EFFECTS OF M-HEALTH ON MEDICATION ADHERENCE AMONG PEOPLE LIVING WITH HIV AND AIDS (PLWHA) AND PEOPLE WITH TUBERCULOSIS IN IMO STATE

BY

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CERTIFICATION

This is to certify that this Dissertation on the "Effects of m-health on medication adherence among people living with HIV and AIDS (PLWHA) and People With Tuberculosis In Imo State" was written by **Ezelote Judith Chinelo** with registration number **20194198908** in partial fulfillment of the requirement for the award of Doctor of Philosophy (Ph.D.) (Health Promotion Option) degree in the Department of Public Health, School of Health Technology, Federal University of Technology Owerri, Imo State.

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ABSTRACT

The study is on the effects of mobile health (m-Heath) on medication adherence among people living with HIV and AIDS (PLWHA) and people with tuberculosis in Imo State. Adherence is crucial in the management of HIV/AIDS and treating Tuberculosis to achieve the required treatment success rate. However, due to the longer treatment duration, adherence to Tuberculosis treatment is the most challenging factor affecting Tuberculosis control. Successful antiretroviral treatment is dependent on sustaining high rates of adherence among People Living With HIV/AIDS (PLWHA). This study assessed the effects of m-Health on medication adherence among PLWHA and people with tuberculosis receiving care at Federal University Teaching Hospital (FUTH) Owerri and Imo State Specialist Hospital Umuguma (ISSH). The study was guided with five objectives and five hypotheses. Quasi-experimental design was used. The study aimed to determine the level of adherence to prescribed medication dosing regimens and schedules, promptness in refilling prescriptions, and keeping appointments with health personnel among test and control groups using M-Health implementation. It also assessed the percentage of people with tuberculosis who tested negative for sputum tests within 3 months of initiating treatment among the test and control groups. Instruments for data collection were the questionnaire and checklist. AIDS Clinical Trials Group (ACTG) as data collection instrument among PLWHA while the eight-item Morisky Medication Adherence Scale (MMAS-8) is used for people with tuberculosis. FUTH Owerri was randomly selected as the test group and ISSH Umuguma as the control group. Among 1740 and 3709 PLWHA receiving care at FUTH Owerri and ISSH Umuguma respectively, 223 at FUTH and 411 at ISSH Umuguma were non-adherent to their medication at the time of the study. Among 1401 and 1026 people with tuberculosis receiving care at FUTH Owerri and ISSH Umuguma respectively, 134 at FUTH and 128 at ISSH Umuguma were non-adherent to their medication at the time of the study. All the non-adherents were included in the study hence no sampling. The M-Health intervention was implemented only for the non-adherents in the test group. The results were analyzed using regression analysis with a p-value of ≤ 0.05. The results showed that both PLWHA and people with tuberculosis displayed improved medication adherence after the intervention compared to those in the control group. Among the 223 non-adherent PLWHA participants, 81.6% improved adherence to medication dosage, 76.8% to medication timing, 90% to refilling prescriptions, and 88.5% to attending doctor's appointments. This was in contrast to only 7%, 11.8%, 24%, and 18.2% improvement in the same categories among the control group. After the intervention and follow-up, the treatment outcome for tuberculosis showed that 91.8% of the test group tested negative, while 95% of the control group still tested positive. Initially, the respondents had sub-optimal adherence levels, but the test group showed a statistical significant increase in adherence post-intervention. This bidirectional SMS and phone call intervention improved adherence medication dosage regimen, time schedule, prompt refilling of drugs and attendance to clinic appointment among PLWHA in the test group while no significant difference was noted in the control group. Conclusion was drawn and it recommended incorporating m-Health as the standard care approach for people living with HIV/AIDS and tuberculosis to improve adherence to medication.

Key words: m-Health, Adherence, HIV/AIDS, Tuberculosis.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Health is wealth; the health of one man is the heath of the whole nation. Mobile health is a term used to describe the practice of medicine and public health supported by mobile devices (Adibi, 2015). Mobile health (M-health) is a part of health care used to ensure good communication between the doctor and patients. It is a rapidly expanding field in the digital health sector providing healthcare support, delivery and intervention via mobile technologies such as smartphones, tablets and wearable. The M-health field has emerged as a sub-segment of e-Health, the use of information and communication technology (ICT), such as computers, mobile phones, communications satellite, patient monitors, etc., for health services and information (Vital Wave Consulting, 2019). Mobile phones are arguably the most prosperous and certainly the most expeditiously adopted modern technology throughout the developing as well as the developed countries. M-Health is also defined as "mobile computing, medical sensor, and communication technologies for healthcare (Istepanian, Jovanov & Zhang, 2004). Mobile-Health approaches are currently emerging as an upcoming promising tool in providing greater access to healthcare to populations in developing countries, as well as creating cost-efficiencies and improving the capacity of health systems to provide quality healthcare (Lemaire, 2011). Current studies postulated that M-Health tools are not just for good communication between doctor and patients, but can also improve medication adherence.

Medication adherence describes the degree to which a patient correctly follows medical advice. Medication adherence usually refers to whether patients take their medications as prescribed (e.g., twice daily), as well as whether they continue to take a prescribed medication (Michael, Chris & John, 2009). Alakija, Fadeyi, Ogunmodede and Desalu (2010) also defined medication adherence as taking all medications at the appropriate time with the appropriate dosage as prescribed by the physician. Medication non-adherence is a growing concern because of its adverse outcomes and higher costs of care. Poor medication adherence and persistence are associated with increased re-hospitalization, morbidity, mortality, and increased healthcare costs (Ho, Bryson & Rumsfeld, 2009). With the recent widespread use of mobile phones, especially smartphones, it argues that mobile apps can help improve in good medication adherence. In 2003, the World health Organziation (WHO) (2003a) declared medication non-adherence as an epidemic and has called for feasible, patient-tailored solutions which Mobile Health seems to be one of the most suitable solutions. Poor medication adherence among patients with chronic diseases is one of the significant health problems globally. It is one of the major concerns in the treatment of tuberculosis as well as in the management of HIV/AIDS, successful management of these diseases depends on good medication adherence. Poor medication adherence has added consequences for both People Living with HIV/AIDS and those with Tuberculosis. Some studies such as the one conducted by Déglise, Suggs and Odermatt (2012) have postulated the importance of good medication adherence on management of Human immunodeficiency virus (HIV).

Human immunodeficiency virus (HIV) is a virus that attacks the body's immune system. If HIV is not treated, it can lead to AIDS (Acquired Immunodeficiency Syndrome) (CDC, 2021). AIDS is caused by two lentiviruses, Human Immunodeficiency Viruses types 1 and 2 (HIV-1 and HIV-2), and currently there is no cure for it. Antiretrovirals (ARVs) are keys in the management of HIV. It helps PLWHA to live a healthy life and prevent the transmission of the virus to others. ARVs have a complex regimen and adherence to it is the major deciding factor on the health of PLWHA. The goal of the therapy is to reach an undetectable viral load. Medication adherence is a common problem to this complex regimen. Good medication adherence to ART is beneficial to patients and the public. Mobile health (mHealth) intervention represents a new approach in improving medication adherence among PLWHA. Nigeria has the second largest HIV epidemic in the world (NACA, 2017). Though there has been a recent drop in prevalence estimates for the country which was largely attributed to better surveillance (PEPFAR, 2019). There are other diseases requiring medication adherence, such as tuberculosis.

Tuberculosis needs a good medication adherence in order to avoid the risks of morbidity, mortality, drug resistance and other unfavorable outcomes. The standard first-line regimen requires people to take two (2) to four (4) medicines daily for at least 6 months. The WHO recommended directly observed therapy (DOT) for decades to promote adherence to TB treatment. Alipanah et al (2018) noted that DOT significantly increased the rates of treatment success, adherence, sputum smear conversion and lowered the rate of development of drug resistance when compared with self-

administered therapy (SAT). It's labor-intensive for both patients and healthcare providers, which makes it unfeasible to cover all patients in high TB burden countries (Wu, 2023). Mobile health will probably help to bridge this gap and that is what this study wants to ascertain. Tuberculosis (TB) is an infectious disease that usually affects the lungs, though it can affect any of the organs in the body. It can develop when bacteria spread through droplets in the air. TB bacteria are spread through the air from one person to another. The TB bacteria are put into the air when a person with TB disease of the lungs or throat coughs, speaks, or sings. People nearby may breathe in these bacteria and become infected. It can be fatal, but in many cases, it is preventable and treatable (James, 2021). More than 95% of TB deaths occur in low- and middle-income countries (LMICs) (WHO, 2016). The disease has been around for most of human history, becoming particularly deadly at times. Proper treatment of all forms of TB is critical to reducing individual morbidity and mortality and interrupting transmission among family and community members.

This study involves two study population groups; PLWHA, while the other will be people diagnosed of tuberculosis excluding those with co morbidity. The people with co-morbidities will be excluded from this study. The aim of this study is to evaluate the effects of mobile health on medication adherence among these two study populations, particularly those at risk for disengaging with care, newly diagnosed or those with a history of non-adherence. To ensure easy access to the PLWHA, those utilizing Heart to Heart centre will be used for this study. The study area will be Imo State, and two selected hospitals will be used which included Federal University Teaching Hospital

Owerri and Imo State Specialist hospital Umuguma. The two hospitals have Heart to Heart centre for PLWHA, and Tuberculosis clinic for those with TB. Heart to Heart Centers cater to the knowledge, psychological, and medical needs of their patients, as long as it is HIV/AIDS related. Some of them provide counseling, testing, and treatment to HIV/AIDS patients while others provide only counseling and testing. Currently, a similar study has not been conducted among the target study populations in Imo State. This study intends to replicate in Imo State the intervention using mobile health that has been carried out in other states to know if the outcome will be the same. Mobile health is the independent variable that will be used as the intervention strategy in this study, while the level of medication adherence will be the dependents. The rationale for this study is the rate of drug resistant among tuberculosis patients due to poor medication adherence, and the fact that Nigeria is yet to attain a negligible level of HIV infection rate. This study will have intervention and control group for the two study populations. The variables of interest are levels of keeping to prescribed drug dosing regimen, maintaining prescribed schedule of drug intake, promptness in refilling prescription, and levels of keeping appointment on schedule.

1.2 Problem Statements

In the management of patients with HIV infection, it is essential to achieve more than 95% compliance to ART (Antiretroviral Therapy) in order to suppress viral replication and avoid the emergence of resistance (Ishwar, Arun, Chandrashekar, & Ram, 2016). The Nigerian National Guidelines for HIV and AIDS Treatment and Care in Adolescents and Adults concurs with this cut off (FMoH, 2007 cited by Maduka & Tobin-West, 2013). Fleishman, Yehia, Moore, Korthuis, and Gebo (2012), discovered

from their study that retaining HIV-infected individuals in care is a significant hurdle to overcome: one in five HIV-infected patients will not establish care after their initial visit. There is need for more proactive actions, such as mobile health intervention, to be taken in order to achieve more medication adherence. It is suggested that more attention should be paid to the adherence of newly treated people living with HIV.

TB is curable provided the treatment commenced quickly, with the right drugs (and dosage) and uninterrupted throughout TB treatment duration. It has been noted that high default rate, treatment interruption and therapy non-adherence coupled with inadequate disease knowledge significantly contribute to poor TB treatment outcome, especially in developing countries. One is classified as non-adherent if they miss two consecutive weeks of DOTS, or a prolongation of treatment>30 days due to sporadic missed doses (Das, R., Baidya, Das, J.C., & Kumar, 2015). Though the government introduced DOTS but it is not yet effective as expected. Researchers suggested the need to put in place appropriate measures to improve the outcome of TB treatment in Imo State, Nigeria.

It has been observed from previous studies that the adherence of PLWHA, and TB patients in the Imo State is not up to the required standard. This study will be focused on using Mhealth to bridge the gap. It is possible that tailored SMS reminders will mitigate the barrier of forgetfulness in ART-adherence and anti-TB drug adherence thereby leading to improved drug compliance, viral suppression, and quality of life among adults living with HIV and those with TB.

1.3 Objectives of the Study

The main objective of this study is to determine the effects of M-Health on medication adherence among people living with HIV and AIDS (PLWHA) and people with tuberculosis in Imo State.

The Specific Objectives of this study are to:

1. Determine the levels of medication dosage adherence among test and control groups on M-Health implementation.
2. Ascertain levels of maintaining prescribed schedule of drug intake among test and control groups on M-Health implementation.
3. Ascertain levels of promptness in refilling prescription among test and control groups on M-Health implementation.
4. Determine levels of keeping appointment on schedule with health personnel among test and control groups of M-Health implementation.
5. Ascertain levels of treatment termination as a result of recovery within 6 months of initiating treatment among test and control groups of people with tuberculosis on M-Health implementation.

1.4 Research Questions

1. What are the levels of medication dosage adherence among the test and control groups on M-Health implementation?
2. What are the levels of maintaining prescribed schedule of drug intake among test and control groups on M-Health implementation?
3. What are the levels of promptness in refilling prescription among test and control groups on M-Health implementation?

4. What are the levels of keeping appointment on schedule with health personnel among test and control groups of M-Health implementation?
5. What are the levels of treatment termination as a result of recovery within 4 months of initiating treatment among test and control groups of people with tuberculosis on M-Health implementation?

1.5 Research Hypotheses

1. There is no significant relationship between medication dosage adherence and M-Health implementation among test and control groups.
2. There is no significant relationship between M-Health implementation and maintaining prescribed schedule of drug intake among test and control groups.
3. There is no significant relationship between M-Health implementation and promptness in refilling prescription among test and control groups.
4. There is no significant relationship between M-Health implementation and keeping appointment on schedule with health personnel among test and control groups.
5. There is no significant relationship between M-Health implementation and recovery outcome among people with tuberculosis in the test and control groups.

1.6 Significance Of The Study

The findings of this study will give clear information on the effect of mobile health on medication adherence among PLWHA and those with tuberculosis. If the effect is positive, it will help to drastically reduce the level of non-medication adherence among people living with HIV and those with TB. High level of drug adherence will help TB

patients to recover fully within the disease recovery time limit. It will help people living with HIV to manage the disease and ensure that it did not progress to AIDS. High level of medication adherence will help the society in a great way because the chain of the disease will be disrupted. When people living with HIV adhere strictly to their drugs, the viral load will be low reducing its chances of transmission.

This study will help to reduce the rate of morbidity and mortality associated with HIV/AIDS and tuberculosis. It will help to suppress HIV viral thereby reducing the disease burden. It will help to ensure prompt recovery from tuberculosis after the first two months intensive care.

It will also help in the reduction of drug resistance among those with tuberculosis. Drug resistance develops when they abandon their prescribed drugs half way without completing it, or not taking it as scheduled. With M-Health intervention, this situation will be curtailed because they will always be reminded to take their drugs at the scheduled time.

1.7 Scope of the Study

This is a study on effect of mobile health in medication adherence among people living with HIV/AIDs and those with tuberculosis in Imo State, Nigeria. This study assessed the effect of mobile health on medication adherence among human immune virus and those with tuberculosis. The study was among two study populations; those with TB, and PLWHA receiving care at FUTH Owerri and Imo State Specialist Hospital Umuguma in Imo State, Nigeria. They were those non-adherents to their medications, those that missed their appointment and those lost to follow up in the past three months

and two months among PLWHA and TB respondents. The respondents were between 18 to 70 years for PLWHA and between 18-90 years for TB patients as at their last birthday. The numbers of PLWHA and TB positive patients receiving care at Imo State Specialist Hospital Umuguma Owerri, Imo state who were non adherent to their drugs and those that missed their appointments in the past three months were 411 and 128 respectively. The numbers of TB patients and PLWHA receiving care at FUTH Owerri who were non adherent in the past three months were 223 and 134 respectively. The people that had co-infection were excluded from the study and also people that are on admission in the hospital, because the health providers in the hospitals were ensuring their drug adherence during admission. Quasi experimental study design was used for this study. This study had both intervention and control group. The study intervention lasted for three months. The exact mobile health intervention techniques to be used are SMS and phone calls.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Framework

2.1.1 Mobile Health

The Global Observatory for eHealth of the World Health Organization defines mHealth as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices" (WHO, 2011). It was predicted that the total market size of mobile health, also known as mHealth, will be almost 60 billion dollars by 2020 (Statista, 2018). Today, mobile phone is used for making standard contacts, Short Message Services (SMS) and multimedia services (MMS) and in some cases, check mail and electronic mail (Gomez, 2008). It is the Information Age and one of the major advantages of mHealth is that it enhances continuity of care. Expanding mobile phone penetration and network coverage will greatly help to remove traditional geographic and economic barriers to health care in developing world.

Mechael et al (2010) noted some of the benefits of mhealth project throughout the world which included: an increase in the access to the health care-related information for various purposes such as population control; an increase in productivity, a decrease in the expenditures of health services provision, an enhancement in the capability of diagnosis, treatment and discovery of the disease; timely use of public health information; widespread access to medical continuous education for health care providers, supporting physicians' and prescribers' orders. These advantages of mobile phones bring the potential of overcoming the challenges

associated with Directly Observed Treatment Short-course (DOTS) in tuberculosis treatment.

Benefits of mobile health technology were heighted below:

1. It gives patients faster access to providers and care**:** Unlike traditional and inefficient telephone access to physicians and healthcare organizations, mobile health technologies enable patients to quickly send secure messages, schedule appointments, and connect to providers 24/7 for telemedicine visits. In fact, telemedicine is one of the fastest growing ways patients are using mHealth apps on their mobile devices. They love the convenience of conducting a provider visit on their phone or tablet, as well as the fact that they don't need to travel to the physician's office or take time off work. Most health systems are responding to the uptick in demand by offering telemedicine visits delivered by network physicians, as well as contracted tele-health physicians after hours and on weekends (Michael, 2019).
2. Improves medication adherence: Once patients are discharged from the hospital or leave the clinic, it's tough to control whether or how they take their medication, or frankly if they pick up their medication from the pharmacy at all. Poor medication adherence is a significant reason for poor management of a patient's chronic condition. It can also result in hospital readmissions and poor outcomes. mHealth and mobile technology solutions improve this by giving patients features such as automated medication and refill reminders, and educational information, that improve the chance they'll take their medications properly.

3. Makes remote patient monitoring possible and easy: Remote patient monitoring is a subcategory of home care and tele-health that enables patients to use mobile devices and mobile health technology to gather, enter, or automatically collect health data and transmit it to healthcare providers. The ability to track patient conditions in between visits, and notify a clinician or care manager when the patient's biological data is putting the patient at risk, is a big step forward in managing care. Without mobile devices and mobile health technology - and in particular, wearable devices such as watches, fitness trackers, and wristbands - continuous tracking and monitoring of such data would be inconvenient or not possible at all. Remote patient monitoring is most often used to help patients manage a chronic condition, or to ensure they are following their hospital discharge instructions and taking their medications correctly. Types of data transmitted from mobile devices included:

i. Weight, blood pressure, and heart rate monitors
ii. Glucose meters
iii. Diet data trackers

4. Increases medication reconciliation accuracy, which improves patient safety: It is common knowledge that many patients do not recall the names and dosages of the medications they are taking. This is a particular problem for polypharmacy patients (those taking more than five different prescription medications each day), elderly patients, and other high-risk patients. The fact that many patients (nor their caregiver or family members) cannot accurately recall their medication

list to a physician, ED intake or hospital admission nurse, or other provider, puts the patient at significant risk. When clinicians aren't sure which medications a patient is taking, it creates an opportunity for drug-to-drug interactions. Adverse drug reactions can occur when a patient is admitted to a hospital and prescribed drug/s that they should be taking, but forgot to report.

5. Improves provider communication and coordination: Given most providers' full appointment schedules, long days, and multiple facility coverage requirements, connecting with colleagues, coworkers, and patients is challenging. Mobile health technology improves the ability to connect across the health system and with referring physicians and office staff using secure messaging and texting, mobile health record access, and cellular phone calls. mHealth apps can also be used to alert providers to patients that need attention or that have been admitted to the hospital. The benefits of mobile health technology continue to expand and evolve. Given the proliferation of mobile devices throughout the US population and patient enthusiasm for using them for managing their condition and health, it is likely these technologies will continue to be prescribed and used more frequently. As mHealth apps become more integrated into the care continuum, we'll begin to see new and favorable impacts on health outcomes.

mHealth plays a larger role in engaging patients in self-care as smartphone ownership is rising globally. Health care providers can use mobile health technology to:

I. Access clinical information (e.g., through mobile health apps and mobile-enabled EHRs),

II. Collaborate with care teams (e.g., with secure text messaging),

III. Communicate with patients (e.g., through patient portals),

IV. Offer real-time monitoring of patients, and

V. Provide health care remotely, also called telemedicine.

Patients use mobile health technology to track their own health data through mHealth apps and devices; access their clinical records through mobile-enabled patient portals, and communicate with their providers (e.g., through HIPAA compliant e-mail and secure text messaging).

Mobile health technology is an important tool in improving the health of patients in underdeveloped nations. In 2011, 70% of the world's five billion mobile wireless subscribers were in low- or middle-income countries (HIMSS 2014). A multitude of m-Health solutions have emerged recently in countries such as Ethiopia, Kenya, Nigeria, and South Africa i.e. leaders in using mobile-health services, as per the Global Observatory report for e-Health by WHO in 2011 (Lemaire, 2011). Déglise, Suggs, Odermatt (2012) noted that mobile phones can be an appropriate and promising tool for disease control interventions in developing countries, for diseases such as HIV/AIDS, and this approach has been found to be well accepted. The integrated nature of mobile communication systems provides unique opportunities for m-health in large geographic areas. At the community level, social networking can be used to exchange information about the local health system. At the individual levels, mobile-health offers improved communication, access to diagnostic tools, and ability to store and access personal medical data in central repositories (Kahn JG, Yang, Kahn JS, 2010). Kaplan (2006)

noted that the potential impact of m-health in health delivery in developing countries is largely untapped due to technical as well as socio-economic, cultural, and regulatory barriers. mHealth technology was designed to improve the quality of care and to minimize costs to patients. World Health Organization (WHO) identified the use of mHealth technology by the public as an important step in providing a cost-effective, convenient, and transparent access to healthcare.

The emergences of many health conditions have led to the development of mobile health (m-Health) interventions aiming at helping to treat or avoid a range of health conditions. Tuberculosis (TB) and HIV/AIDS are two major public health concerns. Mobile technology-based methods (m-Health) may play a supportive role in improving self-care of HIV-infected individuals and TB patients, particularly those newly diagnosed or those with a history of non-adherence. Adherence to antiretroviral therapy and TB drugs is very important towards the success of the treatment. High default rate, treatment interruption and therapy non-adherence coupled with inadequate disease knowledge significantly contribute to poor TB treatment outcome, especially in developing countries. NACA in 2017 reported that Nigeria has the second largest HIV epidemic in the world. These diseases lead to high death rate if they are not curbed. Non-adherence to medication leads to death, rapid spread of the disease, high morbidity rate and drug resistance to mention but few. A randomized control trial among non-adherents carried out in a tertiary hospital in Nigeria by Maduka and Tobin-West (2013) between March and July, 2011 showed that 76.9% of those in the intervention group had achieved adherence to drug treatment as opposed to 55.8% in the control group.

Adherence counseling and text message reminders improved adherence among HIV patients. The rate of Adherence to combined antiretroviral therapy (cART) among people living with HIV/AIDS in a Tertiary Hospital in Ilorin, Nigeria was assessed by Chukwuma et al (2019). This study showed that 89.8% of the patients did not miss their drugs. The mean adherence rate of all the respondents was 92.6% which was below the acceptable standard. In a study conducted in Imo State by Adisa, Ayandokun and Ige (2021), it was noted that Only 10 (4.0%) mentioned adherence to TB medications as a measure to prevent transmission. The study conducted by Duru et al (2016) on tuberculosis treatment outcomes and determinants among patients treated in hospitals in Imo State, Nigeria showed that the success rate recorded in the study was below the set target by WHO. Previous systematic reviews have indicated that the most important and frequent factors that negatively impact adherence in developing countries were cost, stigma, alcohol abuse, and structural barriers such as lack of transportation and pharmacy stock-outs (Mills et al., 2006).

2.1.2 TUBERCULOSIS

Tuberculosis (TB) is an infectious disease caused by bacteria that most often affects the lungs (WHO, 2024). It spreads through the air when people with TB cough, sneeze or spit. Treating tuberculosis (TB) is important to reduce morbidity and mortality as well as the risk of ongoing transmission, but it can be challenging to support and monitor persons with TB over the full course of treatment (WHO, 2017a). Active TB treatment typically requires a daily administration of a combination of medicines for six months or longer (e.g. 20 months or more for multidrug resistant [MDR] TB (WHO, 2017b).

Although in some settings less-forgiving thrice weekly regimens are utilized to allow for the direct observation of treatment. Non-adherence to TB treatment can lead to drug resistance and death. Dosing of regimens for drug-resistant disease can be complex (multiple doses per day or non-daily dosing) and depend upon the individual resistance pattern (WHO, 2010). DOTS can also be too costly and impractical for some patients, especially in developing countries. Many people with TB won't know they have it unless they get tested because there won't be any symptoms from latent TB. WHO (2021) reported that about one-quarter of the world's population has latent TB hence the need to get screenings once exposed to TB. The first thing one may notice is a bad cough that doesn't go away, or chest pain. The symptoms of active tuberculosis included; a general sense of being unwell, coughing, coughing up blood or phlegm, chest pain, trouble breathing, loss of weight and appetite, night sweats, intermittent fever, generalized body aches and fatigue (CDC, 2016). Treatment for TB is time-limited and depends upon the presence and extent of drug resistance in the underlying infecting strain(s). Drug-sensitive TB disease is treated for six months (WHO, 2010). While multi-drug resistant (MDR) disease treatment is extended to between 9 and 20 months (WHO, 2017). The WHO recommends that treatment for drug-sensitive TB is administered once daily (WHO, 2017).

