Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Medicine and Health Sciences
Department of Public Health and Nursing

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Healthcare Workers' Perceptions Towards the Use of mHealth Technologies in Public Health Facilities in Lagos, Nigeria

A Qualitative Study

Master's thesis in Global Health
Supervisor: Beate André
Co-supervisor: Jon Øyvind Odland, Gabriela J. Diaz, Anders Aune, Peter Ubuane and Zainab Imam

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ABSTRACT

BACKGROUND: mHealth technologies play a crucial role in healthcare delivery, especially in low- and middle-income countries (LMICs) and offer a variety of opportunities. The expansion of mobile phone availability and usage has been especially significant in LMICs, facilitating the use of mobile health (mHealth) technologies. In 2020, 2,4 million newborns died worldwide during the neonatal period. Global interest in mHealth interventions to improve neonatal health and eliminate preventable neonatal deaths is expanding rapidly. This is illustrated by the development of the mHealth application *Picterus*, which aids healthcare workers in detecting neonatal jaundice. mHealth solutions can provide cheaper, faster, and more convenient approaches than the conventional methods utilized in many LMICs. Despite some existing mHealth interventions, Nigeria is among the countries worldwide with a low adoption rate; thus, it is essential to investigate the causes of this. Healthcare workers' engagement is essential for mHealth's adoption and sustainability. Therefore, this qualitative study aims to explore healthcare workers' perceptions in Lagos, Nigeria, regarding mHealth technologies.

METHODS: Doctors, nurses, and Community Health Extension Workers (CHEWs) from primary, secondary, and tertiary public health institutions in Lagos, Nigeria, participated in a total of six focus group discussions (FGD). The FGDs were divided into two segments. The first segment addressed mHealth technologies in general, while the second featured a demonstration of the mHealth app *Picterus*, focusing on screening support and neonatal health. The focus group discussions were audio recorded, transcribed, and analyzed using a thematic approach.

FINDINGS: The thematic analysis of the FGDs revealed information regarding the benefits that promote the use of mHealth and the barriers that limit its use, as perceived by healthcare workers. The perceived benefits included expanded access to health-related information, enhanced patient-provider communication, time savings, flexibility, and the development of the health care system. On the other hand, perceived barriers included altering healthcare routine practices, disconnection of face-to-face patient-provider relationships, skepticism and lack of trust, information overload, and lack of awareness, knowledge, and skills. In addition, costs, power supply, internet access, network failure, and lack of- and maintenance of devices were considered barriers.

CONCLUSION: The findings of this study can be disseminated to developers and implementers of mHealth technologies, who can use them to create new or enhance existing mHealth solutions to better meet the needs and requirements of healthcare workers in low- to middle-income health settings, such as Lagos, Nigeria. By doing so, appropriate mHealth initiatives with the potential to improve healthcare for individuals can be adopted and is also crucial for minimizing preventable newborn deaths.

KEYWORDS: Mobile Health, mobile applications, healthcare workers, perceptions, low- and middle-income countries, Nigeria, neonatal deaths, jaundice, *Picterus* app, screening tools, thematic analysis.

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ABBREVIATIONS AND ACRONYMS

CHEW	Community Health Extension Worker
DTA	Data Transfer Agreement
eHealth	Electronic Health
FGD	Focus Group Discussion
FMC	Federal Medical Center
ICT	Information and Communication Technology
IT	Information Technology
LASUTH	Lagos State University Teaching Hospital
LMIC	Low- Middle- Income Country
mHealth	Mobile Health
Mmol	Millimole
MOH	Medical Officer of Health
NNJ	Severe Neonatal Jaundice
NSHDP	National Strategic Health Development Plan
NTNU	Norwegian University of Science and Technology
PDA	Personal Digital Assistants
PHC	Primary Healthcare Center
REK	Regional Committee for Medical and Health Research Ethics
SDG	Sustainable Development Goal
TA	Thematic analysis
TAM	Technology Acceptance Model
TcB	Transcutaneous Bilirubinometry
TSB	Total Serum Bilirubin
UCH	Universal Health Coverage
WHO	World Health Organization

DEFINITIONS

BILIRUBIN: “Substance formed when red blood cells are broken down. The abnormal buildup of bilirubin causes jaundice” (NIH, 2022).

BILIRUBIN ENCEPHALOPATHY: “Brain damage caused by high levels of bilirubin in the blood. Also known as kernicterus” (NHS, 2018).

BASAL GANGLIA: A structure in the base of the brain “responsible primarily for motor control, as well as other roles such as motor learning, executive functions and behaviors, and emotions” (Lanciego et al., 2012).

CEREBRAL PALSY: “Cerebral palsy is the name for a group of lifelong conditions that affect movement and coordination. It's caused by a problem with the brain that develops before, during, or soon after birth” (NHS, 2020).

ELECTRONIC HEALTH (eHEALTH): “The use of information and communications technology in support of health and health-related fields” (WHO, 2019, p. 11).

KERNICTERUS: Brain or central nervous system damage due to excess bilirubin in the blood and it is a severe complication of untreated jaundice in babies. Also known as bilirubin encephalopathy (NHS, 2018).

