birth [[14](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R14)]–[[16](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R16)]. However some respondents were interested in delivering at health facility but were limited by: loss of antenatal cards, abrupt onset and fast progress of labor, lack of transport, bad weather (too much rain), distance, and wee hours.

Just like in studies elsewhere, ANC was considered to be important in: assessing baby’s position, tetanus vaccination, and treatment when sick [[18](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R18)]. However almost half of the respondents, 37.63% considered getting the antenatal card important as a requirement at time of delivery. This might have contributed to late booking and incomplete visits since what is aimed at is the ANC card. These findings were expected apart from just getting antenatal card.

Work, absence of pregnancy problems, advise from friends, just to get a card, long distance, and malaria checkup; were reasons given for late booking. Most of these were expected, they are similar to the findings in UDHS 2006, and elsewhere [[2](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R2)] [[4](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R4)] [[5](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R5)].

As it was found in Hadiya zone; Ethiopia, majority of the mothers never received adequate number of visits [[4](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R4)]. This might be one of the hindering factors for poor utilization of ANC services and predisposes them to delivery at home or TBAs homes.

In this study, some respondents did not get prophylactic treatment because they never knew why. Others never slept under mosquito nets because of; lack of money, inconveniencing (suffocates, smells bad and they feel hot) and torn nets. Almost half of respondents never received Tetanus vaccination due to: lack of knowledge, and poor health worker attitude one respondent said “they behave badly”. These responses were expected given the setting of our study areas. More sensitization has to done to enlighten mothers why they need prophylactic medication and Health workers need to change their attitude in order to quench their clients’ fears.

Similar to study findings elsewhere; religion, occupation, parity and education level influenced place of ANC attendance, and place of delivery and to some extent these findings were expected [[7](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R7)]–[[10](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R10)]. In this study, religious, civil servants, multiparous and educated mothers attended ANC at health facility and delivered at health facilities. Therefore if women are economically empowered, educated and more emphasis made at different places of worship, this could improve ANC attendance and utilization at health facilities [[25](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R25)]–[[27](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R27)] and positively impact on maternal and child health [[27](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R27)] [[28](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4450446/#R28)].

Empowering husbands to escort their wives to attend ANC would encourage and motivate many mothers completing ANC visits, adhering to drugs and utilizing other ANC services since this would making planning easier. The good outcome for both babies and mothers has led to positive attire of many mothers towards ANC.

Stake holders identified were: health workers (Mobilize mothers for ANC, providing mosquito nets, and health education) and Husbands (financial support, accompaniment to ANC clinic, and ensuring adherence to ANC services). However husbands responded poorly because of: fear routine investigations, constrained economically, and traditional restriction. To some extent these findings were expected.

Late booking was due to: absence of complications, long Distance and terrain, husband’s restriction and shame for teenagers. Some of the respondents gave a wrong opinion about number of ANC visits due to reasons like: “anytime a problem develops”, “Once, just to get the ANC card”. However Incomplete ANC visits were attributed to: long distance, and work. Some of these findings were expected and have not yet been demonstrated in studies elsewhere.

Poor compliance for prophylactic medication was due to: morning sickness, large size tablets like fansidar, and native medicines like “mumbwa”, which have not yet been studied elsewhere.

**5. Conclusion**

The study findings show the actual rural setting of ANC services attendance and utilization. Much sensitization has to be done specifically in these rural areas to empower pregnant women and their husbands as to improve ANC attendance and utilization. These findings will also provide a basis for improvement and revision of ANC sensitization schemes, ANC provision, and ANC services utilization.

**Acknowledgements**

1. I thank the Almighty father in heaven for granting us knowledge and wisdom to conduct this study successfully. May His name be praised! Amen.
2. I thank Nurse Dorothy Nabasumba, Clinical epidemiologist and Obstetrician and Gynecologist at Jinja National Referral Hospital for assisting in analyzing the study findings.

## Acronyms and Operational Definitions

|  |  |
| --- | --- |
| UDHS | Uganda Demographic Health Survey |
| ANC | Antenatal Care |
| COBES | Community Based Education and Service |
| TBA | Traditional Birth Attendant |
| MOH | Ministry of Health |
| MDGs | Millennium Development Goals |
| HC | Health Center |
| FGD | Focus Group Discussion |
| KIs | Key Informant interviews |
| Booking | First time ANC attendance during pregnancy |
| Late booking | First time ANC attendance after first trimester (12Weeks) |
| Inadequate ANC utilization | Includes less than 4 visits, not taking fansidar, hematinic and Dewormers, not using mosquito nets and not getting tetanus injection among others plus failure to adhere to advise given during ANC visits |
| Health worker | Cadres including midwives, medical officers, and clinical officers |

**Disclaimer**

In this study all our participants were from a sensitized group since we got them at the ANC clinics while they had come for ANC services. This might have limited the scope of our results.

**References**

[1]. Alarm International. 4th Edition. 2008. Manual.

[2]. Uganda Bureau of Statistics (UBOS) and Macro International Inc. Uganda Demographic and Health Survey 2006. Calverton: UBOS and Macro International Inc.; 2007.

[3]. Villar J, Bakketeig L, Donner A, et al. The WHO Antenatal Care Randomized Controlled Trial: Manual for Implementation of New Model. 2002. pp. 6–28.

[4]. Zeine A, Mirkuzie W, Shimeles O. Factors Influencing Antenatal Care Service Utilization in Hadiya Zone. Ethiopian Journal of Health Sciences. 2010;20:75–82. [[PMC free article](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3275839/)] [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/22434964)]

[5]. Karl P, Ajegbomogun B. Utilisation of Antenatal Care in a Nigerian Teaching Hospital. African Journal of Reproductive Health. 2005;9:159–161. [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/16623200)]

[6]. Mesganaw F, Olwit G, Shamebo D. Determinants of ANC Attendance and Preference of Site or Delivery in Addis Ababa. Ethiopia Journal of Health Development. 1990;6:17–21.