The 2019 Corona Virus pandemic largely added challenges to cure of tuberculosis and management of HIV. Hospitals were not easily accessible hence the increase in the use of Tele-health in health management. One of the major problems in curbing HIV disease and Tuberculosis is non-adherence to drug intake. To curb this problem of non-adherence, use of short message service (SMS) which entails communication between

the healthcare provider and patient as a strategy for improving adherence might be needed. This medium is comparatively cheap and can reach many people as mobile phones are common in most countries. Retaining HIV and TB patients for care is a difficult hurdle to overcome. Some of the patients might be too busy to remember the time for their drug intake. In Nigeria, the standard short-course therapy for all categories of drug-sensitive tuberculosis (DS-TB) comprised a 6-month regimen, with 2-month intensive phase of four medications (HRZE) viz. Isoniazid (H), Rifampicin (R), Pyrazinamide (Z) and Ethambutol (E), and a 4-month continuation phase of two medications viz. Isoniazid and Rifampicin (i.e. 2HRZE/4HR). The directly observed therapy concept is one of the five components of DOTs strategy endorsed by the World Health Organisation to create the basis for standard TB care and management (WHO 2017). M-health helps to increase the patients care of themselves through taking their drugs as and when due. These advantages of mobile phones bring the potential of overcoming the challenges associated with DOTS**.** Distance rendered regular observation of drug ingestion impractical (either on a daily or alternating daily basis) and may have contributed to treatment success rates that fell below WHO targets (Datiko & Lindtjørn, 2010).

Adherence to tuberculosis (TB) treatment is important for promoting individual and public health. Mhealth interventions for TB treatment adherence must be guided by ethical values as much as by technical innovation. According to the World Health Organization (2010), the optimal TB treatment plan consists of an initial treatment phase requiring daily ingestion of 4 first-line anti-TB drugs for 2 months, followed by a

4-month continuation phase during which 2 daily drugs are necessary. Regimens of ingesting drugs thrice weekly in both the initial and continuation phase are also possible. TB susceptible to first-line drugs is called drug-susceptible TB (DS-TB). Two forms of drug-resistant TB (DR-TB) are widely recognized: multidrug-resistant TB and extensively drug-resistant TB. As defined by the WHO, patients who fail to collect their TB treatment for 2 consecutive months are reported as defaulters (World Health Organization, 2002 (WHO 2002). The standard-of-care for treatment monitoring in TB programs often includes Directly Observed Treatment Short-course (DOTS). DOTS can be time consuming to the patients and also financial burden. A holistic approach that integrates digital technologies into various elements of care for persons with TB or LTBI is gaining considerable attention (WHO, 2017c). Increasing access of mobile phone has increases the usage in the faster treatment by enhancing communication between health care providers and TB patients (WHO, 2007c). Treating TB successfully requires prolonged medication regimens with good adherence. Patients most times need to be adequately supported to ensure full compliance. The rapid increase in mobile phone usage is rapidly providing an opportunity to reach patients between clinical visits.

A tuberculosis patient is expected to take at least 70–90% of prescribed doses (WHO, 2003) or all doses (Amuha, 2009) to be considered adherent. Adherence to TB medications is estimated to be as low as 40% in developing countries including Nigeria (Borua, Shimelsb & Bilal, 2017). Study conducted by Gashu, Gelaye, and Tilahun (2021) to assess the adherence to TB treatment during treatment continuation phase

among adult patients in Northwest Ethiopia showed that the majority (58%) of patients mentioned forgetfulness as the reason for non-adherence. Another study conducted among 217 TB patients in Anambra State, to assess the adherence to drug medications amongst Tuberculosis patients showed that 24.2% agreed they had failed to take their drugs. It was noted that forgetfulness (32.7%) was one of the major reasons for failure to take drugs (Ubajaka, Azuike, Azuike, Ugoji & Umeh 2015).

Munro, Lewin, Smith, Engel, Fretheim, & Volmink (2007) elaborated on the barriers of TB drug adherence by identifying and describing 4 categories of adherence barriers related to structural, patient, social, and health care service factors.

Structural Factors: Structural factors are obstacles, such as poverty and gender, over which patients have very little control and which can complicate adherence even when patients are strongly motivated. Poverty, especially when linked to the factors discussed below, can impact adherence. For example, where treatment costs are not covered, poor patients or those supporting others, may feel they must choose between work and health. In LMICs, the mean total cost of TB (i.e., direct medical and non-medical costs and lost income due to sickness) is 39% of annual reported household income, and 148% at its highest. Gender-related factors may also impact adherence (Tanimura, Jaramillo, Weil, Raviglione, & Lönnroth, 2014).

Patient Factors: Variations in patient motivation and willingness can also impact adherence and may be affected by forgetfulness, a lack of understanding regarding the importance of TB treatment, general interpretations of illness such as the belief that one

is sick only if symptomatic; alcohol or drug use, or a perceived loss of agency and aversion to elements of control and surveillance associated with DOT. Furthermore, side effects of TB drugs which included fever, fatigue, weakness, nausea, vomiting, hepatitis, or death, can affect patient motivation due to unpleasantness or substantial interference with a patient's ability to work. This is especially true as the side effects grow more diverse and severe during DR-TB treatment to include psychiatric disorders, hearing loss, and epileptic seizures (Törün et al, 2005).

Social Context: Strong social support within a patient's family, community, or health care context can help counteract structural and personal barriers to adherence by influencing motivation or knowledge and beliefs about TB. However, lack of support or knowledge about TB and its treatment in a patient's family, community, or health care context, as well as real or perceived stigmatization of the sick, can hinder adherence (Munro, Lewin, Smith, Engel, Fretheim & Volmink, 2007).

Health Care Service Factors: Inadequate drug stocks, long waiting times, inconvenient service hours, and difficulties accessing health facilities reveal the opportunity costs associated with attending health facilities, such as neglecting household responsibilities (e.g., caring for one's children) and losing work and income. All these factors can therefore thwart adherence to TB treatment.

While a multitude of barriers to TB treatment adherence needs to be considered, mHealth interventions can potentially address several central adherence challenges. Study conducted in Sudan by Ahmed and Martin, (2019) to assess the effect of mobile

health to improve adherence to tuberculosis treatment in Khartoum state showed that Mobile texting was useful and was highly accepted by participants. The TB patients who owned a cell phone or had shared access to such a devise formed the intervention group while the TB patients on the same DOTS program who did not have access to a cell phone received the current standard of care and were the control group. The patients in the intervention group had a lower default rate (6.8%), higher documented cure rate (78.4%) and better knowledge compared to control group. SMS reminder was useful and facilitated good interaction between patients and health personnel.

Compliance to anti-TB treatment is important in achieving cure and avoiding the onset of drug resistance. Study conducted by Jeffrey et al (2010) among three healthcare professionals along with 13 TB patients recruited from the Mbagathi District Hospital in Nairobi, Kenya showed that Mobile Direct Observation of Treatment (MDOT) was a preferable option to improve drug adherence among TB patients. The patients preferred MDOT to clinic DOT or DOT through visiting Community Health Workers. Both patients and health professionals appeared empowered by the ability to communicate with each other and appear receptive to remote MDOT and health messaging using mobile phone.

2.1.3 HUMAN IMMUNODEFICIENCY VIRUS (HIV)

Human immunodeficiency virus (HIV) is a virus that attacks the body's immune system. If HIV is not treated, it can lead to AIDS (Acquired Immunodeficiency Syndrome) (CDC, 2021). AIDS of humans is caused by two lentiviruses, human

immunodeficiency viruses types 1 and 2 (HIV-1 and HIV-2). Both HIVs are the result of multiple cross-species transmissions of simian immunodeficiency viruses (SIVs) naturally infecting African primates. AIDS was first recognized as a new disease in 1981 when increasing numbers of young homosexual men succumbed to unusual opportunistic infections and rare malignancies (CDC, 1981). There is currently no effective cure for the disease. Once people get HIV, they have it for life. But with proper medical care, HIV can be controlled. NACA (2015) reported that unprotected heterosexual sex accounts for 80% of new HIV infections in Nigeria, with the majority of it occurring among sex workers. NACA (2017) reported that six states in Nigeria accounted for 41% of people living with HIV which included Kaduna, Akwa Ibom, Benue, Lagos, Oyo, and Kano. There are other diseases requiring medication adherence, such as tuberculosis. People with HIV who get effective HIV treatment can live long, healthy lives and protect their partners. NACA (2015) noted that HIV prevalence was highest in Nigeria's southern states (known as the South South Zone) at 5.5%. Percentages of people living with HIV were found to be lowest in the southeast (the South East Zone) where there is a prevalence of 1.8%. There are higher rates of HIV in rural areas (4%) than in urban ones (3%) (NACA, 2015).

Nigeria has the second largest HIV epidemic in the world with about 3.6 million people infected (NACA, 2017). Currently Nigeria ranks 4th in global HIV burden with approximately 1.8 million (estimated) persons living with HIV as of 2019 (Ufornwa & Okoroiwu, 2021; UNAIDS. Global AIDS Monitoring, 2020). Unprotected heterosexual sex accounts for 80% of new HIV infections in Nigeria, with the majority of remaining

HIV infections occurring in key affected populations such as sex workers (Sheehy M, Tun, Vu, Adebajo, Obianwu, & Karlyn, 2014; Djomand G., Quaye S., Sullivan P.S. 2014). People with HIV should take medicine to treat HIV as soon as possible. HIV medicine is called antiretroviral therapy, or ART (CDC, 2018). If taken as prescribed, HIV medicine reduces the amount of HIV in the body (viral load) to a very low level, which keeps the immune system working and prevents illness (CDC, 2018). Anti-retroviral therapy (ART) can suppress the viral replication, enhance immunological status, can reduce HIV transmission to uninfected people, and increase patients' life expectancy (Cohen M.S et al., 2011). These benefits can be achieved only if HIV-positive patients adhere to their medications (≥95% adherence) (WHO, 2019). Adherence to antiretroviral therapy (ART) has become the key for AIDS to become a manageable chronic disease (Deeks SG, Lewin SR, Havlir, 2013). The study conducted by Yang, Dan, Xi, Zhulin, Min, and Shuiyuan (2018) among 207 newly treated people living with HIV on medication adherence to antiretroviral therapy showed that there was 85.5% good adherence by the participants. The rate of adherence was noted to be below the required standard. Osterberg and Blaschke (2005) in their study noted that many studies have shown that optimal compliance is 95% and compliance less than 95% is associated with virological failure rate of more than 50%.

2.2 Theoretical Framework

2.2.1 Health Belief Model

The health belief model (HBM) is a social psychological health behaviour change model developed to explain and predict health-related behaviours, particularly with

regard to the uptake of health services (Janz, & Marshall, 1984). The HBM was developed in the 1950s by social psychologists at the U.S. Public Health Service (Rosenstock, 1974). The HBM suggests that people's beliefs about health problems, perceived benefits of action and barriers to action and self-efficacy explain engagement (or lack of engagement) in health-promoting behaviour (Janz, Nancy & Marshall 1984). The model has been applied to understand responses to symptoms of disease, compliance with medical regimens, lifestyle behaviours (e.g., sexual risk behaviours), and behaviours related to chronic illnesses, which may require long-term behaviour maintenance in addition to initial behaviour change (Janz, & Marshall 1984). Health-related behaviours are influenced by the perceived benefits of taking action (Glanz, Barbara, Rimer & Viswanath 2008). Perceived benefits refer to an individual's assessment of the value or efficacy of engaging in a health-promoting behaviour to decrease risk of disease. If an individual believes that a particular action will reduce susceptibility to a health problem or decrease its seriousness, then he or she is likely to engage in that behaviour regardless of objective facts regarding the effectiveness of the action (Rosenstock, 1974). For example, with regards to this study, individuals living with HIV or TB patient will adhere strictly to his/her drugs if s/he believes that it will be able to cure the disease or help to keep the viral load down (HIV).

Cues to Action: Cues to action are perhaps the most powerful part of the Health Belief Model and of getting individual to change their behavioir. It can be internal or external. Physiological cues (e.g., pain, symptoms) are an example of internal cues to action (Glanz, Barbara, Rimer, & Viswanath, 2008). Interventions based on the HBM may

provide cues to action to remind and encourage individuals to engage in health-promoting behaviours. External cues include events or information from close ones, the media, or health care providers promoting engagement in health-related behaviours (Janz, & Marshall, 1984). For example, cues to action with regards to this study include a reminder SMS from the researcher. A short SMS will be sent to the patient everyday throughout the duration of this study. It will be bi-directional to enable the researcher to obtain feedback from the patients. A motivation will also be sent to the respondents at intervals (at agreed dates so that it won't bore the participants). This will help to remind them to take their medication and keep their doctor's appointment. The intensity of cues needed to prompt action varies between individuals by perceived susceptibility, seriousness, benefits, and barriers. For example, individuals who believe they are at high risk of disengaging with drug intake or those with history of non-adherence might require more attention.

Self-Efficacy: Self-efficacy refers to an individual's perception of his or her competence to successfully perform a behaviour (Glanz, Barbara, Rimer, & Viswanath, 2008). It was added to the Health Belief Model in an attempt to better explain individual differences in health behaviours. Developers of the model recognized that confidence in one's ability to effect change in outcomes (i.e., self-efficacy) was a key component of health behaviour change (Rosenstock, 1974). Interventions may also aim to boost self-efficacy by providing training in specific health-promoting behaviours particularly for complex lifestyle changes (e.g., changing diet or physical activity, adhering to a complicated medication regimen). Self-efficacy is another important factor both in the

Health Belief Model and in behaviour change in general. When people believe that they actually have the power to prevent the given risk, then they are more likely to take the appropriate measures to do so. When individuals believe that they cannot change their behaviour or prevent the risk no matter what they do, they are less likely to engage in behaviour to stop the risk.

The Health Belief Model (HBM) can be applied to mobile health interventions by incorporating the model's core concepts to promote behaviour change and improve health outcomes. This can include:

For People Living With HIV/AIDS:

1. **Perceived Susceptibility and Severity**: The intervention should address the perceived risk of HIV-related complications and emphasize the seriousness of the condition to motivate individuals to take preventive actions.
2. **Perceived Benefits**: Highlight the benefits of adhering to the treatment plan, such as improved health outcomes and quality of life. Show how the mobile intervention can facilitate these benefits.
3. **Perceived Barriers**: Identify and address obstacles that may prevent individuals from following through with treatment or using the mobile health app effectively. This could include issues like access to technology, privacy concerns, or stigma related to HIV.

4. **Cues to Action**: Use the mobile health app to send reminders, notifications, and/or educational messages to prompt users to engage in positive health behaviours or adhere to their treatment regimen.
5. **Self-Efficacy**: Build individuals' confidence in their ability to manage their HIV care effectively through the mobile intervention. Provide resources, support, and tools within the app to enhance self-efficacy.
6. By incorporating these components of the Health Belief Model into a mobile health intervention for people living with HIV, one can create a more effective and tailored approach to support their health and well-being.

For People with Tuberculosis:

1. **Perceived Susceptibility and Severity**: Emphasis on the risks of TB transmission and progression, as well as the seriousness of untreated TB. Mobile intervention was used to educate patients about the potential consequences of not adhering to treatment.
2. **Perceived Benefits:** The benefits of completing the full course of TB treatment were highlighted, such as curing the disease, preventing drug resistance, and protecting loved ones from infection. Show how the mobile app can support treatment adherence and health monitoring.
3. **Perceived Barriers:** Barriers that may hinder treatment adherence, such as medication side effects, stigma, lack of access to healthcare, or forgetfulness, were identified and addressed. The mobile intervention can provide solutions to

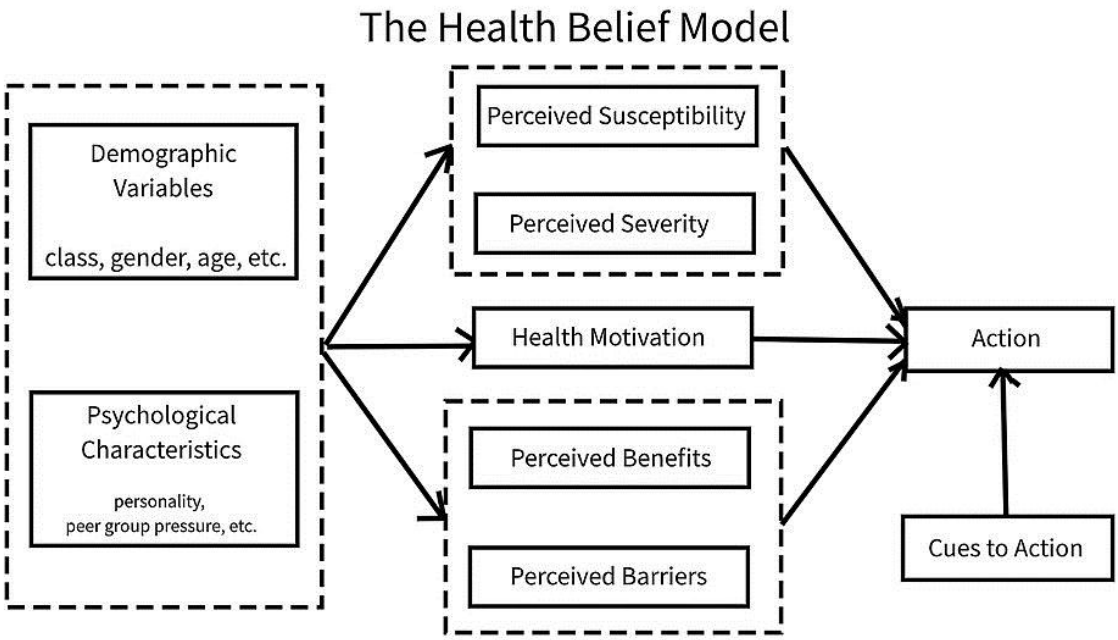
overcome these barriers, such as medication reminders and side effect management tips.

4. **Cues to Action:** Use the mobile app to send reminders for medication doses, dosage time adherence, clinic appointments, and follow-up tests. Provide symptom trackers, and communication channels to prompt users to take action towards their TB treatment goals.
5. **Self-Efficacy:** Build patients' confidence in their ability to manage their TB treatment effectively. When people with TB realized that adhering to their drugs will cure them of the disease, they will be encouraged to take their drugs according to their doctor's prescription. They will adhere to drug intake with or without a cue.

By integrating these elements of the Health Belief Model into a mobile health intervention for TB patients, one can enhance treatment adherence, health outcomes, and overall empowerment in managing the disease effectively.

Health Belief Model Diagram

Fig.1



Source: Health belief model. (2024, August 5). In Wikipedia. https://en.wikipedia.org/wiki/Health_belief_model

2.2.2 Behaviour Change Theory

The second theory adopted for this study is behaviour change theory. Behaviourism, also known as behavioural psychology, is a theory of learning which states that all behaviours are learned through interaction with the environment through a process called conditioning. Thus, behaviour is simply a response to environmental stimuli (McLeod, 2020). Behaviourism emphasizes the role of environmental factors in influencing behaviour, to the near exclusion of innate or inherited factors. This amounts essentially to a focus on learning. We learn new behaviour through classical or operant conditioning (collectively known as 'learning theory').

Behavioural theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of behaviourism hold that the environment has an impact on learning and that all behaviour is learned. Drug adherence can be learned. With ubiquitous increases in mobile phone use, opportunities for remote delivery of health interventions (mHealth) have grown exponentially, particularly in the use of behavioural smartphone applications. Behaviourism is only concerned with observable stimulus-response behaviours, as they can be studied in a systematic and observable manner. They attempt to explain why human behaviours change. This theory cites environmental, personal, and behavioural characteristics as the major factors in behavioural determination. Behaviourism focuses on the idea that all behaviours are learned through interaction with the environment. This learning theory states that behaviours are learned from the environment, and that innate or inherited factors have very little influence on behaviour. A common example of behaviourism is positive reinforcement. When a patient adhered strictly to his/her drug intake and there will be a reward attached to it, in the future, the patient ensures that s/he adheres to drug prescription in order to get the reward. This serves as a form of encouragement. The non-adherent patients will also start taking their drugs in order to get the reward. In the classroom, the behaviuoral learning theory is key in understanding how to motivate and help students.

Behaviourist teaching strategies: With regards to this study, behavioural learning strategy can be applied in many ways, including:

1. Drills: The researcher may practice skills using drill patterns to help patients see the repetition and reinforcement that behavioural learning theory uses.
2. Question and answer: Respondents are encouraged to ask questions about anything in the study they don't understand.
3. Guided practice: Researcher will be directly involved in helping respondent go through problems to give them the reinforcement and behaviour demonstration they ought to follow, such as sending SMS to the respondents to remind them to take their drugs and also sending motivations to them.
4. Regular review: Reviews are important to behavioural learning theory. Going back over material and giving positive reinforcement will help the respondents retain information much better.
5. Positive reinforcement: Researcher will utilize positive reinforcement regularly. This can be in the form of verbal reinforcement such as praise, reward systems, added privileges, and more.

Each behavioural change theory or model focuses on different factors in attempting to explain behaviour change. Of the many that exist, the most prevalent are learning theories, social cognitive theory, theories of reasoned action and planned behaviour, trans-theoretical model of behaviour change, the health action process approach and the BJ Fogg model of behaviour change. Learning theory describes how students receive, process, and retains knowledge during learning. Cognitive, emotional, and environmental influences, as well as prior experience, all play a part in how

understanding, or a world view, is acquired or changed and knowledge and skills retained.

In applying Behaviour Change Theory to a mobile health intervention for people living with HIV, the Trans-theoretical Model (Stages of Change model) as a framework was utilized as a framework. Here are key components of the model into the intervention that was incorporated:

1. **Pre-contemplation Stage/ Initiation stage**: Individuals who may not be considering behaviour change related to their HIV management were identified. Educational content through the mobile app to raise awareness about the importance of adherence to medication, healthy lifestyle choices, prompt refilling of drugs and regular medical check-ups were provided.
2. **Contemplation Stage**: Offer personalized feedback and goal-setting tools to help users evaluate the pros and cons of behaviour change. Encourage them to consider the benefits of adhering to treatment, following a healthy diet, exercising regularly, and managing stress.
3. **Preparation Stage**: Respondents were assisted in developing an action plan for behaviour change. The mobile app featured medication reminders, appointment scheduling tools, reminder to refill drugs, physical activity trackers, and encouragement to healthy living with HIV.
4. **Action Stage**: Respondents were supported in implementing their behaviour change plans. Provide positive reinforcement such as extra airtime, and progress

tracking SMS to motivate continued engagement with treatment and healthy behaviours.

5. **Maintenance Stage**: Help users sustain their behaviour changes over time. Incorporate features that promote long-term adherence to medication, healthy lifestyle habits, and regular medical care. Encourage users to set new goals and celebrate their achievements.
6. **Relapse Prevention**: Strategies to prevent relapse and support users in regaining motivation if they face setbacks were included. Coping mechanisms, stress management techniques, and reminders to stay connected with healthcare providers and support networks were offered.

By incorporating the Trans-theoretical Model into the mobile health intervention, the app's content and features can be customized to cater to users at various stages of behaviour change. This personalization helps improve adherence to HIV treatment, overall health outcomes, and quality of life for people living with HIV.

Application of the Trans-theoretical Model (TTM) to a mobile health intervention for tuberculosis (TB) patients, the intervention was tailored to address each patient's readiness to change and progress through the stages of behaviour change. Here's how the TTM principles was incorporated into your mobile health intervention:

1. **Pre-contemplation Stage**: For people with TB in this stage who may not yet recognize the need for change, educational resources were provided within the

mobile app to increase awareness about the importance of TB treatment, potential risks of non-adherence, and benefits of adopting healthier behaviours.

2. **Contemplation Stage**: People with TB in this stage were helped to weigh the pros and cons of treatment adherence through interactive quizzes, self-assessment tools, and personalized feedback. They were encouraged to reflect on their current behaviours and consider the impact of their choices on their health.
3. **Preparation Stage**: People with TB who are ready to take action towards behaviour change were supported by offering practical tools and resources in the mobile app. Include features like medication reminders, time adherence reminder, reminder for doctor's appointment and refilling of drugs.
4. **Action Stage**: They were enabled in the action stage to implement their treatment plans effectively by providing support for tracking progress, monitoring adherence, and overcoming barriers. Offer rewards such as extra airtime, incentives, or motivational messages to reinforce positive behaviours and maintain momentum.
5. **Maintenance Stage**: The progress of people with TB was sustained and relapse prevented by promoting long-term adherence to treatment regimens. Integrate features like ongoing monitoring, relapse prevention strategies, coping skills training, and social support networks to help patients stay committed to their health goals.
6. **Termination Stage**: Acknowledge and celebrate milestones achieved by patients in managing their condition effectively. They were encouraged to continue engaging with the mobile health intervention for ongoing support,

education, and motivation to lead a healthy lifestyle. They are expected to test negative after eight weeks of the initiation of drugs. Mobile intervention ended after 6 weeks of initiation, respondents were tested after follow up (12 weeks after initiation of treatment) to know the percentage that tested negative to Mycobacterium tuberculosis.

2.3 Empirical Studies

2.3.1. Dosage Adherence

A facility based cross-sectional study was carried out among 116 People Living with HIV (PLHIV) on ART in south India to determine their level of medication adherence using the AIDS Clinical Trials Group (ACTG) by Achappa, Madi, Bhaskaran, Ramapuram, Rao & Mahalingam, 2013). Dosage adherence was assessed using the formula:

$$\frac{\text{Total number of drugs taken}}{\text{Total number of drugs prescribed}} \times 100$$

Patients with adherence of 95% and above were considered as having high adherence while less than 95% were considered as having low adherence. The result showed that among 116 participants, 63.7% reported adherence > 95%, and hundred percent adherence was reported by 54.3% of patients. Among patients who received free ART, 64 (76.2%) of them had high adherence, whereas, only 10 (31.3%) patients who paid for ART had high adherence. It was also noted that 70% of those patients who were self-motivated to take ART had high adherence. It was further noted that all patients who lacked family care, patients who had depression and patients who consumed alcohol had

low adherence which was statistically significant. Social stigma and side effects to treatment also contributed to low adherence which was statistically significant. The researchers concluded by emphasizing that adherence to antiretroviral therapy in the study area is suboptimal. It was recommended that Intensive adherence counseling should be provided to all patients before initiation of antiretroviral therapy. Health care providers must identify possible barriers to adherence at the earliest and provide appropriate solutions.

Institutional based cross-sectional study was conducted on HIV/AIDS patients accessing treatment at Nekemte referral hospital west Ethiopia, from March 01 to March 30, 2019 by Abadiga, Hasen, Mosisa and Abdisa, (2020). At the time of the study, there were 2251 HIV/AIDS patients undergoing treatment follow-up at Nekemte referral hospital. The hospital had 21 medical doctors, 57 nurses, 42 midwives, and 13 pharmacists. The source population for this study was all the ART patients receiving follow-up treatment at Nekemte referral hospital. The study population comprised all the ART patients who had treatment follow-up during the study period. The study included all patients aged 18 years and above. After adding a non-response rate of 5% which is 15 study participants, a total of 311 ART patients were enrolled in the study. A simple random sampling using the lottery method was used to select the study participants. Data were collected from randomly selected patients as they came for a hospital visit using a structured questionnaire and a face-to-face interview. In addition to the interview, other patient information was obtained from patient cards. The adherence level was measured by counting the number of pills that remain in the patients' bottles when he/she comes for follow up. Then, based on WHO guidelines,

patients who reported an intake of ≥ 95% of the prescribed medication were considered adherent; and those with a reported intake of < 95% were considered non-adherent. The adherence rate was calculated by dividing the number of pills the patient actually taken by the number of tablets patients should have taken multiplied by 100.