MOBILE HEALTH (mHEALTH): “Medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices” (WHO, 2011, p. 14).

NEONATAL HYPERBILIRUBINEMIA: “Elevated amount of bilirubin in the blood of newborn babies” (Ansong-Assoku et al., 2022). Also known as neonatal jaundice.

NEONATAL JAUNDICE: Most often, a normal, harmless, and self-limiting condition in newborns (Aune et al., 2020) that causes a yellow coloring of the skin and sclera (the whites of the eyes) in infants due to the accumulation of bilirubin (Ansong-Assoku et al., 2022).

NEONATAL MORTALITY: “Deaths occurring during the first four weeks after birth” (WHO, 2006, p. 1).

TOTAL SERUM BILIRUBIN: “Blood test that measures the amount of a substance called bilirubin” (URMC, 2022).

1 INTRODUCTION

This chapter presents the research background and existing literature for the investigated topics. In addition, the Nigerian context of the study is presented. The chapter then describes the rationale of the investigation. Finally, the study's aim, objectives, and research question are outlined.

1.1 BACKGROUND AND LITERATURE REVIEW

This section describes mHealth, its significance, and its potential to help improve healthcare, particularly by reducing unnecessary neonatal mortality and morbidity in low- and middle-income countries. Furthermore, this section will explain the significance of the various mHealth initiatives, especially mobile phones and applications. In addition, it focuses on mHealth interventions as screening support for healthcare workers. The mHealth application *Picterus* illustrates how healthcare workers could use mHealth technology in their daily practice with newborns to detect neonatal jaundice, hence helping to decrease unnecessary neonatal deaths. Presented are the benefits and barriers of mHealth technologies, their implementation and adoption, and the process of changing current practices.

1.1.1 What is mHealth and the importance of mHealth

The World Health Organization (2011, p. 14) defined mHealth (mobile health) as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices" and it is a subset of electronic health (eHealth).

Several studies have emphasized the great potential for mobile technologies to improve healthcare by making it more effective, accessible and affordable (PWC, 2012, p. 3), which the current healthcare system cannot satisfy alone (Shareef et al., 2014). mHealth is considered crucial in healthcare delivery, particularly in low- and middle-income countries (LMICs) (Fox et al., 2020; McCool et al., 2022). The potential benefits of utilizing mHealth technology to enhance healthcare in LMICs are vast, and they present numerous

opportunities (Qiang et al., 2012). Treatment support, patient tracking, health financing, emergency services, recordkeeping, support for clinical decision making, disease prevention and education and awareness are among the most prevalent applications of mHealth (Qiang et al., 2012, pp. 20–22). In addition, mHealth is viewed as a crucial element in the promotion of Universal Health Coverage (UHC), which "implies that all people, without discrimination, have access, to nationally determined sets of the needed promotive, preventive, curative, and rehabilitative basic health services and essential, safe, affordable, effective, and quality medicines" (United Nations, 2013).

1.1.2 mHealth interventions in low- and middle-income settings

In LMICs, various mHealth interventions to improve healthcare have been proposed. In Nigeria, the 'SMART' project utilized SMS printers to expedite the return of HIV/AIDS test results for infants. SMS printers allowed healthcare facilities to receive and print test results without using computers or the internet. The project results revealed a reduction in infant turnaround time and loss-to-follow-up (World Health Organization, 2013). Similarly, another mHealth intervention in northern Nigeria consisted of an app designed to assist healthcare professionals in providing improved antenatal care services. The results revealed improvements in client education, counseling, and technical aspects of care (McNabb et al., 2015).

Moreover, SMS or text messages are among the most widely used mHealth technologies, especially in LMICs (Gleason, 2015; Kruse et al., 2019). Text message appointment reminders have been used to encourage patients to attend their appointments (Lin et al., 2016). Lin et al. (2016) discovered in their study that text message reminders were an effective strategy to enhance the attendance rate at a clinic for urban pediatric residents with high no-show rates. Because of the advent of text messages, many people living in remote areas can receive health-related information and contact healthcare practitioners for assistance with diagnosis and treatment (Gleason, 2015). Moreover, SMS initiatives are low-cost, simple-to-implement solutions because of the "global proliferation of cellphone infrastructure" (Gleason, 2015, p. 3).

1.1.3 Mobile phones and healthcare

According to 2021 statistics, nearly 15 billion mobile devices were in use worldwide, which is expected to exceed 18 billion by 2025 (Statista, 2021). Faulkenberry et al. (2022) emphasize the benefits of always having mobile devices on hand by highlighting the enhanced access to the rest of the world, which has resulted in unprecedented increases in communication, collaboration, and information sharing. The expansion of mobile phone availability and use has been especially significant in LMICs (Hall et al., 2014). In many places, having access to a mobile phone is more common than having access to clean water and electricity (Hall et al., 2014).

