



UNIVERSITY *of*
RWANDA



**NEED ASSESSMENT OF REMOTE MONITORING SYSTEM FOR ASTHMATIC
PATIENTS**

CASE STUDY

OF NYAMATA DISTRICT HOSPITAL AND 5 HEALTH CENTERS

BY

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College of Medicines and Health Sciences

Master of Science in Health Informatics

August 2023



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**A dissertation is submitted in partial fulfillment of the requirement for the award of
Master of Science in Health Informatics**

Center of Excellence in Biomedical Engineering and E-Health

In College of medicine and health sciences

University of Rwanda

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August 2023

DECLARATION

I, AKINEZA Marie Chantal, hereby certify that the entire content of this dissertation made up of my original work except for properly recognized references. It has undergone through the anti-plagiarism software, demonstrating compliance. Therefore, this version of the thesis has been officially approved.

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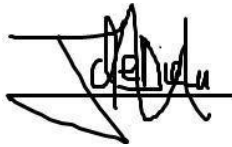
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Date: August 30th, 2023

DEDICATION

I hereby dedicate this work to my beloved husband, my whole family and friends.

ACKNOWLEDGEMENTS

First and foremost, I express my gratitude to the Almighty God Being for the gift of life and the abundance of blessings.

This work has been successfully completed due to invaluable support from a good number of people to whom I feel highly indebted.

My thanks go my supervisors, Dr. NISHIMWE Aurore and Dr. UWISENGEYIMANA Jean De Dieu, for their support on my dissertation. They were able to read my work and provide all necessary guidance with so much encouragement. Also my sincere gratitude goes to my Masters of Science in Health Informatics class of 2021. We had a great time being together. I sincerely appreciate the scholarship I received from the center of excellence in biomedical engineering and eHealth (CEBE), which allowed me to finish my studies without difficulties.

I also take this occasion to thank my family and friends for having been at my sides during the whole period of my studies.

To everyone who supported me in any way, morally, spiritually, financially, etc.
May God bless you all!

ABSTRACT

Background of the study: Approximately 300 million individuals worldwide are currently affected by asthma, and its prevalence is increasing by 50% every decade. Poor adherence to treatment is closely linked to these exacerbations, contributing to up to 60% of asthma-related hospitalizations. Rwanda has decentralized non-communicable diseases (NCDs), to the primary level, ensuring continuous follow-up and medical refills for asthmatic patients at health centers. However, there are still many patients who miss their appointment and have poor adherence to treatment. The Ministry of Health (MOH) of Rwanda has implemented various electronic medical records (EMR) systems in district hospitals across Rwanda which has significantly improved healthcare services in the country. Thus, need of remote monitoring system for asthmatic patients was assessed.

The main objective: To Assess the need of remote monitoring system among asthmatic patients and identify the requirement for the desired system.

Methodology of the study: A quantitative descriptive cross section study was used in this study and was conducted at selected District Hospital and Health Center among asthmatic patients who visited and get treatment at the selected Health Facilities during the study period and the healthcare providers in charge of NCDs. One hundred and thirty asthmatic patients (130) and nine 9 health professionals were recruited and included in this study using Yamane's formula and simple random sampling strategy and the data was collected using questionnaires and analyzed by descriptive and inferential statistics. .

Results: Showed that 95.4%, 92.3% and 93.9% respectively thought that there is a need for continuous health education on asthma self-management and triggers, need of reminding them time of taking their medicine and time of their appointments. Also 100% of Health care provider in charge of NCDs thought that there is need of continuous health education, need for reminder patients time of taking medicine and of their appointments.

Conclusion: Generally, this study revealed that there is a great need of remote monitoring system for asthmatic patients and Health care provider in charge of NCDs.

Key words: Asthma, Asthmatic patients, Healthcare Providers, health education

KEYWORDS DEFINITION

Asthma: It is a chronic condition involving inflammation of the respiratory tract, characterized by recurrent episodes of airflow obstruction and heightened sensitivity to various lung stimuli. This responsiveness is reversible, whether through treatment or without intervention [1]

Patients: An individual who is currently receiving medical care or treatment, often as a result of an illness, injury, or medical condition. These individuals seek out healthcare providers, including doctors, nurses, and other medical experts, to obtain diagnosis, treatment, and guidance related to their health issues [1].

Health care providers: Refers to either an individual or an entity providing medical services, care, and treatment to patients. These services cover a broad spectrum of healthcare activities, including the identification, prevention, treatment, recovery, and handling of illnesses, injuries, and diverse medical conditions [3].

Adherence to treatment: Refer to the degree to which a patient adheres to the medical guidelines, instructions, and counsel given by healthcare practitioners to manage their medical state. This encompasses proper medication usage, adhering to suggested lifestyle modifications, attending medical visits, and complying with all facets of the treatment regimen [4].

Remote Patient Monitoring: Represents a forward-looking strategy designed to advance health promotion and elevate patient care and oversight. This approach entails the electronic conveyance of disease-related and physiological information from the patient's residence to a healthcare facility using telephone, internet, or videoconferencing channels, thereby facilitating clinical interaction [5].

LIST OF ABBREVIATIONS

WHO: World Health Organization

MOH: Minister of Health

GOR: Government of Rwanda

NCDs: Non-Communicable Diseases

HCP: Healthcare Provider

DH: District Hospital

HC: Health Center

ICT: Information Communication Technology

ISAAC: International Study of Asthma and Allergy in Childhood

HIC: High Income Countries

LMIC: Lower Middle-Income Countries

ICS: Inhaled Corticosteroids

SABA: Short Acting Beta2 Agonist

GERD: Gastro-Esophageal Reflex Disease

OSA: Obstructive Sleep Apnea

GINA: Global Initiative for Asthma

ED: Emergency Department

COPD: Chronic Obstructive pulmonary Diseases

USAID: United States Agency for International Development

CHW: Community Health Workers

CAD4TB: Computer-Aided Detection for Tuberculosis

WHS: World Health Survey

GAN: Global Asthma Network

ATA: American Telemedicine Association

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CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1. INTRODUCTION

1.1. 1. BACKGROUND

Asthma described as a persistent inflammatory condition characterized by intermittent instances of airflow obstruction and associated symptoms like wheezing, chest tightness, dyspnea, and cough [2]. The precise cause of asthma remains uncertain; however, it is believed to arise from complex gene-environment interactions, with genetics playing a notable role [3]. Allergens, encompassing both seasonal (outdoor) and perennial (indoor) types, are widely acknowledged as triggers for asthma exacerbations [4]. Episodes of asthma arise due to the narrowing of airways triggered by factors including inflammation, excessive secretions, and constriction of bronchial muscles [3].

When it comes to diagnosing asthma, healthcare practitioners depend on physical assessment, patient medical history, clinical examination, and measurable indicators such as spirometry [5]. The primary aim of asthma management is to attain and sustain optimal control, marked by minimal or absent symptoms, regular sleep, daily activities, and optimal lung function [7]. Medications like inhaled corticosteroids (ICS) and short-acting beta-agonists (SABAs) are employed to mitigate airway inflammation and alleviate symptoms [5]. [8]. Healthcare providers routinely assess asthma control, adjusting the frequency of follow-ups according to the severity of the patient's condition and their engagement in self-management [9].

The variability in symptoms frequently corresponds to changes in exposures, such as allergens, airway irritants, or respiratory infections especially viral infections early in life. The cause of asthma is not known, but gene-environment interaction has been identified as risk factors, where genetics are known to play a big role, asthma with heritability ranging between 35% and 95% [3]. Environment factors such as Allergens are commonly recognized as triggers of asthma attack and may be seasonal (outdoor) or perennial (indoor). Outdoor allergens consist of forms of pollen and can be from trees, grass and weeds, which mainly occur with change of weather at various times in a year. Perennial (indoor) allergens include sources such as dust mites, mice, cockroaches, molds and animal dander from pet) [4]. Asthma episode are the results of airway narrowing that occurs through 3 main mechanisms such as swelling, secretions and muscle

construction of the bronchi and are more common in asthmatic patients under 18 years old, females and blacks compare to whites. Approximately one-half of patients with asthma have an episode each year, however many episodes resolve spontaneously or with minimal treatment whereas others can lead to emergency room visits, hospitalizations, or death [3].

To enhance asthma management, healthcare providers must be aware of factors that aid in asthma diagnosis through physical assessment, medical history (including cough, wheezing, breathlessness, chest tightness, and family or personal history of allergies), physical examination (noting wheezing), and objective measurements (such as spirometry indicating reversible airway obstruction) [5]. Because spirometry and peak expiratory flow proved difficult to standardize, the diagnosis of asthma was established clinically [6]. Once an asthma diagnosis has been confirmed, it's essential to create a treatment strategy aimed at achieving and sustaining optimal asthma control. The primary objective of therapy is to manage asthma effectively, leading to minimal or absence of symptoms, undisturbed sleep, unrestricted activities, and optimal pulmonary function [7]. The main components for asthma control guidelines are patients' education, environmental control, asthma control medication, and regular follow-up at recommended intervals. Asthma control medications work to decrease airway inflammation and prevent the occurrence of asthma symptoms. The primary medications used for this purpose include inhaled corticosteroids (ICS) which are mainstay in treatment of asthma, and short acting beta-agonists (SABAs) which known as quick reliever medicines, quickly reduce airway obstruction (causing relaxation of airway smooth muscles) mainly used during the time of attack [5]. Even though, the control of asthma is a target in management of it, there are numerous comorbidities which can be associated with asthma and influence disease management and control. Among the most frequently contributing comorbid conditions in asthmatic patients are rhinitis, sinusitis, gastroesophageal reflux disease (GERD), obstructive sleep apnea (OSA), hormonal disorders and psychopathologies [8].

When asthma is not effectively managed, the treatment needs to be intensified. Conversely, when asthma is under control, the treatment regimen can be adjusted. The process of maintaining asthma control is overseen by healthcare providers and ideally involves patients monitoring their condition at regular intervals. The frequency of follow-up assessments varies based on the patient's initial clinical severity and their engagement in self-management. Typically, patients are

scheduled for follow-up appointments 1–3 months after the initial visit and then every 3 months subsequently. This interval may be shorter after an exacerbation. Despite the presence of management guidelines, the global prevalence of asthma remains substantial, affecting approximately 300million individuals at present [10].

Annually, around 670,000 visits to the emergency department occur due to asthma exacerbations in children. These exacerbations are notably linked to non-adherence, accounting for up to 60% of asthma-related hospitalizations. Common triggers for exacerbations include failure to adhere to treatment, often due to treatment complexity and memory lapses. Neglecting treatment adherence is a prevalent factor contributing to uncontrolled asthma, resulting in decreased lung function, visits to emergency departments, hospitalizations, and even mortality [10].

Globally, an estimated 180,000 deaths occur each year due to asthma. The majority of these fatalities involve individuals aged 45 and older. Importantly, many of these deaths are preventable, often stemming from insufficient long-term medical management or delays in seeking medical assistance during critical asthma attacks [11].

Findings from the International Study of Asthma and Allergies in Childhood (ISAAC) indicate a concerning surge in asthma-related mortality rates, particularly since the year 2000, observed predominantly in Low Middle-Income countries. This has led to a staggering 80% of global child asthma-related deaths. Subsequently, the Global Asthma Network (GAN) revised the initial estimate of 280 deaths to approximately 100 deaths per 106 of the population. This statistic places South Africa in the unfortunate third position worldwide for asthma-related deaths. South Africa also registers a notably high case fatality rate for asthma, ranking fifth globally, with a projected rate of 18.5 deaths per 100,000 individuals diagnosed with asthma [12].

The asthma prevalence through Africa has increased noticeably in recent years, having previously been uncommon over most parts of the continent. Prevalence data are lacking for many countries in Africa including Rwanda, but it is estimated that nearly 50 million of Africans currently have asthma. The prevalence of the disease is greatest, about 8% of the population in Southern Africa [12].

As per the 2011 survey conducted in Sub-Saharan Africa, the prevalence of asthma varies among countries: Ethiopia: 9.1%, Kenya: 15.8%, Nigeria: 13.0%, Mozambique: 13.3% and South Africa: 20.3% [13].

According to World Health Organization (WHO) data released in 2018, asthma-related fatalities in Rwanda totaled 496, constituting 0.87% of the overall number of deaths. The adjusted death rate was calculated as 8.70 per 100,000 of the population. Additionally, the prevalence of diagnosed asthma stood at 8.9% among 2138 participants. In 2020, the number of asthma-related deaths in Rwanda increased to 717, accounting for 1.24% of total deaths, with a death rate of 11.90 per 100,000 individuals (World Health Ranking).

In 2007, the Rwandan Ministry of Health, in collaboration with Partners In Health, initiated a non-communicable disease program at the district level, encompassing comprehensive asthma care services. At the end of 2012, five (5) health centers in three (3) districts (Burera, Kayonza and Kirehe) had established NCDs services. Since that time the management of asthmatic patients were improved, where, follow-up of patient with less severe symptoms such as moderate and mild persistent asthma, were managed every week by trained nurses who were supervised and mentored by district level.

Asthma management guideline has been developed worldwide and put in place by different organization including Global Initiative for Asthma (GINA). Nevertheless, the prevalence of asthma remains substantial, particularly among individuals experiencing uncontrolled symptoms. A significant contributing factor to uncontrolled asthma is inadequate adherence to treatment, which has been observed in a range of 49% to 71% of pediatric patients. This non-adherence results in a decline in lung function, increased visits to the emergency department, higher rates of hospitalization, heightened morbidity, and even mortality. The survey conducted in Rwanda by Habineza et al in 2016 show 21.1 % of study population (asthmatic patients) lost to care 21.1% were lost to follow-up during 24months.

According to the Ministry of Health, Asthma affected approximately 140 thousand population of Rwanda in 2019, 1.1% of whole population. In Virtual World Health Summit in October 2020, Rwanda minister of health Dr Daniel, has presented the increases of asthma prevalence and death regardless on measures adopted. Therefore, Strategies to help patient to respect their appointment

and improve adherence to medication, self-management, education on some triggers are essential in the management of chronic disease and asthma are needed [14].

Digital health solutions, such as telemedicine and remote monitoring, have emerged as promising tools for achieving optimal and personalized asthma management [15].

Telemedicine, as per the American Telemedicine Association (ATA) definition, encompasses the distant provision of healthcare services and clinical information through telecommunication technology [15]. Patient remote monitoring systems, including internet monitoring, online reminders, text messages, and email reminders, offer advantages such as tracking symptoms and medication, setting drug reminders, improving inhaler technique, and delivering asthma education [15]. Telemonitoring has been used for managing patients' diseases at home and has shown positive results [16]. The widespread availability of web and mobile communication allows for expanded access to care, decreased wait times, and remote monitoring of medical conditions, including asthma, especially beneficial during the COVID-19 pandemic [17].

1.2. PROBLEM STATEMENT

Poor recall is marked as the major cause of poor adherence to treatment and missing appointment among asthmatic patients, where patients forget to take their medicine and time of medical appointment which result in poor asthma control. According to WHO, enhancing adherence may have a more beneficial impact in terms of health than improving any specific treatment. The poor self-care and missing appointment are the main reason of asthma attack resulting to poor quality of life and decreased physical effort [19]. Government of Rwanda through Minister of Health, have used many efforts in management and early detection of NCDs including asthma in different clinic and training of different health care providers where every health center has healthcare providers in charge of NCDs. However, there are still many patients who miss their appointments and poor adhere to treatment due to poor recall which results in poor asthma control and increase asthma crisis as well as death. A study was done to assess the need of remote monitoring system among asthmatic patients and healthcare providers in charge asthma management (NCDs services) to overcome the problems of forgetting appointments and taking medications.