The study showed that about 1.0% of the study participants have adherence rate of < 70%, 2.3% have adherence rate of 70–79.99%, 3.9% have adherence rate of 80–89.99%, 19.7% have an adherence rate of 90–94.99% and 223 73.1% have an adherence rate of ≥ 95%. Summarily, out of the total of 305 study participants, 223 (73.1%) were adherent to their medication (95%) and 82 (26.9%) were not adherent to their medication. The researchers have concluded that the level of adherence to antiretroviral therapy is lower than the WHO's recommendation. They recommended that clinicians focus on reducing adverse drug reactions, detecting and treating co-morbidities early, improving patient knowledge through health education, and encouraging patients to disclose their HIV status to their families.

A study conducted by Georgette et al. (2017) that evaluated adherence to antiretroviral therapy using pharmacy refill records in a rural treatment site in South Africa. The study found an overall median adherence of 95%, with 52.4% of the study population having optimal adherence (>95% drug refills on time). Specifically, among the 410 patients assessed, 210 (52.4%) had optimal adherence (≥95% of pill refills collected on time), indicating that they collected their drugs on time, leading to an optimal level of adherence.

Another similar study was conducted in South Africa by El-Khatib et al. in 2011 which aimed to assess the link between adherence to drug-refill visits and virologic and

immunologic failure among HIV patients on first-line antiretroviral therapy (ART). The retrospective cohort study included 456 patients on non-nucleoside reverse transcriptase inhibitor (NNRTI)-based ART for an average of 44 months. The charts were examined to identify clinical characteristics before and during antiretroviral therapy (ART). Multivariable logistic regression and Kaplan-Meier survival analysis were used to assess associations with virologic failure (defined as two repeated viral loads > 50 copies/ml) and immunologic failure. After a median of 15 months on ART, the results showed that 19% (n = 88) experienced virologic failure, and 19% (n = 87) experienced immunologic failure. The study found that a cumulative adherence of less than 95% to drug-refill visits was significantly associated with both virologic and immunologic failure.

The study conducted by Setor et al. in 2010 in Uganda also focused on medication adherence among people living with HIV/AIDS (PLWHA). This study assessed the relationship between clinic attendance for medication refills and medication adherence among 392 adult patients receiving antiretroviral therapy in Uganda. During the 28-week monitoring period, 392 clients were observed. Out of these, 361 clients (92%) attended all their scheduled refill appointments, indicating regular attendance. The findings showed that regular clinic attendance for medication refills was significantly associated with better medication adherence, with patients who attended all appointments for their refills having about fourfold greater odds of achieving optimal (≥95%) medication adherence.

Study conducted at the HIV clinic of University of Ilorin Teaching Hospital (UITH), Kwara State, a tertiary health care centre in middle-belt, Nigeria in 2012 by Chukwuma

et al (2020) to assess the adherence to combined antiretroviral therapy (cART) among people living with HIV/AIDS in a Tertiary Hospital in Ilorin, Nigeria. The study population was PLWHA aged 18 years and above who are accessing treatment at the clinic and the study design was descriptive survey. To ensure accuracy and avoid recall bias, the study assessed the respondents' self-reported adherence rate over the past 7 days. Each respondent was asked to indicate the number of pills they missed during each of the previous 7 days. Based on the total number of pills taken versus the total number of pills prescribed or expected to take, the mean adherence percentage was calculated. For this study, adherence to treatment was defined as taking at least 95% of the prescribed dose of cART. Patients who scored below 95% were considered non-adherent to treatment. The study included all the consenting PLWHA who have been on antiretroviral therapy for at least 3 months and not on admission were included in the study while PLWHA with co-morbidities such as tuberculosis, Diabetes Mellitus, Hypertension, mental disorders, hepatitis or any other medical conditions whose medications may interact with the antiretroviral drugs were excluded. Data were collected using the adherence survey instrument developed by the AIDS Clinical Trial (ACTG Adherence Instrument). A total number of 550 HIV patients who met the criteria for the study were included in the study, and majority of them (99.8%) received pretreatment adherence instruction.

The study conducted by MOSHA et al. (2019) among People Living with HIV in urban and rural settings in Tanzania which took place in 24 Care and Treatment Centres (CTC) in Dar es Salaam and Iringa regions in Tanzania, assessed adherence based on appointment keeping and four days of medication recall. The study included 943

patients who consented to the study. The results indicated that patients who consistently attended appointments (>95% appointment adherence) demonstrated good adherence to their medications.

The result revealed that 86.9% of patients did not miss their prescribed medication over the last three months. Furthermore, the majority of patients (89.8%) stated that they did not miss their medication in the last 7 days. However, there has been a drop in the acceptance rate of missing medication (3.1%) when compared to responses from three months ago. The adherence rate for HIV patients was reported to be 92.6%. The survey also found that 44.4% of respondents missed their medication because they had to travel outside their usual area, 25% missed their medication due to feeling sick or depressed, 33.3% ran out of medication at home, 5.6% stopped taking their medication because they felt better, 50% missed their medication due to lack of funds for transportation, 37.5% wanted to avoid side effects of the medication, 41.7% simply forgot to take their medication, 30.5% did not want to be seen collecting medication in a clinic, and 19.8% were unable to refill their medication due to unscheduled public holidays by the government. Despite advancements in treatment programmes, the adherence rate was less than optimal. It was recommended that sustaining adherence monitoring plans such as home visits and care is necessary.

A prospective, quasi-experimental study conducted from September 2020 to March 2022 in India by Rajavardhana *et al* (2022) assessed the level of adherence to treatment on a daily-dose regimen for people with TB. The study comprised of patients in NTEP Bathalapalli and NTEP Ananthapuramu who were considered as the control and intervention groups, respectively. Both centres were located in a semi-urban area of

Andhra Pradesh State in India. Patients in the control group received standard-of-care treatment in the NTEP, whereas patients in the intervention group received standard-of-care treatment in the NTEP along with pharmacist-mediated education about TB. Patients in the intervention group were provided with daily SMS reminders about their medication plan, as well as a follow-up hospital visit. Each participant in the intervention group received personalised SMS reminders with information about the drug's name, strength, dosage, frequency, and other essential details. All drug-susceptible pulmonary TB outpatients over the age of 18 who had been on TB treatment for at least 1 month before the start of the study were included. The findings of the study showed that the patients in the intervention group had a greater rate of successful treatment (80.2%) than those in the control group (63.8%), and the intervention group's loss to follow-up (LTFU) rate was lower (6.2%) than in the control group (11.4%). Between groups, there were statistically significant differences in treatment success and LTFU rates ($P < 0.05$). The study findings indicated that patient education and daily SMS reminders have great potential to increase the levels of adherence in people with TB under the NTEP daily-dose regimen.

Sungho Bea conducted a retrospective cohort study in 2017-2018 to explore the adherence and factors associated with adherence among TB patients in South Korea. The study included drug-susceptible TB patients who received triple or quadruple regimens comprising of isoniazid, rifampicin, rifampin, ethambutol, pyrazinamide, and rifabutin, which are the drugs recommended as the first-line treatment for drug-susceptible TB. The study population included incident TB patients who were initiating quadruple or triple regimens and were available for follow-up for 180 days. The

adherence of patients to a medication was assessed using a metric called Proportion of Days Covered (PDC). This was calculated by dividing the total number of days the medication was taken by the total number of days the patient participated in the study, which lasted 180 days from the index date. Patients were then grouped based on their PDC values: those with PDC values of 80% or higher were classified as adherent, while those with PDC values less than 80% were considered non-adherent. Of the 987 patients studied, 558 (56.5%) were found to be adherent while 429 (43.5%) were non-adherent. The average PDC for the entire population was 68.87%, with a standard deviation of 33.37%. The study concluded that approximately 45% of TB patients were non-adherent to the drug, which is a major concern for the treatment outcome. The study recommends that healthcare providers and authorities should pay extra attention to ensure that patients take their TB medication as prescribed.

Worgu, Onotai and Asuquo (2023) conducted a study on medication adherence among pulmonary tuberculosis patients in treatment centers in a Southern Nigerian Local Government Area. The study assessed medication adherence and its determinants among a total of 225 adult PTB clients from eight active DOTS centers in selected Obio/Akpor Local Government Area of Rivers State. The study aimed to assess medication adherence and its determinants among pulmonary TB clients in DOTS centers. A total of 225 adult PTB clients from eight active DOTS centers in the Obio/Akpor Local Government Area of Rivers State were selected. A validated questionnaire, Morisky Medication adherence Scale-8 was used to collect the medication-taking behaviour of clients, dichotomised into adherent and non-adherent.

The result showed that Non-adherence to medication was 35.1%, with forgetfulness and stress with the medication plan as top reasons for non-adherence.

Study conducted by Gebremariam, Wolde, and Beyene, (2021) conducted among adult TB patients in Gondar city administration, Northwest, Ethiopia assessed their medication adherence. The study, an institution-based cross-sectional study, was conducted among Tuberculosis patients receiving anti-tuberculosis treatment in Gondar city health facilities from February 20 to March 26, 2020. A total of 265 Tuberculosis patients were selected using systematic random sampling techniques, including patients who had been on treatment follow-up for at least 1 month and were aged 18 years or older. Data were collected by trained interviewers using structured questionnaires. The results showed that the overall rate of adherence to anti-tuberculosis treatment was 90.6% within the last 4 weeks and 96.6% within the last 4 days.

A retrospective cohort study conducted by Sungho Bea in 2017-2018, on adherence and factors associated with adherence among TB patients in South Korea were explored revealed that not all respondents showed 100% compliance. The participants included drug-susceptible TB patients who were on triple or quadruple regimens consisting of isoniazid, rifampicin, ethambutol, pyrazinamide, and rifabutin, which are the recommended first-line treatments for drug-susceptible TB. The study population comprised incident TB patients initiating these regimens and who were available for follow-up for 180 days. Patient adherence to medication was measured using a metric called Proportion of Days Covered (PDC). This was calculated by dividing the total number of days the medication was taken by the total number of days the patient participated in the study, which lasted 180 days from the index date. Patients were

categorized based on their PDC values: those with PDC values of 80% or higher were classified as adherent, while those with PDC values less than 80% were considered non-adherent. Out of the 987 patients studied, 558 (56.5%) were found to be adherent, while 429 (43.5%) were non-adherent. The average PDC for the entire population was 68.87%, with a standard deviation of 33.37%. The study concluded that approximately 45% of TB patients were non-adherent to the drug, which is a major concern for the treatment outcome.

In a study conducted by Worgu, Onotai and Asuquo (2023) in Treatment Centers in a Southern Nigerian Local Government Area among tuberculosis patients on DOTS treatments, it was found that their level of adherence was below the recommended standard. The study aimed to assess medication adherence and its determinants among pulmonary TB clients in DOTS centers. A total of 225 adult PTB clients from eight active DOTS centers in the Obio/Akpor Local Government Area of Rivers State were selected. The medication-taking behaviour of clients was collected using a validated questionnaire, Morisky Medication Adherence Scale-8, and was dichotomized into adherent and non-adherent. The result showed that non-adherence to medication was 35.1%, with forgetfulness and stress with the medication plan as top reasons for non-adherence.

Similarly, a separate study in Kilifi County, Kenya also assessed the tuberculosis Treatment Adherence among Patients Taking Anti-TB Drugs in the study area using a cross-sectional study design. Data was collected using a structured standardized questionnaire from the Morisky medication adherence scale and focus group

discussions among 8 high burden facilities selected for the study. Among the 235 sampled, the study showed that only 75% had a treatment adherence level.

2.3.2 Mobile Health Intervention

Aadia, Jacob, Eric and Curt (2016) conducted a 6-month pilot study at a large urban health center in New England to investigate the use of a clinic-based bi-directional texting intervention among patients who were newly diagnosed with HIV, re-engaging with HIV medical care, or those considered by their medical providers to be at risk for non-adherence to medications or appointments. The objective of the study was to investigate the use of a clinic-based bi-directional texting intervention to enhance engagement in HIV care. The study was conducted among HIV-infected English-speaking patients age 18 and older with a cell phone capable of sending/receiving text messages. The respondents eligible to participate were those either: newly entering into care within one year of diagnosis, re-engaging with medical care after a lapse of ≥1 year, or, in the opinion of their medical providers, were at risk for antiretroviral therapy (ART) or appointment non-adherence. Individuals who met eligibility criteria were offered enrollment in the 6-month pilot study of a bi-directional texting intervention, which included adherence reminders and appointment reminders with optional additional supportive messaging. The sample size was thirty two (32) though only twenty (20) completed the study. A semi-structured interview guide which was digitally recorded and transcribed verbatim was used. It allowed the interviewer and participant to discuss topics freely as appropriate. It was analyzed using the qualitative data management program, NVivo (Version 10, Los Angeles, CA). The result of the study showed that clinic-based bi-directional mHealth intervention greatly improved the drug

adherence. The researchers' findings supported the use of a clinic-based bi-directional mHealth intervention among patients at risk for disengaging with medical care given the prevalence of cell phone use, text messaging, and acceptability of the intervention among the study participants.

Nhavoto, Grönlund, and Klein (2017) conducted a study to assess the effect of mobile health treatment support intervention on HIV and tuberculosis in Mozambique. The study was conducted at five healthcare centres in Mozambique. The study participants on ART care received SMS messages from March 2012 to September 2014, and those on TB care received SMS messages from October 2013 to March 2015. PLWHIV were eligible for participation if they were over 18 years old, able to access a mobile phone on a near-daily basis, and communicate via SMS text message. People who did not own mobile phones were eligible if they had shared access (with corroborative agreement by the phone owner). TB patients were eligible if they were initiating TB treatment for the first time. Automated SMS health promotions and reminders were sent to patients in a RCT. Patients received automated SMS text messages sent based on their medical appointments and drug pick-ups. Also, patients on TB treatment received motivational messages, and both PLHIV and TB patients received educational messages. SMS reminders were sent seven and two days before their scheduled appointment and/or drug pick-ups. A total of 141 patients and 40 Health Care Workers (HCWs) were interviewed. Both patients and HCW found the SMS system useful and reliable. A Likert scale questionnaire and a semi-structured interview guide were used. Interviews were transcribed, and thematic analysis was conducted. For qualitative analysis, data

were coded and underwent thematic content analysis while Man-Witney U test, Fisher's exact test, and Spearman's Rho correlation test were used to understand relationships between patients' and HCWs' perspectives. The participants noted that the SMS system helped to stay in treatment and increases treatment compliance. The system reduces the number of dropouts and the number of patients lost to follow-up. The system also improved adherence to medication, reminding patients to collect medication on time. Majority noted that they would recommend the system to other patients or healthcare centres. SMS reminders helped patients not only to collect medication but also to comply with dosage instructions. They also reported that patients expressed happiness when they receive SMS text messages.

Remi, Mansur, O. O., Mansur, O. R., Godwin and Zainab (2020) carried out a study in two health facilities in Usmanu Danfodiyo University Teaching Hospital (UDUTH) to assess the effect of telephone calls and text message reminder interventions on the adherence to antiretroviral drugs among HIV/AIDS clients receiving care in Sokoto state, Nigeria. The intervention site is Usmanu Danfodiyo University Teaching Hospital (UDUTH), a tertiary health care, while the control site is Specialist Hospital Sokoto (SHS), a secondary health care facility in Sokoto. The study population were HIV positive patients on treatment who were non-adherent to their ART (including patients that missed their appointment and not taking ART and cases of lost to follow-up (LTFU) that were tracked back into care) in the selected health facilities in Sokoto State. The inclusive criteria is all non-adherent (<95% adherent) patients aged 18 years and above, receiving HAART for at least six months in the selected health facilities. A

quasi-experimental study was conducted among 196 non-adherent HIV patients between February and July 2017. The intervention group received monthly telephone calls and weekly text messages for twelve weeks while the control group received only standard of care. Data were processed and analysed using IBM Statistical package for social sciences (SPSS) version 22 computer statistical software package. The major reason given by the respondents for missing ART medications at baseline in the intervention and control group were mainly forgetfulness (78.6%). At post intervention, respondents with good knowledge and adherent to ART were significantly higher in the intervention group. There was also a significantly lower proportion of forgetfulness among the intervention group compared with control group.

A systematic review was conducted by Amankwaa et al (2018) on the effectiveness of short message services and voice call interventions for antiretroviral therapy adherence. The researchers performed a systematic review and meta-analysis of randomized controlled trials and quasi-experimental studies. The sources of their information were PUBMED, MEDLINE, EMBASE, PsychINFO, Cochrane Central Register of Controlled Trials (CENTRAL), CINAHL, AMED and Web of Science. A total of Thirty-Five (35) full-text articles were assessed for eligibility, thirteen (13) studies met the inclusion criteria, and 11 were used in the meta-analysis. Included studies were conducted in high, low and middle-income countries and reported ART adherence interventions delivered by mobile phones (standard or smartphones) in the form of voice calls, interactive voice response calls (IVR), and short message service (SMS). It was discovered that Mobile SMS interventions improved adherence to ART compared

with control conditions. It is important to note that only scheduled SMS was significant whereas triggered SMS had no effect on adherence to ART. The interventions were highly rated by > 90% of participants in the studies who expressed satisfaction with regards to the intervention. Mobile voice calls did not significantly increase adherence to ART. It was suggested that mobile SMS adherence interventions that allow two-way communication may be more acceptable than standalone SMS reminders, which are seen to be intrusive, producing habituation and response fatigue.

Study conducted by Adetunji et al. (2015) in Nigeria, which assessed the use of mobile phones as a social strategy to improve antiretroviral refill experience at a low-resource HIV clinic used focus groups consisting of five categories of adult patients receiving combination antiretroviral therapy. A cross-sectional qualitative study was conducted to provide insight into modifiable gaps between patients' expectations and experiences of the use of mobile phones in facility-based antiretroviral refill service at a public HIV clinic in Nigeria. one of the study findings showed the patients' preference for utilizing informal social support (through intermediaries with mobile phones) to maintain adherence to antiretroviral refill appointments when they could not present in person. This evolving social support strategy also has the potential to enhance defaulter tracking.

A similar study was conducted by Reid et al. (2017) which focused on the impact of cellular SMS reminders on the consistency of antiretroviral therapy (ART) pharmacy for pickups using randomized controlled trial was among HIV-infected adults in Botswana. One hundred and eight treatment-experienced adult patients were randomly

assigned to either a control group or an intervention group. Participants in the intervention group received SMS reminders in advance of monthly ART refills. The study found that 100% of the participants in the intervention group collected their ART medication on time, compared to 70% in the control group. Secondary outcomes included frequency of physician visits, CD4 cell counts and viral loads.

The study by Lester et al. (2010) examined the impact of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1). The results of the randomized trial showed that patients who received SMS support demonstrated significantly improved ART adherence and rates of viral suppression compared to those in the control group. The study, conducted between May 2007 and October 2008, randomly assigned participants to either the SMS intervention or standard care. The findings indicated that 168 out of 273 patients in the SMS intervention group reported adherence to ART, compared to 132 out of 265 in the control group. Additionally, suppressed viral loads were reported in 156 out of 273 patients in the SMS group and 128 out of 265 in the control group. The researchers concluded that patients who received SMS support had significantly improved ART adherence and rates of viral suppression compared to the control individuals.

A Randomized Controlled Trial conducted by Dongsheng, Sangthong, McNeil, Chongsuvivatwong, Zheng and Yang (2013) in Baoshan among HIV/AIDS patients also showed consistent results. This study assessed the effects of a phone call intervention on promoting adherence to antiretroviral therapy and quality of life among the participants.

The results suggested that a phone call intervention could help maintain high self-reported adherence among both treatment-naive and treatment-experienced patients.

An integrative review study that involves extensive research analysis was carried out by Yndiara and Telma (2020) to analyze the evidence available in the literature on the effectiveness of text messages in the adherence to antiretroviral therapy in adults. The search for primary studies was carried out in April 2019 through the Capes Journal Portal. The chosen databases were the following: Medical Literature Analysis and Retrieval System Online (MEDLINE), via the US National Library of Medicine (PubMed), Web of Science, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Scopus, and Latin American and Caribbean Literature in Health Sciences (Literatura Latino-Americana e do Caribe em Ciências da Saúde, LILACS), via the Virtual Health Library (Biblioteca Virtual de Saúde, BVS). Out of 743 related articles, only 18 studies met the pre-established inclusion and exclusion criteria, constituting the final sample of the integrative review. A study with 37 participants using ART to measure the ease of using a text message program showed relatively high satisfaction in the use of the intervention and a significant association with age, though the older participants reported greater difficulty in using the intervention. It was highlighted that participants in three intervention studies reported at the end of the study that they would like to continue receiving text messages in support of ART adherence, that is, that the text messaging program persists. The content of the text messages employed by the scholars covered everything from reminders of medication doses to motivational messages and relevant information about HIV/AIDS. Some studies chose not to use the

words HIV/AIDS in order to protect the participants, which pleased them, as privacy and confidentiality are important factors for adhering to the text message program. It was observed that the vast majority of studies reported benefits from using text messages to support ART; however, the instruments for assessing adherence to the therapy varied between the studies, including from self-reporting to more complex technologies for monitoring the correct use of the ARVs.

A quasi-experimental study was conducted by Akamike, Okedo-Alex, Alo, Agu, Uneke, and Ogbonnaya (2021) in six health facilities in Ebonyi State, southeast Nigeria on the effect of mobile-phone messaging on patient and health-worker knowledge and adherence to the isoniazid preventive therapy guideline in HIV clinics. The aim of the study was to determine the effect of m-health on health worker knowledge and adherence to isoniazid preventive therapy (IPT) guidelines and on patient knowledge and adherence to isoniazid treatment. Three health facilities were assigned to intervention and control arms, and all eligible health workers were recruited. The total populations recruited for this study were 45 and 41 in intervention and control arms respectively. Data were also collected from 200 patients (100 per arm). The eligible participants were those health care workers who render services at the HIV clinics and among people living with HIV who access HIV care at the selected health facilities. Simple random sampling technique was used to select the six health facilities from a list of the health facilities that provide comprehensive HIV care in the State. The public health facilities were assigned as the intervention arm while the private/mission hospitals were assigned as the control arm. The data were analysed using Statistical

Package for Social Sciences (IBM-SPSS) for Microsoft Windows version 20 and chi-square test was carried out to test for the effect of the intervention on knowledge and adherence. The study showed that mobile-phone positively affected the knowledge and adherence of health workers and patients in the treatment regimen. It was discovered at baseline that 54.5% and 63.4% of health workers in intervention and control arms respectively had good knowledge which improved significantly to 90.2% in the intervention arm after the intervention. At baseline, 61.4% and 90.2% of health workers had good adherence to the guideline in intervention and control arms respectively which also improved in the intervention arm by 28.8% after intervention. More than 50% of the patients in both studies were found to have poor knowledge, with the intervention arm having a significantly higher proportion of respondents (68.0%) with poor knowledge at baseline. The proportion of patients with good knowledge however increased significantly (88.8%) in the intervention arm after intervention.

A study conducted by Asaolu et al. (2023) in Niger State, Nigeria, assessed the impact of text messaging on treatment adherence practices among young people living with HIV. The study, conducted over six weeks using a quasi-experimental design, involved two selected hospitals. One hospital received a once-weekly text message intervention (TMI) for the entire six-week study period, while the other served as the control group (CG). Data were collected at baseline, immediate post-intervention, and at the six-week follow-up. The findings revealed a significant increase ($p < 0.05$) in the mean score between baseline and immediate post-intervention for medication adherence and

antiretroviral therapy (ART) retention practices in the intervention group, while no significant difference ($p > 0.05$) was observed in the control group.

A similar study was conducted in Gambia by Peterson et al. (2013) which took place at the Genito-Urinary Medicine (GUM) clinic at the Gambia Unit of the Medical Research Council (UK) to evaluate the use of self-reported adherence and keeping clinic appointments as indicators of viremia in routine HIV care. It was a prospective study where the clinic provided regular care and follow-up to a population of over 1500 HIV-infected individuals identified through a combination of STI services, tuberculosis, general medical care, and referrals. Baseline information on patients was collected at the time of HIV diagnosis confirmation. Patients on ART were scheduled for visits at weeks 2, 4, 8, and 12 after starting ART, and at least every 12 weeks thereafter, with more frequent visits available upon patient or physician request. CD4 counts and HIV viral loads were measured at weeks 12, 24, and every 24 weeks thereafter, or as deemed necessary based on clinical judgment. Patients were asked at each visit after starting antiretroviral therapy (ART) about the frequency of missed or late ARV drug doses in the preceding 7 days and 4 weeks. For the 1-week self-report, the number of missed doses out of 14 was recorded, while the 4-week self-report was categorized as 0, 1 to 3, 4 to 6, 7 to 14, 15 to 28, or more than 28 missed doses "out of about 56 possible. The study findings revealed a modest connection between having a high level of virus in the blood and being late for clinic appointments. This association remained even for short delays when patients were likely not running out of antiretroviral (ARV) drugs. This

finding suggests that missed appointments could be an indicator of poor adherence, but only to a certain extent.

Similar study was also conducted among people living with HIV/AIDS (PLWHA) at a Ryan White-funded HIV clinic in El Paso, Texas by Anthony, Molokwu, Alozie, and Magallanes in 2019. The researchers implemented a web-based text messaging service to remind patients about their clinic, social work, and laboratory follow-up appointments. This text service utilized Google's text messaging service, Google Voice, and allowed the operators to maintain control over who sent the messages, ensuring confidentiality within the clinic among authorized users. The text messages informed patients of their appointments at the internal medicine clinic within the institution, making it difficult for outsiders to link the messages to the HIV care clinic. Additionally, participants could respond to the messages to request rescheduling of appointments or inform staff that they could not attend a particular appointment. In the period before the intervention, a total of 326 individual appointments were scheduled at the HIV/AIDS clinic. Out of these, 245 patients attended their appointments, resulting in a no-show rate of 24.85%. In the follow-up period after text messages were initiated, 243 patients were scheduled, with 200 patients attending their appointments. This led to a reduced no-show rate of 17.7%, which is a statistically significant improvement compared to the pre-intervention rate of 24.85%. The increase in clinic adherence was 7.15%, with a P value of .05. These results indicate a statistically significant improvement in appointment attendance after the implementation of text message reminders.