The first standard mobile phone was introduced in 1973, allowing communication via phone calls and text messages (McCool et al., 2022). However, in 2001, the smartphone was introduced, bringing a slew of new features. People can use their smartphones to access more advanced features such as the internet, make video calls, and download various applications (McCool et al., 2022). Furthermore, the modern smartphone is a technology that is well-suited for use in healthcare (Latif et al., 2017). The number of programmable sensors, such as the camera, microphone, and touch-sensitive screen, reflects its broad applicability (Latif et al., 2017). Moreover, according to statistics, 48 percent of the total population in Sub-Saharan Africa were owners of a smartphone in 2020 (GSMA, 2021).

Furthermore, smartphones are expected to account for just under two-thirds of total connections in Sub-Saharan Africa by 2025, with Nigeria ranking among the top three countries in smartphone connections (GSMA, 2021). The development of applications or apps is one of the areas of mHealth that is rising rapidly due to the increasing use of mobile devices such as smartphones in different parts of the world (Coppock, 2009). Apps or applications are defined as “programs developed to run on a device for a specific purpose” (Wallance, 2012, p. 2) and “are designed to operate on mobile technology such as smartphones, tablet computers, and other mobile devices” (Malvey & Slovensky, 2014, p. 67). Developers have taken advantage of the enormous potential and opportunities for mHealth applications to positively influence health care (Chatzipavlou et al., 2016). In 2017, there were approximately 325.000 health-related apps on the market and over 80.000 mHealth app publishers, with the industry experiencing an annual download of more than 3.7 billion (Globe Newswire, 2020).

1.1.4 mHealth interventions as screening support

Numerous screening apps are available on the market today, and many of these apps are designed to provide screening- and treatment support to healthcare workers (Coppock, 2009; Jutel & Lupton, 2015). For instance, in the study by Raghu et al. (2015), they designed a mHealth platform to screen and manage cardiovascular diseases in rural India. Furthermore, mHealth interventions to enhance neonatal health are a rapidly expanding area of global interest. Detecting neonatal jaundice is one example (Aune et al., 2020). mHealth solutions can provide cheaper, quicker, and more convenient approaches to diagnosis compared to traditional methods used in many LMICs (Osei & Mashamba-Thompson, 2021).

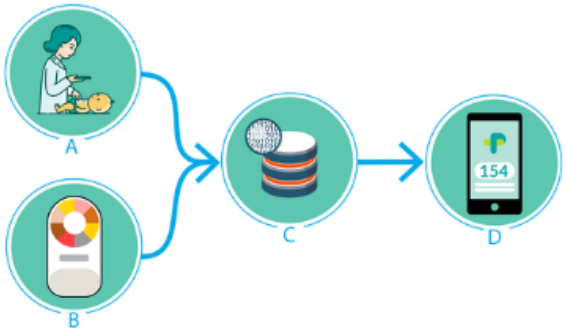
1.1.5 mHealth application to assist in the detection of neonatal jaundice: *Picterus*

Picterus is a mHealth application developed by researchers from the Norwegian University of Science and Technology and *Picterus AS* to assist healthcare workers in assessing neonatal jaundice (Aune et al., 2020). It is a smartphone-based solution that estimates newborn babies' bilirubin levels using digital images and a calibration card (Aune et al., 2020). Neonatal jaundice, also known as neonatal hyperbilirubinemia, is caused by increased total serum bilirubin levels and appears as a discoloration of the baby's skin and sclera (Ansong-Assoku et al., 2022). When the bilirubin level is 90 mmol/liter, the condition is often visible in babies with pale skin tone. However, according to Mitra and Rennie (2017, p. 14), it can be more difficult to assess visually in babies with darker skin color.

If discovered, monitored, and treated promptly, neonatal jaundice is usually harmless and self-limiting (Aune et al., 2020; Ansong-Assoku et al., 2022; Bhutani et al., 2013). However, when treatment is required and not received on time, jaundice can sometimes cause severe brain injury if enough bilirubin penetrates the blood-brain barrier and accumulates in the brain's basal ganglia (Maisels, 2015). Bilirubin encephalopathy, also known as kernicterus, is a type of brain injury that can result in long-term disabilities such as cerebral palsy and deafness. In the worst-case scenario, it can be fatal (Aune et al., 2020; Maisels, 2015). Furthermore, most bilirubin-induced deaths occur during the neonatal period (Olusanya et al., 2018).

According to numbers, South Asia and Sub-Saharan Africa have the highest prevalence of neonatal jaundice (Olusanya et al., 2018). A nationwide study of pediatricians in Nigeria highlighted neonatal jaundice as a priority neonatal illness requiring global health action (Olusanya et al., 2012). Moreover, one of the problems associated with newborn jaundice in LMICs is the delay in administering adequate treatment (Olusanya et al., 2018).

The gold standard for identifying neonatal jaundice in infants is the measurement of total serum bilirubin (TSB) (Aune et al., 2020). Transcutaneous bilirubinometry (TcB) is an alternative; however, both screening procedures are costly and, therefore, unavailable in all health facilities in LMICs (Aune et al., 2020). In addition, laboratory investigation facilities are sometimes positioned distant from neonatal units, making it challenging to receive test results quickly to make prompt treatment judgments. Consequently, many healthcare providers in LMICs rely on visual assessment of neonatal jaundice, which is not advised due to the high risk of missed cases (Aune et al., 2020; Olusanya et al., 2018). The *Picterus* app provides a cost-effective way of detecting neonatal jaundice in newborns. It has the ability to detect neonatal jaundice early, hence minimizing neonatal fatalities and long-term impairments in neonatal jaundice-affected infants (Aune et al., 2020).