1.3. SIGNIFICANCE OF THE STUDY

This study presents preliminary data on need of remote patients monitoring system among patients with asthma and their health care providers. As the requirements of the desired system were identified, the study provides baseline data for developers. Remote monitoring system will reduce the cost for care and asthma crisis for patients where the patient's health condition will be improved as they will be taking medicine on time and the system will provide asthma health education.

The government will benefit from this research where their asthmatic patients alerted for the scheduled visit and time of taking medication will improve their wellbeing by preventing them from asthma crisis and exacerbation which will result in improved population health and in development because asthmatic patients will have improved health enabling them to do their daily activities.

My fellow researchers will use this research to conduct further research on remote monitoring systems of other health related conditions.

1.4. OBJECTIVES OF THE STUDY

1.4.1. General Objective

To assess need of remote monitoring system for asthmatic patients and identify the requirements of the desired system in NCDs clinic at Nyamata DH, Mayange, Gashora, Nyamata and Ntarama HCs, and Gashora camp.

1.4.2. Specific Objectives

1. To identify need of remote monitoring system for providing continuous health education among asthmatic patients and Health care provider in charge of NCDs.
2. To identify need of remote monitoring system for providing reminder for taking medicine and appointment among asthmatic patients and Health care provider in charge of NCDs
3. To identify requirements that would facilitate patient remote monitoring system design

1.4.3. Research Questions

1. Is there a need for providing continuous health education remotely to asthmatic patients?
2. Is there a need for providing reminder remotely to asthmatic patients for medications and appointments?
3. What will be the requirements of patient remote monitoring system design?

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Asthma is a chronic lung ailment distinguished by airway inflammation and constriction, which results in breathing challenges. Its impact spans across the globe, affecting over 330 million individuals, and it ranks as a prominent factor contributing to illness and death on a global scale. Remote monitoring systems have emerged as a potential solution to manage asthma effectively. This literature review aims to explore the feasibility of remote monitoring systems in asthmatic patients.

A thorough exploration was carried out across diverse electronic databases, which encompassed PubMed, Medline, and Google Scholar. This search involved utilizing keywords like "remote monitoring," "telehealth," "asthma," "feasibility," and "remote patient monitoring." The search was limited to English language articles published from 2016 to 2021. The reviewed studies showed that remote monitoring systems can be a feasible option for managing asthma. The use of remote monitoring systems can improve patient outcomes and reduce healthcare costs. The studies demonstrated that remote monitoring systems can help in early detection of exacerbations, reduce emergency department visits, and hospitalizations. The patients reported high satisfaction levels with remote monitoring systems.

However, the studies also highlighted some challenges associated with remote monitoring systems. The lack of patient engagement, technological literacy, and privacy concerns were some of the significant barriers identified. The healthcare providers also raised concerns about the reliability of the data generated by remote monitoring systems

2.1. OVERVIEW OF ASTHMA

Asthmatic patients used to have episode of crisis, which can be caused by respiratory infection, change in exposures, such as allergens and airway irritants. The cause of asthma is not known, but gene-environment interaction has been identified as risk factors, where genetics are known to play a big role, asthma with heritability ranging between 35% and 95% [3].

Severity of asthma is classified into four (4) including intermittent, persistent mild, persistent moderate and persistent severe. The table below explain 4 classification of asthma severity

Table 2.1: Classification of asthma severity

Asthma severity	Dyspnea	Ability to speak	State of consciousness	Respiratory rate	Heart rate	Protocol
Intermittent	With effort	In complete sentences	Normal	20-25/min	<100	Other causes should be excluded because asthma is over diagnosed at this stage
Persistent-Mild	While talking	In short sentences	Normal or restless	25-30/min	100-120	Call a physician and admit to the hospital
Persistent-Moderate	All the time	Words	Restless	>30/min	>120	Call a physician and admit to the hospital
Persistent-Severe	All the time	Unable to speak	Drowsy or confuse	>30/min	Bradycardia	Call a physician and admit to the hospital
Asthma Attack	All the time	Unable to speak	Drowsy or confuse	>30/min	Bradycardia	Call a physician and admit to the hospital

Source: MOH, “National guideline for management NCDs,” *Rwanda*, p. 250, 2016.

2.1.1 Signs and symptoms

There are 4 main symptoms of asthma such as: such as a wheezing, shortness of breath, chest tightness and cough, which vary in intensity and over time.

2.1.2 Treatment of Asthma

Asthma treatment use two (2) categories of medications: controllers and relievers. Below table shows steps to follow:

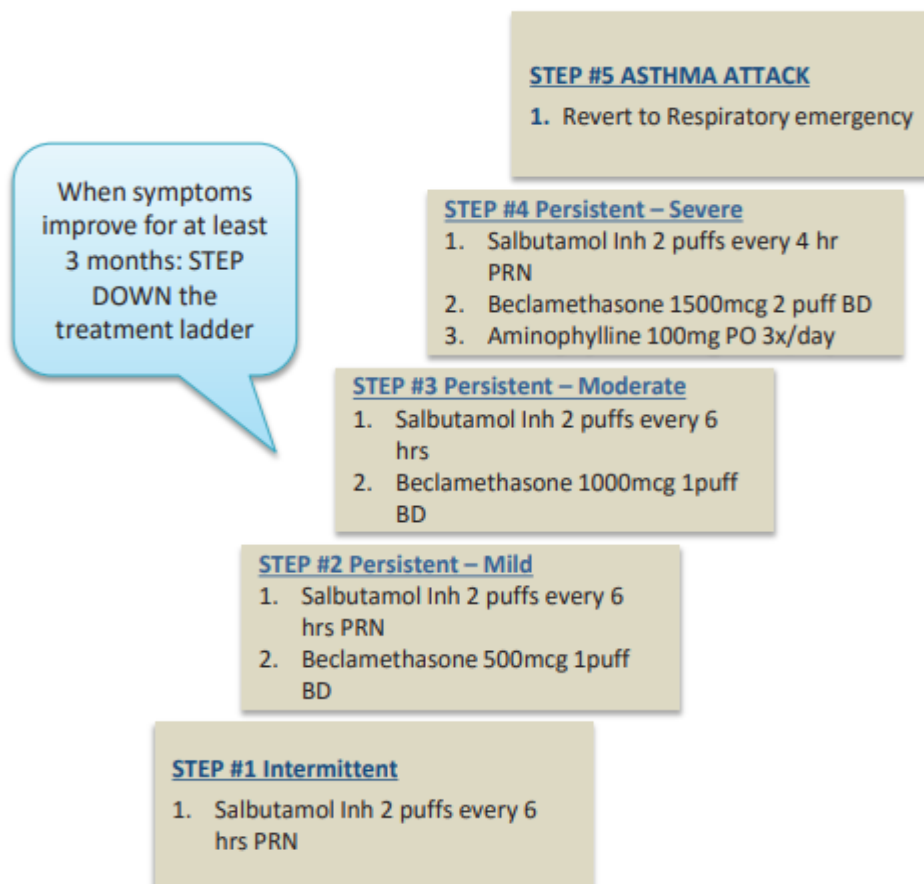


Figure 2.1: Steps to follow in management of asthma

Source: MOH, “National guideline for management NCDs,” Rwanda, p. 250, 2016.

2.2. GLOBAL BURDEN OF ASTHMA

Asthma impacts a considerable global populace, with approximately 300 million individuals presently identified as having the ailment. Its frequency is escalating by 50% every ten years, and in North America, roughly 10% of the populace experiences asthma. The rise in hospital admissions for asthma, particularly among young children, is indicative of the growing severity of the disease, inadequate disease management, and socioeconomic factors such as poverty. Globally, asthma is responsible for approximately 180,000 deaths each year [11].

In 2015, it was estimated that asthma affected as many as 385 million people of all ages worldwide, posing a substantial burden on both individuals and public healthcare systems [12]. Over the past 40 years, there has been a global increase in asthma prevalence, morbidity, mortality, and economic impact. Studies such as the International Study of Asthma and Allergies in Childhood (ISAAC) and the World Health Survey (WHS) have reported asthma prevalence rates ranging from 11.5% to 14.1% among children and 14.4% among adults aged 18-45 years [12]. Similar trends have been observed in South Africa, where the prevalence of wheezing increased from 16% to 20% between 1995 and 2002 [12].

Developed countries such as the United Kingdom, New Zealand, Australia, Ireland, Canada, and the United States have the highest asthma prevalence rates. Over time, there has been a notable rise in the count of asthma patients in Western Europe and Japan. Developing countries in Africa, Central and South America, Asia, and the Pacific also experience rising asthma prevalence due to factors such as urbanization, industrialization, and westernization. Peru, Costa Rica, Brazil, and South Africa have reported high asthma prevalence rates in their populations [11, 12].

Hospital admissions for asthma have been on the rise globally, especially among young children, reflecting the increasing severity of the disease, poor management, and socioeconomic factors. In Europe, acute asthma is the primary cause of hospital admissions in children. While overall hospital admissions for respiratory diseases have declined in North America, asthma-related admissions have increased. The United States witnessed a significant increase in hospitalization rates for adults and children with asthma from the 1960s to the 1980s. Disparities in admission rates exist, with patients from marginalized communities experiencing higher rates, likely

influenced by poverty, limited education, inadequate access to medical care, and potential ethnic factors [11].

2.3. REMOTE PATIENT MONITORING SYSTEM

Remote monitoring is an innovative approach aimed at promoting health and enhancing patient management and care [16]. It involves the digital transmission of disease-related and physiological data from the patient's home to a healthcare center through telephone, internet, or videoconferencing, enabling clinical feedback. This method facilitates early detection of disease decompensating, allowing for timely interventions and reducing mortality rates and hospitalizations. Additionally, it provides patient education, empowering individuals to improve their self-management skills [16].

Remote monitoring can be implemented in various forms, such as teleconsultation and tele-education. Teleconsultation employs telecommunication technologies to connect geographically distant healthcare providers or link healthcare providers with patients. It facilitates diagnosis, treatment, and allows physicians to remotely monitor their patients, thereby enhancing the physician-patient relationship and treatment outcomes. On the other hand, tele-education refers to the continuous provision of education by healthcare professionals to patients, enhancing their understanding of their illness, individualized treatments, and clinical outcomes by managing comorbidities and improving treatment adherence [16].

Simpler telemonitoring methods encompass receiving telephone assistance from healthcare experts, with patients communicating their symptoms during predetermined phone conversations. Patient-initiated electronic monitoring employs high-speed internet connections to transmit physiological data and symptom information to healthcare providers. These professionals subsequently reach out to patients for additional details or suggest interventions at specific time intervals to enhance the management of the condition [16].

A study conducted in 2019 focused on the feasibility and assessment of inhaled corticosteroid (ICS) adherence with and without a text message-based daily medication reminder intervention in children following an asthma-related emergency department visit or hospitalization. The study demonstrated that leveraging mobile health technology to provide medication reminders was feasible and acceptable among most caregivers. They perceived the intervention as helpful in

avoiding missed doses and improving medication adherence (27% and 54% higher than the control group, respectively), highlighting its potential to prevent readmissions and enhance asthma outcomes [22].

In 2021, Chan conducted a separate investigation delving into the application of digital inhalers for asthma and chronic obstructive pulmonary disease (COPD). This study unveiled a growing array of digital inhalers, along with their functionalities and the consequent advantages. These benefits encompassed enhanced adherence leading to cost savings and improved health results, particularly in the context of asthma and COPD management [23].

For patients with chronic diseases, remote monitoring has shown to increase disease-specific knowledge, prompt earlier clinical assessment and treatment, improve self-management, and support shared decision-making. However, many patients express concerns about reduced contact with healthcare professionals, as personal interactions help establish trust and facilitate better communication. Patients view remote monitoring as a tool to support them at home rather than replacing interpersonal interactions [24]."

2.4. Context of Rwanda

The Government of Rwanda's vision is to use ICTs to transform the health sector by employing specific policy directions, such as strengthening interoperability of health information systems and improving health service delivery and accessibility through digital health. Currently, the healthcare system in Rwanda is using different EMR system such as Open Clinic, Open MRS. The information about remote monitoring in Rwanda are limited, However, Digital Square mapped 44 existing digital system in Rwanda. Over the course of a decade, from 2010 to 2020, Digital Square undertook a comprehensive assessment of Rwanda's digital systems. This evaluation received validation from tool implementers, designers, digital health specialists, and stakeholders from the Ministry of Health (MOH) through the USAID-backed Map and Match initiative. The primary objective was to recognize the digital tools presently in use within Rwanda, map those tools that were already utilized for responding to COVID-19 according to applicable use cases, and bring attention to potential avenues where existing tools could be swiftly adjusted and employed to bolster the response to the COVID-19 situation [20]. Below are some of those tools identified:

- Zipline Drone Delivery Service initiated a blood-delivery service in Rwanda back in 2016, utilizing drones to transport medical supplies to remote and hard-to-reach areas within minutes. During the COVID-19 pandemic, Zipline extended its services to deliver medicines and essential logistics.
- Viamo, in Rwanda, serves as a mobile phone training platform for Community Health Workers (CHWs) on mental health. It has also been employed to support the training of CHWs for Ebola preparedness.
- The Rwanda Biomedical Centre Health Facility Level Services is an online national health facility database and dashboard. It provides information on local health facility locations, resources for travelers, COVID-19 test bookings, an online portal for test results, and additional COVID-19-related informational resources.
- E-Heza Data Solutions is a digital data collection system that supports health workers in the catchment area of Ruli District Hospital and the Ministry of Health (MOH) in Rwanda. It is the first point-of-care system used by nurses and CHWs for data collection.

Babylon Health is an active telehealth system operating in Rwanda. It offers a telemedicine service where patients can book appointments with healthcare providers by dialing a USSD short code, *811#. The providers subsequently contact the patients to assess their symptoms, prescribe medication, request lab tests, and provide other necessary medical support [25]. Additionally, Babylon Health operates a toll-free call center that offers support, advice, and information to patients. It is worth noting that approximately 30% of the Rwandan population is registered on Babylon Health services, and the platform conducts around 3,000 consultations daily. Furthermore, telemedicine has been implemented at the Rwanda Military Hospital to enhance student training. This includes facilitating remote instruction for medical students, enabling them to connect with renowned healthcare professionals worldwide.

2.5 Empirical literature

In 2020, Landon et al. conducted a study in the Netherlands titled "Remote monitoring of medication and lung function of asthmatic children." The study aimed to address the issue of poor disease control in asthma patients, with previous studies showing that 90% of patients struggle with correct inhaler use and home lung function tracking. Landon et al. demonstrated the feasibility of using CapMedic, a digital interactive tracking device for metered-dose inhaler

(MDI) and lung function, to remotely monitor asthma patients. Six asthma patients aged 10 to 17 were recruited from a referral clinic within a 200-mile radius. They were provided with the CapMedic device to use with daily inhaled corticosteroids. The data collected through the device was transferred for remote monitoring via a smartphone app. The study identified patients with low MDI adherence, competence, and lung function at home, highlighting the need for future interventions.

Jacome et al. conducted a mixed-method study in Portugal and Spain in 2021 to evaluate the feasibility and acceptability of the InspirerMundi app for monitoring medication adherence in adolescents and adults with persistent asthma. Poor medication adherence is a significant challenge in asthma management, and objective assessment of inhaler adherence is crucial. The study involved 107 patients from 26 secondary care centers, and 92.5% installed the app, with 73.8% completing the 1-month interview. The patients showed median medication adherence rates of 75% for inhalers and 82% for other drug formulations. Patients were generally satisfied with the app, especially regarding adherence and symptom monitoring features.