In a study conducted by Zebina, Melot, Binachon, Ouissa, Lamaury, and Hoen (2019), it was found that sending an SMS reminder two days before a scheduled doctor's appointment had a positive but not significant impact on the attendance rate of people living with HIV/AIDS (PLWHA). The study included PLWHA aged 18 years and older who had a mobile phone and a scheduled appointment at Pointe-à-Pitre University Hospital. The intervention took place between March and April 2015 at the infectious diseases department. On the visit day, a questionnaire was used to assess patient perceptions regarding the SMS reminder. The results indicated that the SMS reminders helped increase the likelihood of patients keeping their doctor's appointments.

The study conducted by Salama et al. (2012) focused on strategies to improve adherence to antiretroviral therapy (ART) among people living with HIV/AIDS (PLWHA) in Tanzania. The study demonstrated that medication adherence increased after the intervention. It was carried out in two regions, with each region consisting of 3 selected intervention facilities and 1 control facility. At each facility, a cohort of 100 patients who had been on treatment for at least 9 months at the start of the study was recruited. The intervention included implementing a standardized appointment register, negotiating appointments with patients, and strengthening connections with communities to locate patients who missed appointments. The primary outcome indicator was the percentage of patients who missed visits by more than 3 days or more than 14 days. The study revealed that before the interventions, between 15% and 20% of patients in both regions missed visits by more than 3 days each month. After the intervention, the rate decreased to about 11% in Region 1, but did not show a decline in Region 2 or the control facilities. The study concluded by emphasizing that effective

appointment systems and strengthening connections with community programs are viable and sustainable approaches to reducing high rates of missed visits and enhancing people-centered public health.

Eliza Barclay (2009) reported how text messages could hasten tuberculosis drug compliance. The researcher reported a study conducted from July, 2006, to April, 2007. It was a pilot study among 155 tuberculosis patients at three clinics in the Cape Town area with the Western Cape Department of Health. The importance of SIMpill to TB drug adherence was assessed. It was discovered that after patients used the SIMpill for 10 months, drug adherence stabilized between 86–92% with a treatment success rate of 94%. Ann-Mari Albertsen (cited by Eliza Barclay 2009), managing director of SIMpill, says in addition to helping patients adhere to their treatment, SIMpill also frees up health workers from daily observation of patients taking their medication. Albertsen noted that with SIMpill, a nurse could keep tabs on 50–60 patients rather than just ten patients. Instead of monitoring patients through a pill bottle, SIMmed asks patients to press the speed dial button on their mobile phone after taking their medication. The number dials into a server, which records the medication event, and reminds the patient by SMS or contacts a caregiver if the patient fails to call. “We see staff focusing on other parts of their job, like counseling, training, and actual follow-up with patients who need more attention, instead of keeping up with tablets and glass of water”, said Albertsen (Eliza Barclay, 2009).

A study on Mobile Health Technologies as an acceptable tool for providing social support to tuberculosis patients in rural Uganda was conducted by Angella, et al (2020).

The salient mHealth approaches to monitor and enhance TB treatment adherence was described. TB patients were recruited from the TB clinic within Mbarara Regional Referral Hospi- tal (MRRH) in rural, southwestern Uganda between June 2017 and June 2018. The objective of the study was to explore TB patients' current access to social support and perceptions of utilizing real-time adherence monitoring interventions to support medication adherence. Purposive sampling method was used to recruit the participants. The eligibility criteria were: patients receiving TB treatment in Mbarara; (b) having documented drug-sensitive TB, (c) receiving treatment with a first-line 6-month course of anti-TB regimen as described above for at least one month, (d) having a personal mobile phone, (e) able to send and receive SMS, (f) being 18 years or older, (g) residing in Mbarara district, (h) being willing and able to give consent, (i) being willing and able to name one social supporter, and (j) being able to speak the local language (Runyankole) or English. TB patients who owned phones, had been taking TB medications for ≥1 month, were receiving their treatment from Mbarara Regional Referral Hospital, and reported having ≥1 social supporter. STATA 13 by ATM and TW was used to describe participants' socio demographic and social support characteristics while the qualitative data were analyzed using content analysis to derive categories describing accessibility and perceptions. The study used a parallel mixed-method study design that comprised of semi-structured interviews and surveys. TB patients reported requesting and receiving a variety of different forms of social support, including instrumental (e.g., money for transport and other needs and medication reminders), emotional (e.g., adherence counseling), and informational (e.g., medication side effects) support through mobile phones. Participants felt that SMS notifications

motivated medication adherence by creating a personal sense of obligation to take medications regularly. Mobile telephones provided alternative approaches to providing social support for TB medication adherence especially where patients do not stay close to their social supporters. Reminders and encouragement were the most common type of support received. The participants expressed the need to be oriented about the use of SMS notifications before they start receiving them in order to match expectations of patients and those of social supporters.

A comparative study was conducted by Samira et al., (2021) at National Research Institute of Tuberculosis and Lung Disease, Masih Daneshvari Hospital, Shahid Beheshti Medical University, a hospital in Tehran, Iran to assess the effectiveness of short message service-based intervention on medication adherence for patients with tuberculosis. It was a comparative study conducted between TB patients in National Research Institute of Tuberculosis and Lung Disease, Masih Daneshvari Hospital, Shahid Beheshti Medical University. Using the census method, 180 patients were recruited in the. Patients in the intervention group received SMS reminders reminding them to take their medication at specific times for 30 days beginning on the second day after discharging. Adherence was assessed with the Combination of visual analog scale (10 points liner VAS), eight-item Morisky Medication Adherence Scale and Pills count. Data were analyzed by nonparametric chi square Mann-Whitney test and Kruskal-Wallis test using SPSS software. Patients in the intervention group received SMS reminders reminding them to take their medication at specific times for 30 days beginning on the second day after discharging and could not choose the times the

reminders were sent. SMS reminders also contained Information on diet and times of the follow-up appointments. The result of the study showed that the case group had 8.9% low adherers, 32.5% medium adherers, and 55.6% high adherers, while the population in control group had 16.1% low adherers, 51.7% medium adherers, and 32.2% high adherers. According to these results, there was a significant difference between the case and control groups. There was a significant positive impact of SMS medication reminders on self-reported adherence.

Sarah, et al (2013) conducted a study on the feasibility and efficacy of a text messaging intervention to support TB treatment adherence at a specialized reference hospital located within Health Region V in the province of Buenos Aires, Argentina. The objective of the study was to assess a text messaging intervention on the promotion of tuberculosis (TB) treatment adherence. Two arms were used; text messaging based intervention receiving usual care or a medication administration calendar. Patients who were newly diagnosed with TB and were 18 or older, and had mobile phone access were recruited and randomized to usual care plus either medication calendar or text messaging intervention for the first two months of treatment. Block randomization of 10 was used to ensure balanced representation in the control and intervention arms. The random allocation sequence was generated using a computer-generated randomized list. Opaque envelopes sequentially numbered and sealed were used for treatment allocation concealment. Patients were recruited during medication retrieval at the nurses' station after seeing the healthcare provider. Due to the nature of the intervention, blinding of the group allocation could not be conducted for research staff, patients to other patients,

or physicians to their patients. However, physicians were not made aware of the group allocation of their patient unless the patient informed them. The in-person interviews lasted on average 25 minutes (range 15–47 minutes) and were transcribed verbatim in Spanish by a local, native Spanish speaker. Interviews and field notes were analyzed using descriptive content analysis while the Statistical analyses were performed using IBM SPSS, version 20 (Chicago, IL). Independent-sample -tests were used for continuous outcomes, and chi-square test was used for dichotomous or categorical variables. The result showed that participants in the texting group self-reported adherence on average 77% of the days whereas only 53% in calendar group (control group) returned diaries. The SMS intervention, developed in collaboration with a multidisciplinary research team and patients, consisted of four components in which patients (a) were instructed to text-in after medication administration (they received reminders if they did not); (b) received confirmation of receipt of notification; (c) were encouraged to text-in questions or concerns; and (d) received twice weekly educational texts. Participants in the intervention arm received verbal and written instructions at recruitment and were asked to send an initial text to test the program's receipt and function. The texting intervention was well accepted and feasible with greater number of the respondents reporting of adherence using text messaging than the diary. Findings of the study suggested that the TextTB intervention was feasible to implement in the population and well accepted as demonstrated by patients' statements of approval, their use of the system to ask questions, report TB drug side effects, and report self-administration. Furthermore, there was greater reporting of adherence in the SMS group

than with the use of a medication diary with low numbers of patients returning their calendars.

José, Åke and Gunnar (2017) conducted a study at five healthcare centers in Mozambique on the perspectives of patients and healthcare workers outcome on the use of mobile health treatment support intervention for HIV and tuberculosis patients. A total of 141 patients and 40 Healthcare workers' (HCWs) were interviewed. Automated SMS health promotions and reminders were sent to patients in a RCT. Respondents rated usefulness, perceived benefits, ease of use, satisfaction, and risks of the SMS system using a Likert scale questionnaire. It was discovered that almost all (95%) HCWs agreed or strongly agreed that SMS helped respondents' participation in their health care. They all agreed that SMS system helped to reduce the number of patients who missed appointments. All HCWs agreed or strongly agreed that 'The SMS system helped to reduce the number of patients who missed collecting medications'. A large majority of the HCWs (83%) agreed or strongly agreed with the statement: 'The SMS system helped to discuss health-related issues with patients'. Participants agreed that the SMS system helps patients to stay in treatment and increases treatment compliance. Also, the system reduces the number of dropouts and the number of patients lost to follow-up.

A prospective quasi-experimental study conducted from September 2020 to March 2022 in India by Rajavardhana et al (2022) focused on assessing the level of adherence to treatment on a daily-dose regimen for people with TB among patients in NTEP Bathalapalli and NTEP Ananthapuramu, considered as the control and intervention

groups, respectively. Both centers were located in a semi-urban area of Andhra Pradesh State in India. In the control group, patients received standard-of-care treatment in the NTEP, while patients in the intervention group received the same standard-of-care treatment along with pharmacist-mediated education about TB. This included daily SMS reminders about their medication plan and a follow-up hospital visit. Each participant in the intervention group received personalized SMS reminders containing information about the drug's name, strength, dosage, frequency, and other essential details. The study included drug-susceptible pulmonary TB outpatients over the age of 18 who had been on TB treatment for at least 1 month before the study began. The study's findings revealed that the intervention group had a higher rate of successful treatment (80.2%) compared to the control group (63.8%). Additionally, the intervention group's loss to follow-up (LTFU) rate was lower (6.2%) than that of the control group (11.4%). Statistically significant differences in treatment success and LTFU rates ($P < 0.05$) were observed between the groups. The study suggested that providing patient education and daily SMS reminders holds great potential for enhancing adherence levels among individuals with TB following the NTEP daily dose regimen.

The RCT study conducted by Nhavoto, Grönlund, and Klein (2017) focused on HIV and tuberculosis patients in Mozambique to understand the viewpoints of both patients and healthcare workers. A total of 141 patients and 40 healthcare workers were surveyed. TB patients qualified for the study if they were starting TB treatment for the first time. Both interventions involved a regimented series of automated SMS text messages. Patients received automated SMS text messages tailored to their medical

appointments and medication pick-ups. Additionally, patients undergoing TB treatment received motivational messages, while both PLHIV and TB patients received educational messages. SMS reminders were dispatched seven and two days prior to their scheduled appointment and/or medication pick-ups. Participants receiving antiretroviral therapy (ART) care were sent SMS messages from March 2012 to September 2014, while those on tuberculosis (TB) care received SMS messages from October 2013 to March 2015. The outcome demonstrated positive effects, including a decrease in missed medication collections and appointments. The majority of participants reported that the system improved communication between healthcare providers and patients, as well as aiding in education and motivation. Additionally, most participants expressed a willingness to recommend the system to other patients or healthcare facilities. Based on their findings, the researchers suggested utilizing SMS technology to send reminders for appointments, medications, motivational messages, and health education in order to improve patient retention in HIV and TB care.

A study by Brar et al. (2018) examined the impact of tailored and interactive mobile text messaging on medication refill adherence in Medicare patients with tuberculosis. The 3-month program aimed to determine whether customized interactive text message dialogues could enhance medication refills in Medicare patients with chronic diseases. The study used the mPulse mobile interactive text messaging solution with partially adherent and non-adherent Medicare patients of Kaiser Permanente Southern California (KP) and compared refill rates of the text messaging group to a group of partially adherent or non-adherent Medicare patients at KP who did not receive text messages (non-text messaging group) from December 2016 to February 2017. The refill rates of

the text messaging group and non-text messaging group were compared using independent samples T-test to assess the difference in average refill rates between the two groups. The analysis revealed a significant disparity in medication refill rates, with the text messaging group exhibiting a 14.07 percentage points higher refill rate ($P<.001$). These results underscore the substantial benefits of employing text messaging to enhance medication refill rates among Medicare patients. Furthermore, they provide strong evidence in support of utilizing interactive text messaging as a cost-effective, convenient, and user-friendly approach to engage with patients.

A review by Schwebel and Larimer (2018), which consisted of a systematic literature review of 2316 articles which utilized SMS reminders to enhance patient health care outcomes were included in the review. The study methodology adhered to the PRISMA guidelines for systematic reviews. After the screening process, 162 articles met the inclusion criteria. The findings revealed that 93 of the qualifying studies explored medical compliance reminders, while 56 focused on appointment reminders. The review demonstrated that nearly all the SMS reminder studies contributed to enhancements in patient medical compliance and appointment attendance. Furthermore, researchers noted various benefits associated with using SMS reminders, including user-friendliness, cost-effectiveness, and swift and automated message delivery. Minimal risks were reported, and the majority of participants found the reminders to be acceptable. In conclusion, the review suggested that text messages represent an effective reminder mechanism for promoting improved patient appointment adherence and medical compliance.

Based on a systematic review conducted by D'Arcey, Collaton, Kozloff, Voineskos, Kid, Foussias. (2020), mobile interventions have been found to positively impact adherence to appointments. The review aimed to gain insights into how SMS text messaging contributes to clinical engagement in the treatment of psychosis. The included studies were published from the year 2000 onward in the English language, with no methodological restrictions. They were identified using three core databases and gray literature sources. Out of the 233 studies extracted, 15 met the eligibility criteria for inclusion. The results revealed that most of the studies demonstrated the positive effects of SMS text messaging on various dimensions of engagement, such as medication adherence, clinic attendance, and therapeutic alliance. Studies examining the feasibility of SMS text messaging interventions concluded that they are safe, easy to use, and well-received.

Study conducted in Shanghai, China by Wu et al (2023) assessed the impact of mobile health reminders on tuberculosis treatment outcomes. The researchers enrolled newly diagnosed pulmonary TB (PTB) patients aged 18 or above, who were treated with the first-line regimen (2HREZ/4HR) and registered at Songjiang CDC (Shanghai) between April and November 2019. All eligible patients were given the option to receive standard care, use a reminder app, or utilize a smart pillbox to support their treatment. A total of 260 out of 324 eligible patients participated, with 88 choosing standard care, 82 using the reminder app, and 90 using the smart pillbox, and they were followed for a total of 77,430 days. Among the participants, 175 (67.3%) were male. The results revealed that 99.6% of doses were taken, with 87.7% of doses being monitored by mHealth reminders. A significant time-dependent downward linear trend in the monthly

proportion of dose intake ($p < 0.001$) was observed. Ultimately, 247 (95%) patients were successfully treated. The standard care group's median treatment duration for successfully treated patients was significantly longer than those in the reminder app group and the smart pillbox group (both $p < 0.01$). Utilizing the reminder app and the smart pillbox was linked to a 1.58-fold and 1.63-fold increase in the likelihood of treatment success compared with the standard care, respectively (both $p < 0.01$). The study's authors concluded that the reminder app and smart pillbox interventions were well-received and led to improved treatment outcomes compared with standard care among the participants.

The systematic review conducted by Lee, Rajaguru, Baek, Shin and Park (2023) aims to comprehensively review the literature on the use of digital health interventions (DHIs) to improve TB treatment adherence and identify key strategies for their implementation. The researchers searched the PubMed, Cochrane Library, Ovid Embase, and Scopus databases for relevant studies published between January 2012 and March 2022. Included studies focused on web-based or mobile phone-based interventions, medication adherence, digital health, randomized controlled trials, digital interventions, and mobile health and ubiquitous health technology for TB treatment and related health outcomes. The study examined 27 relevant studies and categorized them based on the intervention method, treatment success, and health outcomes. The study highlighted the importance of interventions such as SMS text messaging, medication reminders, and web-based direct observation therapy. The use of digital health technology greatly facilitated disease management for both patients and healthcare providers. However, the

research pointed out that there are relatively few studies focusing on two-way communication interventions, such as interactive SMS text messaging and feedback systems. The researcher concluded by emphasizing that studies on Digital Health Interventions (DHIs) for TB patients have shown potential for self-management of the disease. While DHIs are still evolving, evidence on the impact of digital technologies in improving TB treatment adherence is currently limited. Therefore, there is a need to encourage patient engagement in TB treatment and self-management through interactive communication.

CHAPTER THREE

MATERIALS AND METHODS

3.1 MATERIALS

The materials used in this study were questionnaire administered to people living with HIV/AIDS, and to people with tuberculosis. Checklist was also used during the intervention phase to collect data from the participants in the test group.

3.1.1 Study Design

The study design employed for this study was the quasi-experimental design. Quasi-experimental design aims to establish a cause-and-effect relationship between an independent and dependent variable. This design has been used successfully in similar research studies in the past (Akamike *et al.* 2021, Remi *et al.*, 2020).

3.2 METHODS

3.2.1 Study Area

The area of study is Imo State. Imo State is one of the 36 States in Nigeria and lies in the South East of Nigeria with Owerri as its capital and largest city. It occupies the area between the lower River Niger and middle Imo River (Elizabeth, 2015). It came into existence in 1976 along with other new states created under the leadership of the late military ruler of Nigeria, Murtala Muhammad, having been previously part of East Central state. Part of it was split off in 1991 as Abia state and another part became Ebonyi state. It has 27 Local Government Areas. It is bordered by Abia State on the East, Rivers State to the South, Delta State to the West and Anambra State on the North (Elizabeth, 2015). The State lies within latitudes 4 degrees 45`N and 7 degrees 50`E and

7 degrees 25`E with an area of 100sq km. The State is rich in natural resources, including crude oil, natural gas, lead and Zinc (Elizabeth, 2015).

Many trades and investment opportunities abound in the peaceful state, including oil and gas exploration, chemical plants, brewery plants, hydroelectricity and gas fired power plants, grain milling, starch production, integrated multi oil seeds processing plant, ceramic industry, Inland waterway transport, Integrated Palm Produce among others. The projected State's population according to National Bureau Statistics (NBS 2017) was 5,408,756 in 2016 and Christianity is the predominant religion. The male and female populations were projected to be 2,758,466 and 2,650,290 respectively in 2016 (NBS, 2017). In addition to English being the official language, Imo State is a predominantly Igbo speaking State, with Igbo people constituting majority.

The two hospitals that were used for this study are Federal University Teaching Hospital (FUTH) Owerri and Imo State Specialist Umuguma, both in Imo State. The FUTH Owerri is a public health care centre located in Owerri city in Imo State, Southeastern Nigeria (Nwaokoro, 2014). In 1903, FUTH was founded as a colonial dispensary. It was promoted to a District Hospital, then a General Hospital, before finally becoming a Federal Medical Centre in 1995 (Nkwopara, 2022). It was currently upgraded to Teaching Hospital in 2023 and named Federal University Teaching Hospital Owerri. It has a heart to heart center and a centre for TB patients. The both centres will be included in this study. It is 700-bed capacity hospital (Nations Newspaper, 2021).

The Imo State Specialist Hospital is a Public hospital, located at Umuguma, Owerri West Local Government, Imo State. It was established on 2nd June 1960, and operates

on 24hrs basis. It is a licensed hospital by the Nigeria Ministry of Health. It has a heart to heart centre and a TB centre, which will both be included in this study.

Federal University Teaching Hospital Owerri

The history of FUTH Owerri, as obtained from the hospital management, details that it initially started as a Shell-Darcy/military colonial hospital in 1902, with the main objective of rendering services to soldiers, police officers, colonial officials, and Shell staff. At inception, the hospital facility included three wards: the male ward, the female ward, and the maternity ward. Other hospital facility services provided then included general outpatient services and theater. In terms of staff, the hospital started with just one general practitioner and a few nurses. After the Shell-Darcy Company relocated from Owerri in the late 1950s, the hospital was transferred to the Eastern Regional Government following Nigerian independence in 1960. It fell under the administration of the then premier of Eastern Nigeria, M.I. Okpara. It was converted to a district hospital, and the area previously used by the Shell-Darcy company became an amenity ward of the hospital facility, named after the premier as "Okpara Nursing Home." As the regions in the country were reorganized into states, the hospital became part of the East Central State of Nigeria. The government of the East Central State upgraded the hospital to a divisional hospital, resulting in an additional ward and 44 extra hospital beds. In 1976, when Imo State was created from East Central State, the hospital automatically became the property of the Imo State Government.

In the early 1990s, in accordance with the National Health Policy of Nigeria, the Federal Government initiated the construction of tertiary healthcare facilities in states without Federal teaching hospitals. The hospital was formally taken over by the Federal Government of Nigeria on March 21, 1994, and renamed Federal Medical Centre Owerri. It commenced full operations on January 1, 1995 and underwent significant expansion in terms of infrastructure and staff. The hospital has received accreditation from the Medical and Dental Council of Nigeria and other regulatory bodies to provide training to residents, house officers, pharmacy interns, medical lab scientists, radiography interns, dental technologists and therapists, and physiotherapy interns. In 2022, the Federal Medical Center Owerri was approved as a Federal University Teaching Hospital (FUTH) Owerri, allowing its medical services to be utilized by University medical institutions in and around Imo state.

Imo State Specialist Hospital Umuguma

The history of the Imo State Specialist Hospital (ISSH) Umuguma, as obtained from the hospital management, shows that it was formerly called Imo State General Hospital. It has shared some historical origins and characteristics with the Federal Medical Center Owerri, especially in terms of being established in 1902 as a colonial hospital with just one general practitioner and a few nurses. Both were simply one and the same health facility until January 1, 1995, when it was taken over by the Government of Nigeria as the Federal Medical Centre Owerri. Thus, the old hospital was initially established with three wards: maternity, male, and female/children wards; with basic operations on medical and surgical care and facilities, which include the General Out-patient

Department (GOPD). It later grew into a district hospital and then into a general hospital in 1976, following the creation of Imo State. The hospital was taken over by the Federal Government of Nigeria, resulting in the establishment of a state-owned General Hospital at Okigwe Road, Owerri. Subsequently, construction began at a permanent site in Umuguma, Owerri (off Port Harcourt Road, Owerri). It relocated to its permanent site in March 2000 and has since undergone several expansions, including significant renovation in 2011 under the administration of the former Governor of Imo State, Anayo Rochas Okorocha.

As the largest state-owned hospital in the state, it is notable for its specialized and general medical services. In 2014, the hospital was officially designated as the Imo State Specialist Hospital, Owerri, in accordance with the Imo State law number 3 of 2014. The hospital is overseen by a Chief Medical Director, assisted by a Chief Nurse in charge of nursing services, and a team of specialized staff responsible for both medical and non-medical services. It is currently consists of thirteen departments and several wards. It can accommodate up to 182 beds and offers primary, secondary, and special care services. The hospital has a well-equipped medical laboratory for microbiology, hematology, blood banking, and clinical chemistry, and also serves as a referral institution for primary healthcare facilities and private maternity homes. Training opportunities at the facility include housemanship, pharmacy, medical laboratory science, dental technology, and nursing and midwifery. Additionally, the hospital regularly attracts medical consultants from various disciplines and has made significant improvements to its overall services.

3.2.2 Study Population

Study population comprised of two study populations, people living with HIV/AIDS and people with tuberculosis. For PLWHA, the total numbers of non-adherents were 223 and 411 at FUTH Owerri and ISSH Umuguma respectively. For people with tuberculosis, the total numbers of non-adherents were 134 and 128 at FUTH Owerri and ISSH Umuguma respectively.

3.2.2.1 PLWHA

Following the baseline assessment, it was observed that 223 individuals receiving care at FUTH Owerri and 411 individuals at Imo State Specialist Hospital Owerri met the inclusion criteria for the study.

They comprised:

i. Those who were not taking the right dosage of their drugs.

ii. Those that were not taking their drugs at the scheduled time.

iii. Those who were not coming to re-fill their drugs.

iv. Those who were not coming for their doctor's appointment.

v. Cases lost to follow up in the past three months before the commencement of the study determined from hospital records.

3.2.2.2 People with tuberculosis

The population of people with tuberculosis receiving care at FUTH Owerri and Imo State Specialist Hospital Owerri were 134 and 128 respectively. They comprised of:

i. Those who were not taking the right dosage of their drugs.

ii. Those that were not taking their drugs at the scheduled time.

iii. Those that were not coming to re-fill their drugs.

iv. Those that were not coming for their doctor's appointment.

v. Cases lost to follow up in the past three months before the commencement of the study determined from hospital records.

3.2.3 Sample Size and Sampling Methods

3.2.3.1 Sample size

3.2.3.1.1 PLWHA

The number of People Living With HIV/AIDS (PLWHA) receiving care at FUTH Owerri who met the inclusion criteria was 223. At Imo State Specialist Hospital Umuguma Owerri, 411 were not taking the right dosage of their medication.

3.2.3.1.2 People with tuberculosis

The numbers of People with TB receiving care at FUTH Owerri and Imo State Specialist Hospital Umuguma Owerri who met the inclusion criteria were 134 and 128 respectively.

3.2.3.2 Sampling method

The entire study population who were non adherent was used in the study, hence there was no sampling carried out. Nevertheless, the facility that served as control among the two was selected by simple random sampling method (flipping of a coin for head or tail). The test facility was assigned to heads, while the control was assigned to tails. The result revealed that FUTH Owerri was the test group, while Imo State Specialist Hospital Umuguma Owerri was the control group. Mobile health intervention was carried out at the test groups while the control groups were just given standard care.