(A) A photo is taken of the baby's chest, where the calibration card is placed, using a phone with the *Picterus* app installed
(B) The calibration card which is used to calibrate the photo
(C) Calibrated colours are then compared with a large database of colour and bilirubin pairs
(D) The bilirubin estimate is presented to the user of the app

Figure 1. Workflow of the Picterus app (source: Aune et al., 2020).

1.1.6 Global initiatives to reduce preventable neonatal deaths

One of the key areas where mHealth interventions have already demonstrated significant results and improvements is in the field of neonatal health, with the common goal of reducing neonatal deaths (WHO, 2022), and a variety of mHealth interventions has shown to reduce neonatal mortality (Keisling, 2014). The WHO (2006, p. 1) defines neonatal mortality as "deaths occurring during the first four weeks after birth." According to statistics, 2.4 million babies died during their first month of life, also known as the neonatal period, in 2020 (WHO, 2022). The neonatal period is described as "the most vulnerable period for child survival" (WHO, 2022). According to 2020 data, up to 47 percent of all under-5 deaths occurred during the first 28 days of life (WHO, 2022). In accordance with the WHO (2022), conditions and diseases associated with a lack of proper treatment "at or immediately after birth and in the first days of life" are among the leading causes of death in the first few months of life. Most neonatal deaths occur in low- and middle-income countries (United Nations, 2021). Reducing these deaths has been and continues to be one of the global focus areas and is included in SDG target number 3, "ensure healthy lives and promote well-being for all at all ages" (United Nations, 2021). There has been substantial progress in lowering newborn fatalities worldwide, with projections from the WHO (2022) showing a decline from 5 million neonatal deaths in 1990 to 2.4 million in 2020. Despite global improvements in neonatal mortality rates, there is still a long way to go (Unicef, 2021). According to the WHO (2022), many neonatal deaths in LMICs are preventable, and a high number of newborn deaths could be prevented with decent care, treatment, and cost-effective alternatives, such as mHealth technologies (Unicef, 2021). Therefore, according to Slusher et al. (2011), appropriate technologies are required immediately.

1.1.7 Neonatal mortality in the Nigerian context

Across countries, neonatal mortality rates vary significantly (WHO, 2022), whereas Nigeria is one of the countries with the highest newborn mortality globally. Moreover, Nigeria's leading cause of mortality is neonatal disorders (IHME, 2022).

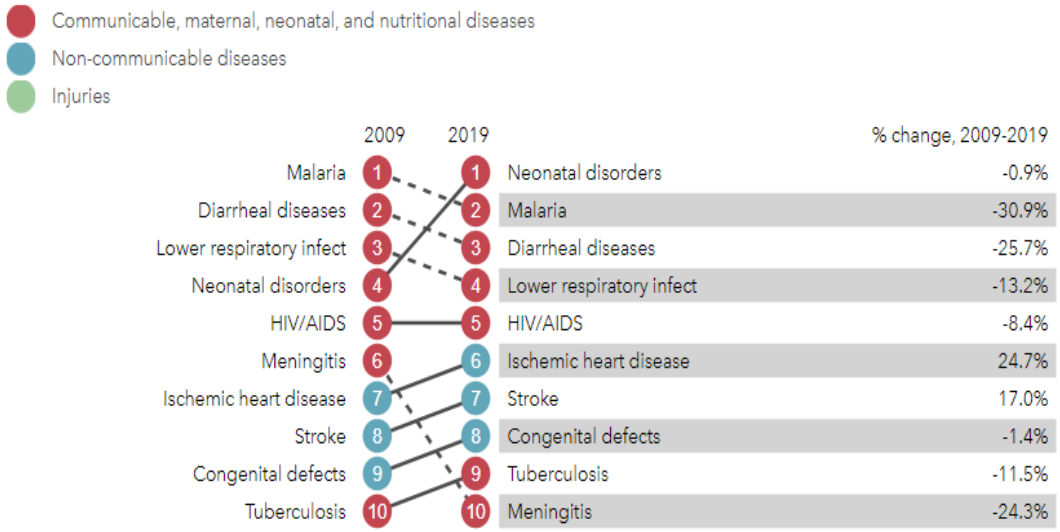


Figure 2. Leading causes of mortality in Nigeria (source: IHME, 2022).

According to statistics, there were 36 neonatal deaths per 1,000 births in 2020 (The World Bank, 2022). Asphyxia, premature birth, severe infections, and severe hyperbilirubinemia are Nigeria's top causes of infant mortality (Ogunlesi et al., 2019). According to previous research, severe neonatal jaundice (NNJ) is the most prevalent reason for admission in the first week of life after infection (Udo et al., 2008). In addition, severe neonatal jaundice accounts for 5-14 percent of neonatal deaths in Nigeria (Diala et al., 2018). Those newborns who survive severe NNJ are also at risk for neurodevelopmental abnormalities (Olusanya et al., 2009), from auditory neuropathy spectrum disorder to severe cerebral palsy (Diala et al., 2018). Early detection, monitoring, and treatment can prevent most bilirubin-induced deaths (Olusanya et al., 2018). Therefore, it is vital to adopt behaviors that promote care-seeking and make available resources necessary for early detection and treatment.