In 2017, Oduor conducted a study in Kenya titled "A Model for home-based remote monitoring of asthmatic patients." Asthma is a prevalent chronic lung illness among children, and monitoring its severity at home is challenging and costly in low-resource settings like Kenya. The study aimed to develop a wearable device for in-home remote monitoring of asthmatic children to determine asthma severity instantly. The device captured heart rate and oxygen saturation measurements using a pulse oximeter sensor and sent the results, along with severity levels, to parents and clinicians via a GSM module. This approach allowed for proper care and management of severe cases and proved to be a cost-effective solution.

Jing conducted a study in China in 2012 to examine the feasibility of a remote monitoring system for home-based non-invasive positive pressure ventilation of children and infants with upper airway obstruction. The study included 14 pediatric patients treated in an ENT unit, and the system demonstrated good compliance, safety, and ease of use. Both parents and physicians were highly satisfied with the remote monitoring system, indicating its potential for safe and effective home-based non-invasive positive pressure ventilation, especially in developing countries with limited healthcare budgets or for patients from remote regions.

Kamps and Brand conducted a study in 2021 on education, self-management, and home peak flow monitoring in childhood asthma. The study emphasized the importance of patient education in asthma self-management and questioned the assumptions regarding peak flow monitoring. According to their findings, self-management plans based on education alone were just as effective as those incorporating peak flow monitoring. Therefore, education plays a pivotal role in asthma self-management, and home peak flow monitoring may not be necessary for the majority of asthmatic children.

2.6. Conceptual Framework

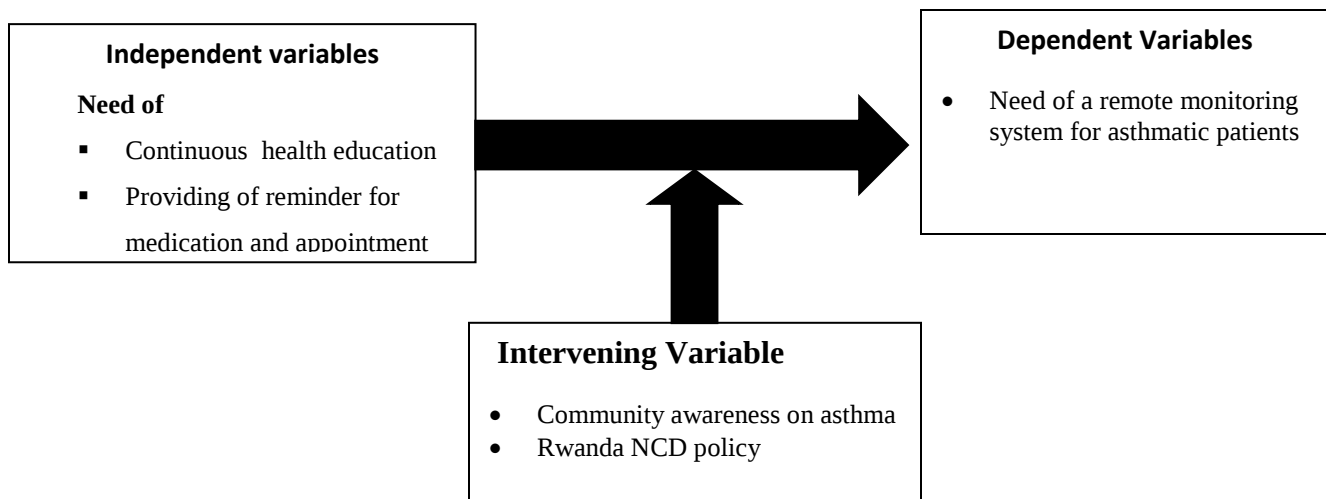


Figure 2.2 Conceptual Framework for patient

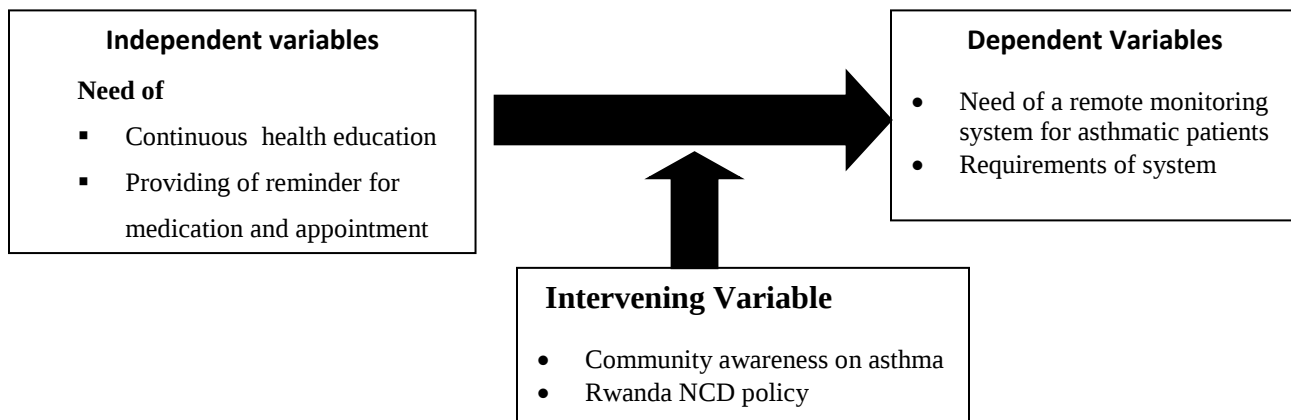


Figure 2.3 Conceptual Framework for HCP responsible for NCDs

According to the information summarized in this conceptual framework, the independent variables Need of remote monitoring system for continuous health education and for providing reminder for medication and appointment. These variables have an impact on the dependent variable which is the need assessment of a remote monitoring system for asthmatic patients. Intervening variables for this study include the community awareness on asthma and the national NCD policy.

2.7. Summary

This chapter dealt with the literature review in which an overview of asthma was provided. On this section, the researcher explained the signs and symptoms of asthma, the treatment of asthma and the global burden of asthma. The chapter also explained the remote patient monitoring system in the world and in the context of Rwanda. Finally, the chapter drew a conceptual framework in which the relationship between different variables has been explained. The next chapter gives details on the methodology to be used in the study.

CHAPTER THREE. STUDY METHODOLOGY

3.1. Study Design

A quantitative cross-section study design focusing on need of remote monitoring system in asthmatic patients and healthcare provider in charge of NCDs working at Nyamata district hospital and 5 health centers in catchment area and was used.

3.2. Study setting

The research was conducted at Nyamata District hospital and five (5) selected health centers , which located in Eastern province, Bugesera district, Nyamata, Ntarama, Gashora and Mayange sectors.

The researcher targeted these area as they are among health facilities which provide NCDs services in Bugesera District.

3.3. Study population

The Population study is defined as entire group of participants in which the researcher is interested on and in which sample size is taken from [27]. The entire population of this study was all adult patients with asthma who visited and get treatment from selected health facilities (Mayange, Nyamata, Ntarama,Gashora Health Centers, Gashora camp and Nyamata District Hospital) during the study period and HCP responsible for NCDs. The whole population was 202persons (193 patients and 9 HCP).

3.3.1. Target population per setting

According to monthly report at the selected health facilities, the following table gives details on the number of asthmatic patients who visited the concerned health facilities during the study period.

Table 3.1 Target population per setting

Settings		Asthma Patients who visited the health facility per month	HCP in charge of NCDs	Sample size per setting (patients)	Sample size per setting (HCP)
Nyamata hospital	NCDs	23	2	16	2
	Emergency service	9	2	5	2
Nyamata HC		30	1	21	1
Mayange HC		38	1	26	1
Ntarama HC		25	1	18	1
Gashora HC		40	1	25	1
Gashora ETM		28	1	19	1
Total		193	9	130	9

Source: Nyamata DH, 2022

3.3.2. Inclusion Criteria

All adults who aged 18 years or above asthmatic patients of all sex who visited and got treatment at above mentioned study area during the time of data collection and healthcare providers responsible for NCDs.

3.3.3. Exclusion Criteria

All asthmatic patients who aged less than 18, patients and healthcare providers in charge of NCDs who are not willing to participate in study were not considered among study participants.

3.4. Sample design

3.4.1 Sample size

Asthmatic patients were selected from each pre-selected health facility (Nyamata DH, Nyamata HC, Ntarama HC, Mayange HC, Gashora HC and Gashora ETM) and sample size was calculated using the Yamane's Formula.

Patients and healthcare providers were selected from each health study settings in Nyamata district. Sample size was calculated by using Yamane's formula.

$$n = N / 1 + N(e)^2$$

We got people by using the stratified proportional random sampling helped to get the number of at each site.

The sample size was calculated as follows:

$$n = \frac{193}{1 + 193(0.05)^2} = 130 \text{ patients}$$

For healthcare providers, total population was used as sample size due to small number of healthcare providers in charge of NCDs.

Therefore, the sample is composed by 130 asthmatic patients and 9 healthcare providers in charge of NCDs

3.4.2 Sampling technique

We got patients by using the stratified proportional random sampling helped to get the number of at each site. Concerning HCP, in this study, the total population sampling strategy was used; those HCP who were responsible for NCDs in the concerned health facilities during the study period. A total population strategy is one of purposeful sampling method used when the population to be studied is small and used as a whole without selecting.

3.5. Data collection procedures

After receiving the approval from IRB/UR/CMHS, the researcher requested the Hospital and Health Center authorities, the permission of conducting research before interacting with

asthmatic patients and HCP in charge of NCDs. Participants voluntarily signed informed consent form prior to include into the study. The questionnaires were written in both English and Kinyarwanda and participants chose their familiar and convenient language. Besides that, the questionnaire had two (2) sections. Section one included basic personal and demographic information of respondents and Section two includes questions which helped respond to the objectives of the study participants took approximately 30-45 minutes to fulfill the questionnaire.

3.6. Reliability and validity of instruments

Reliability

To test the reliability of the research instruments means to verify if the research instruments will give the same results if applied in a similar study (Robson, 2002). In this study, the researcher tested reliability using SPSS version 25. As stated by Kombo (2006), for the instrument to be considered reliable, the Cronbach alpha coefficient of the study's outcomes should be equal to or higher than 0.7. The findings of the research indicated a Cronbach alpha coefficient of 0.8, surpassing the threshold of 0.7..

Validity

In the context of research, validity pertains to the suitability of research tools in gathering data that, upon analysis, can effectively mirror the phenomenon under investigation (Mohajan, 2017). Research tools are deemed valid when they can be trusted to accurately measure the intended aspects (Rauvola, Briggs, & Hinyard, 2020). Similarly, the validity of this study was evaluated under the same conditions as its reliability assessment.

3.7 Data Analysis

Data analysis is the systematic examination, cleansing, transformation, and modeling of gathered information with the main goal of identifying relevant data that informs conclusions and facilitates decision-making about the studied phenomenon (Thomson and Emery, 2014). Furthermore, the process of data presentation includes arranging the analyzed data into different formats like tables, histograms, bar charts, pie charts, and graphs, among other options. This aids in deriving logical and statistical conclusions.

The study utilized primary data obtained from sampled healthcare professionals (HCPs) and individuals with asthma as input. The data was structured in a manner that enhanced its significance and interpretability, aligning with the study's goals. Following data collection in the field, it was inputted into a computer using SPSS version 25, facilitating straightforward analysis and interpretation.

As output, concerning objective one, descriptive analysis was done and frequencies and percentages were computed to identify need of remote monitoring system for providing continuous health education among asthmatic patients and Health care provider in charge of NCDs.

Concerning objective two, descriptive analysis was done and frequencies and percentages were computed to assess the need of a remote monitoring system for providing reminder to both medication and medical appointment among asthmatic patients and Health care provider in charge of NCDs.

Concerning objective three, descriptive analysis was done and frequencies and percentages were computed to identify requirements that would facilitate patient remote monitoring system design and development. In addition, logistic regression was conducted and bivariate and multivariate analyses were done to determine the relationship between different factors and the fact of missing to take asthma medication in order to show the importance of a remote monitoring system for asthmatic patients. All these analyses were done using SPSS.

3.8 Ethical Consideration

Before commencing this research, approval was granted by the Institutional Review Board (IRB)/University Research (UR)/College of Medicine and Health Sciences (CMHS). Prior to the data collection phase, consent was acquired from the relevant Hospital and Health Centers. Participation in this study was entirely optional. The details and consent form were translated into Kinyarwanda. A signed agreement from each participant was retained, and individuals declining to provide consent were not included. The data was maintained confidentially, and the study's implementation did not involve any anticipated risks.

CHAPTER FOUR. RESEARCH FINDINGS AND DISCUSSION

4.0 Introduction

This chapter provide an overview of the outcomes obtained from assessing need of Remote Monitoring System among asthmatic patients and healthcare providers in charge of NCDs at Nyamata district hospital and 5 selected health centers in catchment area of Nyamata DH. The results are presented in accordance with the research goals. Tables and graphs were used to present the study findings. The Key findings were compared with other previous studies.

4.1 Presentation of the findings

The findings of this study were presented in form of tables and figures with respect to the study objectives. It successively spoke of the socio-demographic characteristics of the respondents, the need of remote monitoring system for providing continuous health education among asthmatic patients and Health care provider in charge of NCDs, need of a remote monitoring system for providing reminder for both time of medication and medical appointment among asthmatic patients and Health care provider in charge of NCDs and the requirements that would facilitate patient remote monitoring system design and development, bivariate and multivariate analysis of factors associated with remote monitoring system for asthmatic patients and Health care provider in charge of NCDs.

4.1.1 Socio-demographic characteristics of the respondents

The details concerning socio-demographic characteristics of the respondents are displayed in the table below:

Table 4.1 Socio-Demographic Characteristics of asthmatic patients

Variables	Frequency	Percentage
Gender		
Male	46	35.4
Female	84	64.6
Age		
18-30	22	16.9

31-40	14	10.8
41-50	20	15.4
51-60	34	26.2
Above60	40	30.8
Marital Status		
Single	15	12.3
Married	93	70.8
Widower	22	16.9
Profession		
Farming & Agriculture	70	53.8
Employed	21	15.4
Self-Employed	17	12.3
Unemployed	22	18.5
Education level		
Primary	62	47.7
Secondary	26	20.0
University	20	15.4
Uneducated	22	16.9
Religion		
Christian	116	89.2
Muslim	8	6.2
Other	6	4.6
Experience with asthma		
Less than 1 year	2	1.5
Between 1 to 4 years	20	15.4
Between 5 to 10 years	52	40.0
Above 10 years	58	43.1
Having telephone		
Yes	98	75.4
No	32	24.6
Kind of telephone		

Smartphone	42	32.3
Non_Smart phone	56	43.1
N/A	32	24.6
Using internet		
Yes	42	32.3
No	88	67.7
Knowing to download an application		
Yes	38	29.2
No	92	70.8
N	130	

As shown in table 4.1, female asthmatic patients represented 64.6% while male were 35.4%; about 30.8% of the respondents were aged more than 60 years old; about 70.8% of the respondents were married; about 53.8% were doing farming and agricultural activities; about 47.7% have done primary school; 89.2% of the respondents were Christian; 43.1% have been diagnosed for asthma for more than 10 years; 75.4% possess telephones; 43.1% use non smart phones; 67.7% did not use internet while 70.8% did not know to download an application.