3.2.4 Inclusion criteria

a. PLWHA

1. PLWHA who have been receiving care at Heart to Heart Centre at FUTH Owerri and Imo State Specialist for at least six months prior to the commencement of the study.
2. PLWHA who had a history of non-adherence to their medication (adherence below 95%), doctor's visit, and prompt re-filling of their drugs at the time of the study.
3. PLWHA who owned a mobile phone or had daily access to a phone and were able to use the SMS (Short Message Sending) feature on these phones.
4. Those aged 20 and above as at their last birthday.
5. Those who consented to the study.

b. P**eople with tuberculosis**

1. Newly diagnosed patients (in the past two months) with smear positive pulmonary TB.
2. Those who had a history of non-adherence to their medication (adherence below 95%), doctor's visit, and prompt re-filling their drugs at the time of the study.
3. Those who owned a mobile phone or had daily access to a phone and were able to use the SMS (Short Message Sending) feature on these phones.
4. Those aged 20 and above as at their last birthday.
5. Those who consented to the study.

3.2.5 Exclusion criteria

a. PLWHA

1. Clients on HAART who were on admission since drug adherence would be ensured via provider administered treatment.
2. Clients on HAART who also had other chronic diseases (co-morbidities) that necessitated daily medication e.g., tuberculosis, hypertension. This was because of the increased pill burden from co-morbidities that could introduce undesirable effects into the study.
3. Those who refused to give consent to the study.

b. People with tuberculosis

1. Those who were on admission since drug adherence would be ensured via provider administered treatment.
2. Those who also had other chronic diseases (co-morbidities) that necessitated daily medication e.g., HIV/AIDS, hypertension. This was because of the increased pill burden from co-morbidities that could introduce undesirable effects into the study.
3. Those who refused to give consent to the study.

3.2.6 Adherence measurement

3.2.6.1 PLWHA

Adherence to medication was calculated by dividing the number of pills the patient actually took in the last 7 days by the number of tablets patients should have taken multiplied by 100. Also, the number of pills remaining in the patient's bottle during follow-up was counted. Based on WHO guidelines (2013), patients who reported an

intake of ≥ 95% of the prescribed medication were considered adherent; and those with a reported intake of < 95% were considered non-adherent.

Refill adherence was calculated based on the cumulative sum of days that a patient was late for ART pick-up appointments, divided by the total number of days over all such periods in the study, resulting in the percentage of time the patient was without medication over the whole study period. Anyone with ≥ 95% of drug re-fill was regarded as optimal adherence and <95% was regarded as poor adherence.

Out of the total of 1740 study population at FUTH Owerri, 1517 (87.2%) adhered to their medication while 223 (12.8%) did not. Specifically, 41 (2.3%) of the study participants have adherence rate of < 70%, 64 (3.7%) have adherence rate of 70–79.99%, 50 (2.9%) have adherence rate of 80–89.99%, 68(3.9%) have an adherence rate of 90–94.99% and 1517 (87.2%) have an adherence rate of ≥ 95%. Those with adherence rate of ≥95% were regarded as good adherence while the rest were regarded as non-adherents.

Out of the total of 3709 study populations at Imo State Specialist Hospital Umuguma, 3298 (88.9%) adhered to their medication while 411 (11.1%) did not. Specifically, 122 (3.3%) of the study participants have adherence rate of < 70%, 108 (2.9%) have adherence rate of 70–79.99%, 96 (2.6%) have adherence rate of 80–89.99%, 85(2.3%) have an adherence rate of 90–94.99% and 3298 (88.9%) have an adherence rate of ≥ 95%. Those with adherence rate of ≥95% were regarded as good adherence while the rest were regarded as non-adherents.

Additionally, the viral loads of the population were assessed at baseline and post study. At FUTH Owerri, the baseline result showed that a total number of 650 had viral load

less than 100 copies, 896 were between 101 and 499 copies, 94 were between 500 and 999, while 100 had viral load that was more than 1000 copies. Among the 223 non-adherents, 29 (13%) had suppressed viral load at baseline.

At ISSH Umuguma, the baseline result showed that a total number of 2296 had viral load less than 100 copies, 1021 were between 101 and 499 copies, 125 were between 500 and 999, while 267 had viral load that was more than 1000 copies. Among the 411 non-adherents, 19 (5%) had suppressed viral load at baseline.

3.2.6.2 People with tuberculosis

Among the people with tuberculosis, One is classified as non-adherent if they miss two consecutive weeks of DOTS, or a prolongation of treatment>30 days due to sporadic missed doses (Das et al, 2015). As defined by the WHO, patients who fail to collect their TB treatment for 2 consecutive months are reported as defaulters (WHO, 2002). A tuberculosis patient is expected to take at least 70–90% of prescribed doses (WHO, 2003) or all doses (Amuha, 2009) to be considered adherent. For this study, those with adherence level less than 80% were considered non-adherent.

Out of the total of 1401 study population at FUTH Owerri, 1267 (90.4%) adhered to their medication while 134 (9.6%) did not. Specifically, 52 (3.7%) of the study participants have adherence rate of < 30%, 33 (2.4%) have adherence rate of 30–39.99%, 17 (1.2%) have adherence rate of 40–59.99%, 32 (2.3%) have an adherence rate of 60–79.99% and 1267 (90.4%) have an adherence rate of ≥ 80%. Those with adherence rate of ≥80% were regarded as good adherence while the rest were regarded as non-adherents.

Out of the total of 1026 study population at ISSH Umuguma, 898 (87.5%) adhered to their medication while 128 (12.5%) did not. Specifically, 77 (7.5%) of the study participants have adherence rate of < 30%, 31 (3%) have adherence rate of 30–39.99%, 9 (0.9%) have adherence rate of 40–59.99%, 11 (1.1%) have an adherence rate of 60–79.99% and 898 (87.5%) have an adherence rate of ≥ 80%. Those with adherence rate of ≥80% were regarded as good adherence while the rest were regarded as non-adherents.

3.2.7 Instrument for Data Collection

Instruments for data collection were the questionnaire and checklist. There were different types of questionnaire.

3.2.7.1 Questionnaire for People Living With HIV/AIDS (PLWHA)

The questionnaire had three sections (A-C). Section A covers the socio-economic characteristics of the participants with 6 items. Section A was developed by the researcher, while sections B and C were adopted from a questionnaire named AIDS Clinical Trials Group (ACTG) used in study conducted by Reynolds et al., (2008). Section B addressed the information on medication dosage adherence with 3 items, while C addressed the medication time adherence of the respondents with 2 items in it (Appendix C).

3.2.7.2 Questionnaire for People with tuberculosis

The questionnaire had three sections (A-C). Section A covers the socio-economic characteristics of the participants with 6 items. It was developed by the researcher, while sections B and C were adapted from a questionnaire named the eight-item Morisky Medication Adherence Scale (MMAS-8) in study conducted by Carlos and

Wenceslao (2015). Section B addressed the information on medication dosage adherence with 5 items, while C addressed the medication time adherence of the respondents with 3 items in it (Appendix D and E).

3.2.8 Checklist

The checklist was developed by the researcher to align with the M-Health Messages and delivery responses. Each participant in the test group had a dedicated section in the checklist to capture all their responses (Appendix H).

3.2.9 Validity of the Instruments

The sections of the two questionnaires that were developed by the researcher were given to the three supervisors for their input for face, criterion, construct and content validity. Corrections made were used to modify the final copy of the instruments. The other sections have their validity already established as they were standardized.

3.2.10 Reliability of Instruments

The instruments' reliability was already established in previous studies. The reliability of the aspect of the questionnaire developed by the researcher was established by pre-testing and employing the Cronbach Alpha co-efficient reliability test for internal consistency. It involved 20 people living with HIV/AIDS and 20 individuals receiving care for tuberculosis at Imo State University Teaching Hospital Orlu. The questionnaire was administered to them twice, with an interval of two weeks between each administration. The p-value was 0.75 showing high reliability.

3.2.11 Development of M-Health Messages

The contents of the messages were developed based on literature reviews (Menacho (2013), Uhrig *et al.*, 2012, Wagner, Ouedraogo, Artavia-Mora, Bedi and Thiombiano,

(2016), Cook, Carrington, Schmiege, Starr and Reeder (2015), Orrell, Cohen, Mauff, Bangsberg, Maartens and Wood (2015), Pop-Eleches *et al*., (2011), Rana, Berg, Lamy and Beckwith (2016), Dowshen, Kuhns, Johnson, Holoyda and Garofalo (2012), Georgette *et al*., (2016), Davey *et al*., (2016), Christopoulos *et al*., (2014). It has different sections for PLWHA and for people with tuberculosis. The message was developed to be in line with the specific objectives of the study and covered the 6 weeks of the study intervention. Each week comprised of two messages delivered on Sundays and Thursdays. The messages provided reminders for medication dosage and time adherence, keeping clinic appointments, and refilling of drugs. See appendix F for the detailed message content development and appendix G for the message delivered to PLWHA and people with tuberculosis. .

3.2.12 Method of Data Collection

The study involved two population groups, namely people living with HIV/AIDS (PLWHA) and those with tuberculosis (TB). The groups were randomly divided into test and control groups, with FUTH Owerri serving as the test group and Imo State Specialist Hospital Umuguma serving as the control group. The questionnaire was administered to the respondents face to face by the researcher and two trained research assistants who were health personnel at the Heart-to-Heart Centers and tuberculosis centers at FUTH and Imo State Specialist Hospital Umuguma.

The questionnaire was administered to all the respondents (in test and control group) at the baseline. The study was discussed with them on phone and a date and time scheduled with them during which the questionnaire was shared to them at baseline. The people that couldn’t make it to the scheduled date and times were sent soft copy of

the questionnaire through goggle form. Throughout the interaction period, data was collected from the participants in the test group through SMS and voice call interaction. The second data was collected from the respondents in the control group at the end of the study. The participants were evaluated to assess their level of adherence. This was done by comparing their responses at the beginning of the study with their feedback during the study interaction. This was possible because the content of the message was designed to contain the information in the questionnaire. In contrast, the adherence level of the control group was determined by comparing the information in the questionnaire they filled at the beginning of the study with the one they filled at the end of the study.

3.2.13 Data Analysis

Data analysis was performed in SPSS (Statistical package of Social Sciences) version 22. Frequencies, percentages, and other descriptive statistics were done as univariate analysis. Qualitative and quantitative analysis were carried out. A native local language expert, who is also proficient in English, transcribed and translated the voice notes into English. The researcher checked the transcriptions to ensure consistency with the recordings and translated the transcriptions into English. For qualitative analysis, data were coded and underwent thematic content analysis (Virginia & Victoria, 2006).

The inter comparison was done using bivariable logistic regression to find an association between each independent variable and adherence to antiretroviral medication between the participants in the test and control group. All association and statistical significance were measured using an odds ratio at a 95% confidence interval with a p-value of less than 0.05.

3.2.14 ETHICAL CONSIDERATION/INFORMED CONSENT

Ethical clearance was obtained from the Ethics Review Committee, Federal University Teaching Hospital, Owerri, Imo State (Appendix J). A written informed consent was obtained from the respondents before administering the questionnaires, ensuring the principle of anonymity and confidentiality.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 RESULTS

PLWHA

Socio-Demographic Characteristics of the Participants

Table 4.1.1 contained the socio-demographic information of all the people living with HIV/AIDS at FUTH and ISSH who were non-adherent to their medication dosage intake, scheduled medication intake, promptness in drug refill, and adhering to clinics appointment at the time of this study. There were 223 PLWHA at FUTH and 411 at ISSH. The majority of the participants at ISSH Umuguma, 283(68.9) and FUTH Owerri, 146(65.5), were females. Most of the participants at FUTH Owerri were within the age bracket of 40-49 years while it was 30-39 years at ISSH Umuguma. The lowest number of participants was within the age bracket of 78 and above, with 5(1.2) at ISSH Umuguma and 2(0.9) at FUTH. The majority of participants at ISSH Umuguma had a Bachelor's Degree (33.6%), followed by those with senior secondary certificates (27.3%), primary school certificates (22.6%), and no formal education (1.7%). For FUTH Owerri, 45.3% had a Bachelor's Degree, 45.3% had senior secondary certificates, 11.2% had primary school certificates, and 5% had no formal education. Regarding marital status, the majority at ISSH Umuguma, 140(34.1), were married while the majority at FUTH Owerri were single 83(37.2), and the smallest percentage were divorced, 19(8.5) and 10(2.4%), at FUTH and ISSH respectively.

Table 4.1.1: Socio-Demographic Characteristic of the Participants (PLWHA) At FUTH Owerri and ISSH Umuguma

Demographic Information	FUTH 223 (%)	ISSH 411 (%)
Gender		
Female	146(65.5)	283(68.9)
Male	77(34.5)	128(31.1)
Total	**223(100%)**	**411(100%)**
Age		
20 – 29	16(7.2)	38(9.2)
30 – 39	56(25)	146(35.5)
40 -49	90(40)	131(31.9)
50-59	40(17.9)	57(13.9)
60-69	19(9)	34(8.3)
70+	2(0.9)	5(1.2)
Total	**223(100%)**	**411(100%)**
Education Level		
Post-graduate	41(18.4)	61(14.8)
B.sc	101(45.3)	138(33.6)
SSCE	45(20.1)	112(27.3)
Primary School Certificate	25(11.2)	93(22.6)
None	11(5)	7(1.7)
Total	**223(100%)**	**411(100%)**
Occupation		
Private Firm	27(12)	74(18)
Civil Servant	57(26)	70(17)
Unemployed	9(4)	13(3.2)
Trader	98(44)	201(48.9)
Farmer	32(14)	53(12.9)
Total	**223(100%)**	**411(100%)**
Marital Status		
Married	72(32.3)	140(34.1)
Single	83(37.2)	128(31.1)
Cohabiting	9(4)	21(5.1)
Widowed	10(4.5)	68(16.5)
Separated	30(13.5)	44(10.7)
Divorced	19(8.5)	10(2.4)
Total	**223(100%)**	**411(100%)**

Adherence Level of the Participants at Baseline and Post-Intervention

Table 4.1.2 contained the breakdown of participants' viral load percentages before and after the intervention. The "post-intervention adherent participants" column represents participants who became adherent after the study from each viral load range. At FUTH, 41 (18.4%), 64 (28.7%), 50 (22.4%), and 68 (30.5%) participants had viral loads of 0-69%, 70-79%, 80-89%, and 90-94% respectively at the baseline.

At ISSH Umuguma, 122 (29.7%), 108 (26.3%), 96 (23.4%), and 85 (20.6%) participants had viral loads within the ranges of 0-69%, 70-79%, 80-89%, and 90-94% respectively. None of the participants at either hospital had a viral load of ≥95% at the beginning of the study.

After the intervention, at FUTH Owerri, 41 out of 41 (100%), 61 out of 64 (95%), 47 out of 50 (94%), 68 out of 68 (100%), and 217 out of 223 (97.3%) participants became adherent from the viral load ranges of 0-69%, 70-79%, 80-89%, 90-94%, and ≥95% respectively. On the other hand, at ISSH, 19 out of 122 (15.5%), 17 out of 108 (15.7%), 13 out of 96 (13.5%), 31 out of 85 (36.5%), and 80 out of 410 (19.5%) participants became adherent from the viral load ranges of 0-69%, 70-79%, 80-89%, 90-94%, and ≥95% respectively after the study.

Table 4.1.2: Adherence Level of the Participants (PLWHA) At Baseline and Post-Intervention

	FUTH (n=223)			ISSH (n=411)		
	Baseline	**Post-intervention**	**Post intervention adherent participants**	**Baseline**	**Post-intervention**	**Post intervention adherent participants**
0-69%	41 (18.4%)	NIL	41 (100%)	122 (29.7%)	103 (25.1%)	19 (15.5%)
70–79%	64 (28.7%)	3 (1.3%)	61(95%)	108 (26.3%)	91 (22.1%)	17 (15.7%)
80–89%	50 (22.4%)	3 (1.3%)	47 (94%)	96 (23.4%)	83 (20.2)	13 (13.5%)
90–94%	68(30.5%)	NIL	68 (100%)	85(20.6%)	54 (13.1%)	31 (36.5%)
≥ 95%	NIL	217 (97.3%)	217 (97.3%)	NIL	80 (19.5%)	80 (19.5%)
Total	**223 (100%)**	**223 (100%)**		**411 (100%)**	**411 (100%)**	

Medication Dosage Adherence among PLWHA at FUTH Owerri and ISSH Umuguma

The data presented in the Table 4.1.3 compared the adherence levels of PLWHA to their prescribed drug dose regimen in the test group with those in the control group before and after an intervention. Out of a total of 223 non-participants in the test group, 81.6% became adherent post-intervention compared to only 7% that became adherent in the control group post-intervention.

Table 4.1.3 Level of Medication Dosage Adherence among PLWHA at FUTH Owerri and ISSH Umuguma

Hospital	Pre-test Adherent level	Pre-test Non Adherent Level	Total	Post-Test Adherent level	Post Test Non Adherent Level	Total
FUTH	NIL	223(100%)	**223(100%)**	182(81.6%)	41(18.4%)	**223(100%)**
ISSH	NIL	411(100%)	**411(100%)**	28(7%)	383(93%)	**411(100%)**

Regression Analysis of Level of Medication Dosage Adherence among PLWHA at FUTH Owerri and ISSH Umuguma

In Table 4.1.4, significant difference was found in adherence to prescribed drug dose regimen between the control group and the test group (P=0.000, $\chi 2$ = 365.15). Adherence to prescribed drug dosing regimen was found to be much higher in the test group compared to the control group. A total of 81.6% adhered in the test group compared to 7% in the control group. The odds for non-adherence was found to be approximately 61 folds significantly higher among the control group compared to that of the test group (OR= 60.7, 95% CI = 35.38, 104.94).

Table 4.1.4 Regression Analysis of Level of Medication Dosage Adherence among PLWHA at FUTH Owerri and ISSH Umuguma

Group	Adhered	Non-adhered	$\chi 2$	P	OR	Lower (95%CI)	Upper (95%CI)
Test (FUTH)	182(81.6%)	41(18.4%)					
Control(ISSH)	28(7%)	383(93%)					
Total	210	424	365.15	0.000	60.7	35.38	104.94

Adherence to Prescribed Schedule of Drug Intake among PLWHA at FUTH Owerri and ISSH Umuguma

The data in the Table 4.1.5 compares the adherence levels of PLWHA to their drug intake schedule in the test group and the control group before and after an intervention. After the intervention, 76.7% of the 223 non-adherents in the test group became adherent, while only 23.4% of 411 non-adherent did so in the control group.

Table 4.1.5 Adherence to Prescribed Schedule of Drug Intake among PLWHA at FUTH Owerri and ISSH Umuguma

Hospital	Pre-test Adherent level	Pre-test Non Adherent Level	Total	Post-Test Adherent level	Post Test Non Adherent Level	Total
FUTH	NIL	223(100%)	**223(100%)**	171(76.7%)	52(23.3%)	**223(100%)**
ISSH	NIL	411(100%)	**411(100%)**	96 (23.4%)	315(76.6%)	**411(100%)**

Regression Analysis of Adherence to Prescribed Schedule of Drug Intake among PLWHA at FUTH Owerri and ISSH Umuguma

Table 4.1.6 shows that the adherence to maintaining prescribed schedule of drug intake was higher among PLWHA at FUTH Owerri (test group) compared to those of the ISSS (control group). While only 23.4% adhered in the control group, 76.7% adhered among the test group and the difference in adherence was found significant between the two groups (P=0.000, $\chi 2 = 168.62$). The likelihood for non-adherence was found to be close to 11 times higher among the control group than in the test group (OR= 10.79, 95% CI =7.22, 16.19). The intervention led to an increase in level of promptness in maintaining prescribed schedule of drug intake by the participants.

Table 4.1.6 Regression Analysis of Adherence to Prescribed Schedule of Drug Intake among PLWHA at FUTH Owerri and ISSH Umuguma

Group	Adhered	Non-adhered	$\chi 2$	p	OR	Lower (95%CI)	Upper (95%CI)
Test (FUTH)	171(76.7%)	52(23.3%)					
Control(ISSH)	96 (23.4%)	315(76.6%)					
Total	267	367	168.62	0.000	10.79	7.22	16.19

Adherence to Promptness in Refilling Prescription among PLWHA at FUTH Owerri and ISSH Umuguma

The data in the Table 4.1.7 compares the levels of promptness in refilling prescription among the participants to their drug intake schedule in the test group and the control group before and after an intervention. Post intervention result showed that 90% of the non-adherents in the test group became adherent, while only 24% did so in the control group.

Table 4.1.7 Adherence to Promptness In Refilling Prescription Among PLWHA At FUTH Owerri And ISSH Umuguma

Hospital	Pre-test Adherent level	Pre-test Non Adherent Level	Total	Post-Test Adherent level	Post Test Non Adherent Level	Total
FUTH	NIL	223(100%)	**223(100%)**	200(90%)	23 (10%)	**223(100%)**
ISSH	NIL	411(100%)	**411(100%)**	98 (24%)	313 (76%)	**411(100%)**

Regression of Adherence to Promptness in Refilling Prescription among PLWHA at FUTH Owerri and ISSH Umuguma

The result for adherence to promptness in refilling prescription among the test group (FUTH Owerri) and the control group (ISSH Owerri) for PLWHA is presented in Table 4.1.8. The Table shows that significant difference exist in adherence between the two groups (P=0.000, $\chi 2 = 251.58$). Adherence to promptness in refilling prescription was found to be much higher in the test group (90%) compared to the control group (24%). The odds for non-adherence was found to be approximately 28 times higher among the control group compared to that of the test group (OR= 27.77, 95% CI = 16.75, 47.17).

Table 4.1.8 Regression Analysis of Adherence to Promptness in Refilling Prescription among PLWHA at FUTH Owerri and ISSH Umuguma

Group	Adhered	Non-adhered	$\chi 2$	p	OR	Lower (95%CI)	Upper (95%CI)
Test (FUTH)	200(90%)	23 (10%)					
Control(ISSH)	98 (24%)	313 (76%)					
Total	298	336	251.58	0.000	27.77	16.75	47.17

Adherence to Appointment on Schedule with Health Personnel among PLWHA at FUTH Owerri and ISSH Umuguma

The data in the Table 4.1.9 presents a comparison of appointment adherence with health personnel before and after an intervention between the test group and the control group. Following the intervention, 88.3% of the 223 non-adherents in the test group became adherent, while only 18.2% of 411 did so in the control group.

Table 4.1.9 Levels of Adherence to Keeping Appointment on Schedule with Health Personnel among PLWHA at FUTH Owerri and ISSH Umuguma

Hospital	Pre-test Adherent level	Pre-test Non Adherent Level	Total	Post-Test Adherent level	Post Test Non Adherent Level	Total
FUTH	NIL	223(100%)	**223(100%)**	197(88.3%)	26 (11.7%)	**223(100%)**
ISSH	NIL	411(100%)	**411(100%)**	75 (18.2%)	336 (81.8%)	**411(100%)**

Regression Analysis of the Adherence to Appointment on Schedule with Health Personnel among the Control Group and the Test Group for PLWHA

The result in Table 4.1.10 indicates that adherence to appointment on schedule with health personnel was higher among the study group at the test group (FUTH Owerri) that among the control group (ISSH Owerri). There were significant difference in adherence between the two groups (P=0.000, $\chi 2$ = 289.0) with 88.3% adherence achieved among the test group compared to 18.2% adherence observed among the control group. Thus the odds for non-adherence was found to be significantly higher among the patients in the control group than among the patients in the test group by 34 folds (OR= 33.94, 95% CI = 20.57, 56.82). The intervention led to an increase in level of keeping appointment on schedule with health personnel among the participants in the test group.

Table 4.1.10: Adherence to Appointment on Schedule with Health Personnel among PLWHA at FUTH Owerri and ISSH Umuguma

Group	Adhered	Non-adhered	$\chi 2$	P	OR	Lower (95%CI)	Upper (95%CI)
Test (FUTH)	197 (88.3%)	26 (11.7%)					
Control(ISSH)	75 (18.2%)	336 (81.8%)					
Total	272	362	289	0.000	33.94	20.57	56.82

Adherence to Medication at Follow up Among the Control Group and the Test Group for PLWHA Studied

The rate of adherence to medication at follow up among the control group and the test group for PLWHA studied is on Table 4.1.11. In can be observed from the table that adherence was higher for the test group at follow-up periods. At 3 week follow-up, 91% of the test group adhered compared to 20% of the control group. At six weeks follow-up, 97% of the test group adhered compared to 19% among the control. Significant differences in adherence between the two groups were found at both two time follow-ups (Week3: P=0.000, $\chi 2 = 300.94$; Week 6: P=0.000, $\chi 2 = 351.81$) with higher odds for non-adherence found among the control group in both periods (Week 3: OR= 43.74, Week 6: OR=149.63).

Table 4.1.11: Follow-Up Adherence of the Participants (PLWHA) At FUTH Owerri and ISSH Umuguma

Group	Adhered	Non-adhered	$\chi 2$	p	OR	Lower (95%CI)	Upper (95%CI)
After 3 weeks							
Test (FUTH)	204 (91%)	19 (9%)					
Control(ISSH)	81 (20%)	330 (80%)					
Total	285	349	300.94	0.000	43.74	25.25	78.14
After 6 weeks							
Test (FUTH)	217 (97%)	6 (3%)					
Control(ISSH)	80(19%)	331 (81%)					
Total	297	337	351.81	0.000	149.63	63.675	442.68

People with Tuberculosis

Socio-Demographic Characteristics of the Participants

Table 4.1.12 contained the socio-demographic information of all the people with tuberculosis at FUTH and ISSH who were non adherent to their medication dosage, scheduled time of intake, drug refill and their doctor's appointment at the time of this study. There were 134 people with tuberculosis at FUTH and 128 at ISSH. The majority of the participants at ISSH Umuguma, 72 (56.3%), and FUTH Owerri, 79 (59%) were males. Most of the participants were within the age bracket of 48-57 years. The lowest number of participants was within the age bracket of 78-87, with 33 (4.7%) at ISSH Umuguma and 8(6%) at FUTH.

The majority of participants at ISSH Umuguma had senior secondary school certificate, 48 (37.5%), followed by those with primary school leaving certificate (29.7%), primary school certificates, 35 (27.3%), and the least was post-graduates (1.6%). For FUTH Owerri, 42 (31.3%), had a senior secondary school certificate; 36(26.9%) had primary school leaving certificate, and post-graduates had the least percentage (3.79%). Regarding marital status, the majority at both ISSH Umuguma and FUTH Owerri were married (59 (46.1%) and 54 (40.3%) respectively), while 59 (46.1%) and 54 (40.3%) were single, and the smallest percentage were divorced (3.1% and 4.4% respectively).