1.1.8 Benefits and barriers of mHealth technologies

Benefits

Utilizing mHealth has the potential to improve health outcomes by enhancing the delivery of health care services (WHO, 2019). Furthermore, the advent of mHealth offers various benefits, including providing previously unavailable care, increased access to services and care delivery, enhanced professional education, treatment adherence, and decreased

healthcare costs (Odendaal et al., 2020; Ventola, 2014). In addition, it has been demonstrated that mHealth technologies facilitate communication and improve access to medical information for health care providers and consumers (Hall et al., 2014). Increased access to information enables patients, healthcare workers, and communities to make informed health-related decisions (Ventola, 2014). Furthermore, when healthcare providers have access to information, they can learn more from others and keep up with the most recent medical trends and best practices (Ventola, 2014). mHealth has the potential to address issues in regions with limited access to health services, whether because of distance or a lack of healthcare providers (Mechael, 2009). Moreover, mHealth technologies, such as mobile devices, can assist patients with medication adherence and healthy lifestyle maintenance (Armitage et al., 2020). This is made possible by using messages reminding patients to take their medication regularly and providing feedback to the healthcare provider. For example, to encourage adherence to chronic disease management, SMS is the mHealth technique that is most regularly, successfully, and broadly employed (Hamine et al., 2015). Furthermore, it can be made accessible on any mobile phone for a reasonable price, automated, customized, and easily integrated with existing health systems (Hamine et al., 2015, p. 8). Moreover, according to Hamine et al. (2015), it can be utilized by individuals with little technological knowledge or experience.

Currently, patient health records are maintained digitally rather than on paper in many settings, which reduces the risk of medical information loss (Rajput et al., 2012). Information gathered with handheld devices is less likely to contain errors, is more comprehensive, requires less cleaning, and is not more expensive than information gathered with pen and paper (Rajput et al., 2012). In the study by Rajput et al. (2012), community health workers who used mobile devices to collect data believed they produced higher-quality data more quickly and easily than paper-based data collection tools.

In addition, mobile health is regarded as a more flexible method of delivering healthcare. It is flexible in that it is easily accessible, can be used anywhere, and can be utilized without difficulty by anyone with adequate training (Odendaal et al., 2020). In a study by Pokhrel et al. (2021) investigating how people perceive a mobile app designed to identify and treat mental health concerns, participants listed the mobile app usability and accessibility as beneficial. According to the study's health professionals, the app's availability on a smartphone made it accessible from any location (Pokhrel et al., 2021). Furthermore, a review of healthcare professionals' perceptions regarding the use of mHealth technology

revealed that healthcare professionals valued the fact that such technologies made it easier for them to reach patients in remote areas (Odendaal et al., 2020). In addition, their findings indicated that healthcare professionals believed mobile phone communication with patients improved patient care and the patient-provider relationship (Odendaal et al., 2020).

Barriers

Many studies have been undertaken over the years to examine the effects of mHealth on healthcare, demonstrating the tremendous global impact that arises and underlining the significance of employing such technology to improve health in the developing world in particular (Sezgin et al., 2017). Although multiple mHealth technologies have been introduced and despite their numerous benefits and opportunities for improving health (PWC, 2012), few have successfully scaled up in LMICs beyond the pilot stage (Sant Fruchtman et al., 2021). Consequently, surprisingly few mHealth initiatives have been properly adopted or incorporated into health programs in developing countries (Kenny et al., 2017; Labrique et al., 2013). According to research, implementing new mHealth technology is a complex process including various components (Sundin et al., 2016). In addition, research indicates that several variables can limit the adoption and utilization of mHealth (PWC, 2012), resulting in a low scale-up rate for mHealth interventions in low- and middle-income settings (Sundin et al., 2016). According to Sundin et al. (2016), the limited scale-up in such contexts can be linked to barriers associated with costs, technological issues, management, and the technology users (PWC, 2012).

Furthermore, Zakerabasali et al. (2021) conducted a recent systematic review that investigated the barriers to mHealth adoption and identified three major categories of barriers: technical, individual, and the healthcare system. The eight technical barriers were related to lack of existing technology, concerns about efficacy, security concerns, user-friendliness, compatibility with workflow, internet connectivity, and integration with current systems (Zakerabasali et al., 2021). Individual barriers included lack of support, acceptance, and resistance to change, problems related to understanding technology, knowledge, and limited literacy (Zakerabasali et al., 2021). Additionally, the barriers in the healthcare system were related to legal barriers, reimbursement, financial factors, a lack of health system policies, and a lack of standards (Zakerabasali et al., 2021).