Table 4.2 Socio-Demographic Characteristics of healthcare professionals

Variables	Frequency	Percentage
Gender		
Male	4	44.4
Female	5	55.6
Age		
31-40	4	44.4
41-50	4	44.4
51-60	1	11.1
Marital Status		
Married	9	100
Education level		

Secondary	3	33.3
University	6	66.7
Religion		
Christian	8	88.9
Muslim	1	11.1
Experience in working in NCDs specifically with asthmatic patients		
Between 1 to 5 years	7	77.8
Over 5 years	2	22.2
N	9	

As shown in table 4.2, female healthcare professionals represented 55.6% while male were 44.4%; about 44.4% of the respondents were aged between 31-40 and 41 and 50 years old; all the respondents were married; about 66.7% have done primary university; 88.9% of the respondents were Christian and 77.8% have between 1 -5 years of experience in working in NCDs specifically with asthmatic patients.

4.1.2 Need of remote monitoring system for continuous health education among asthmatic patients and Health care provider in charge of NCDs

The first objective of this study was to identify need of remote monitoring system for continuous health education among asthmatic patients and Health care provider in charge of NCDs, where the study participants were asked a set of questions about their opinions on this kind of need.

Table 4.3 Opinion of asthmatic patients on the need of remote monitoring system for health education

Variables	Frequency	Percentage
Having had asthma crisis in last 1 month		
Yes	96	73.8
No	34	26.2

Number of crises		
Once	26	20.0
Twice	30	23.1
3 times	18	13.8
Above 3 times	22	16.9
N/A	34	26.2
Action undertaken during asthma crisis		
Go to hospital or HC	41	30.8
Use medicine	65	50.8
No action	24	18.5
Action undertaken to prevent asthma crisis		
Regular follow up	30	23.1
Respect time of taking medicine	24	18.5
To know and avoid triggers exposure	18	13.8
Nothing	26	20.0
Others(please specify)	32	24.6
Knowing triggers exacerbating symptoms		
Yes	123	93.8
No	7	6.2
Needs for continuous health education on asthma self-management and triggers		
Yes	124	95.4
No	4	3.1
Don't know	2	1.5
Methods of health education		
By phone call	18	13.8
By SMS	19	15.4
By phone notification	11	7.7
By using app in my phone or in phone of CHWs	52	40.0
Others (please specify)	26	20.0

N/A	4	3.1
Frequency of remote health education		
Weekly	12	9.2
Biweekly	26	20.0
Monthly	66	50.8
Every 2 months	20	15.4
Others (please specify)	2	1.5
N/A	4	3.1
N	130	

Concerning the need of remote monitoring system for health education, Table 4.3 demonstrated the study findings where 73.8% of the asthmatic patients have had asthma crises in last 1 month; 23.1% of the respondents had crises twice in the last month; 50.8% of the respondents used medicine during asthma crisis; 23.1% use regular follow up to prevent asthma crisis; 93.8% know triggers exacerbating their symptoms; 95.4% thought that there is a need for continuous health education on asthma self-management and triggers; 13.8% said that this can be done using phone call, 15.4% said it would be better to use SMS, 7.7% evoked phone notification and 40% talked about using app in patients' phone or CHW's phone while 50.8% thought that remote health education should be done monthly. The following figure gives details on the patients who agree that there is a need for continuous health education on asthma self-management and triggers.

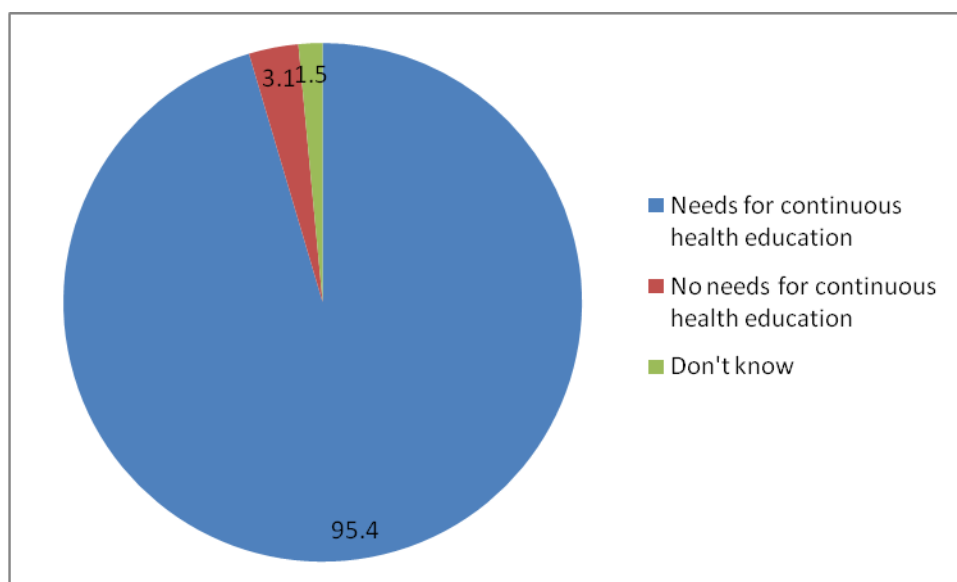


Figure 4.1 Opinion of asthmatic patients on the need of remote monitoring system for health education

The same questions were asked to the HCP in charge of NCDs in order to have their answers compared to those obtained from the patients. The obtained information is summarized in the following table:

Table 4.4 Opinion of healthcare professionals on the need of remote monitoring system for health education

Variables	Frequency	Percentage
Do you have a computer in your department?		
Yes	6	66.7
No	3	33.3
Do you know about the general term “Information Systems”?		
Yes	9	100
No	0	0
Do you use Information Systems at the health facility?		
Yes	9	100
No	0	0

Which health system do you use at the health facility?		
Open MRS	1	11.1
Open Clinic	5	55.6
Others(please specify)	3	33.3
Is there an option of reminder in the system you are using at your health facility?		
No	4	44.4
Don't know	5	55.6
How long have you been using this system?		
Less than 1year	2	22.2
Between 1-5 years	5	55.6
Over 5 years	2	22.2
Do you know about general term “Remote monitoring system”?		
Yes	4	44.4
No	5	55.6
If yes, is remote monitoring system currently used in Rwanda?		
Yes	3	33.3
No	1	11.1
N/A	5	55.6
How many asthmatic patients do you receive per visit?		
Less than 10 patients	7	77.8
10-20 patients	1	11.1
21-30 Patients	1	11.1
What are the main reasons causing asthmatic patients to attend the clinic?		
Medication refill	1	11.1
Routine follow-up	5	55.6

Asthma crisis	3	33.3
Do you think continuous health education on asthma self-management and triggers is needed?		
Yes	9	100
No	0	0
According to your experience, what are the benefits of providing health education for asthmatic patients?		
To know triggers to avoid	3	33.3
Early identification of crisis symptoms	3	33.3
All of the above	3	33.3
What kind of patient education do you think patients need?		
Know and avoid triggers of their crisis	9	100
How do you think Health education can be provided to patients?		
By phone call	2	22.2
By SMS	1	11.1
By phone notification	2	22.2
By using app in their phones or CHW	3	33.3
Others (please specify)	1	11.1
How often do you think health education can be provided to you remotely?		
Weekly	2	22.2
Biweekly	1	11.1
Monthly	6	66.7
n	9	

Concerning the need of remote monitoring system for health education, Table 4.4 demonstrated the study findings where 66.7% of the healthcare professionals have a computer in their department, all the participants know about the general term “Information Systems”, use

Information Systems at the health facility; 55.6% use Open Clinic as a health system at the health facility, 11.1% use Open MRS and 33.3% use other health systems; 55.6% of the respondents did not know if there is an option of reminder in the system they were using at their health facility; 55.6% have been using the said system for between 1-5 years; 55.6% know about general term “Remote monitoring system”; 33.3% did not know if remote monitoring system were used in Rwanda; 77.8% received less than 10 asthmatic patients per visit; 55.6% recognized that routine follow up is the main reasons causing asthmatic patients to attend the clinic; all the respondents recognized that continuous health education on asthma self-management and triggers is needed; 33.3% of the respondents recognized to know triggers to avoid and early identification of crisis symptoms as the benefits of providing health education for asthmatic patients; all the respondents recognized to know and avoid triggers of their crisis as the kind of patient education patients needed; 22.2% of the respondents think that health education can be provided to patients using phone call, 11.1% evoked By SMS, 22.2% evoked phone notification and 33.3% evoked using app in their phones or CHWs’ phones and the majority of the respondents (66.7%) thought that health education can be provided to them remotely on a monthly basis.

4.1.3 Need of remote monitoring system for providing reminder for both time of medication and medical appointment among asthmatic patients and Health care provider in charge of NCDs

The second objective of this study was to identify need of remote monitoring system for providing remainder for both time of medication and appointment among asthmatic patients and Health care provider in charge of NCDs, where the study participants were asked a set of questions about their opinions on this kind of need.

Table 4.5 Opinion of asthmatic patients on the need of reminder for medication

Variables	Frequency	Percentage
Do you currently take medication for asthma?		
Yes	128	98.5
No	2	1.5
What types of asthma medication do you take?		
Salbutamol spray	9	7.7

Salbutamol tab	4	3.1
Prednisolone tab	2	1.5
Aminophylline tab	6	4.6
Salbutamol tab and prednisolone tab	37	27.7
Salbutamol tab, Prednisolone tab and aminophylline tab	20	15.4
Salbutamol spray and Prednisolone tab	8	6.2
Salbutamol spray, prednisolone tab and Aminophylline tab	6	4.6
Aminophylline & salbutamol tab	16	12.3
Don't know	20	15.3
N/A	2	1.5
Have you missed taking asthma medication in the last 1month?		
Yes	107	83.1
No	23	16.9
If yes, how many times?		
Less than 3 times	82	63.1
3-5 times	20	15.4
6-10 times	6	4.6
N/A	22	16.9
What was the reason of not taking medicine?		
Poor recall of time of taking medicine	70	53.8
Medicine were not helping me	10	7.7
I was feeling good	16	12.3
Medicine was finished	12	9.2
N/A	22	16.9
Do you think there is a need of reminding you time of taking medication for asthma?		
Yes	120	92.3
No	10	7.7

How do you think it can be done?		
by Phone	16	12.3
by SMS	42	32.3
by Phone notification	30	23.1
by Using app in my phone on in phone of CHWs	22	15.4
Others (please specify)	12	9.2
N/A	10	7.7
How often do you think can be done?		
2 times a day	20	15.4
Daily	63	49.2
Every 3 days	27	20.0
Weekly	10	7.7
N/A	10	7.7
n	130	

Concerning the need of reminder for medication, Table 4.5 demonstrated the study findings where 98.5% of the asthmatic patients were taking medication for asthma; 27.7% of the respondents were taking Salbutamol tab and prednisolone tab as medication; 83.1% of them have missed taking asthma medication in the last 1month; 63.1% missed it less than 3 times; the reason of not taking medicine for 53.8% was poor recall of time of taking medicine; 92.3% thought that there is a need of reminding them time of taking medication for asthma; 32.2% thought that it can be done using SMS and 49.2% said that it should be done on a daily basis. The following figure gives details on the patients who agree that there is a need of reminder for medication.

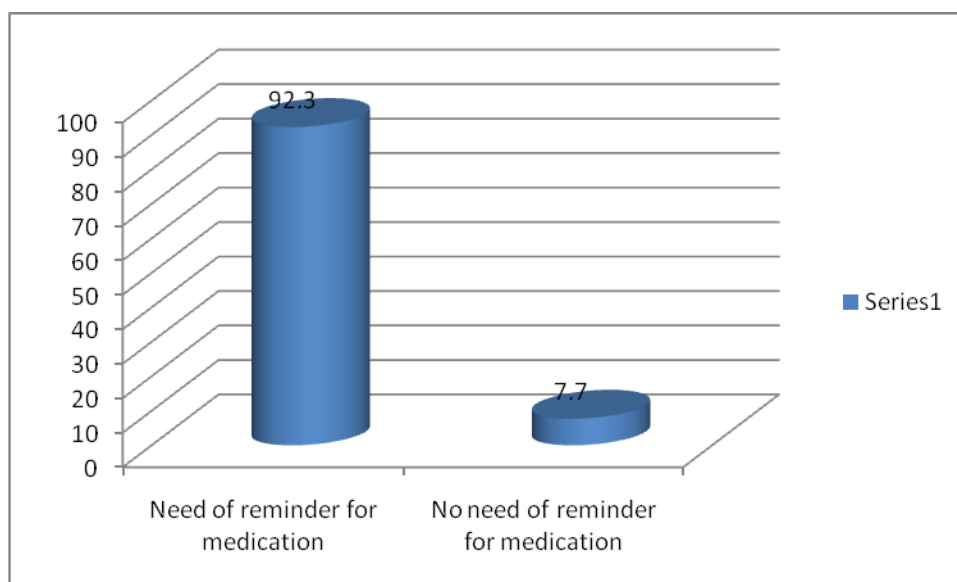


Figure 4.2 Opinion of asthmatic patients on the need of reminder for medication

The same questions were asked to the HCP in charge of NCDs in order to have their answers compared to those obtained from the patients. The results are summarized in Table 4.6.

Table 4.6 Opinion of healthcare professionals on the need of reminder for medication

Variables	Frequency	Percentage
Did asthmatic patients take appropriately their medicine?		
Sometimes	8	88.9
Don't know	1	11.1
What is the main cause of not well taking medications?		
Poor recall of taking medicine	4	44.4
Controlled symptoms	4	44.4
Others (please specify)	1	11.1
Do you think there is a need of reminding asthmatic patients time of taking medication for asthma?		
Yes	9	100

How do you think patients can be reminded		
time of taking medication?		
by SMS	1	11.1
by Phone notification	5	55.6
by Using app in their phone or of CHW	3	33.3
How often can this be done?		
2 times a day	1	11.1
Daily	4	44.4
Weekly	4	44.4
n	9	

Source: Primary data, 2023

Concerning the need of reminder for medication, Table 4.6 demonstrated the study findings where 88.9% of the healthcare professionals thought that asthmatic patients take appropriately their medicine sometimes; 44.4% said that Poor recall of taking medicine was the main cause of not well taking medications; all the respondents thought that there is a need of reminding asthmatic patients time of taking medication for asthma; 55.6% thought that patients can be reminded time of taking medication using phone notification and 44.4% of them would like the call to be done on a weekly basis.

Table 4.7 Opinion of asthmatic patients on the need of reminder for appointment

Variables	Frequency	Percentage
How do you often go for follow-up?		
Every 2 weeks	6	4.6
Every 1 month	92	70.8
Every 3 months	4	3.1
If I have crisis	28	21.6
Did you missed appointment		
during last 12 months?		
Yes	90	69.2
No	40	30.8
If yes, how many times?		

Less than 3 times	54	41.5
3-5 times	32	24.6
Between 6-10 times	4	3.1
N/A	40	30.8
What are the main reasons of missing appointment?		
Forgetfulness	48	36.9
Lack of money for transport	10	7.7
Feeling good	18	13.8
Still having medicine	14	10.8
N/A	40	30.8
Do you think there is a need of reminding you time of medical appointment for asthma?		
Yes	122	93.9
No	6	4.6
Don't know	2	1.5
How do you think it can be done?		
by Phone call	18	13.8
by SMS	40	30.8
by Phone notification	20	15.4
using app in my phone or in phone of CHWs	28	21.5
Others (please specify)	16	12.3
N/A	8	6.2
How often do you think patients can be reminded for their appointment?		
Weekly	8	6.2
Biweekly	34	26.2
Monthly	78	60.0

Others (please specify)	2	1.5
N/A	8	6.2

Concerning the need of reminder for appointments, Table 4.7 demonstrated the study findings where 70.8% of the asthmatic patients were going for follow-up every 1 month; 69.2% missed appointment during last 12 months and 41.5% were missing appointment less than 3 times; 36.9% said that the main reasons of missing appointment is Forgetfulness; 93.8% thought that there is a need of reminding them time of medical appointment for asthma; 30.8% thought that it can be done using SMS and 60% though that patients can be reminded for their appointment on a monthly basis. The following figure gives details on the patients who agree that there is a need of reminder for appointment.