Table 4.1.12 Socio-Demographic Characteristics of the Participants (People with Tuberculosis) At FUTH Owerri and ISSH Umuguma

Demographic Characteristics	ISSH (n=128)	FUTH (n=134)
Gender		
Male	72 (56.3%)	79 (59%)
Female	56 (43.7%)	55(41%)
Total	**128(100%)**	**134 (100%)**
Age (years)		
18-27	6 (4.7%)	7(5%)
28-37	14 (10.9%)	11 (8.2%)
38-47	22 (17.2%)	20 (14.9%)
48–57	39 (30.5%)	41 (30.6%)
58–67	30(23.4%)	32 (23.9%)
68-77	11(8.6%)	15(11.2%)
78-87	6 (4.7%)	8(6%)
Mean age($\bar{x}$)	35 ±	
Standard Deviation (σ)	9.23	
Total	**128 (100%)**	**134 (100%)**
Educational Qualification		
Post-graduate	2 (1.6%)	5(3.7%)
Tertiary	19 (14.8%)	22 (16.4%)
Secondary	48 (37.5%)	42 (31.3%)
Primary	35 (27.3%)	36(26.9%)
No formal educ tion	24 (18.8%)	29 (21.6%)
Total	**128 (100%)**	**134 (100%)**
Occupation		
Private Firm	41 (32%)	37 (27.6%)
Civil Servant	13 (10.2%)	9(6.7%)
Trader	31 (24.2%)	40 (29.9%)
Farmer	24(18.8%)	30 (22.4%)
Unemployed	19 (14.8%)	18 (13.4%)
Total	**128 (100%)**	**134 (100%)**
Marital Status		
Married	59 (46.1%)	54 (40.3%)
Single	31 (24.2%)	39(29.1%)
Cohabiting	- ----	4 (3%)
Widowed	18 (14.1%)	12 (9%)
Separated	16 (12.5%)	19 (14.2%)
Divorced	4 (3.1%)	6 (4.4%)
Total	**128 (100%)**	**134 (100%)**

Adherence to Prescribed Drug Dose Regimen among People with Tuberculosis at FUTH Owerri and ISSH Umuguma

Table 4.1.13 presents a comparison of the adherence levels to the prescribed drug dose regimen among participants in the test and control groups before and after the intervention. At the baseline, all 134 of the people with tuberculosis at FUTH Owerri were adherent, compared to 128 in the control group. After the intervention, 86.6% of the 134 non-adherents in the test group became adherent, while only 13.3% of the 128 non-adherents in the control group became adherent.

Table 4.1.13 Adherence to Prescribed Drug Dose Regimen among People with Tuberculosis at FUTH Owerri and ISSH Umuguma

Hospital	Pre-test Adherent level	Pre-test Non Adherent Level	Total	Post-Test Adherent level	Post Test Non Adherent Level	Total
FUTH	NIL	134(100%)	**134(100%)**	116(86.6%)	18(13.4%)	**134(100%)**
ISSH	NIL	128(100%)	**128(100%)**	17(13.3%)	111(86.7%)	**128(100%)**

Regression Analysis of the Adherence to Prescribed Drug Dose Regimen among People with Tuberculosis in the Control Group and the Test Group

The result in Table 4.1.14 represents adherence to prescribed drug dose regimen among the control group and the test group for TB Patients studied. The table indicates that adherence was higher among the study test group (FUTH Owerri) at 86.6% than among the control group (ISSH Owerri) at 13.3%. There were significant difference in adherence between the two groups (P=0.000, $\chi 2$ = 140.67). Thus the odds for non-adherence was found to be significantly higher among the patients in the control group than among the patients in the test group by 42 folds (OR= 42.08, 95% CI = 19.59, 91.57).

Table 4.1.14 Level of Keeping to Prescribed Drug Dose Regimen among People with Tuberculosis at FUTH Owerri and ISSH Umuguma

Group	Adhered	Non-adhered	$\chi 2$	P	OR	Lower (95%CI)	Upper (95%CI)
Test (FUTH)	116(86.6%)	18(13.4%)					
Control (ISSH)	17(13.3%)	111(86.7%)					
Total	133	129	140.67	0.000	42.08	19.59	91.57

Adherence to Prescribed Schedule of Drug Intake among People with Tuberculosis at FUTH Owerri and At Imo State Specialist Hospital Umuguma

Table 4.1.15 presents a comparison of the adherence levels to the prescribed schedule of drug intake among participants in the test and control groups before and after the intervention. At the baseline, 134 people with tuberculosis at FUTH Owerri were non-adherent to their schedule of drug intake, while 128 were the non-adherents in the control group. After the intervention, 76.9% of the 134 non-adherents in the test group became adherent, while only 7% of the 128 non-adherents in the control group became adherent.

Table 4.1.15: Level of Maintaining Prescribed Schedule of Drug Intake among People with Tuberculosis at FUTH Owerri and ISSH Umuguma

Hospital	Pre-test Adherent level	Pre-test Non Adherent Level	Total	Post-Test Adherent level	Post Test Non Adherent Level	Total
FUTH	NIL	134(100%)	**134(100%)**	103(76.9%)	31(23.1%)	**134(100%)**
ISSH	NIL	128(100%)	**128(100%)**	9(7%)	119(93%)	**128(100%)**

Regression Analysis of the Adherence to Prescribed Schedule of Drug Intake among People with Tuberculosis in the Control Group and the Test Group

The output presented in Table 4.1.16 shows that the adherence to maintaining prescribed schedule of drug intake by was higher among study TB patients at FUTH Owerri (test group) compared to those of the ISSS (control group). While only 7% adhered among the control group, 76.9% adhered among the test group and the difference in adherence was found significant between the two groups (P=0.000, $\chi 2$ = 130.46). The probability for non-adherence was found to be close to 44 times higher among the control group than in the test group (OR= 43.94, 95% CI =19.12, 107.94).

Table 4.1.16: Adherence to Prescribed Schedule of Drug Intake among People with Tuberculosis at FUTH Owerri and ISSH Umuguma

Group	Adhered	Non-adhered	$\chi 2$	p	OR	Lower (95%CI)	Upper (95%CI)
Test (FUTH)	103 (76.9%)	31 (23.1%)					
Control (ISSH)	9 (7%)	119 (93%)					
Total	112	150	130.45	0.000	43.93	19.12	107.94

Adherence to Promptness in Refilling Prescription among People with Tuberculosis at FUTH Owerri and At Imo State Specialist Hospital Umuguma

The comparison the Table 4.1.17 shows the adherence to the in promptness of refilling prescriptions among participants in the test and control groups before and after the intervention. At the baseline, 134 of the participants at FUTH Owerri were non-adherent to their drug intake schedule, and 128 were those non-adherents at the control group. After the intervention, 90.3% of the 134 non-adherents in the test group became adherent, while only 17.2% of the 128 non-adherents in the control group became adherent.

Table 4.1.17 Adherence to Promptness in Refilling Prescription among People with Tuberculosis at FUTH Owerri and ISSH Umuguma

Hospital	Pre-test Adherent level	Pre-test Non Adherent Level	Total	Post-Test Adherent level	Post Test Non Adherent Level	Total
FUTH	NIL	134(100%)	**134(100%)**	121(90.3%)	13 (9.7%)	**134(100%)**
ISSH	NIL	128(100%)	**128(100%)**	22(17.2%)	106 (82.8%)	**128(100%)**

Regression Analysis on the Adherence to Promptness in Refilling Prescription among People with Tuberculosis in the Control Group and the Test Group

The result for adherence to promptness in refilling prescription among the test group (FUTH Owerri) and the control group (ISSH Owerri) for the study of people with tuberculosis is presented in Table 4.1.18. It can be observed from the table that the two groups differ significantly in adherence (P=0.000, $\chi 2$ = 141.16). Adherence to promptness in refilling prescription was found to be much higher in the test group (90.3%) compared to the control group (17.2%). The odds for non-adherence was found to be approximately 45 times higher among the control group compared to that of the test group (OR= 44.85, 95% CI = 20.45, 100.69).

Table 4.1.18 Levels of Promptness in Refilling Prescription among People with Tuberculosis at FUTH Owerri and ISSH Umuguma

Group	Adhered	Non-adhered	$\chi 2$	P	OR	Lower (95%CI)	Upper (95%CI)
Test (FUTH)	121 (90.3%)	13 (9.7%)					
Control (ISSH)	22 (17.2%)	106 (82.8%)					
Total	143	119	141.16	0.000	44.85	20.45	100.69

Adherence to Appointment on Schedule with Health Personnel among People with Tuberculosis at FUTH Owerri and At Imo State Specialist Hospital Umuguma

The comparison in the Table 4.1.19 shows the levels of adherence to appointment on schedule with health personnel among people with tuberculosis at FUTH Owerri and ISSH. After the intervention, 88.8% of the 134 non-adherents in the test group became adherent, while only 6% of the 128 non-adherents in the control group became adherent.

Table 4.1.19: Adherence to Appointment on Schedule with Health Personnel among People with Tuberculosis at FUTH Owerri and ISSH Umuguma

Hospital	Pre-test Adherent level	Pre-test Non Adherent Level	Total	Post-Test Adherent level	Post Test Non Adherent Level	Total
FUTH	NIL	134(100%)	**134(100%)**	119(88.8%)	15 (11.2%)	**134(100%)**
ISSH	NIL	128(100%)	**128(100%)**	8(6%)	120 (94%)	**128(100%)**

Regression Analysis on the Adherence to Keeping Appointment on Schedule with Health Personnel among the Control Group and the Test Group for TB Patients Studied

The result in Table 4.1.20 represents the adherence to keeping appointment on schedule with health personnel among the two TB study groups. It shows that adherence was higher among the test group (88.8%) than among the control group (6%). There were significant difference between the two groups (P=0.000, $\chi 2$ = 178.64). The odds for non-adherence was found to be significantly higher among the TB patients in the control group than among the patients in the test group by whopping 119 folds (OR= 119, 95% CI = 45.50, 327.69).

Table 4.1.20: Adherence to Appointment on Schedule with Health Personnel among People with Tuberculosis at FUTH Owerri and ISSH Umuguma

Group	Adhered	Non-adhered	$\chi 2$	P	OR	Lower (95%CI)	Upper (95%CI)
Test (FUTH)	119 (88.8%)	15 (11.2%)					
Control (ISSH)	8 (6%)	120 (94%)					
Total	127	135	178.64	0.000	119	45.50	327.69

Adherence to Medication at Follow-Ups among People with Tuberculosis in the Control Group and the Test Group

The rate of adherence to medication at follow up among the control group and the test group for the study of TB patients is presented on Table 4.1.21. The result in Table showed that adherence was higher for the test group at both follow-up periods. At 3 week follow-up, 80% of the test group adhered compared to just 5% of the control group. Significant differences in adherence between the two groups were found at 3 weeks follow-ups (P=0.000, $\chi 2 = 150.79$), with higher odds of over 80 folds for among the control group (OR= 80.58 95% CI = 30.65, 241.58). At six weeks follow-up, no significant difference was found between the test and control groups (P=0.2474, $\chi 2 = 1.34$, OR= 1.818, 95%CI =0.593, 6.171). Adherence rate was slightly higher at test group. Adherence proportion for test and control groups were 8.2% and 5% respectively.

Table 4.1.21: Follow-Up Adherence Level of People with Tuberculosis at FUTH Owerri and ISSH Umuguma

Group	**Adhered**	**Non-adhered**	$\chi 2$	P	OR	Lower (95% CI)	Upper (95% CI)
After 3 weeks							
Test (FUTH)	107 (80%)	27(20%)					
Control(ISSH)	6 (5%)	122(95%)					
Total	113	149	150.79	0.000	80.58	30.65	241.58
After 6 weeks							
Test (FUTH)	11(8.2%)	123 (91.8%)					
Control(ISSH)	6 (5%)	122(95%)					
Total	17	245	1.34	0.2474	1.818	0.593	6.171

Number that Tested Negative to Sputum Test after 6 Months Of Initiating Drug at FUTH Owerri and at Imo State Specialist Hospital Umuguma

The Table 4.1.22 below compares the percentage of respondents who tested positive before and after the test in the test and control groups. At baseline, they all tested positive to tuberculosis. After a 6-week study and an additional 18 weeks of follow-up, it was found that 122 out of 128 non-adherent individuals in the control group still tested positive, while only 11 out of 134 in the test group tested positive. In the test group, 91.8% out of 134 non-adherent tested negative after the study intervention.

Table 4.1.22: Number That Tested Negative to Sputum Test after 6 Months of Initiating Drug at FUTH Owerri and ISSH Umuguma

Hospital	Pre-test Positive	Pre-test Negative	Total	Post-test Positive	Post-test Negative	Total
FUTH	134(100%)	NIL	**134(100%)**	11(8.2%)	123 (91.8%)	**134(100%)**
ISSH	128(100%)	NIL	**128(100%)**	122(95%)	6 (5%)	**128(100%)**

Regression Analysis of Negative Results to Sputum Test Among People with Tuberculosis in the Control Group

The test sputum result for the study control and test groups is presented in Table 4.1.23 which shows that overwhelm majority of the patients in the study test group recorded negative in the sputum test (91.8%) compared to the control group at just 5%. The likelihood of having negative sputum test was found to be 99.6% lower in the test group compared to the control group (OR= 0.004, 95%CI = 0.0013, 0.0133).

Table 4.1.23: Number That Tested Negative to Sputum Test after 6 Months of Initiating Drug at FUTH Owerri and ISSH Umuguma

Group	**Positive**	**Negative**	$\chi 2$	P	OR	Lower (95% CI)	Upper (95% CI)
Test (FUTH)	11(8.2%)	123 (91.8%)					
Control(ISSH)	122(95%)	6 (5%)					
Total	133	129	198.72	0.000	0.004	0.0013	0.0133

4.1.24 Qualitative Results

The participants' verbal and voice note responses in the test group were transcribed and translated into English language by a native local language expert, also proficient in English. They were categorized into five main themes: varying usefulness of the intervention, the need for confidentiality, concerns about delivery modes, reasons for non-compliance, and barriers to attending appointments.

Usefulness of reminders

The majority (92%) of the participants found that mobile phone reminders helped them establish a routine for taking their medication, while others did not. Some of the reasons they gave for being averse to the mobile reminders were fear of disclosure, faith healing, preference for herbal drugs, not being permitted to leave the office, and drug reactions, while the majority noted that they appreciated the intervention. Many of the participants noted that the intervention was a helpful reminder during the day and week, and they preferred that it occurred twice a week. They mentioned that it helped reduce forgetfulness, particularly when they were busy with work or away from home.

One of the PLWHA provided this response: *"I'm always rushing out to work and getting busy throughout the day, which makes me forget to take my medication. This reminder is so timely and has helped me develop the habit of taking my medication at the right time."*

One of the people with tuberculosis responded: *“I am happy about this programme. It has helped me to complete my drug in the intensive part of my therapy”.*

The majority of the people with tuberculosis tested negative for the sputum test after completing the intensive phase of treatment. One of them gave this response at the end of the follow-up:

"I am happy that I tested negative on the sputum test. Although I am still taking my medication, I am pleased to see the positive effect of being part of this study and adhering to the treatment."

The study helped the participants to develop the skill of taking the right dosage of their drugs. One of the people with tuberculosis responded:

"The message reminders have helped me to inculcate the habit of not just taking my medications but also taking the right dosage. I now know the importance of taking the complete dosage of my medications."

The participants have also developed the skill of taking their medications at the right time for effective functioning of their medications. One of the PLWHA expressed her satisfaction:

"I never knew that I needed to take my drugs at a particular time. I thought that I could take them anytime I remembered. The messages, calls, and reminders had helped me develop a specific schedule for taking my medications."

One participant mentioned: *"It's a fantastic idea and it works really well. I receive an SMS at 7 am on Sunday and Thursday. I don't even have to check; I already know. It's a great innovation."*

One of the people living with tuberculosis responded: *"It's a constant reminder to make sure I'm taking my medications. Without the text, it would be difficult to remember to take them... In the first two weeks of the study, I was not following. I was still non-*

adherent. Then the motivational messages encouraged me. I realized that I had to do it for myself. Failing each day makes me feel guilty. The messages and motivational messages boosted my spirits."

One of the participants living with HIV/AIDS said, *"I believe the reminders helped me establish a routine for taking my medication. I won't overlook them. I am capable of managing it on my own now, but without the reminders, I might just decide to go to bed without taking my meds. When I receive the text, I pause to check who messaged me. Then I realize it's the reminder, so I take my meds right away."*

One of the participants, who are living with HIV/AIDS, emphasized the importance of receiving message and call reminders. These reminders helped them to refill their medications on time and keep their doctor's appointments. The participant explained, *"I often forget to refill my medications. I only realize that I've run out when I open the pack. Sometimes it takes me days to go to the hospital to refill, which makes me non-adherent for days or even weeks. But these reminders helped me to refill my medication before it ran out, so I didn't miss any doses."*

During the study period, another participant living with HIV/AIDS mentioned, *"I didn't miss any doctor's appointments. I received a reminder a week before the appointment, which helped me to keep the day free. I will continue to follow this routine."*

A participant with tuberculosis said, *"The reminder helped me to refill my medication ahead of time without running out. I refilled ahead of time. "*

Concern about confidentiality of the mode of message delivery (SMS)

The emphasis on maintaining the confidentiality and privacy of the SMS intervention was crucial. Many participants expressed their concerns about privacy and highly

valued the confidential nature of the messages throughout the study. Participant living with HIV/AIDS said:

“I appreciate how the text messages remind me to take my medication without disclosing any details about my condition.”

Another participant living with HIV/AIDS responded*: "If somebody sees my message, they don’t know what it’s for."*

A participant with tuberculosis emphasized the importance of privacy, stating, *"I like it, it’s good. Only I know what the text means. If you get my phone, you don’t know what that means."*

Overall, the participants, especially PLWHA, appreciated that the messages, if seen by others, would not reveal anything about their status. They were grateful for receiving medication reminders that didn't disclose any information about their health condition.

Many participants found the texts helpful in reminding them to take their medications. They were also grateful for the bi-directional mode of messaging, feeling more in control of the messages. Some participants appreciated the capability to change the time of the text alert, which the researcher agreed with.

A participant living with HIV/AIDS expressed, *"It feels good to be able to respond and express my concern about the intervention. I am happy that the researcher granted my request for my message delivery time to be 7 pm. I knew it was not convenient for her, but she had to agree. I felt more involved."*

Some participants, especially those who were not literate, appreciated the voice note messages more. A businesswoman with tuberculosis responded:

"I like that I could use voice notes. I am always too busy to type, so I often communicate back to her using voice notes."

An elderly man with tuberculosis explained, *"I don't know how to read or write. My children taught me how to use voice notes, so I asked the researcher to send me voice notes in Igbo, which she obliged. I responded in the same manner using voice notes, and it made it so easy for me."*

Reasons for non-compliance

"Some participants provided reasons for not adhering to their medications despite receiving SMS and phone calls from the researcher.

One person living with HIV/AIDS mentioned that ART conflicted with her religious beliefs: *"I stopped taking ART because it goes against my faith in healing. I believe I have been healed and no longer need ART."*

Another individual on antiretroviral therapy (ART) mentioned that it conflicted with her fasting schedule. She said, *"I had to discontinue ART during my fasting period. While fasting, I abstain from taking any medications. I resumed taking my medications after I finished fasting."*

One of the participants in the ART program mentioned that he prefers herbal drugs over ART drugs. He mentioned that: “I combine ART and herbal drugs by alternating the intake. For example, if I take ART drugs one day, I take an herbal drug the next day. This is my personal belief and practice”.

One participant mentioned that he only takes herbal medication and decided to withdraw from the study during the first week. He stated, *"I will not continue with this study. I only use herbal drugs, which I believe will heal me. We have highly medicinal*

plants in Igbo land that our ancestors relied on for survival. I will rely on them for my health."

Barriers for keeping to clinical appointment

Some participants said they missed their appointments because they were recognized by someone from the hospital. Others mentioned issues with transportation costs, staff attitudes, and difficulty leaving work. When asked why she didn't go to her doctor's appointment, one participant living with HIV/AIDS said, *"I am considering changing hospitals because someone recognized me the last time I was there. I will not be going back there."*

One of the individuals with tuberculosis replied, *"My workplace is always very busy. They hardly allow us to go out during work hours. By the time I finish work, the clinic has already closed. I work from Monday to Saturday. It's difficult for me to refill my medications and attend doctor's appointments."*

A woman living with HIV expressed frustration with the staff, saying, *"Some of the staff members are rude. I really don't like interacting with them."*

Some participants complained that they lost their phones, which disrupted their ability to follow up on the intervention. One cyclist with tuberculosis said, *"I lost my phone one month into the study. It was so painful. That phone contains everything about me. I bought a new phone after two weeks later. I didn't get the message for the hospital appointment, though I later attended."*

4.2 DISCUSSION

This study evaluated the impact of M-health on medication adherence among PLWHA and people with tuberculosis in Imo State. The study involved two distinct populations: PLWHA and individuals with tuberculosis. Each population was divided into a test group and a control group, with the test group being treated at the Federal University Teaching Hospital Owerri and the control group at Imo State Specialist Hospital Umuguma.

4.2.1. PLWHA

Adherence to medication dosage adherence among the test and control groups post M-health implementation

The result of adherence to medication dosage for people living with HIV/AIDS (PLWHA) both before and after the intervention showed that 81.6% of the previously non-adherent respondents in the test group became adherent, whereas only 7% of those in the control group achieved adherence at the post-study stage. The statistical analysis in Table 4.1.4 indicated a significant difference in the participants' medication dosage at the baseline and post-intervention. The mobile health intervention effectively increased the level of adherence among the participants in the test group. This result was the expected result because the percentage of the participants that adhered to the researcher’s instruction during the intervention was encouraging. This findings were similar to previous related study such as the study conducted by Achappa, Madi, Bhaskaran, Ramapuram, Rao and Mahalingam (2013) that evaluated dosage adherence among PLWHA in South India; study conducted on HIV/AIDS patients receiving treatment at Nekemte Referral Hospital in west Ethiopia from March 1 to March 30,

2019, by Abadiga, Hasen, Mosisa, and Abdisa (2020); study conducted at the HIV clinic of the University of Ilorin Teaching Hospital (UITH) in Kwara State, Nigeria in 2012 by Chukwuma et al (2020) aimed to assess adherence to combined antiretroviral therapy (cART) among people living with HIV/AIDS in a Tertiary Hospital in Ilorin, Nigeria; study conducted by Asaolu et al. (2023) in Niger State, Nigeria, which assessed the impact of text messaging on treatment adherence practices among young people living with HIV; the study by Lester et al. (2010) which examined the impact of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1); and a Randomized Controlled Trial conducted by Dongsheng et al. (2013) in Baoshan among HIV/AIDS patients also showed consistent results.

Adherence to prescribed schedule of drug intake among the test and control groups post M-health implementation.

The result of the participants' adherence to their prescribed drug intake schedule assessed before and after the intervention presented in Table 4.1.6 showed that the adherence to maintaining prescribed schedule of drug intake was higher among PLWHA at FUTH Owerri (test group) compared to those of the ISSS (control group), ($P=0.000$, $\chi 2 = 168.62$). The intervention led to an increase in level of promptness in maintaining prescribed schedule of drug intake by the participants. This outcome was the expected outcome post-intervention because the participants were frequently reminded to take their drug at the scheduled time and they were encouraged to communicate their challenges. This aligns with the findings of a quasi-experimental study conducted by Akamike et al (2021) in six health facilities in Ebonyi State,

southeast Nigeria. The study aimed to determine the impact of m-health on health worker and patient knowledge and adherence to isoniazid preventive therapy (IPT) guidelines. The eligible participants were health care workers in HIV clinics and people living with HIV accessing care at selected health facilities. It's worth noting that there is paucity of existing data on medication time adherence from previous studies.

Adherence to promptness in refilling prescription among the test and control groups on M-health implementation

The result of the participants' adherence to promptness in refilling drugs assessed at baseline and post-intervention showed that mobile health intervention increase in the promptness of drug refills among the participants in the test group. Out of the 223 non-adherent participants in the test group, 90% became prompt in refilling their drugs, compared to 24% of the 411 non-adherent participants in the control group who became adherent after the study. The mobile health intervention significantly improved the promptness with which the participants in the test group refilled their medications and this was the expected outcome because the participants in the test group were well motivated and encouraged to refill their drugs. Those that had no money for transport fare were given transport fare to go and refill their drugs hence a high level of adherence was indeed expected among them. This was similar to the findings of study conducted by Gachara, Mavhandu, Rogawski, Manhaeve, and Bessong (2017) which evaluated adherence to antiretroviral therapy using pharmacy refill records in a rural treatment site in South Africa; the study conducted in South Africa by El-Khatib et al. in 2011, aimed

to assess the link between adherence to drug-refill visits and virologic and immunologic failure among HIV patients on first-line antiretroviral therapy (ART) also showed consistency; the study conducted by Setor et al. in 2010 in Uganda which focused on the relationship between clinic attendance for medication refills and medication adherence among 392 adult patients receiving antiretroviral therapy in Uganda showed similar finding; study conducted by Adetunji et al. (2015) in Nigeria, which assessed the use of mobile phones as a social strategy to improve antiretroviral refill experience at a low-resource HIV clinic showed similar findings; study conducted by Nhavoto et al. (2017) to assess the impact of a mobile health intervention on drug adherence among people living with HIV/AIDS (PLWHA) and tuberculosis patients in Mozambique demonstrated consistency with this research findings; Similarly, the study by Reid et al. (2017) which focused on the impact of cellular SMS reminders on the consistency of antiretroviral therapy (ART) pharmacy pickups showed consistency with this research finding.

Adherence to appointment on schedule with health personnel among the test and control groups on M-health implementation

The findings from the participants' ability to keep appointments with health personnel assessed in both test and control groups revealed that there was a notable increase in the test group's adherence to doctor's appointments. The intervention led to an increase in level of keeping appointment on schedule with health personnel among the participants in the test group and this was the expected outcome because the participants in the test group were well motivated and encouraged to refill their drugs. Those that had no

money for transport fare were given transport fare to go and refill their drugs. This was aligned with previous studies such as the study conducted by MOSHA et al. (2019) among People Living with HIV in urban and rural settings in Tanzania; study conducted in Gambia by Peterson et al. (2013) at the Genito-Urinary Medicine (GUM) clinic at the Gambia Unit of the Medical Research Council (UK) to evaluate the use of self-reported adherence and keeping clinic appointments as indicators of viremia in routine HIV care; the study conducted among people living with HIV/AIDS (PLWHA) at a Ryan White-funded HIV clinic in El Paso, Texas by Anthony et al. in 2019; study conducted by Zebina, Melot, Binachon, Ouissa, Lamaury, and Hoen (2019), on the significant impact of sending an SMS reminder two days before a scheduled doctor's appointment on the attendance rate of people living with HIV/AIDS (PLWHA); and study conducted by Salama et al. (2012) focused on strategies to improve adherence to antiretroviral therapy (ART) among people living with HIV/AIDS (PLWHA) in Tanzania.