According to O'Connor et al. (2016, p. 221), a lack of understanding of the opportunities offered by mHealth technologies is one of the most significant challenges faced by users (healthcare workers and patients) in low- and middle-income settings, and consequently influences the adoption. Furthermore, Kaium et al. (2020) underline that many of the initiated mHealth projects have not been sufficiently adopted due to a lack of public awareness of these services. In addition, Goel et al. (2013) found that adequate training of healthcare workers is essential when implementing mHealth technologies, which is often not the case, and thus, limiting the uptake.

1.1.9 Acceptance and the process of changing

Acceptance

User acceptability, or "the acceptance of using the technology" (White et al., 2016), is regarded as crucial for implementing new technologies (Taherdoost, 2019). According to Taherdoost (2019), various technologies can be initiated and developed. However, success is unlikely if targeted users do not engage in the process and refuse to utilize the technology (Taherdoost, 2019). Exploring this is a crucial step in implementing innovative mHealth technologies, as it can provide implementers with essential knowledge regarding factors that influence the users' motivation to use the technology (Taherdoost, 2019). Several theoretical models that describe the diversity in people's intentions to accept and utilize various technologies have been developed as a result of research on user acceptance (Venkatesh et al., 2003). The Technology Acceptance Model (TAM) was outlined by Fred Davis in 1985 (Davis, 1989) and is a central model used to grasp the technology acceptance of the users more thoroughly (Venkatesh et al., 2003).

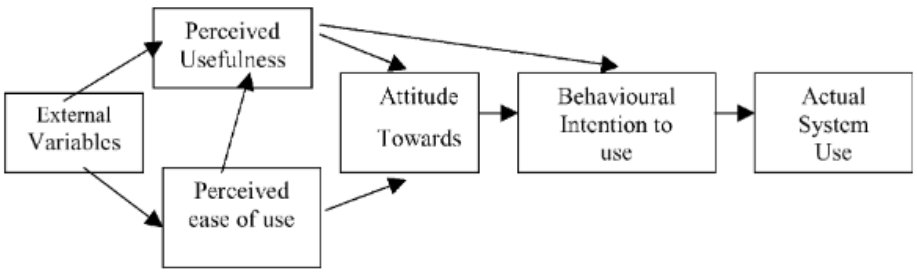


Figure 3. Technology Acceptance Model (TAM) (source: (Legris et al., 2003).

According to Alomary and Woollard (2015), the TAM model “provides a framework to measure users' perceptions of and intentions to use technology within and across organizations,” and examines the influence of “external variables on internal beliefs, attitudes, and intentions” (Legris et al., 2003, p. 192). Moreover, the goal is to better understand user adoption and why a particular technology is accepted or rejected by the users (Legris et al., 2003). The model proposes that two critical factors influence people's intention to use new technology, including 'perceived ease of use’ and 'perceived usefulness' (Charness & Boot, 2016). Perceived usefulness involves the users’ expectation that the technology will be helpful in their job, while perceived ease of use involves the users’ expectation that the technology is user-friendly and easy to use (Ammenwerth, 2019). Furthermore, according to Ammenwerth (2019), because users find easy-to-use technology more useful, perceived ease of use influences perceived usefulness. In addition, the user's attitude towards using technologies is determined by both perceived usefulness and perceived ease of use (Ammenwerth, 2019).

Furthermore, this attitude determines the behavioral intention to use the technology, which can be translated as technology acceptance (Ammenwerth, 2019). Various studies have utilized the TAM model, where TAM-based surveys have aided in identifying factors that influence health Information Technology (IT) implementation optimization (Ammenwerth, 2019). The model demonstrates which variables influence the behavioral intention of a specific health technology, either directly or indirectly. As a result, decision-makers can now intervene in the development of mHealth technologies (Ammenwerth, 2019).

The process of changing

According to Nilsen et al. (2016), one of the most significant barriers to the implementation and adoption of mHealth technology is the resistance of users (healthcare workers and patients), which can be related to both resistance directed to the technology and resistance to change. Several variables have been linked to resisting change, such as negative attitudes (Rehman et al., 2021), lack of knowledge, beliefs, trust, and acceptance (Angonese & Lavarda, 2014). According to Campbell, changes will come if new technologies are to be implemented (2015, p. 20). Thus, adopting new mHealth technologies in healthcare will modify existing health systems and healthcare workers' current routines and practices (Shareef et al., 2014). Campbell further underlines the importance of healthcare workers

adapting and embracing new technologies “in order to provide patients with the healthcare and caring that they deserve” (2015, p. 20), which is also essential for the longevity of the technology (Shareef et al., 2014). However, resisting change is identified as a ‘natural defense mechanism,’ and it is important to take precautions when entering unknown territory (Craine, 2007; Haslam & Pennington, 2010), such as various mHealth technologies. Adjusting to change can be seen as a process that is rarely straightforward, with no single ideal recipe for how individuals should respond to it (Craine, 2007). According to Craine (2007), there are various stages of a change process, which can be summarized by the ‘Change Cycle,’ a four-stage emotional cycle that people frequently experience when experiencing change processes (Craine, 2007). The cycle consists of the four following phases: the comfort zone, the "no" zone, the chasm, and the "go" zone (Craine, 2007), and each step of the process is described below.