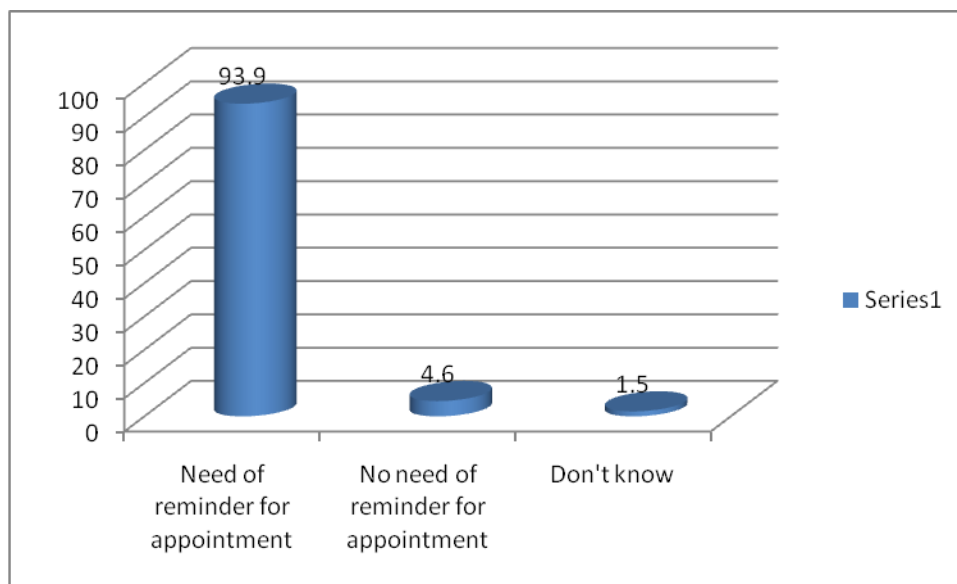


Figure 4.3 Opinion of asthmatic patients on the need of reminder for appointment

The same questions were asked to the HCPs in charge of NCDs in order to have their answers compared to those obtained from the patients. The results are summarized in Table 4.8.

Table 4.8 Opinion of healthcare professionals on the need of reminder for appointment

Variables	Frequency	Percentage
Did all asthmatic patients respect their appointment?		
Never	1	11.1
Rarely	2	22.2
Sometimes	6	66.7
According to your experience, what is the main causes of missing appointments?		
Forgetfulness	4	44.4
Patient think that s/he is in good condition	2	22.2
Financial (transport) issue	1	11.1
Do you think there is a need of reminding asthmatic patients time of medical their appointment?		
Yes	9	100
How do you think patients can be reminded the time of appointment?		
by Phone call	1	11.1
by SMS	2	22.2
by Phone notification	2	22.2
using app in their phone or CHW	4	44.4
How do you think it can be done?		
by Phone call	2	22.2
by SMS	2	22.2
by Phone notification	1	11.2
using app in my phone or in phone of CHWs	14	21.5
Others (please specify)	8	12.3

N/A	4	6.2
How often do you think patients can be reminded for their appointment?		
Weekly	2	22.2
Biweekly	1	11.1
Monthly	5	55.6
Every 2 months	1	11.1
N	9	

Source: Primary data, 2023

Concerning the need of reminder for appointment, Table 4.8 demonstrated the study findings where 66.7% of the healthcare professionals said that asthmatic patients respect their appointment sometimes; 44.4% thought that Forgetfulness is the main cause of missing appointments; all the respondents agreed that there is a need of reminding asthmatic patients time of medical their appointment; 44.4% said that patients can be reminded the time of appointment using app in their phone or CHW and 55.6% said that patients can be reminded for their appointment on a monthly basis.

4.1.2. Requirements facilitating patient remote monitoring system design and development

The third objective of this study was to identify requirements that would facilitate patient remote monitoring system design and development, where the study participants were asked a set of questions about the requirements for effective functioning of the system.

Table 4.9 Opinion of healthcare professionals on the system requirement

Variables	Frequency	Percentage
According to you, is there a need of pre-identification of requirements of the above-described system?		
Yes	8	88.9
No	1	11.1
Hospital should have internet		

Yes	8	88.9
N/A	1	11.1
Hospital should have devices such as computers,..		
Yes	8	88.9
N/A	1	11.1
Hospital should have servers		
Yes	6	66.7
Don't know	3	33.3
Security of the system should be ensured		
Yes	8	88.9
N/A	1	11.1
Hospital should have power supply		
Yes	8	88.9
N/A	1	11.1
Hospital should be able to connect to the internet		
Yes	8	88.9
N/A	1	11.1
System should provide reminder		
Yes	8	88.9
N/A	1	11.1
System should provide alert		
Yes	6	66.7
Don't know	3	33.3
System should be able to send and receive message		
Yes	6	66.7
Don't know	3	33.3
System should provide health education		
Yes	8	88.9
N/A	1	11.1
System should be easy to use for user		
Yes	8	88.9

N/A	1	11.1
System should be able to authenticate users		
Yes	5	55.6
Don't know	4	44.4
Healthcare provider should have access to internet		
Yes	3	33.3
No	1	11.1
Don't know	5	55.6
Healthcare providers in charge of NCDs should be familiar with internet use		
Yes	7	77.8
Don't know	2	22.2
Users should have access to Computers or smart phone		
Yes	8	88.9
N/A	1	11.1
Training on the use of system should be provided to both users (HCP and Asthmatic patients)		
Yes	8	88.9
N/A	1	11.1
IT personnel should be needed		
Yes	5	55.6
No	1	11.1
Don't know	3	33.3
N	9	

Concerning the Requirements facilitating patient remote monitoring system design and development, Table 4.9 demonstrated the study findings where 88.9% of the healthcare professionals agreed that there a need of pre-identification of requirements of the system; 88.9% said that hospitals should have internet and devices such as computers; 66.7% said that hospitals should have servers; 88.9% said that security of the system should be ensured, power supply, be able to connect to the internet ; 88.9% said that the system should provide reminder; 66.7% said

that the system should provide alert, be able to send and receive message; 88.9% of the respondents said that the system should provide health education, be easy to use for user; 55.6% of the respondents said that the system should be able to authenticate users; 33.3% said that healthcare provider should have access to internet; 77.8% said that healthcare providers in charge of NCDs should be familiar with internet use; 88.9% said that Users should have access to Computers or smart phone; 88.9% said that training on the use of system should be provided to both users (HCP and Asthmatic patients) and 55.6% of the respondents said that IT personnel should be needed.

4.1.4 Bivariate and multivariate analyses of factors associated with missing to take asthma medication

Under this section, the researcher determined the bivariate analysis which depicted the relationship of socio demographic factors towards missing to take asthma medication in order to show the importance of a remote monitoring system for asthmatic patients. All these analyses were done using SPSS (Table 4.12).

Table 4.10 Bivariate analysis of factors associated with missing to take asthma medication

Indicator	Missing to take asthma medication		Chi-square	P-value
	Yes n(%)	No n(%)		
Gender			3.714	0.044
Male	42(91.3)	4 (8.7)		
Female	66(78.6)	18 (21.4)		
Marital Status			1.045	0.324
Single	14(87.5)	2 (12.5)		
Married	78(84.8)	14 (15.2)		
Widower	6 (20.1)	16 (79.9)		
Profession			3.711	0.215

Farming & Agriculture	56 (80)	14 (20)		
Employed	14 (70)	6 (30)		
Self-Employed	16(100)	0 (0)		
Unemployed	22 (91.7)	2 (8.3)		
Education level			0.998	0.962
Primary	50 (80.6)	12 (19.4)		
Secondary	24 (92.3)	2 (7.7)		
University	16(80)	4 (20)		
Uneducated	18 (81.8)	4 (18.2)		
Religion			1.598	0.242
Christian	94 (81)	22 (19)		
Muslim	8 (100)	0 (0)		
Other	6 (100)	0 (0)		
Experience with asthma			3.146	0.329
Less than 1 year	2 (100)	0 (0)		
Between 1 to 4 years	16 (80)	4 (20)		
Between 5 to 10 years	48 (92.3)	4 (7.7)		
Above 10 years	42 (75)	14 (25)		
Having telephone			0.985	0.329
Yes	84 (85.7)	14 (14.3)		
No	24 (75)	8 (25)		
Using internet			0.018	0.897
Yes	36 (85.7)	6 (14.3)		
No	54 (84.4)	10 (15.6)		

The findings of this study showed that the relationship of gender towards missing to take asthma medication was statistically significant with $p < 0.05$. Indeed, being male presented a positive relationship with missing to take asthma medication with 91.3%, $X^2 = 3.714$, $p < 0.044$. Other indicators (Marital Status, Profession, Education level, Religion, Experience with asthma, Having telephone and Using internet) did not present any relationship with missing to take asthma medication as their $p > 0.05$.

Table 4.11 Multivariate analysis of factors associated with missing to take asthma medication

Indicator	AOR	95% C.I		P-value
		Lower	Upper	
Gender				
Male	1.849	0.069	1.777	0.049
Female	Ref.			

The findings of this study as shown in Table 4.11 demonstrated that male participants were 1.849 more likely to be associated with missing to take asthma medication with AOR 1.849 95% CI (1.777-0.069), $p < 0.049$.

4.2 Discussion

This study findings on the need of remote monitoring system for health education revealed that 95.4% of asthmatic patients thought that there is a need for continuous health education on asthma self-management and triggers; 13.8% said that this can be done using phone call, 15.4% said it would be better to use SMS, 7.7% evoked phone notification and 40% talked about using app in patients' phone or CHW's phone while 50.8% thought that remote health education should be done monthly. On the other hand, 66.7% of the HCP in charge of NCDs thought that health education can be provided to asthmatic patients remotely using different devices on a monthly basis.

These results were reported to be almost similar to the results obtained by Chan in 2021 exploring the use of digital inhalers for asthma and chronic obstructive pulmonary disease (COPD). It revealed that 87% know triggers exacerbating their symptoms and 91% thought that there is a need for continuous health education on asthma self-management and triggers. The study revealed an increasing number of digital inhalers, their capabilities, and the associated benefits, such as cost savings resulting from improved adherence and better health outcomes in asthma and COPD management. The reason for this similarity might be due to the similarity of symptoms of asthma and its complications in different parts of the world. Both of them have been conducted in rural areas where some habits are almost the same even if the two studies have been conducted in different countries and continents.

Also, the findings of the present study showed that 58.5% of asthmatic patients agreed that Remote system for continuous health education on asthma self-management and triggers will help patients in prevention and management of asthmatic crisis while 55.6% of the HCP in charge of NCDs strongly agreed that Remote system for continuous health education on asthma self-management and triggers will help patients in prevention and management of asthmatic crisis.

These findings are also most similar to the one conducted in 2019 by Kenyon et al. on HHS Public Access, focusing on the feasibility and assessment of inhaled corticosteroid (ICS) adherence with and without a text message-based daily medication reminder intervention in children following an asthma-related emergency department visit or hospitalization. The study demonstrated that leveraging mobile health technology to provide medication reminders was feasible and acceptable among most caregivers. They perceived the intervention as helpful in avoiding missed doses and improving medication adherence (27% and 54% higher than the control group, respectively), highlighting its potential to prevent readmissions and enhance asthma outcomes. The reason for this similarity might be due to resemblance in place of residence of the participants to those studies. Indeed, the present study was conducted in Nyamata DH and 5 selected HCs while the one conducted by Kenyon et al. concerned particularly rural areas.

At the end, the findings of this study showed that 66.7% of asthmatic patients said that asthmatic patients respect their appointment sometimes; 44.4% thought that Forgetfulness is the main cause of missing appointments. The same findings have been found among HCP in charge of NCDs as 66.7% of them said that asthmatic patients respect their appointment sometimes; 44.4% thought that Forgetfulness is the main cause of missing appointments; all the respondents agreed that there is a need of reminding asthmatic patients time of medical their appointment;

Also, the relationship of gender towards missing to take asthma medication was statistically significant with $p < 0.05$. Indeed, being male presented a positive relationship with missing to take asthma medication with 91.3%, $X^2 = 3.714$, $p < 0.044$. Other indicators (Marital Status, Profession, Education level, Religion, Experience with asthma, Having telephone and Using internet) did not present any relationship with missing to take asthma medication as their $p > 0.05$. Multivariate analysis showed that male participants were 1.849 more likely to be associated with missing to take asthma medication with AOR 1.849 95% CI (1.777-0.069), $p < 0.049$.

The results of the present differ from the findings of Walker and Tong in 2018 on Patient expectations and experiences of remote monitoring for chronic diseases : Systematic review and thematic synthesis of qualitative studies. In this study, it was revealed that having a lower education level presented a positive relationship with missing to take asthma medication with. Also, having a limited experience with asthma presented a positive relationship with missing to take asthma medication. Walker and Tong's findings also revealed that for patients with chronic diseases, remote monitoring has shown to increase disease-specific knowledge, prompt earlier clinical assessment and treatment, improve self-management, and support shared decision-making. However, many patients express concerns about reduced contact with healthcare professionals, as personal interactions help establish trust and facilitate better communication. Patients view remote monitoring as a tool to support them at home rather than replacing interpersonal interactions. The similarity of the findings between the present study and Chow et al.'s one may be explained by the resemblance of the population who participated to the two studies because the present study considered the HCP in charge of NCDs and asthmatic patients and Chow et al. considered the same population as they included asthmatic patients and their caregivers.

In sum, this study has some strength and limitations; the results of this study reflect the views and opinions of asthmatic patients and their caregivers in Nyamata DH and 5 selected HCs. The agreement in their views and opinions is the key strength of this study. The other strength is our ability to work with healthcare provider. Since our data collectors entered into contact with healthcare provider, this may have given us more force and credibility to the findings. However, some participants might have feared to give real information related to their daily activities such as the forgetting to take their crucial medication. Indeed, some of them might have not been able to tell data collectors that they often forget to take their medication because it would be seen as irresponsible behavior. In other words, they may have feared to fully express their views and opinions on their lifestyle for the fear that other persons may access this information. During the informed consent process, we assured all our participants of anonymization and confidentiality. However, the obtained information cover the essential situation of asthmatic patient remote monitoring system in Nyamata DH and 5 selected HCs and the suggestions framed could constitute a better solution to the said situation.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

At the end of this work, the present chapter presents a summary of the findings. It further makes conclusions and gives recommendations based on the objectives set in chapter one of this particular study.

5.1 Summary

5.1.1 Objective one

On the one hand, this study findings on the need of remote monitoring system for continuous health education for asthmatic patients and Health care provider in charge of NCDs showed that 73.8% of asthmatic patients have had asthma crises in last 1 month; 23.1% of the respondents had crises twice in the last month; 50.8% of the respondents used medicine during asthma crisis; 23.1% use regular follow up to prevent asthma crisis; 93.8% know triggers exacerbating their symptoms; 95.4% thought that there is a need for continuous health education on asthma self-management and triggers; 13.8% said that this can be done using phone call, 15.4% said it would be better to use SMS, 7.7% evoked phone notification and 40% talked about using app in patients' phone or CHW's phone while 50.8% thought that remote health education should be done monthly. Also, 33.3% of Health care provider in charge of NCDs recognized to know triggers to avoid and early identification of crisis symptoms as the benefits of providing health education for asthmatic patients; 22.2% of the respondents think that health education can be provided to patients using phone call, 11.1% evoked By SMS, 22.2% evoked phone notification and 33.3% evoked using app in their phones or CHWs' phones and the majority of the respondents (66.7%) thought that health education can be provided to them remotely on a monthly basis.