4.2.1. People with Tuberculosis

Adherence to the prescribed drug dose regimen among test and control groups on M-health implementation

The result of the study assessed level of adherence among people with tuberculosis at baseline and post-intervention revealed that among those who were non-adherent at baseline, 86.6% became adherent in the test group post-intervention, compared to 13.3% in the control group. Mobile intervention increased the level of dosage adherence among the participants in the test group. This outcome was the expected outcome because previous study on related topic found an increase in dosage adherence after an m-Health intervention, such as study conducted by Gebremariam, Wolde and Beyene

(2021) conducted among adult TB patients in Gondar city administration, Northwest, Ethiopia to assess their levels of medication adherence; a retrospective cohort study conducted by Sungho Bea in 2017-2018, on adherence and factors associated with adherence among TB patients in South Korea; in a study conducted by Worgu, Onotai, and Asuquo (2023) in Treatment Centers in a Southern Nigerian Local Government Area among tuberculosis patients using Morisky Medication Adherence Scale-8; study conducted in Kilifi County, Kenya to assessed tuberculosis Treatment Adherence among Patients Taking Anti-TB Drugs using Morisky medication adherence scale and focus group discussions; a prospective, quasi-experimental study conducted from September 2020 to March 2022 in India by Rajavardhana et al (2022) which focused on assessing the level of adherence to treatment on a daily-dose regimen for people with TB among patients in NTEP Bathalapalli and NTEP Ananthapuramu using SMS reminders; In a study by Angella et al (2020), conducted between June 2017 and June 2018 in TB clinic within Mbarara Regional Referral Hospital (MRRH) in rural, southwestern Uganda using mobile health technologies for providing social support to tuberculosis patients; in a recent comparative study led by Samira et al. (2021) at the Masih Daneshvari Hospital, Shahid Beheshti Medical University in Tehran which investigated the impact of a short message service (SMS)-based intervention on medication adherence for tuberculosis patients at the National Research Institute of Tuberculosis and Lung Disease; in a study conducted by Sarah et al. (2013) at a specialized reference hospital in Health Region V, Buenos Aires, Argentina, which examined the feasibility and effectiveness of using text messaging as an intervention to support treatment adherence in patients with tuberculosis (TB); and in a pilot study

conducted by Eliza Barclay (2009) which revealed how text messaging could improve tuberculosis drug compliance.

Adherence to prescribed schedule of drug intake among test and control groups on M-health implementation

The result of the adherence to scheduled drug intake times assessed at the beginning and after the intervention in both the test and control groups showed that following the intervention, adherence in the test group increased to 76.9% from 9.6% baseline non-adherents, compared to 7% in the control group. The statistical analysis result presented in Table 4.1.16 showed that the adherence to maintaining prescribed schedule of drug intake was higher among the test group compared to those of the control group. The outcome was an expected one because of the motivation and encouraging words the researcher used. The participants in the test group were constantly reminded that they will soon be free from the disease if only they will stick to the scheduled time of intake. This study on medication time adherence is innovative, as there are no previous studies for comparison.

Adherence to Promptness in Refilling Prescription among Test and Control Groups on M-Health Implementation

The findings on the promptness of medication refills by participants at both the beginning and end of the intervention in both the test and control groups revealed that the adherence level among the previously non-adherent participants increased to 90.3% in the test group, while only 17.2% became adherent in the control group. The statistical

analysis presented in Table 4.1.18 showed that the two groups differ significantly in adherence. This outcome was in line with majority of past researches conducted on similar topic hence the outcome was an expected one. The RCT study conducted by Nhavoto et al. (2017) on HIV and tuberculosis patients in Mozambique using a regimented series of automated SMS text messages aligns with this research discovery; the study by Brar, Jeong, Feger, Noble, Kmiec and Prayaga (2018) which examined the impact of tailored and interactive mobile text messaging on medication refill adherence in Medicare patients with tuberculosis in Kaiser Permanente Southern California (KP) and compared also showed consistency with this study finding.

Adherence to appointment on schedule with health personnel among the test and control groups

The findings of the participants' adherence to keeping to their appointments with health personnel assessed showed that following the intervention, the adherence rate in the test group increased to 88.8%, while it only increased to 6% in the control group. The data in Table 4.1.20 demonstrated a significant difference between the test and control groups. The mobile intervention effectively improved appointment adherence among the test group participants. These findings align with a review by Schwebel and Larimer (2018), which consisted of a systematic literature review of 2316 articles which utilized SMS reminders to enhance patient health care outcomes were included in the review; and the systematic review conducted by D'Arcey et al. (2020), mobile interventions have been found to also positively impact adherence to appointments.

Treatment termination as a result of recovery within 4 months of initiating treatment among test and control groups of people with tuberculosis on m-health implementation

After the study intervention, the treatment outcome of tuberculosis patients was assessed and the result revealed that 91.8% of the participants in the test group tested negative for the sputum test after the intervention, while 95% of those in the control group remained positive post-test. This outcome was very well expected because according WHO guideline on treatment of tuberculosis, anyone that's adherent to their medication is expected to test negative to sputum test at the completion of the intensive care treatment. The test sputum result for the study control and test groups presented in Table 4.1.23 shows that overwhelm majority of the patients in the study test group recorded negative in the sputum test (91.8%) compared to the control group at just 5%. The mobile health intervention contributed to an increased positive outcome among tuberculosis patients in the test group. These findings are in line with a study conducted in Shanghai, China by Wu et al (2023) that assessed the impact of mobile health reminders on tuberculosis treatment outcomes. The systematic review aims to comprehensively review the literature on the use of digital health interventions (DHIs) to improve TB treatment adherence and identify key strategies for their implementation conducted by Sol et al. (2023) also aligned with the findings of this study.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

It is crucial to find innovative methods to enhance Tuberculosis treatment and HIV drug (ART) adherence in Nigeria, especially with the increasing number of non-adherents. Directly Observed Therapy (DOTS) has been used worldwide to ensure Tuberculosis (TB) drug compliance. However, digitalizing this system into a virtual monitoring system through mobile health can help provide a more efficient tuberculosis treatment and HIV management system. The study included two populations: People Living With HIV/AIDS and people with tuberculosis. Mobile health (M-health) is a component of healthcare used to facilitate communication between doctors and patients. It is a rapidly expanding field in the digital health sector, providing healthcare support, delivery, and intervention via mobile technologies such as smartphones, tablets, and wearables.

In this study, it was used as an intervention mechanism among non-adherent individuals in both study populations. Short Message Service, voice calls, and voice notes were utilized. The results demonstrated a significant difference between the test and control group post-intervention. M-health increased medication adherence among the participants in the test group, showing a significant difference when compared to the control group. The participants' adherence levels were sub-optimal. Adherence to complex and/or daily drug regimens can be very challenging, especially in old age, which may negatively affect their motivation to continue drug therapy or lead to incorrect drug consumption. M-Health has shown promise in improving HIV

medication adherence on a global scale. It should be inculcated as one of the major methods of achieving optimal medication adherence among those with chronic diseases thereby reducing the disease burden drastically.

5.2 RECOMMENDATIONS

With regards to the findings of this research, the following recommendations were made:

1. There is need to raise awareness of the importance of taking ART among the religious leaders. Some of the participants didn't take their drugs because of their faith belief. They will most probably listen to their religious leaders more.
2. There is need for government to test the content of the herbal drugs in the country. Some participants dropped from the study because they believed more in herbal drugs. The knowledge of the exact content of the herbal drugs which are dully certified by the appropriate bodies will help the PLWHA to know the exact things they are taking as drug.
3. There is need for the pharmacy section of heart to heart centre and tuberculosis centre to open for half day during weekends to accommodate the people that couldn't leave their work place during the day for drug re-fill.
4. There is need for mass campaign about the importance of medication adherence and its health consequences.
5. Private sectors should be more liberal with time to those living with chronic diseases to enable them meet up with their doctor's appointment.

5.3 CONTRIBUTION TO KNOWLEDGE

This study on medication adherence using SMS message, WhatsApp audio messages and voice calls for the management of HIV/AIDS and tuberculosis had positive outcomes.

1. Among PLWHA in the test group who were non adherent at the baseline; 81.6%, 76.7%, 90% and 88.3% became adherent to their drug dosage intake, prescribed schedule of drug intake, refilling prescription, keeping appointment on schedule with health personnel at post-test respectively. This has reduced the burden of the disease on these people and also reduces their chances of the virus getting transmitted.
2. Among people with tuberculosis, 91.8% of those in the test group tested negative to sputum test at the end of the study and follow up. This has improved the health status of these individuals, reduced the chances of the disease getting transmitted and also reduced multi drug resistant as a result of non-completion of doses.
3. Some parts of this work have been published in revered journals while some are still under peer review in same journal. This will help in high visibility of this work and ensure that individuals, government and policy makers have access to it for better health management.
4. It will also significantly contribute to the body of knowledge in this field.

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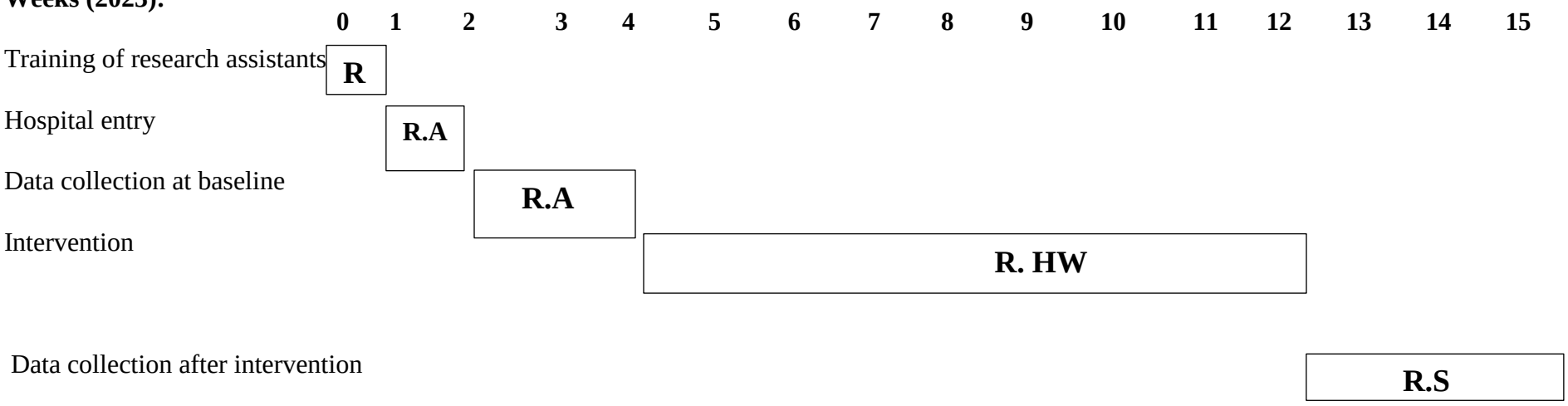
APPENDIX A

GANTT CHART

WORK PLAN/GANTT CHART

Weeks (2023):



Principal Researcher = R; Health worker= HW; Research Assistants= A; Supervisor = S

APPENDIX B

CONSENT FORM

Introduction: You have been selected to participate in a study on: **Effects of m-Health on medication adherence among people living with HIV and AIDS (PLWHA) and people with Tuberculosis in Imo State.** This study is based on the assumption that the findings will help the post graduate students to know the positive strategies that will help to increase drug adherence.

Voluntary nature of participation: Participation in this study is completely voluntary. This means that although you have been selected, you are free to participate in the study or decide otherwise. If you decide to participate, you are free to withdraw form it at any stage of the study without incurring negative consequences.

Study Procedure: You will be asked questions on your socio demographic profile (Bio data) including religion and occupation. You will also be required to answer questions on your level of ART adherence/ Anti TB drug. The study is an intervention study. An SMS will be sent to you daily (or the frequency you chose) for 8 weeks to serve as a reminder for you to take your drug and keep your doctor's appointment.

Confidentiality: Information obtained from you will be treated as confidential and will not be used against you in any form. You will not be required to write your name anywhere or present any information that will reveal your identity at any stage of the study. In addition, data analysis and presentation from this study will be aggregate, and will not in any way reveal your identity.

Feedbacks: The principal researcher will be at hand every time to answer any question(s) you may have concerning the study. Similarly throughout the course of the study, the researcher team will be available to answer any question(s) or deal with any problem that may arise. You can always reach the principal researcher on 08037911310 or at Public Health Department, Federal University Of Technology Owerri Imo State , Nigeria.

Respondent: I have read and understood the above (or had someone read and explained the entire study to me). All the gray areas have also been clarified. I fully understand the nature, risk and benefits of the study and hereby consent to take part in it.

…… **…..……**

Signature of Respondent **Name and signature of Researcher**

Date …….. **Date……**

…… **……**

Name and Signature of Witness **Date**

APPENDIX C

ACTG ADHERENCE FOLLOW UP QUESTIONNAIRE

Date _____ **Self** **Interviewer** **Both**

How Administered? 1 2 3

This page is to be completed by the patient and the researcher together

Section B (drug dosage and frequency)

You are currently taking the following drugs at the frequency and doses listed.

Study Drug Name/Dose	# Pills Each Time (Pills Each Dose)	# Times Per Day (Doses Per Day)

INSTRUCTIONS: Complete this worksheet with the patient**.**

The answers you give on this form will be used to plan ways to help other people who must take pills on a difficult schedule. Please do the best you can to answer all the questions. If you do not wish to answer a question, please draw a line through it. If you do not know how to answer a question, ask the researcher to help. Thank you for helping in this important study.

PATIENT ONLY continue here

Section C (Dosage Adherence)

The next section of the questionnaire asks about your HIV study medications that you took over the last four days.

Most people with HIV have many pills to take at different times during the day. Many people find it hard to always remember their pills:

- Some people get busy and forget to carry their pills with them.
- Some people find it hard to take their pills according to all the instructions, such as "with meals," or "on an empty stomach," "every 8 hours," "with plenty of fluids."
- Some people decide to skip doses to avoid side effects or to just not be taking pills that day.

We need to understand how people with HIV are really doing with their pills. Please tell us what you are **actually** doing. Don't worry about telling us that you don't take all your pills. We need to know what is really happening, not what you think we "want to hear.

This section of the questionnaire asks about the study medications that you may have **missed** taking over the last four days. Please complete the following table by filling in the boxes below.

1. **IF YOU TOOK ONLY A PORTION OF A DOSE ON ONE OR MORE OF THESE DAYS, PLEASE REPORT THE DOSE(S) AS BEING MISSED.**

Step 1 Names of your anti-HIV study drugs	HOW MANY DOSES DID YOU MISS			
	Step 2 Yesterday	**Step 3** Day before yesterday (2 days ago)	**Step 4** 3 days ago	**Step 5** 4 days ago
	Doses	doses	Doses	doses
	Doses	doses	Doses	doses
	Doses	doses	Doses	doses
	Doses	doses	Doses	doses
	Doses	doses	Doses	doses
	Doses	Doses	Doses	doses

The following questions pertain to the study regimen on page 2.

If you took only a portion of a dose on one or more of these days, please report the dose(s) as being missed.

2. **During the past 4 days, on how many days have you missed taking all your doses?**

None

One day

Two days

Three days

Four days

3. **When was the last time you missed any of your medications?** Check one.

5	Within the past **week**
4	1-2 **weeks** ago
3	2-4 **weeks** ago
2	1-3 **months** ago
1	More than 3 **months** ago
0	**Never** skip medications or **not** applicable

Section C (Time Adherence)

1. . Most anti-HIV medications need to be taken on a schedule, such as "2 times a day" or "3 times a day" or "every 8 hours." How closely did you follow your specific schedule over the past six days/ during the study intervention?

Never The Time	Some Of Of The Time	About Half The Time	Most Of The Time	All Of the time
0	1	2	3	4

2. How often were you able to maintain to the two/one hour window for scheduled drug intake agreed on at baseline.

Never The Time	Some Of Of The Time	About Half The Time	Most Of The Time	All Of the time
0	1	2	3	4

3. Some people find that they forget to stick to their scheduled drug intake time over the week-ends. Did you miss any of your anti-HIV medications during the weekends throughout the intervention period— Saturdays or Sundays?

1 Yes 2 No

4. If Yes, how often did you miss it during the weekends?

Some Of Of The Time	About Half The Time	Most Of The Time	All Of the time
0	1	2	3	4

5. When was the last time you missed taking any of your medications at the correct scheduled time? Check one.

5 Within the past week
4 1-2 weeks ago
3 2-4 weeks ago
2 1-3 months ago
1 More than 3 months ago
0 Never skip medications or not applicable

APPENDIX D

Original Eight-Item Morisky Medication Adherence Scale (MMAS-8)

	YES	NO
1. Do you sometimes forget to take your medication?		
2. People sometimes miss taking their medications for reasons other than forgetting. Over the past 2 weeks, were there any days when you did not take your medication?		
3. Have you ever cut back or stopped taking your medication without telling your doctor because you felt worse when you took it?		
4. When you travel or leave home, do you sometimes forget to bring your medication?		
5. Did you take all your medication yesterday?		
6. When you feel like your symptoms are under control, do you sometimes stop taking your medication?		
7. Taking medication every day is a real inconvenience for some people. Do you ever feel hassled about sticking to your treatment plan?		
8. How often do you have difficulty remembering to take all your medication? Never/Rarely…….. Once in a while…….. Sometimes…….. Usually…… All the time……..		

© Morisky Medication Adherence Scale (MMAS-8-Item). Use of the ©MMAS is protected by US copyright laws. Permission for use is required. A license agreement is available from: Donald E. Morisky, ScD, ScM, MSPH, Professor, Department of Community Health Sciences, UCLA School of Public Health, 650 Charles E. Young Drive South, Los Angeles, CA 90095-1772.

APPENDIX E

Adapted Eight-Item Morisky Medication Adherence Scale (MMAS-8) used for TB respondents.

Items	Rotation factors	
Section A: Dosage Adherence	**1**	**2**
1. Do you sometimes forget to take your Tuberculosis pills especially when you travel?		
2. People sometimes miss taking their medications for some reasons especially forgetting. Thinking over the past one week, were there any days when you did not take your Tuberculosis medicine?		
3. Have you ever cut down on dosage or stopped taking your medication without telling your doctor, because you felt worse when you took it?		
4. Did you take your Tuberculosis medicine yesterday?		
5. When you feel like your Tuberculosis symptoms are under control, do you sometimes stop taking your medicine?		
Section B: Medication Time Adherence		
6. Taking medication every day and at a particular time is a real inconvenience for some people. Do you ever feel hassled about sticking to your Tuberculosis treatment plan?		
7. How often do you have difficulty taking your medication at the doctor's stipulated time of the day in the last one week?		
8. How often did you miss taking your Tuberculosis drug at the exact recommended time in the last one month?		

- Never/rarely ----------
- Once in a while ----------
- Sometimes ----------
- Usually ----------
- All the time----------

➢ α Reliability, .83.

APPENDIX F

MESSAGE CONTENTS DEVELOPMENT

The titles of the messages were:

1. “Climate setting” and “Encourager for the first week”.
2. Adhering to required drug dosage, and Review of the dosage adherence and initiation of time adherence for the second week.
3. Review of previous day’s medication-time adherence, and Assessment of medication drug reaction (for PLWHA only), message on the importance of nutrition and good hygiene (for people with tuberculosis and PLWHA) for the third week.
4. Clinic appointment reminder and Review of attendance to clinic appointment for the fourth week.
5. Reminder to refill medication, and Review of drug refill for the fifth week.
6. Review of study intervention, and message on maintenance for the sixth week.

The messages were written in English language, but the voice notes were sent in the respondents' preferred language. It comprised of a total number of 12 messages delivered twice a week (Sunday and Thursday) for 6 weeks. They were sent through SMS, WhatsApp messages, and voice notes. The messages provided reminders for medication dosage and time adherence, keeping clinic appointments, and refilling of drugs. Each of the messages has an average of two minutes to read, and a two page message. The first week messages were preparatory and did not include any feedback. From the second week onwards, participants were asked to provide feedback on the

messages they received. Each message concluded with a reminder for participants to take their medication regularly to avoid relapse.

The messages were pre-tested by sending them to 20 people living with HIV/AIDS and 20 individuals receiving care for tuberculosis at Imo State University Teaching Hospital Orlu to determine the clarity of the messages. They were also given to trained health personnel at Heart-to-heart centre and tuberculosis centre at FUTH Owerri and Imo State Specialist hospital Umuguma for their input on relevance.

For PLWHA and People with tuberculosis

Message 1: The title of the message was climate setting. The message was a brief welcoming message and brief background information on the interaction and its benefits. The message ended with an appreciation note to the participants for given consent to the study.

For PLWHA and People with tuberculosis

Message 2: The title of the message was "Encourager". The message focused on motivating the participants and assuring them of their ability to adhere to their medication dosage and time-adherence.

For PLWHA and People with tuberculosis

Message 3: The title of the message was "adhering to required drug dosage". The message was on information on the importance of taking the correct dosage of medication and urging them to adhere to it.

For PLWHA and People with tuberculosis

Message 4: The title of the message was **"**Review of dosage adherence and initiation of time adherence**".** The message has two parts. The first part is a review of the participants who followed the recommended dosage in the past four days. This review is limited to the past four days to avoid recall bias and in accordance with the adopted questionnaires. Their responses were recorded in the checklist. The second message was conveyed to two groups of people regarding their medication dosage. The first group was reminded to adhere to the complete dosage, starting immediately if they had missed any dosages in the past 4 days. The second group, who had adhered to the complete dosage for the past 4 days, was congratulated and encouraged to take their medication at the scheduled time for optimal effectiveness. This was the next level of the study interaction.

For PLWHA and People with tuberculosis

Message 5: The message was titled "Review of Previous Days' Medication-Time Adherence". It contained encouraging words along with a review of medication time adherence over the previous four days. The first part of the message involved a review of the medication time adherence. Those who adhered to the schedule for the past four days were congratulated and moved on to the next interaction session. Those who didn't adhere were sent messages of encouragement and urged to start adhering immediately.

For PLWHA

Message 6: The message was titled "Assessment of medication drug reaction". The message was titled "Assessment of medication drug reaction". The message contained

leading questions to elicit information on the presence of any drug reaction amongst the participants.

For People with tuberculosis

Message 6: The message was titled "Importance of nutrition and good hygiene". It contained a brief message that encouraged the recipients to continue adhering to their medication dosage at the scheduled time. The message emphasized the importance of adequate nutrition and good hygiene to help their medication work optimally and break the chain of the spread of the disease.

For PLWHA and People with tuberculosis

Message 7: The message was titled "Clinic appointment reminder". It reminded the participants of the exact date of their upcoming clinic appointment and urged them to attend the appointment as scheduled.

For PLWHA and People with tuberculosis

Message 8: The message was titled "Review of attendance to clinic appointment". The message contained questions on whether they attended the clinic appointment. Those who attended the appointment and have been following the prescribed medication dosage and time were commended and rewarded with extra airtime. For those who did not attend, they were urged to reschedule their appointment immediately. Some participants were assisted by the researcher to reschedule their appointments and were then closely followed up to ensure they kept their appointment.

For PLWHA and People with tuberculosis

Message 9: The message was titled "Reminder to Refill medication". The recipient was encouraged to refill their prescription before it ran out, and reminded that it was important not to run out of their medication.

For PLWHA and People with tuberculosis

Message 10: The message was titled "Review of drug refill". The message contained questions on whether they refilled their drugs as reminded four days ago. Those who refilled were commended and congratulated. For those who did not were urged to go to their clinic immediately for it. Some participants were assisted by the researcher with their transport fare to go to the clinic were then closely followed up to know the percentage that finally refilled it.

For PLWHA and People with tuberculosis

Message 11: The message was titled "Review of study intervention". The participants were thanked for their participation in the study and asked some questions to evaluate their overall experience with the intervention. They were asked if they felt it was worthwhile, if it caused any discomfort, if it felt intrusive, and if they would like to continue. They were encouraged to provide their feedback.

For PLWHA

Message 12: The message was titled "Maintenance". The recipients were congratulated on making it to the final day of the study and were given uplifting and motivational messages. They were encouraged to remember that medication adherence is a routine that must be maintained and to continue practicing their newly developed habits of taking their medication regularly, as well as eating nutritious food and getting enough

rest. Lastly, they were reminded that they could contact the researcher if they had any questions or challenges.

For People with tuberculosis

Message 12: The message was titled “Maintenance”. The participants were praised for successfully reaching the last day of the study. They were encouraged to keep taking their medication at the right dosage and at the scheduled time until the end of their treatment. Additionally, they were reminded to maintain good personal hygiene and ensure that they are consuming nutritious food. Finally, they were informed that the researcher would follow up with them for an additional six weeks, after which their sputum sample would be collected to determine the presence or absence of Mycobacterium tuberculosis.

APPENDIX G

MESSAGE DELIVERY

Delivery of M-Health Messages to participants

The study intervention was conducted on the test group where M-health messages were sent via SMS and WhatsApp voice notes to the participants twice a week (Sundays and Thursdays) at 7 am prompt. In the first week, messages were focused on climate setting and motivation, so no feedback was expected. However, from the second week (day 4), participants were asked to provide feedback using an alphabetical option as specified in the checklist. The researcher reviewed the transcriptions to ensure consistency with the recordings and translated them into English.

The respondents were encouraged to answer the researcher's questions during the intervention objectively and were instructed to text back any questions or comments that they may have to the researcher or well-trained research assistants with an expected response of 24 hours during weekdays and 48 hours during weekends. The researcher assured them of confidentiality and anonymity, and part of it is that the customized messages did not include participant names, reference to the Immunology Center, HIV infection (for PLWHA), or medications. Encouraging words were used all through to enable them to be objective with their answers, and not defensive. Throughout the study, the researcher provided airtime to respondents every week, but only to those who complained about not having enough airtime. This was done to encourage bi-directional communication and ensure that the respondents could provide feedback when necessary. To make sure that the respondents received the text messages and could seek clarification if needed, the researcher added their phone contact to every message. The

participants were also encouraged to call, send an SMS, or give a missed call if they needed further information. Lastly, delivery reports were used to determine who had received the text message and who had not. All of these measures were clearly explained to the participants at the beginning of the study.