'The comfort zone'

The cycle starts with the comfort zone, which is the zone where people are often found before a change (Craine, 2007). This is a zone where most individuals are happy with their current situation and believe they can handle any issue that may happen. When people are exposed to new and unfamiliar solutions and ways of doing things, which disrupt their established habits, they frequently lose confidence because it is no longer "the way they are used to doing things" (Craine, 2007, p. 44). Craine underlines that "change affects people's ability to feel comfortable, capable, and confident because it means that they must learn new systems, work in new ways, and accept new responsibilities" (2007, p. 44).

'The "no" zone'

The subsequent phase of the cycle is the "no" zone, which presents a variety of possible responses to change, and Craine refers to this phase as an "emotional phase" (2007, p. 46). During this cycle phase, responses such as astonishment, denial, anger, resentment, frustration, and sabotage may arise. When in this phase, the individual or group facing an impending transition may lack the motivation and willingness to plan for the future (Craine, 2007).

'The chasm'

The chasm, training, and education become crucial in the next phase of the change cycle (Craine, 2007). People are now aware that there is no turning back, but they are also

attempting to find their place in the transformation. According to Craine, during the chasm phase, individuals may not oppose the change but may also not accept it, indicating that they are somewhere in between (2007). Nonetheless, he emphasizes that acceptance is very subjective; some individuals embrace changes quickly, while others require more time to comprehend and accept them (2007). Furthermore, when facing changes, it is not uncommon to feel anxious. People would be interested in how changes will influence them; thus, it is essential to have an open discourse about this (Craine, 2007).

'The "go" zone'

The "go" zone is the final phase of the change cycle. According to Craine (2007), if individuals are given time and assistance to go through the preceding stages, they will eventually begin to accept the change. However, not everyone reaches acceptance, and they battle with each stage of the transformation cycle (Craine, 2007). Craine emphasizes the significance of informing people of "what they need to do to support the change and what will happen if they do not" (2007, p. 48). The "go" phase is when technology is ready to be implemented, and people are enthusiastic about the implementation and the path forward (Craine, 2007).

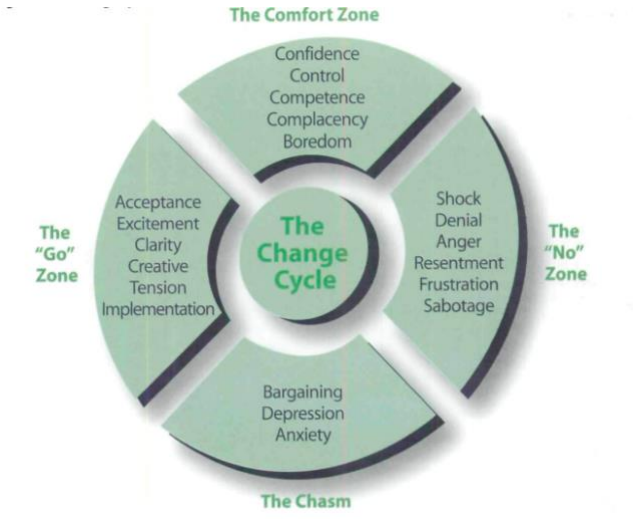


Figure 4. The change cycle (source: Craine, 2007).

1.2 THE NIGERIAN CONTEXT

Nigeria, a country in West Africa, has a population of around 216 million people, making it the most populous country in Africa. In addition, it is the seventh most populous country in the world (UBA Nigeria, 2022). There are around 250 ethnic groups that live in Nigeria, with Hausa, Yoruba, and Igbo representing the three largest groups (UBA Nigeria, 2022). Furthermore, there are 500 distinct languages. According to numbers from 2017, the median age was 18.1 years (UBA Nigeria, 2022). Lagos is the largest city in Nigeria, with a population of around 15.5 million (Statista, 2022). All Nigerian ethnic groups exist in this area, but the Yoruba ethnic group predominates (UBA Nigeria, 2022).

Healthcare in Nigeria is a shared responsibility of the country's three levels of government. There are three stages of healthcare: primary, secondary, and tertiary. There are generally both public and private healthcare providers. Local-, state-, and federal governments are responsible for public healthcare services at primary, secondary, and tertiary levels, respectively. Private healthcare providers play a prominent role in healthcare delivery (Welcome, 2011). Data from the World Bank (2019) indicate that around 70 percent of healthcare expenditures in Nigeria were paid out of pocket. This implies that most Nigerians have no health insurance and the poorest Nigerians have restricted access to high-quality medical treatment (Okunola, 2020). Moreover, Nigeria lacks a national health registry, and most of its healthcare industry still uses analog record-keeping and data collection techniques, making it more difficult to track everything throughout the healthcare system (Okunola, 2020). Frequently, patient information is lost, misdiagnosis is widespread, and a great deal of record keeping is duplicated. In addition, there are no comprehensive medical equipment registries, and data from blood banks is limited (Okunola, 2020). Priority lies in digitizing predominantly paper-based records (Pilling, 2022).