5.1.2 Objective two

Concerning the need of reminder for medication, 98.5% of the participants were taking medication for asthma; 27.7% of the respondents were taking Salbutamol tab and prednisolone tab as medication; 83.1% of them have missed taking asthma medication in the last 1month; 63.1% missed it less than 3 times; the reason of not taking medicine for 53.8% was poor recall of

time of taking medicine; 92.3% thought that there is a need of reminding them time of taking medication for asthma; 32.2% thought that it can be done using SMS and 49.2% said that it should be done on a daily basis. Also, 55.6% of Health care provider in charge of NCDs thought that patients can be reminded time of taking medication using phone notification and 44.4% of them would like the call to be done on a weekly basis.

Concerning the need of reminder for appointments, 70.8% of the asthmatic patients were going for follow-up every 1 month; 69.2% missed appointment during last 12 months and 41.5% were missing appointment less than 3 times; 36.9% said that the main reasons of missing appointment is Forgetfulness; 93.8% thought that there is a need of reminding them time of medical appointment for asthma; 30.8% thought that it can be done using SMS and 60% thought that patients can be reminded for their appointment on a monthly basis. The following figure gives details on the patients who agree that there is a need of reminder for appointment. Also 66.7% of Health care providers thought that asthmatic patients respect their appointment sometimes; 44.4% thought that Forgetfulness is the main cause of missing appointments; all the respondents agreed that there is a need of reminding asthmatic patients time of medical their appointment; 44.4% said that patients can be reminded the time of appointment using app in their phone or CHW and 55.6% said that patients can be reminded for their appointment on a monthly basis.

The findings of this study showed also that the relationship of gender towards missing to take asthma medication was statistically significant with $p < 0.05$. Indeed, being male presented a positive relationship with missing to take asthma medication with 91.3%, $X^2 = 3.714$, $p < 0.044$. Other indicators (Marital Status, Profession, Education level, Religion, Experience with asthma, Having telephone and Using internet) did not present any relationship with missing to take asthma medication as their $p > 0.05$. Multivariate analysis demonstrated that male participants were 1.849 more likely to be associated with missing to take asthma medication with AOR 1.849 95% CI (1.777-0.069), $p < 0.049$.

5.1.3 Objective three

Also, 88.9% of Health care provider in charge of NCDs agreed that there a need of pre-identification of requirements of the system; 88.9% said that hospitals should have internet and devices such as computers; 66.7% said that hospitals should have servers; 88.9% said that

security of the system should be ensured, power supply, be able to connect to the internet; 88.9% said that the system should provide reminder; 66.7% said that the system should provide alert, be able to send and receive message; 88.9% of the respondents said that the system should provide health education, be easy to use for user; 55.6% of the respondents said that the system should be able to authenticate users; 33.3% said that healthcare provider should have access to internet; 77.8% said that healthcare providers in charge of NCDs should be familiar with internet use; 88.9% said that users should have access to Computers or smart phone; 88.9% said that training on the use of system should be provided to both users (HCP and Asthmatic patients) and 55.6% of the respondents said that IT personnel should be needed.

5.2 Conclusion

Generally, this study revealed that there is a great need of remote monitoring system for asthmatic patients and Health care provider in charge of NCDs and the requirements that would facilitate patient remote monitoring system design and development have been identified.

5.3 Recommendations

At the end of this study, the researcher recommends the following:

1. The government should put in place a program helping to start the remote monitoring system for asthmatic patients
2. The government in partnership with NGOs should make available the requirements to facilitate patient remote monitoring system design and development.

5.4. Suggestion for further research

The current study was based on asthmatic patients and caregivers in Nyamata DH and 5 selected HCs. However, according to Chan (2017), we know that there are disparities among different area. Therefore, further research done in a specific Hospital with other characteristics could give further information on the feasibility of the remote monitoring system for asthmatic patients among different populations and highlight the requirements. Therefore, the researcher recommends future studies to further analyses the need of the remote monitoring system for asthmatic patients in other specific Hospitals.

REFERENCES

- [1] T. R. M. Rrt-nps, “Guidelines for Asthma Management : A Review and Comparison of 5 Current Guidelines”.
- [2] “J OURNAL D E L ’ A S S O C I A T I O N M É D I C A L E C A N A D I E N N E CMAJ • JAMC Canadian asthma,” vol. 161, 1999.
- [3] J. W. Mims, “Asthma: Definitions and pathophysiology,” *Int. Forum Allergy Rhinol.*, vol. 5, pp. S2–S6, Sep. 2015, doi: 10.1002/alr.21609.
- [4] T. D. Wu, E. P. Brigham, and M. C. McCormack, “Asthma in the Primary Care Setting,” *Medical Clinics of North America*, vol. 103, no. 3. W.B. Saunders, pp. 435–452, May 01, 2019. doi: 10.1016/j.mcna.2018.12.004.
- [5] D. Press, “CIA-33609-management-of-asthma-in-the-elderly-patient,” pp. 913–922, 2013.
- [6] H. Habineza *et al.*, “Treating persistent asthma in rural Rwanda: Characteristics, management and 24-month outcomes,” *Int. J. Tuberc. Lung Dis.*, vol. 21, no. 10, pp. 1176–1182, 2017, doi: 10.5588/ijtld.17.0039.
- [7] D. Price, L. Bjermer, D. A. Bergin, and R. Martinez, “Asthma referrals: A key component of asthma management that needs to be addressed,” *Journal of Asthma and Allergy*, vol. 10. Dove Medical Press Ltd., pp. 209–223, 2017. doi: 10.2147/JAA.S134300.
- [8] L. Boulet and M.-ève Boulay, “Asthma-related comorbidities,” vol. 6348, no. 2011, 2014, doi: 10.1586/ers.11.34.
- [9] D. P. Goeman and J. A. Douglass, “Optimal Management of Asthma in Elderly Patients Recommended Interventions,” vol. 24, no. 5, pp. 381–394, 2007.
- [10] U. Katwa and E. Rivera, “Asthma Management in the Era of Smart-Medicine : Devices , Gadgets , Apps and Telemedicine,” 2018.

- [11] S. S. Braman, “The global burden of asthma,” *Chest*, vol. 130, no. 1 SUPPL., pp. 4S-12S, 2006, doi: 10.1378/chest.130.1_suppl.4S.
- [12] H. C. Lion-Cachet, J. M. M. Musonda, and O. B. Omole, “Severe asthma in South Africa: A literature review and management approach for primary care,” *South African Fam. Pract.*, vol. 63, no. 1, pp. 1–10, 2021, doi: 10.4102/safp.v63i1.5179.
- [13] P. C. R. J, F. Van Gemert, T. Van Der Molen, R. Jones, and N. Chavannes, “Copyright PCRS-UK - reproduction prohibited The impact of asthma and COPD in sub-Saharan Africa op y rig ht rim R a ep ry ro C du ar ct e R io e n sp pr ir oh at ib ory ite S d o ci et Copyright PCRS-UK - reproduction prohibited y rig ht R a ep ry ro C du,” *Nat. Publ. Gr.*, vol. 20, no. 3, pp. 240–248, 2011, doi: 10.4104/pcrj.2011.00027.
- [14] G. Ferrante, A. Licari, G. L. Marseglia, and S. La Grutta, “Digital health interventions in children with asthma,” *Clin. Exp. Allergy*, vol. 51, no. 2, pp. 212–220, 2021, doi: 10.1111/cea.13793.
- [15] U. Katwa and E. Rivera, “Asthma Management in the Era of Smart-Medicine: Devices, Gadgets, Apps and Telemedicine,” *Indian Journal of Pediatrics*, vol. 85, no. 9. Springer, pp. 757–762, Sep. 01, 2018. doi: 10.1007/s12098-018-2611-6.
- [16] F. Arriaga *et al.*, “Remote Patient Monitoring: A Systematic Review ’,” vol. 00, no. 00, pp. 1–8, 2019, doi: 10.1089/tmj.2019.0066.
- [17] A. C. Wu, N. Rehman, and J. Portnoy, “The Good, the Bad, and the Unknown of Telemedicine in Asthma and Allergy Practice,” *J. Allergy Clin.Immunol.Pract.*, vol. 7, no. 8, pp. 2580–2582, 2019, doi: 10.1016/j.jaip.2019.08.017.
- [18] I. Baiardini, S. Novakova, S. Mihaicuta, I. K. Oguzulgen, and G. W. Canonica, “Adherence to treatment in allergic respiratory diseases,” *Expert Rev. Respir. Med.*, vol. 13, no. 1, pp. 53–62, 2019, doi: 10.1080/17476348.2019.1554438.
- [19] H. Pinnock *et al.*, “Implementing supported self-management for asthma: A systematic review and suggested hierarchy of evidence of implementation studies,” *BMC Med.*, vol. 13, no. 1, 2015, doi: 10.1186/s12916-015-0361-0.

- [20] O. Health, “Digital health systems to support pandemic response in Zambia,” pp. 2017–2021, 2021.
- [21] Ministry of Health, “National guideline for management of Non Communicable Diseases (NCDs),” *Minist. Heal. Rwanda*, p. 250, 2016.
- [22] C. C. Kenyon *et al.*, “HHS Public Access,” vol. 56, no. 1, pp. 95–103, 2020, doi: 10.1080/02770903.2018.1424195.Controller.
- [23] A. H. Y. Chan, “Digital Inhalers for Asthma or Chronic Obstructive Pulmonary Disease : A Scientific Perspective,” *Pulm. Ther.*, vol. 7, no. 2, pp. 345–376, 2021, doi: 10.1007/s41030-021-00167-4.
- [24] R. C. Walker, A. Tong, K. Howard, and S. C. Palmer, “International Journal of Medical Informatics Patient expectations and experiences of remote monitoring for chronic diseases : Systematic review and thematic synthesis of qualitative studies,” *Int. J. Med. Inform.*, vol. 124, no. August 2018, pp. 78–85, 2019, doi: 10.1016/j.ijmedinf.2019.01.013.
- [25] P. Actuaries, “Telehealth innovation in Rwanda Lessons and insights from the babyl experience,” no. December, 2020.
- [26] R. S. Alkassim and X. Tran, “Comparison of Convenience Sampling and Purposive Sampling Related papers”, doi: 10.11648/j.ajtas.20160501.11.
- [27] Mugenda, O., & Mugenda, A. (2003). *Research Methods: Quantitative and Qualitative approaches*. Nairobi: Acts Press.
- [28] Landon, C. et al. (2020). Remote monitoring of medication and lung function of asthmatic children. *European Respiratory Journal* 2020 56: 417;
- [29] Jacome, C. (2021). Feasibility and Acceptability of an Asthma App to Monitor Medication Adherence: Mixed Methods Study. *JMIR Mhealth Uhealth* 2021;9(5):e26442
- [30] Oduor, J. T. (2017). A Model for home-based remote monitoring of asthmatic patients (Thesis). Strathmore University. Retrieved from <http://su-plus.strathmore.edu/handle/11071/5635>

- [31] Jing, Z. (2012). Feasibility of a remote monitoring system for home-based non-invasive positive pressure ventilation of children and infants. *Int J Pediatr Otorhinolaryngol.* 2012 Dec;76(12):1737-40.
- [32] Kamps, A. and Brand, P. (2021). Education, self-management and home peak flow monitoring in childhood asthma. *Paediatr Respir Rev.* 2001 Jun;2(2):165-9.
- [33] Stuti, D. (2019). Evaluating the evidence base for the use of home telehealth remote monitoring in elderly with heart failure. *Telemed J E Health.* 2009 Oct;15(8):783-96.

LIST OF APPENDICES

Appendix 1: Individual Consent Form

Introduction

I am **AKINEZA Marie Chantal**; a student in Masters studies in Health Informatics, School of Public Health in the college of medicine and health sciences/University of Rwanda. My supervisors are **Dr NISHIMWE Aurore** and **Dr. UWISENGEYIMANA Jean De Dieu**.

I am conducting a research dissertation on “**THE NEED OF A REMOTE MONITORING SYSTEM FOR ASTHMATIC PATIENTS** in Rwanda”. Therefore, I am inviting you to participate in this study by filling questionnaire voluntarily. This study is important because it will help researchers to know the need of remote monitoring system which can help asthmatic patients in different ways. I kindly request you to give as much information as possible seek by responding to the questions in the questionnaire that will be addressed to you. Feel free to ask for more clarification if you see that some words or are not well understood. The information you provide will be kept with confidentiality and it will be used only for the research purpose. Your decision to participate or not to participate in this research will not affect you at all in your daily life. While you agree to participate in this study, there are no risks associated with the participation in this study. You will not put your names on this questionnaire. The participation in this research is voluntary, If you agree to be included in this study, please sign the section below.

CONSENTFORM

I..... confirm that the purpose of this study and my role have been well explained to me by **Marie Chantal AKINEZA**, my participation in this study is voluntary. I understand that I will not be paid for my participation. I may withdraw and discontinue participation at any time without penalty. I understand that the researcher will not identify me by name in any reports using information obtained from this study, and that my confidentiality as a participant in this study will remain secure. I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study. I am guarantee anonymity for the information obtained from me as the findings of this study. I am aware that all the information that I give and all the findings of the study may be looked at by responsible individuals and are for the use of this study.

Participant's name.....Signature.....Date ../../....

This chapter concerns the presentation of the study findings and discussion. The findings are presented according to the specific objectives. Tables and graphs were used to present the study findings. The Key findings were compared with other previous studies.

This chapter concerns the presentation of the study findings and discussion. The findings are presented according to the specific objectives. Tables and graphs were used to present the study findings. The Key findings were compared with other previous studies.

Researcher's name **AKINEZA MARIE CHANTAL**. Signature.....Date ../. /....

URUPAPURO RWO KWEMERA KUGIRA URUHARE MUBUSHAKASHATSI KU BUSHAKE

Njyewe **Marie Chantal AKINEZA**, umunyeshuri uri kwiga icyiciro cya gatatu cya kaminuza mu ishamba ry'ikoranabuhanga muri service z'ubuzima muri kaminuza y'u Rwanda, mfatanyije n'abarimu banjye aribo **Dr. Aurore NISHIMWE** na **Dr. Jean de Dieu UWISENGEYIMANA**

Turi gukora ubushakashatsi mu **"Ikenerwa ry'ikoranabuhanga byashoboka mugutanga service kubarwayi barwaye asima"**. Kubwibyo rero, tukaba tubasaba ko mwagira uruhare muri ubu bushakashatsi bivuye k'ubushake bwanyu, mwuzuzamurira amakuru yose akenewe kuri uru rupapuro. Ubu bushakashatsi n'ubw'ingirakamaro kuko buzafasha kumenya neza imikenerwe y'ikoranabuhanga mukwita kubarwayi ba asima mu Rwanda.

Turabasaba gutanga amakuru menshi ashoboka mu kubizaza neza ibibazo byose byabajijwe kandi aho bidasobanutse neza mu kubwira kudasobanuka. Amakuru dutanga yose azagirwa ibanga kandi azakoreshwa gusa muri ubu bushakashatsi. Mufite uburenganzira busesuye bwo kwemera cyangwa kwanga kugira uruhare muri ubu bushakashatsi kandi nta ngaruka n'imwe bizabagira. Igihe mwemeye kugira uruhare muri ubu bushakashatsi, singombwa kugaragaza izina ryawe.