According to behaviour change theory, drug adherence can be learned. Individuals who stick to their medication regimen were praised and motivated to continue doing so. The researcher used positive reinforcement - a key element of behaviour change theory - to encourage adherent behaviour. This included verbal praise, reward systems, added privileges, and other forms of positive feedback. Additionally, participants who adhered to their medication and kept their doctor's appointments were given extra airtime. Each message concluded with a reminder for participants to take their medication regularly to avoid relapse.

Content Of The Message Sent To PLWHA

Week 1

Day 1 (Sunday)

Topic: Climate setting

Thank you for signing up to the 6 weeks mobile health interaction that promises to be interesting and beneficial to health. Welcome to the first session which is tagged climate setting. How are you doing? This interaction requires you to resolution for effective participation. You will never regret the time you will spend with us. our messages will be short and will not consume your time. You will receive health related information through phone to particularly improve your ART medication adherence. We promise

you confidentiality in all our interactions. Wait for our next message on Thursday. We appreciate your participation. Thank you. We will be back on Thursday.

Week 1

Day 2 (Thursday)

Topic: Encourager

How are you today? I hope you remembered to take your ART medication as prescribed. If you did not there is no cause for alarm provided you start today and maintain it. Start today and make sure you do not derail. Don't forget that you are strong, unique, responsible, blessed of God. You can take care of your health and protect your loved ones and others. Forming a habit takes less than a month with dedication and concentration and I know you can do it. I am glad to remind you to regularly take your drug as prescribed by your health worker. We care for you. Never hesitate to ask any question of your concern throughout this interaction. We will be back on Sunday.

Week 2

Day 3 (Sunday)

Topic: Adhering to required drug dosage

How are you today? Did you remember to take your prescribed drug accordingly? Congratulations if you did. If you didn't, start today. You have a lot to gain by doing that you can live your normal life and achieve life goals if you adhere to health instructions especially as related to your drugs. Remember you are on daily ART drugs. Endeavor to take it. Go for it now if you have not taken today. We will be back on Thursday.

Week 2

Day 4 (Thursday)

Topic: Review of dosage adherence and initiation of time adherence

How are you doing today? Did you remember to take the correct dosage of medication in the past four days? How many days were you able to take the complete dosage of your medication in the last four days? Your health is your wealth. Kindly reply the appropriate response stating the letter beside the response. We will be back on Sunday.

i. **Feedback from participants:**

a. I took the complete drug dosage for the past four days.

b. I took the complete drug dosage for just one day, two days or 3 days but not the complete 4 days.

c. I was unable to take the complete drug dosage in the past 4 days.

Reply

i. Response to (a): congratulations! You did well. Keep it up. A vacation from your medicine is dangerous to your health, so don't stop taking your drugs. Endeavor to stick to the correct time of your medication intake as well. Your medication works better when taken within one hour of the recommended time. We will be back on Thursday.

ii. Response to (b): I congratulate you for your attempt, however you need the complete drug dosage. You can do it. I believe in you. If you can do it for a day, you can do it for other days. Call or send text to me if you are having any challenge in taking your complete drug dosage.

iii. Response to (c): Don't be discouraged. Don't feel down. You can still meet up. Just start now to take the correct dosage of your drug. Think about what makes it hard for you to take medication/ correct dosage right now, and tell me. We can work it out. You can do this!

Week 3

Day 5 (Sunday)

Topic: Review of medication-time adherence

How are you faring today? Did you remember to take your medication at the scheduled time in the past 4 days? If you did, how many days were you able to do that in the last four days? Your health is your wealth. Kindly reply the appropriate response stating the letter beside the response. We will be back on Thursday.

i. Feedback from participants:

a. I took my medication at the correct scheduled time for the past four days.

b. I took my medication at the correct scheduled time for just one day, two days or 3 days, but not the complete 4 days.

c. I was unable to take my medication at the correct scheduled time in the past 4 days.

Reply

i. Response to (a): Well done! You did well. Continue to endeavor to stick to the correct time of medication intake and correct dosage always. You got this!

We will be back on Thursday.

ii. Response to (b): Well-done on the initiation of medication time adherence!! You can do this. Remember that taking your medication at the right time and the correct dosage helps the drug to function optimally and enables you to live your normal life daily. You can start it today.

iii. Response to (c): Don't be discouraged. Don't feel down. You have the power to take care of your own health and protect others. Please do the right thing! Sometimes, it may feel like it, but you are not alone. Call this number 08037911310 for more information and support. I am here for you.

Week 3

Day 6 (Thursday)

Topic: Drug reaction

Hello! How are you faring today? Remember to continue taking the right dosage of your medication and at the right time. A vacation from medication is not good for your health. People are counting on you to take the best care of your health. Do you have drug reaction when you take your daily medication? Does it interfere with your drug adherence? Please feel free to talk to me. I am here for you. Kindly reply the appropriate response stating the letter beside the response. We will be back on Sunday.

i. Feedback from participants:

a. Yes, I am having drug reaction but it doesn't stop me from taking my drugs.

b. Yes, I am having drug reaction and it makes me not to take my medication as schedule.

c. No, I don't have drug reaction.

Reply

i. Response to (a): well-done on taking your medications in spite of the drug reaction. Don't be discouraged. Please talk to your health care providers now. They can sort the drug reaction problem for you.

ii. Response to (b): Don't be discouraged. If you don't want to talk to me, talk to your health care provider. Never hesitate to ask your provider questions. If you don't understand the answer, keep asking until you do. Talk to health provider today! They have a way around this. Please you can't afford to be non-adherent to your medication.

iii. Response to (c): That's great. Continue taking the right dosage of your medication and at the right time. A vacation from your medication is dangerous to your health!

Week 4

Day 7 (Sunday)

Topic: Clinic appointment reminder

Hello! Happy Sunday! How are you today? This is your clinic appointment reminder. We are concerned about you. Remember that visiting your clinic on schedule helps keep you healthy. With health there is joy. Love yourself. Endeavor to attend your next clinic appointment scheduled for ***** day! Remember to continue taking the right dosage of your medication and at the right time. We will be back on Thursday.

Week 4

Day 8 (Thursday)

Topic: Review of attendance to clinic appointment

Good morning. How are you faring today? Were you able to attend your clinic appointment scheduled for ******? Your health is your wealth. I am rooting for you! Kindly reply the appropriate response stating the letter beside the response. We will be back on Sunday.

i. **Feedback from participants:**

a. Yes, I attended my clinic appointment.

b. No, I did not attend my clinic appointment.

c. I rescheduled my appointment

Reply

i. Response to (a): Congratulations! I have extra 100 naira airtime for you for keeping to your medication adherence and doctor's appointment till this week 4. You are doing very well. I am proud of you. Remember to continue taking the right dosage of your medication and at the right time. A vacation from meds is not good for your health. You got this!

ii. Response to (b): Don't worry. It's never too late to make an appointment. Your health matters. Be active in your health care. Keep your scheduled appointments. Call or text your clinic provider to re-schedule appointment now. Or I can help you re schedule it. Taking care of yourself and health takes only a few minutes. Please take a few minutes for yourself today. Will you like to share with me why you missed your appointment? You can call, text or flash me.

Week 5

Day 9 (Sunday)

Topic: Reminder to Refill your medication

Message: hello! Good morning. Happy new week. Take care of yourself today. Eating healthy foods, reducing stress, getting some exercise, and sleeping well all help. They will help to build up your immune system and help in the optimal function of the drug**. Remember to refill your medication. You can't afford to be out of your medications!** We will be back on Thursday.

Week 5

Day 10 (Thursday)

Topic: Review of Refill of your medication

Good morning. Well done!! We are almost at the end of the study interaction. I am grateful that you are still here with me. Have you refilled your medication? Kindly reply the appropriate response stating the letter beside the response. We will be back on Sunday.

i. **Feedback from participants:**

a. Yes, I have refilled my drugs

b. No, I have not refilled my drugs

c. No, I have not refilled my drugs. I still have some drugs remaining.

Reply

i. Response to (a): Congratulations on the prompt refilling of your drugs!! I am so proud of you. Continue to take the correct dosage of your medication and at the

right time. Knowledge is power. Continue to use yours to make responsible and healthy decisions.

ii. Response to (b): What could be the reason for not refilling your meds? Please you need to visit your clinic immediately to get a refill. Taking care of yourself and health takes only a few minutes. Please take a few minutes for yourself today.

iii. Response to (c): you don't need to wait for your medication to finish before you refill. Please visit your clinic today to get a drug re-fill. You cannot afford to be out of medicine.

Day 11 (Sunday)

Topic: Evaluation of study interaction

Message: Congratulations for making it to the last week of this study. I appreciate your patience, commitment and participation though out. Please kindly call or send a text and describe your experience with this mobile health intervention. Was it worth it? Was it disturbing? Was it prying? Would you want it to continue? Your honest feedback is important to me please. Kindly reply the appropriate response stating the letter beside the response. We will be back on Thursday.

i. Feedback from participants:

a. Yes, it was worth it. It helped me to adhere to my drugs. I wish it would continue.

b. No, I don't like it. It was prying, intrusive, and disturbing.

Week 6

Day 12 (on Thursday)

Topic: Maintenance

Message: Congratulations for making it to the last day of this study. This is your life! Remember to take the time to enjoy it. Scientists have proven that smiling makes you healthier. Share a laugh with a friend today. Take care of yourself today. Eating healthy foods, reducing stress, getting some exercise, and sleeping well all help. Knowledge is power. Use yours to make responsible and healthy decisions. Always remember: no vacation from your medication!! Feel free to call or text me if you are having any challenge or any question.

Thank you for being part of this study!!

Content of the Message Sent To People with Tuberculosis

Week 1

Day 1 (Sunday)

Topic: Climate setting

Thank you for signing up to the 6 weeks mobile health interaction that promises to be interesting and beneficial to health. Welcome to the first session which is tagged climate setting. How are you doing? This interaction requires your resolution for effective participation. You will never regret the time you will spend with us. Our messages will be short and will not consume your time. You will receive health related information through phone to particularly improve your TB medication adherence. We promise you confidentiality in all our interactions. We appreciate your participation. Thank you.

Week 1

Day 2 (on Thursday)

Topic: Encourager

How are you today? I hope you remembered to take your anti-tuberculosis medication as prescribed. If you did not there is no cause for alarm provided you start today and maintain it. Start today and make sure you do not derail. Don't forget that you are strong, unique, responsible, blessed of God. You can take care of your health and protect your loved ones and others. Forming a habit takes less than a month with dedication and concentration and I know you can do it. I am glad to remind you to regularly take your drug as prescribed by your health worker. We care for you. Never hesitate to ask any question of your concern throughout this interaction.

Week 2

Day 3 (Sunday)

Topic: Adhering to required drug dosage

How are you today? Did you remember to take your prescribed drug accordingly? Congratulations if you did. If you didn't, start today. You have a lot to gain by doing that. You will get cured completely, live your normal life and achieve life goals if you adhere to health instructions especially as related to your drugs. Remember you are on daily anti-TB drugs. Endeavor to take it. Go for it now if you have not taken today.

Week 2

Day 4 (Thursday)

Topic: Review of dosage adherence and initiation of time adherence

Message: How are you doing today? Did you remember to take the correct dosage of medication in the past four days? How many days were you able to take the complete dosage of your medication in the last four days? Your health is your wealth. Kindly reply the appropriate response stating the letter beside the response.

i. **Feedback from participants:** kindly reply the appropriate response stating the letter beside the response.

   a. I took the complete drug dosage for the past four days.

   b. I took the complete drug dosage for just one day, two days or 3 days but not the complete 4 days.

   c. I was unable to take the complete drug dosage in the past 4 days.

Reply

i. Response to (a): congratulations! You did well. Keep it up. A vacation from your medicine is dangerous to your health, so don't stop taking your drugs. Endeavor to stick to the correct time of your medication intake as well. Your medication works better when taken within one hour of the recommended time. We will be back on Thursday.

ii. Response to (b): I congratulate you for your attempt, however you need the complete drug dosage. You can do it. I believe in you. If you can do it for a day, you can do it for other days. Call or send text to me if you are having any challenge in taking your complete drug dosage.

iii. Response to (c): Don't be discouraged. Don't feel down. You can still meet up. Just start now to take the correct dosage of your drug. Think about what makes it hard for you to take medication/ correct dosage right now, and tell me. We can work it out. You can do this!

Week 3

Day 5 (Sunday)

Topic: Review of medication-time adherence

How are you faring today? Did you remember to take your medication at the scheduled time in the past 4 days? If you did, how many days were you able to do that in the last four days? Your health is your wealth. Kindly reply the appropriate response stating the letter beside the response. We will be back on Thursday.

i. **Feedback from participants**: kindly reply the appropriate response stating the letter beside the response.
   a. I took my medication at the correct scheduled time for the past four days.
   b. I took my medication at the correct scheduled time for just one day, two days or 3 days, but not the complete 4 days.
   c. I was unable to take my medication at the correct scheduled time in the past 4 days.

Reply

i. **Response to (a):** Well done! You did well. Continue to endeavor to stick to the correct time of medication intake and correct dosage always. You got this! We will be back on Thursday.

ii. Response to (b): Well-done on the initiation of medication time adherence!! You can do this. Remember that taking your medication at the right time and the correct dosage helps the drug to function optimally and enables you to live your normal life daily. You can start it today.

iii. Response to (c): Don't be discouraged. Don't feel down. You have the power to take care of your own health and protect others. Please do the right thing! Sometimes, it may feel like it, but you are not alone. Call this number 08037911310 for more information and support. I am here for you.

Week 3

Day 6 (Thursday)

Topic: Adequate Nutrition and Good Hygiene

Good morning. How are you today? Remember to continue taking the right dosage of your medication and at the right time. People are counting on you to take the best care of your health that you can. Please take your meals regularly; this improves your immunity against the disease. Endeavor to always use your own cup and plate. Also cover your mouth and nose when sneezing or coughing. Ensure that your windows are open to ensure good ventilation. We will be back on Sunday

.**Week 4**

Day 7 (Sunday)

Topic: Clinic appointment reminder

Hello! Happy Sunday! How are you today? This is your clinic appointment reminder. We are concerned about you. Remember that visiting your clinic on schedule helps keep you healthy. With health there is joy. Love yourself. Endeavor to attend your next clinic

appointment scheduled for ***** day! Remember to continue taking the right dosage of your medication and at the right time. We will be back on Thursday.

Week 4

Day 8 (Thursday)

Topic: Review of attendance to clinic appointment

Good morning. How are you faring today? Were you able to attend your clinic appointment scheduled for ******? Your health is your wealth. I am rooting for you! Kindly reply the appropriate response stating the letter beside the response. We will be back on Sunday.

i. **Feedback from participants:**

a. Yes, I attended my clinic appointment.

b. No, I did not attend my clinic appointment.

Reply

a. Response to (a): Congratulations! I have extra 100 naira airtime for you for keeping to your medication adherence and doctor's appointment till this week 4. You are doing very well. I am proud of you. Remember to continue taking the right dosage of your medication and at the right time. A vacation from medication is not good for your health. You got this!

b. Response to (b): Don't worry. It's never too late to make an appointment. Your health matters. Be active in your health care. Keep your scheduled appointments. Call or text your clinic provider to re-schedule appointment now. Or I can help you re schedule it. Taking care of yourself and health takes only a few minutes.

Please take a few minutes for yourself today. Will you like to share with me why you missed your appointment? You can call, text or flash me.

Week 5

Day 9 (Sunday)

Topic: Reminder to Refill medication

Hello! Good morning. Happy new week. Please take care of yourself today. Eating healthy foods, reducing stress, getting some exercise, and sleeping well all help. They will help to build up your immune system and help in the optimal function of the drug. **Remember to refill your medication this week. Remember to go with your TB medicine and TB card.** We will be back on Thursday.

Week 5

Day 10 (Thursday)

Topic: Review of Refill of your medication

Good morning. Well done!! We are almost at the end of the study interaction. I am grateful that you are still here with me. Have you refilled your medication? Kindly reply the appropriate response stating the letter beside the response. We will be back on Sunday.

i. **Feedback from participants:**

a. Yes, I have refilled my drugs.

b. No, I have not refilled my drugs.

c. No, I have not refilled my drugs. I still have some drugs remaining.

Reply

i. Response to (a): Congratulations on the prompt refilling of your drugs!! I am so proud of you. Continue to take the correct dosage of your medication and at the right time. Knowledge is power. Continue to use yours to make responsible and healthy decisions.
ii. Response to (b): What could be the reason for not refilling your medication? Please you need to visit your clinic immediately to get a refill. Taking care of yourself and health takes only a few minutes. Please take a few minutes for yourself today.
iii. Response to (c): you don't need to wait for your medication to finish before you refill. Please visit your clinic today to get a drug re-fill. You cannot afford to be out of medicine.

Week 6

Day 11 (Sunday)

Topic: Evaluation of study intervention

Message: Congratulations for making it to the last week of this study. I appreciate your patience, commitment and participation throughout. Please kindly call or send a text and describe your experience with this mobile health intervention. Was it worth it? Was it disturbing? Was it prying? Would you want it to continue? Your feedback is important to me please. Kindly reply the appropriate response stating the letter beside the response. We will be back on Thursday.

i. **Feedback from participants:**

a. Yes, it was worth it. It helped me to adhere to my drugs. I wish it would continue.

b. No, I don't like it. It was prying, intrusive, and disturbing.

Week 6

Day 12 (Thursday)

Topic: Maintenance

Message: Congratulations for making it to the last day of this study. This is your life! Remember to take the time to enjoy it. Scientists have proven that smiling makes you healthier. Share a laugh with a friend today. Take care of yourself today. Eating healthy foods, reducing stress, getting some exercise, and sleeping well all help. Knowledge is power. Use yours to make responsible and healthy decisions. Tuberculosis is a curable disease, and you are almost at the end of your treatment plan. If you have any challenges or questions, please do not hesitate to call or text me. Remember that at the end of this interaction, you will be followed up for an additional six weeks, during which your sputum will be collected for lab analysis. This is to determine whether you still have Mycobacterium tuberculosis in your sputum.

APPENDIX H

CHECKLIST

Dosage Adherence

	A	B	c	Percentage of dosage adherence
Name /ID No	**I took the complete drug dosage for the past four days.**	**I took the complete drug dosage for just one day, two days or 3 days but not the complete 4 days.**	**I was unable to take the complete drug dosage in the past 4 days.**	

Time adherence

	A	B	c	Percentage of time adherence
Name /ID No	**I took my medication at the correct scheduled time for the past four days.**	**I took my medication at the correct scheduled time for just one day, two days or 3 days, but not the complete 4 days.**	**I was unable to take my medication at the correct scheduled time in the past 4 days.**	**Percentage of time adherence**

Doctor's Appointment

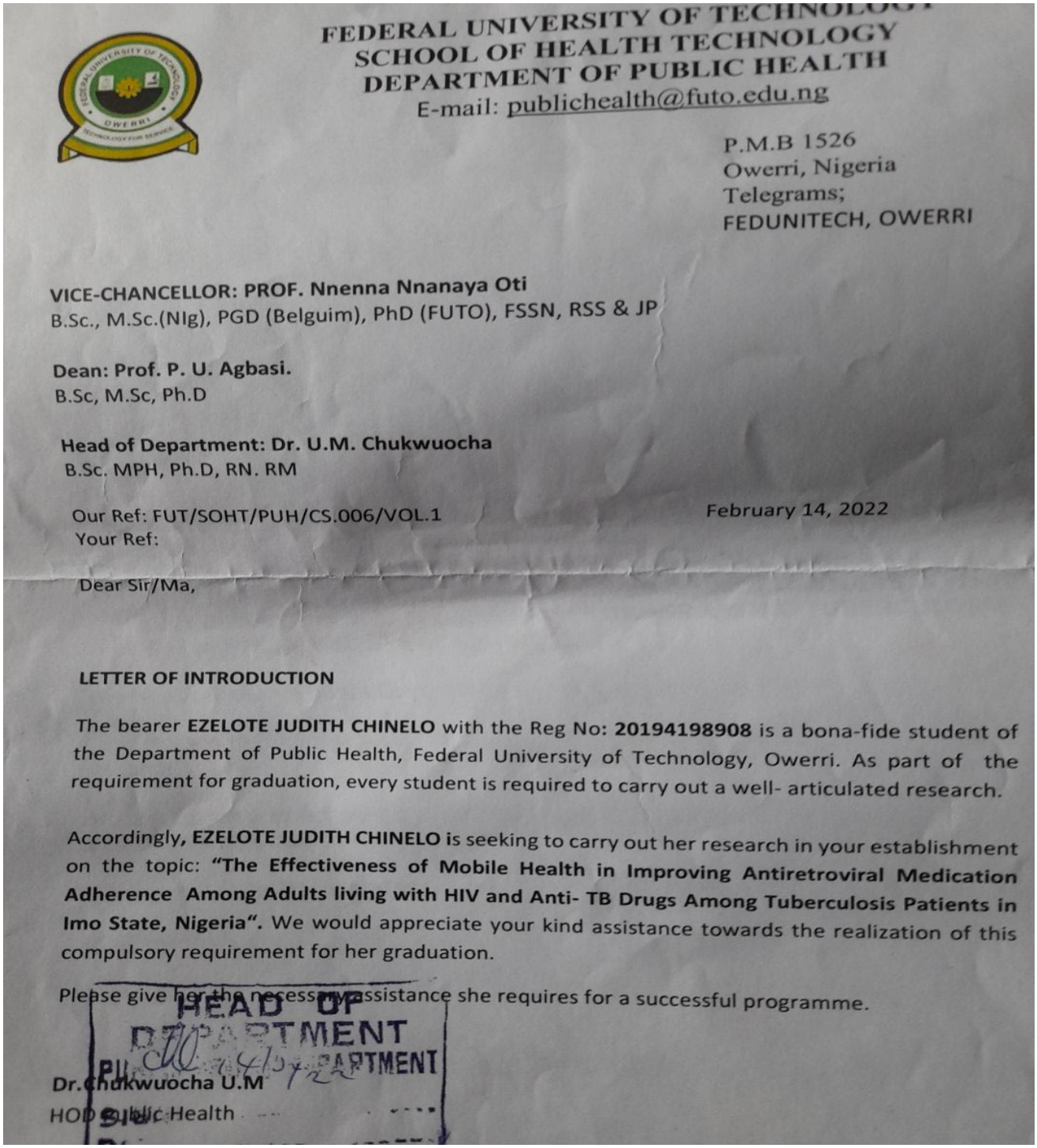
	A	b	c	d
Name /ID No	**Yes, I attended my clinic appointment.**	**No, I did not attend my clinic appointment.**	**I rescheduled my appointment**	**Percentage of time adherence**

Refill of drugs

	a	B	c	d
Name /ID No	**Yes, I have refilled my drugs**	**No, I have not refilled my drugs**	**No, I have not refilled my drugs. I still have some drugs remaining.**	**Percentage of time adherence**

APPENDIX I

LETTER OF INTRODUCTION FROM FUTO



FEDERAL UNIVERSITY OF TECHNOLOGY
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B.Sc, M.Sc, Ph.D

Head of Department: Dr. U.M. Chukwuocha
B.Sc. MPH, Ph.D, RN. RM

Our Ref: FUT/SOHT/PUH/CS.006/VOL.1
Your Ref:

February 14, 2022

Dear Sir/Ma,

LETTER OF INTRODUCTION

The bearer **EZELOTE JUDITH CHINELO** with the Reg No: **20194198908** is a bona-fide student of the Department of Public Health, Federal University of Technology, Owerri. As part of the requirement for graduation, every student is required to carry out a well- articulated research.

Accordingly, **EZELOTE JUDITH CHINELO** is seeking to carry out her research in your establishment on the topic: **"The Effectiveness of Mobile Health in Improving Antiretroviral Medication Adherence Among Adults living with HIV and Anti- TB Drugs Among Tuberculosis Patients in Imo State, Nigeria".** We would appreciate your kind assistance towards the realization of this compulsory requirement for her graduation.

Please give her the necessary assistance she requires for a successful programme.

HEAD OF DEPARTMENT

Dr.Chukwuocha U.M
HOD, Public Health

APPENDIX J

ETHICAL APPROVAL FROM FUTH

FEDERAL MEDICAL CENTRE

P. M. B. 1010, Orlu Road Owerri, Imo State, Nigeria

Medical Director
DR. K. I. ACHIGBU
MBBS, FWACP
Chief Consultant Paediatrician

Ag. Head of Clinical Services
DR. CHUKWUMAM D.O.C
M.B.B.S, FWACS, FICS
Chief Consultant Orthopaedic/
Trauma Surgeon.

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Chairman of Board
SENATOR (DR) IS'HAQ SALMAN

Head of Administration
KELECHI O. OTUNEME
B.TECH, MILR, MSC, MNIM, AHAN, ANIPR

21576

FMC/OW/HREC/VOL.II/048 February 25, 2022.

Ezelote Judith Chinelo,
Department of Public Health,
School of Health Technology,
Federal University of Technology,
Owerri.
Imo state.

Dear Ezelote Judith Chinelo,

ETHICAL APPROVAL

RE: "THE EFFECTIVENESS OF MOBILE HEALTH IN IMPROVING ANTIRETROVIRAL MEDICATION ADHERENCE AMONG ADULTS LIVING WITH HIV AND ANTI-TUBERCULOSES DRUGS AMONG TUBERCULOSIS PATIENTS IN IMO STATE NIGERIA".

The Health Research Ethics Committee has reviewed your proposal on the above study.

I am pleased to inform you that ethical approval has been granted for the conduct of your research.

You are advised to adhere to your methodology as stated in the proposal and submit a copy of your dissertation to this Committee on completion of your study.

This approval is valid for one year.

Yours faithfully,

DR. I. I. IKE (MBBS, FMCPAED)
CHAIRMAN, HEALTH RESEARCH ETHICS COMMITTEE.

APPENDIX K

DEFINITION OF TERMS

Adherence	A tuberculosis patient is expected to take at least 70–90% of prescribed doses (WHO, 2003) or all doses (Amuha, 2009) to be considered adherent. In the treatment of patients with HIV infection it is essential to achieve more than 95% compliance to ART (Antiretroviral Therapy) in order to suppress viral replication and avoid the emergence of resistance (Ishwar et al 2016). For this study, adherent will be 80% of prescribed anti-TB drugs and 95% of ART drugs among the TB patients and PLWHIV respectively.
PLWHIV	People Living With HIV
PLWHA	People living with HIV and AIDS
LTFU	Lost To Follow-Up
FUTH	Federal University Teaching Hospital
ISSH	Imo State Specialist Hospital