[7]. World Bank. World Development Report: Infrastructure for Development. New York: Oxford University Press; 1994.

[8]. Simkhada B, Teijlingen ER, Porter M, Simkhada P. Factors Affecting the Utilization of Antenatal Care in Developing Countries: Systematic Review of the Literature. Journal of Advanced Nursing. 2008;61:244–260. [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/18197860)]

[9]. Dairo MD, Owoyokun KE. Factors Affecting the Utilization of Antenatal Care Services in Ibadan, Nigeria. Benin Journal of Postgraduate Medicine. 2010;12:5–7.

[10]. Nguyen HTH, Hatt L, Islam M, Sloan NL, Chowdhury J, Schmidt J-O, Hossain A, Wang H. Encouraging Maternal Health Service Utilization: An Evaluation of the Bangladesh Voucher Program. Social Science & Medicine. 2012;78:989–996. [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/22326107)]

[11]. Ebuehi OM, Akintujoye IA. Perception and Utilization of Traditional Birth Attendants by Pregnant Women Attending Primary Health Care Clinics in a Rural Local Government Area in Ogun State, Nigeria. International Journal of Women’s Health. 2012;4:25–34. [[PMC free article](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3282603/)] [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/22371657)]

[12]. Belsey MA. Traditional Birth Attendants: A Resource for the Health of Women. International Journal of Gynecology Obstetrics. 1985;23:247–248. <http://dx.doi.org/10.1016/0020-7292(85)90019-0>.

[13]. Bang AT, Bang RA, Sontakke PG. Management of Childhood Pneumonia by Traditional Birth Attendants. Bulletin of the World Health Organization. 1994;72:897–905. [[PMC free article](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2486734/)] [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/7867135)]

[14]. Allotey PK. Where There’s No Tradition of Traditional Birth Attendants: Kassena Nankana District, Northern Ghana. In: Berer M, Ravindran S, editors. Safe Motherhood Initiatives: Critical Issues. Oxford: Blackwell Science; 1999. pp. 147–154.

[15]. Alisjahbana A, Williams C, Dharmayanti R, Hermawan D, Kwast BE, Koblinsky M. An Integrated Village Maternity Service to Improve Referral Patterns in a Rural Area in West-Java. International Journal of Gynecology Obstetrics. 1995;48:S83–S94. <http://dx.doi.org/10.1016/0020-7292(95)02323-5>. [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/7672178)]

[16]. Amin R, Khan AH. Characteristics of Traditional Midwives and Their Beliefs and Practices in Rural Bangladesh. International Journal of Gynecology Obstetrics. 1989;28:119–125.<http://dx.doi.org/10.1016/0020-7292(89)90470-0>. [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/2563697)]

[17]. Akpala CO. An Evaluation of Knowledge and Practices of Trained Traditional Birth Attendants in Bodinga, Sokoto State, Nigeria. Journal of Tropical Medicine and Hygiene. 1994;97:46–50. [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/8107173)]

[18]. Ndyomugyenyi R, Neema S, Magnussen P. The Use of Formal and Informal Services for Antenatal Care and Malaria Treatment in Rural Uganda. Health Policy Plan. 1998;13:94–102.<http://dx.doi.org/10.1093/heapol/13.1.94>. [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/10178189)]

[19]. Ghosh R. Child Mortality in India: A Complex Situation. World Journal of Pediatrics. 2012;8:11–18.<http://dx.doi.org/10.1007/s12519-012-0331-y>. [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/22282378)]

[20]. Ssengooba F, Neema S, et al. Health Systems Development Programme. Maternal Health Review Uganda. Kampala: Makerere University Institute of Public Health; 2010.

[21]. Mugisha C, Odit A, Luzze H, et al. Uganda Clinical Guidelines: National Guidelines on Management of Common Conditions. Uganda: Ministry of Health; 2010. pp. 325–378.

[22]. FAO. Conducting Small-Scale Nutrition Surveys: A Field Manual. Rome: 1990.

[23]. Magnani R. Sampling Guide. Arlington, VA: IMPACT Food Security and Nutrition Monitoring Project; 1997.

[24]. UNICEF. Monitoring Progress toward the Goals of the World Food Summit for Children: A Practical Handbook for Multiple Indicator Surveys. New York: 1995.

[25]. Kabir M, Iliyasu Z, Abubakar IS, Sani A. Determinants of Utilization of Ante-Natal Care Services in Kumbotso Village, Northern Nigeria. Tropical Doctor. 2005;35:110–111.<http://dx.doi.org/10.1258/0049475054036814>. [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/15970041)]

[26]. Manju R, Sekhar B, Harvey S. Differentials in the Quality of Ante-Natal Care in India. International Journal for Quality in Health Care. 2008;20:62–71. [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/18024998)]

[27]. Lawn J, Kerber K, editors. Opportunities for Africa’s Newborn: Practical Data, Policy and Programmatic Support for New Born Care in Africa. Cape Town: PMNCH; 2006.

[28]. Ram F, Sigh A. Is Ante-Natal Care Effective in Improving Maternal Health in Rural Uttar Pradesh? Evidence from a District Level Household Survey. Journal of Biological Sciences. 2006;38:433–434.<http://dx.doi.org/10.1017/S0021932005026453>. [[PubMed](https://www.ncbi.nlm.nih.gov/pubmed/16762083)]