Niba mwemeye kugira uruhare murubu bushakashatsi muruzuzamurira urupapuro ruri muni

KWEMERA KWINJIRA MU BUSHAKASHATSI KUBUSHAKE

Njyewe

Nemeye ko nahawe ibisobanuro birambuye na **MARIE CHANTAL AKINEZA** kuri

ubu bushakashatsi mpabwa n'umwanya wo gusobanuka. Kwitabira ubu bushakashatsi nubushake bwanyije. Numvishe ko ntazishyurwa kugira nitabire. Nshobora guhagarika kwitabira igihe cyose kandi ntangaruka byangiraho. Nasobanukiwe ko umushakashatsi atazakoresha amazina yanyije muri raporo mugihe hazaba hakoreshe amakuru yavuye murubu bushakashatsi. Nasomye kandi nasobanukiwe nubusobanuro bampaye. Ibabazo narimfite byose byasobijwe kandi nayuzwe, nkaba nemeye kubushatse kwitabira ubu bushakashatsi. Nasobanukiwe ko amakuru yose natanze nibizaza murubu bushakashatsi bizabwaho nabo biri munshingano gusa.

Amazinawutabiriye ubushakashatsi.....Umukono.....tariki.../.../.....

Amazinay'ukorabushakashatsi **AKINEZA MARIE CHANTAL**

Umukono.....itariki...../...../.....

Appendix 2: Asthmatic Patients Questionnaire

A. SOCIO DEMOGRAPHIC DATA

1. Age

☐ 18-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ Above 61

2. Gender

☐ Male ☐ Female

3. Marital status

☐ Single ☐ Married ☐ Divorced ☐ Widower ☐ Separated

4. What is your profession?

☐ Farming ☐ Employed ☐ Self-employed ☐ Unemployed

5. Level of education

☐ Primary ☐ Secondary ☐ University ☐ Uneducated

6. Religion

☐ Christian ☐ Muslim ☐ Other

7. How long have you been diagnosed for asthma?

☐ Less than 1 year ☐ Between 1 to 4 years
☐ Between 5 to 10 years ☐ Above 10 years

8. Do you have telephone?

☐ Yes ☐ No

a. If yes. What type of telephone you have?

☐ Smart phone ☐ Normal phone

9 . Do you use internet?

☐ Yes ☐ No

a. If yes. Do you know how to download an application?

☐ Yes ☐ No

B. NEED OF REMOTE MONITORING SYSTEM

I. FOR HEALTH EDUCATION

1. Did you had asthma crisis in last 1 month?

☐ Yes ☐ No

a. If yes. How many crises have you had in the last 1 month?

☐ Once ☐ Twice
☐ 3 times ☐ More than 3 times

2. What action do you typically do during asthma crisis?

☐ Go to hospital or HC ☐ use medicine
☐ Nothing ☐ call HCP
 Other (please specify)

4. what do you typically do to prevent asthma crisis?

☐ Regular follow-up ☐ Respect time of taking medicine
☐ Avoiding smoking ☐ To know and avoid triggers exposure
 Others (please specify)

5. Do you know some triggers which exacerbate your symptoms?

☐ Yes ☐ No

Example of some triggers	Yes	No	Don't Know
Smoking or Secondhand smoking			
Indoor air pollution (from cooking)			
House dust			
Cold environment			
Hot environment			
Industry air pollution			
Stress or emotional upset			
Animals such as cuts,cockroach,...			
Physical exercise			

6. Do you think continuous health education on asthma self-management and triggers is needed?

☐ Yes ☐ No ☐ Don't know

a. If yes. How do you think it can be done?

☐ by phone call ☐ by SMS ☐ by phone Notification
☐ by using app in my phone or in phone of CHW ☐ Others (please specify)

7. How often do you think health education can be provided to you remotely?

☐ Weekly ☐ Biweekly
☐ Monthly ☐ Every 2 months

II. NEED OF REMINDERS

➤ FOR MEDICATION

1. Do you currently take medication for asthma?

☐ Yes ☐ No

2. What types of asthma medication do you take?

☐ Salbutamol spray ☐ Salbutamol tab ☐ Prednisolone tab
☐ Beclomethasone spray ☐ Aminophylline tab ☐ Don't know
 Others (please specify)

3. Have you missed taking asthma medication in the last 1month?

☐ Yes ☐ No

a. If yes. How many times?

☐ Less than 3 times ☐ 6-10 times
☐ 3-5 times ☐ More than 10 times

b. What was the main reason that caused you to not take your medicine?

☐ Poor recall of time of taking medicine ☐ Medicine were not helping me
☐ I was feeling good ☐ Medicine was over Others (please specify)

3. Do you think there is a need of reminding you time of taking medication for asthma?

☐ Yes ☐ No ☐ Don't know

5. Which method do you think would be effective?

- ☐ by phone call ☐ by SMS
☐ by phone Notification ☐ by using app in my phone or in CHWs
 Others (please specify)

6. How often do you think can be done?

- ☐ 2 times a day ☐ Daily ☐ Every 3 days ☐ Weekly
 Others (please specify)

➤ **FOR APPOINTMENT**

1. How do you often go for follow-up?

- ☐ Every 2 weeks ☐ Every 1 month
☐ Every 3 months ☐ Over 3 months
☐ If I have crisis Other (please specify)

2. Did you missed appointment during last 12 months?

- ☐ Yes ☐ No

a. If yes. How many times?

- ☐ Less than 3 ☐ Between 6 - 10 times
☐ Between 3-5 times ☐ More than 10 times

3. What are the main reasons that causes you to frequently miss appointments?

- ☐ Forgetfulness ☐ Lack of money for transport
☐ Feeling good ☐ Family issues
☐ Still having medicine others (please specify)

4. Do you think there is a need of reminding you time of medical appointment for asthma?

- ☐ Yes ☐ No ☐ Don't know

If yes. Which method do you think would be good?

- ☐ by phone call ☐ by SMS ☐ by phone Notification
☐ by using app in my phone or in phone of CHW others (please specify)

5. How often do you think patients can be reminded for their appointment?

- ☐ Weekly ☐ Biweekly ☐ Monthly ☐ Every 2 months
 Others (please specify)

URUPAPURO RW' IKUSANYA MAKURU MUBUSHAKASHATSI

1. ABARWAYI BA ASIMA

A. AMAKURU RUSANGE

1. Imyaka

☐ 18-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ Hejuru ya 61

2. Igitsina

☐ Gabo ☐ Gore

3. Irangamimerere

☐ Ingaragu ☐ Ndubatse ☐ Twaratandukanye byemewe

☐ Twaratandukanye bitemewe ☐ Umupfakazi

4. Akazi ukora

☐ Uwikorera ☐ Ubuhinzi n'ubworozi ☐ Nkorera abandi ☐ Nta kazi mfite

5. icyiciro cy'amashuri warangarukiyemo

☐ Abanza ☐ Ayisumbuye ☐ Kaminuza ☐ Ntabwo nigeze niga

Andi

6. Idini

☐ Umukirisitu ☐ Umuyisilamu ☐ Utemera

7. Hashize igihe kingana gute umenye ko urwaye asima?

☐ Minsi y'umwaka ☐ Hagati y'umwaka 1-4

☐ Hagati y'imyaka 5-10 ☐ Hejuru y'imyaka 10

8. Waba ugira telephone ngendanwa?

☐ Yego ☐ Oya

a. Niba ari yego. Nubuho bwoko bwa telephone ufite?

☐ Telephone igezweho ☐ Telephone isanzwe

9. Ukoresha murandasi?

☐ Yego ☐ Oya

a. Niba ari yego. Waba uzi gukuraho (download) porogaramu?

☐ Yego

☐ Oya

B. IKENERWA RY'IKORANABUHANGA

I. MU GUTANGA INYIGISHO KUBUZIMA

1. Waba waragize kirize ya asima mukwezi gushize?

☐ Yego

☐ Oya

a. Niba ari Yego. Wagize kirize incuro zingahe mukwezi gushize?

☐ Incuro imwe (1) ☐ Incuro ebyiri(2) ☐ Incuro eshatu(3) ☐ Incuro ziri hejuru y'eshatu

2. Nigiki ukora akenshi iyo warembejwe n'asima?

☐ Njya kwa muganga

☐

Nkoresha imiti

☐

Mpamagara muganga

☐ Ntanakimwe

☐

Ibindi (bisobanure)

3. Nigiki ukora cyane ngo wirinde kugira kirize ya asima?

☐ Kujya kwamuganga kuri buri rendevu

☐

Kubaha igihe cyo gufata imiti

☐ Kutanywa itabi

☐

Kumenya ibindembya no kubyirinda

Ibindi (bisobanure)

4. Waba uzi ibituma ugira kirize?

☐ Yego

☐

Oya

Bimwe mubitera abarwayi baa sima kuremba	YEGO	OYA	Don't know
Kunywa itabi cyangwa guhumurirwa numwotsi w'itabi			
Ikirere gikonje			
Ikirere gishyushye			
Umwuka mubi cyane uvuye kubicanywa			
Imyanda munzu			
Inyamaswa zo munzu nkinjangwe,			
Imyuka ivuye munganda			
Guhinduka kwamarangamutima yanjye			

Imyitozo ngorora mubiri			
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6. Utekerezeza ko gahunda ihoraho yo gutanga inyigisho kubuzima mkwiwitaho no mukurwanya kirize ya asima ikenewe?

☐ Yego ☐ Oya ☐ Simbizi

a. Niba ari yego. Nubuho buryo bwiza gutanga inyigisho kubuzima mukurwanya kirize ya asima byakorwamo?

☐ Guhamagarwa kuri telefone ☐ Kohererezwa ubutumwa bugufi
☐ Kwibutsa (notification) hakoreshejwe ubutumwa ☐ Ibindi (sobanura)
☐ Gukoresha porugaramu muri telephone yanyje cyangwa iyumujyanama wubuzima

7. Niburigihe kingana gute wumva inyigisho zajya zihabwa abarwayi ba asima?

☐ Buri cyumweru ☐ Buri byumweru bibiri (2) ☐ Buri kwezi ☐ Buri mezi abiri (2)

Ibindi (sobanura)

II. IKENERWA RYO KWIBUTSWA GUFATA IMITI NIGIHE CYA RENDEVU

➤ GUFATA IMITI

1. Waba muriki gihe ufata imiti ya asima?

☐ Yego ☐ Oya

2. Waba kurubu ufata iyihe imiti ya asima muriyi ikurikira?

☐ Salbutamol pompe ☐ Salbutamol ibinini ☐ Prednisolone ibinini
☐ Aminophylline ibinini ☐ Beclomethasone pompe ☐ Ntayo nzi ☐ Ibindi(sobanura)

3. Waba warigeze usiba kunywa imiti y' asima mukwezi gushize?

☐ Yego ☐ Oya

a. Niba ari yego. Nincuro zingahe wasibye?

☐ Incuro ziri muni yeshatu ☐ Nincuro ziri hagati 6-10
☐ Incuro ziri hagati 3-5 ☐ Hejuru yincuro 10

b. Niyihe mpamvu ikunda kugutera kudafata imiti neza?

☐ Nibagirwa igihe cyo gufata imiti ☐ Ntabwo imiti iba irikumfasha
☐ Numvaga meze neza ☐ Imiti iba yashize ☐ Ibindi (sobanura)

4. Uratekerezwa ko kwibutsa abarwayi ba asima igihe cyo gufata imiti ya asima bikenewe?

☐ Yego ☐ Oya ☐ Simbizi

5. Nubuhe buryo wumva bwiza bwakoreshwa mukubibutsa igihe cyo gufata imiti?

☐ Guhamagarwa kuri telefone ☐ Kohererezwa ubutumwa bugufi
☐ Kwibutsa (notification) hakoreshejwe ubutumwa ☐ Ibindi (sobanura)
☐ Gukoresha porugaramu muri telephone cyangwa muyabajyanamabubuzima

6. Niburigihe kingana gute wumva bajya bibutswa gufata imiti?

☐ Iri kumunsi Buri m ☐ Buri ☐ nsi 3 buri cy ☐ veru

➤ **MUKUBAHIRIZA RENDEVU**

1. Ujya kwikurikiranisha buri gihe kingana gute?

☐ byumweru bibiri ☐ uri kwezi ☐ Buri mezi atatu ☐ Hejuru y'amezi atatu

2. Wigeze usiba rendezu yo kujya kwa muganga mumezi cumi nabiri (12) ashize?

☐ Yego ☐ oya

a. Niba ari yego. Nincuro zingahe wasibye kujya kuri rendezu na muganga?

☐ ro ziri munsu yeshatu ☐ Nincuro ziri hagati 6-10
☐ Incuro ziri hagati 3-5 ☐ Incuro ziri hejuru 10 ☐ Ibi (sobanura)

3. Akenshi nibiki bigutera kutajya kuri rendezu ?

☐ Nibagiwe ko mfite gahunda ☐ Ntamaranga yo gutegeza ☐ Numvaga meze neza
☐ Ibibazo byo mumuryango ☐ Naringifite imiti (anura)

3. Uratekerezwa hakenewe uburyo bwo kwibutsa abarwayi ba asima rendezu bafitanye na muganga?

☐ Yego ☐ Oya ☐ Simbizi

4. Nubuhe buryo bwiza wumva abarwayi b' asima bakwibutswamo rendezu bafitanye na muganga?

☐ Guhamagarwa kuri telefone ☐ Kohererezwa ubutumwa bugufi

☐ Wibutsa (notification) hakoreshejwe ubutumwa ☐ Indundi (sobanura)
☐ Gukoresha porugaramu muri telephone cyangwa muyabajyanamabubuzima

5. Niburi gihe kingana gute wumva abarwayi ba asima bajya bibutswa rendezu bafitanye na muganga?

☐ Cyumweru ☐ byumweru bibiri ☐ kwezi ☐ i mezi abiri

Appendix 3: Healthcare Provider Questionnaire

I, **Marie Chantal AKINEZA** a student in Masters of Sciences in Health Informatics in the School of Public Health, College of Medicine and Health Sciences, University of Rwanda. I am doing this thesis to accomplish my studies; Therefore, I kindly ask you to fulfill the provided questionnaire of my study entitled “**THE NEED OF A REMOTE MONITORING SYSTEM AMONG ASTHMATIC PATIENTS**” in selected Health facilities in Rwanda.

If you find any challenge or question please ask, I am here for providing the clarifications and responses. You can also contact me on:

Telephone: 0788331411 **Email:** akichanny2020@gmail.com

INSTRUCTIONS:

- Participant must have 18 years old and above
- Participant must provide services to asthmatic patients
- Do not mention your names
- The response provided will be kept with confidentiality
- Read the question carefully and respond individually by writing response in provided space and tick in provided box.

A. SOCIO DEMOGRAPHIC DATA

1. Age

☐ 18-30 ☐ 31-40 ☐ 41-51 ☐ 51-60 ☐ Above 61

2. Gender

☐ Male ☐ Female

3. Marital status

☐ Single ☐ Married ☐ Divorced ☐ Widowed ☐ Separated

4. Level of education

☐ Secondary ☐ University ☐ Master degree

5. Religion

☐ Christian ☐ Muslim ☐ Other

6. How long did you work for NCDs specifically with asthmatic patients?

☐ Less than 1 year ☐ 1-5 years ☐ 5 years or more

B. NEED OF REMOTE MONITORING SYSTEM

I. FOR HEALTH EDUCATION

1. Do you have a computer in your department?

☐ Yes ☐ No

2. Do you know about the general term “Information Systems”?

☐ Yes ☐ No

3. Do you use Information Systems at the health facility?

☐ Yes ☐ No

4. If yes. Which health system do you use at the health facility?

☐ OpenMRS ☐ OpenClinic
 Other (please specify)

5. Is there an option of reminder in the system you are using at your health facility?

☐ Yes ☐ No ☐ Don't know

6. How long have you been using this system?

☐ Less 1Year ☐ 1 – 5 Years ☐ Over 5 Years

6. Do you know about general term “Remote monitoring system”?

☐ Yes ☐ No

7. If yes, is remote monitoring system currently used in Rwanda?

☐ Yes ☐ No ☐ Don't know

8. How many asthmatic patients do you receive per visit?

☐ Less than 10 patients ☐ 10-20 patients
☐ 21-30 patients ☐ Over 30 patients

9. what the main reasons cause asthmatic patient to attend the clinic?

☐ Medication refill ☐ Routine follow-up
☐ Asthma crisis ☐ Health education

10. Do you think continuous health education on asthma self-management and triggers is needed?

☐ Yes ☐ No ☐ Don't know

11. According to your experience, what are the benefits of providing health education for asthmatic patients?

☐ Help in adherence to treatment ☐ To know triggers to avoid

Environmental control

☐ Early identification of crisis symptoms ☐ Improve disease control

above

All of the above

Others (please specify)

12. What kind of patient education do you think patients need?

☐ Taking medication properly ☐ Know and Avoid triggers of their crisis

☐ Respect appointment ☐ To early detection of crisis

☐ All the above ☐ None of the above

13. Which method of providing health education do you think would be effective?

☐ Phone call ☐ by SMS

☐ Using app in their phone or CHWs phone ☐ by phone Notification

Others (please specify)

14. How often do you think health education can be provided to patients remotely?

☐ Weekly ☐ Biweekly ☐ Monthly ☐ Every ☐ months

Others (please specify)

I. NEED OF REMINDER

➤ For Medication

1. Did asthmatic patients take appropriately their medicine?

☐ Never ☐ Rarely ☐ Sometimes ☐ Always ☐ Don't know

2. What is the main cause of not well taking medications?

☐ Poor recall of taking medicine ☐ Controlled symptoms ☐ unwillingly

☐ Don't know others (please specify)

3. Do you think there is a need of reminding asthmatic patient's time of taking medication for asthma?

☐ Yes ☐ No ☐ Don't know

4. How do you think patients can be reminded time of taking medication?

☐ Phone call ☐ by SMS ☐ by phone Notification
☐ Using app in their phone or in CHWs phone ☐ Others (please specify)

5. How often can be done

☐ 2 times a day ☐ Daily ☐ Every 3 days ☐ Weekly
 Others (please specify)

➤ **FOR APPOINTMENT**

1. Did all asthmatic patients respect their appointment?

☐ Never ☐ Rarely ☐ Sometimes ☐ Always ☐ Don't know

2. According to your experience, what are the main causes of patients missing appointment?

☐ Forgetfulness ☐ Patient thinks s/he is in good condition
☐ Financial (Transport) issue ☐ Still have medications ☐ Don't know

3. Do you think there is a need of reminding asthmatic patients time of medical their appointment?

☐ Yes ☐ No ☐ Don't know

4. How do you think patients can be reminded the time of appointment?

☐ Phone call ☐ by SMS ☐ by using app ☐ their phone or CHWs phone
☐ Phone Notification Others (please specify)

5. How often can be done

☐ Weekly ☐ Biweekly ☐ Monthly ☐ Every 2 months
 Others (please specify)

C. SYSTEM REQUIREMENT

According to you, Is there a need of pre-identification of the requirements of the above-described system?

☐ Yes No ☐ Don't know ☐

If yes.what will be the requirements the above-described system should have?

System requirements	Yes	NO	Don' know
Hospital should have internet			
Hospital should have devices (computers,..)			
Hospital should have servers			
Hospital should have power supply			
Hospital should be able to connect to the internet			
System should provide reminder			
System should provide alert			
System should be able to send and receive message			
System be user friendly			
The system shall be able to authenticate users			
The system should be Web based application			
The system should be easy to use for user			
Healthcare provider and patients should have access to internet			
Healthcare providers in charge of NCDs should be familiar with internet use			
Users should have access to Computers or smart			
Training on the use of system should be provided to both users (HCP and Asthmatic patients)			
IT personnel should be needed			

2. ABAGANGA BASHINZWE KUVURA ASIMA

A. AMAKURU RUSANGE

1. Imyaka

☐ 18-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ Hejuru ya 61

2. Igitsina

☐ Gabo ☐ Gore

3. Irangamimerere

☐ Ingaragu ☐ Ndubitse ☐ Twaratandukanye byemewe
☐ Twaratandukanye bitemewe ☐ Umupfakazi

4. icyiciro cy'amashuri warangariyemo

☐ Ayisumbuye ☐ Kaminuza Andi

5. Idini

☐ Umukirisitu ☐ Umusilamu ☐ Ibindi

6. Umaze igihe kingana gute ukora muri service yindwara zitandura?

☐ Muri y'umyaka 2 ☐ Hagati y'umyaka 2-5 ☐ Hejuru y'umyaka 5

B. IKENERWA RY'IKORANABUHANGA

I. MU GUTANGA INYIGISHO KUBUZIMA

1. Mufite mudasobwa (computer) munzu mukoreramo?

☐ Yego ☐ Oya

2. Waba uzi ijamba "Information system"?

☐ Yego ☐ Oya

3. Hari system zikoranabuhanga zikoreshwa muvuriro ukoreramo?

☐ Yego ☐ Oya

4. Nizihe system zikoranabuhanga zikoreshwa muvuriro ukoreramo?

☐ OpenMRS ☐ OpenClinic Izindi (sobanura)

5. Hashize igihe kingana gute ukoresheya izo system?

☐ Muri y'umwaka 1 ☐ Hagati y'umyaka 1-5 ☐ Hejuru y'umyaka 5

6. Haba hari uburyo bwo kwibutsa(Patient Reminder) muri sisitemu ukoresha hano kwivuriro?

☐ Yego ☐ Oya ☐ Simbizi

7. Waba uzi ijamba rusange "Sisitemu yo gukurikirana kure"/ Remote monitoring system?

☐ Yego ☐ Oya

8.Niba ari Yego. Haba hari Sisitemu yo gukurikirana kure uzi ikoreshe mu Rwanda?

☐ Yego ☐ Oya

9. Ni abarwayi ba asima bangahe wakira kumunsi?

☐ Munsi yabarwayi 10 ☐ Abarwayi bari hagati ya 21-30
☐ Abarwayi bari hagati 10-20 ☐ Hejuru y'abarwayi 30

10. Niyihe mpamvu nyamukuru ituma abarwayi ba asima baza kuri rendevu?

☐ Kwandikisha imiti ☐ Kuri rendevu isanzwe
☐ Iyo bagize kirize ☐ Kwigishwa kubijyanye na asima
 Ibindi (sobanura

11. Uratekereza kwigisha bihoraho abarwayi b'asima kwiwitaho, kumenya ibibatera kuremba, nuburyo babyirinda bikenewe?

☐ Yego ☐ Oya ☐ Simbizi

12.Ukurikije uburambe ufite, wumva ari akahe kamaro ko kwigisha bihoraho abarwayi ba asima kubijyanye nuburwayi bwabo?

☐ Bibafasha gufata imiti uko bigomba ☐ Kumenya no kurwanya ibituma baremba
☐ Kumenya kare ibimenyetso bya kirize ☐ Bibarinda kugira crisis
☐ Ibindi(sobanura

13. Nubuho buryo bwiza bwakoreshwa mugutanga inyigisho kubarwayi ba asima?

☐ Guhamagarwa kuri telephone ☐ Kwibutsa (notification) hakoreshejwe ubutumwa
☐ Kohererezwa ubutumwa bugufi
☐ Gukoresha porugaramu(application) muri telephone y'umurwayi cg umujyanama wubuzima
 Ibindi (sobanura)

14. Niburigihe kingana gute wumva inyigisho zajya zihabwa abarwayi ba asima?

☐ Buri cyumweru ☐ Buri byumweru bibiri(2) ☐ Buri kwezi ☐ Buri mezi abiri (2)

Ibindi (sobanura)

II. IKENERWA RYO KWIBUTSWA GUFATA IMITI NIGIHE CYA RENDEVU

➤ GUFATA IMITI

1. Abarwayi b'asima bafata imiti uko bikwiye?

☐ Ntanarimwe ☐ Gake cyane ☐ Rimwe na rimwe ☐ Burigihe ☐ Simbizi

2. Niyihe mpamvu nyamukuru itera abarwayi baa sima kudafata imiti uko bikwiye?

☐ Bibagirwa igihe cyo gufata imiti ☐ Bumva imiti itari kubafashaga ☐ Simbizi

☐ Bumvaga bameze neza ☐ Banga kuyifata kubushake

Ibindi (sobanura)

3. Uratekereza hakenewe uburyo bwo kwibutsa abarwayi b' asima igihe cyo gufata imiti yabo?

☐ Yego ☐ Oya ☐ Simbizi

4. Nubuho buryo wumva bwiza abarwayi b' asima bakwibutswamo igihe cyo gufata imiti?

☐ Guhamagarwa kuri telefone ☐ Kwibutsa (notification) hakoreshejwe ubutumwa

☐ Kohererezwa ubutumwa bugufi

☐ Gukoresha porugaramu muri telephone y'umurwayi cg umujyanama wubuzima

Ibindi (sobanura)

5. Niburigihe kingana gute wumva bajya bibutswa gufata imiti?

☐ Kabiri kumunsi ☐ Buri munsi ☐ Buri minsi 3 ☐ buri cyumweru

➤ MUKUBAHIRIZA RENDEVU

1. Abarwayi bose bafite rendezu barayubahiriza burigihe?

☐ Ntanarimwe ☐ Gake cyane ☐ Rimwe na rimwe ☐ Burigihe ☐ Simbizi

2. Ushingiye kubunararibonye ufite, niyihe mpamvu nyamukuru ituma abarwayi batubahiriza rendezu baba bahawe?

- ☐ Bibagirwa ko bafite gahunda ☐ Ntamafaranga yurugendo bafite
☐ Bumva bameze neza ☐ Baba bagifite imiti yaradwaye
 Ibindi(sobanura)

3. Uratekereza hakenewe kwibutsa abarwayi b' asima rendezu bafitanye na muganga?

- ☐ Yego ☐ Oya ☐ Simbizi

4. Nubuhe buryo wumva bwiza abarwayi b' asima bakwibutswamo rendezu bafitanye na muganga?

- ☐ Guhamagarwa kuri telephone ☐ Kwibutsa (notification) hakoreshejwe ubutumwa
☐ Kohererezwa ubutumwa bugufi
☐ Gukoresha porugaramu muri telephone y'umurwayi cg umujyanama wubuzima
 Ibindi (sobanura)

5. Niburigihe kingana gute wumva abarwayi b' asima baja bibutswa rendezu bafitanye na muganga?

- ☐ Kabiri kumunsi ☐ Buri munsi ☐ Buri minsi 3 ☐ buri cyumweru

Ibindi (sobanura)

C. IBIKENEWE BYA SISITEMU (SYSTEM REQUIREMENT)

**Kubwawe, wumva ibyanditswe hasi byaba bikenewe kuri sistemu twasobanuye haruguru?
 Urasubiza Yegocyangwa Oya kuri burinteruro**

	YEG O	OY A
Ivuriro rigomba kuba rifite murandasi/ Hospital should have internet		
Ivuriro rigomba kuba rifite mudasobwa / Hospital should have devices (computers,..)		
Sisitemu igomba kuba irinzwe/ Security of the system should be ensured		
Ivuriro rigomba kuba rifite seriveri/ Hospital should have servers		
Ivuriro rigomba kuba rifite umuriro w'amashanyarazi/ Hospital should have power supply (Electricity)		

Sisitemu igomba kuba ibasha guhura na murandasi/ The system shall be able to connect to the Internet		
Sisitemu igomba kuba ishobora kwibutsa/ The system should provide reminder		
Sisitemu igomba kuba ibasha gutanga inyigisho kubuzima/ The system should provide health education		
Sistemu igomba kuba itanga/ The system should provide alert		
Sisitemu igomba kuba ibasha kohereza no kwakira ubutumwa/ The system should be able to send and receive messages		
Sisitemu igomba kuba yoroshye kuyikoresha/ The system should be easy to use for user		
Sisitemu igomba kuba ibasha kwemeza uyikoresha/ The system shall be able to authenticate users		
Sistemu igomba kuba ari porugaramu ya murandasi/ The system should be Web based application		
Ibereye abayikoresha/ User friendly		
Abatanga ubuvuzi bagomba kuba bafite murandasi/ Healthcare provider should have access to internet		
Abatanga ubuvuzi kundwara zitandura bagomba kuba bamenyereye gukoresha murandasi/ Healthcare providers in charge of NCDs should be familiar with internet use		
Abakoresha system bagomba kuba bashobora kubona mudasobwa cyangwa telephone igezweho/ Users should have access to Computers or smart phone		
Training on the use of system should be provided to both users (HCP and Asthmatic patients)		
Abashinzwe ikoranabuhanga bagomba kuba bahari/ IT personnel should be available		

Appendix 4: Ethical clearance



UNIVERSITY of
RWANDA

COLLEGE OF MEDICINE AND HEALTH SCIENCES
DIRECTORATE OF RESEARCH & INNOVATION

CMHS INSTITUTIONAL REVIEW BOARD (IRB)

Kigali, 14/11/2022
Ref: CMHS/IRB/485/2022

AKINEZA Marie Chantal
Health Informatics Program,
Center of Excellence in Biomedical Engineering and E-Health (CEBE)
CMHS, UR

Dear AKINEZA Marie Chantal,

RE: ETHICAL CLEARANCE

Reference is made to your application for ethical clearance for the study entitled "*Assessment and design of telemedicine for follow up and adherence to medicine in asthmatic patients at Nyamata DH and 2 selected HC*".

Having reviewed your application and been satisfied with your protocol, your study is hereby granted ethical clearance. The ethical clearance is valid for one year starting from the date it is issued and shall be renewed on request. You will be required to submit the progress report and any major changes made in the proposal during the implementation stage. In addition, at the end, the IRB shall need to be given the final report of your study.

We wish you success in this important study.

The seal of the College of Medicine and Health Sciences, University of Rwanda, is a circular emblem with a central design and text around the perimeter.
Assoc. Prof. Stefan Jansen (PhD)
Acting Chairperson Institutional Review Board,
College of Medicine and Health Sciences, UR

Cc:

- Principal College of Medicine and Health Sciences, UR
- University Director of Research and Postgraduate studies, UR

Email: researchcenter@ur.ac.rw

P.O Box 3286 Kigali, Rwanda

www.ur.ac.rw

Appendix 5 : Acceptance letter

REPUBLIC OF RWANDA
BUGESERA DISTRICT

NYAMATA LEVEL II TEACHING HOSPITAL
ADEPR

December 13th 2022
Ref No. 399/2022

AKINEZA Marie Chantal

RE : DATA COLLECTION PERMISSION

After reviewing your research proposal entitled: "Assessment and Design of telemedicine for follow-up and adherence to treatment in asthmatic patients at Nyamata DH and 5 selected HCs "as required to fulfill your Master's degree in health informatics the Nyamata Hospital Ethics Committee have decided to give you permission to continue your research procedures.

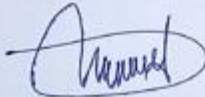
The Ethics Committee finally recommends you to:

- Ensure confidentiality of individual information.
- Submit a final copy of your Research findings after completion of the study.
- Consult Nyamata Hospital administration in case you need to publish the findings.

Yours sincerely.

Prepared by
Mrs MUREBWAYIRE Marie Grace
Chairperson Ethic Committee

Approved by
Dr William RUTAGENGWA
Director General Nyamata Hospital







P.O Box 7112 Kigali Rwanda, Phone :0780637766, Email : nyamata.hospital@moh.gov.rw



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College of Medicine and Health Sciences, UR

Cc:

- Principal College of Medicine and Health Sciences, UR
- University Director of Research and Postgraduate studies, UR