Through the federal ministry of health, the Nigerian government established the Second National Strategic Health Development Plan (Second National Strategic Health Development Plan, 2018-2022, p. 2). This development plan provides a road map for the healthcare sector to assist the country in achieving the goals and objectives of the National Health Policy (National Strategic Health Development Plan, 2018-2022, p. 12). According to the most recent national survey, neonatal disorders account for the major proportion of the disease burden in Nigeria (IHME, 2022). Through a reinforced healthcare system, this program aims to "guarantee that the Nigerian population has universal access to complete, appropriate,

cheap, efficient, equitable and quality necessary healthcare" (Second National Strategic Health Development Plan, 2018-2022, p. 13). The Second National Strategic Health Development Plan includes several guiding principles to help achieve its objectives, one of which is to use appropriate technology to address health-related problems (Second National Strategic Health Development Plan, 2018-2022). Furthermore, mHealth is a practical technology that can assist in achieving this goal to address the present health-related issues.

1.3 RATIONALE FOR CONDUCTING THE STUDY

The current study focuses on healthcare workers, who will be exposed to various mHealth technologies throughout their careers. Evidence reveals that healthcare workers play a significant role in the adoption and sustainability of mHealth (Odendaal et al., 2020). For the successful adoption of mHealth technologies in healthcare, it is essential to evaluate healthcare workers' perceptions of mHealth technologies. Doing this is important because their perceptions might disclose critical information about their acceptance and motivation to utilize various technologies in practice (Venkataraghavan et al., 2021; Ratanawong et al., 2022). Implementation of mHealth technologies, especially in LMICs, has been demonstrated to be crucial to supporting the current health systems (McCool et al., 2022).

In addition to perceptions of mHealth technologies in general, mHealth technologies used as screening support, with a focus on neonatal health, are among the focus areas of this research because neonatal mortality serves as a major global issue (Olusanya et al., 2018). Furthermore, neonatal jaundice is widespread at the chosen study site, accounting for a significant proportion of preventable newborn deaths (Olusanya et al., 2018) As a result, the *Picterus* app was included as an example and demonstration of a mHealth solution to the healthcare workers in the current study. It was deemed essential for the study's primary researchers to include a demonstration of a mHealth solution which was seen as valuable for usage in patient care by the included healthcare workers.

Globally, various mHealth interventions have been initiated. Although mHealth technologies have the potential to influence the health system on a global scale significantly, it also has limitations (Malvey & Slovensky, 2014). mHealth is still in a stage of rapid and unpredictable

change; therefore, to achieve long-term success, it is crucial to evaluate trends and risks to gain insight into what changes are necessary.

Qiang et al. (2012, p. 24) stated that mHealth would not be able to succeed and expand in developing countries if the needs and requirements of patients, healthcare providers, and health systems are not considered by the developers. Malvey and Slovensky (2014, p. 14) claimed that for a mHealth initiative to be successful, inventors must analyze the larger picture and comprehend the consumers' demands. Moreover, developers and decision-makers may benefit from receiving user comments and opinions (Qiang et al., 2012, p. 15). Therefore, it becomes vital to investigate the perception of healthcare workers toward mHealth technology to uncover factors that influence the use of various technologies in low- and middle-income settings.

1.4 STUDY AIM, RESEARCH OBJECTIVES, AND RESEARCH QUESTION

This section describes the study's aim, research objectives, and research question.

1.4.1 Study aim

The present study aims to explore the perceptions of healthcare workers working in public health facilities in Lagos State, Nigeria, regarding mHealth technologies.

1.4.2 Research objectives

The study's general objective is to create an overview of the perceptions of healthcare workers working in public health facilities in Lagos State, Nigeria. Furthermore, the study is guided by the two following specific objectives:

- To discover factors that determine healthcare workers' use of mHealth technologies
- To explore the perceptions of healthcare workers regarding the use of mHealth applications as screening tools

1.4.3 Research question

- What factors influence healthcare workers' use of mHealth technology in Lagos, Nigeria?

2 METHODOLOGIES

This chapter presents a description of the selected research design. In addition, it describes the recruitment of study participants and the data collection procedure. Furthermore, the procedure for data analysis is described. The chapter elaborates on the data management methods and how the data was stored. In addition, the study's ethical considerations are presented.

2.1 STUDY DESIGN OVERVIEW

This section describes the study's research method.

2.1.1 Research method

A qualitative research approach was chosen for this study. Qualitative data enables the researcher to comprehend the phenomenon of interest using methods that emphasize the meanings or experiences of the study subjects (Clarke & Braun, 2013, p. 24). It is crucial to research and comprehend the perspectives of healthcare workers on this topic since they are patient-centered and have a unique understanding of how mHealth technology could complement their existing practice and the potential challenges. Therefore, it is vital to focus on healthcare workers' perceptions, which could provide inventors of such technology with valuable information. Focus group discussions (FGD) with subjects from various levels of public health institutions in Lagos, Nigeria, were used to collect data. Using Braun and Clarke's six-step thematic analysis method, data were analyzed thematically (2006).

2.2 RECRUITMENT OF INFORMANTS AND DATA COLLECTION

This section describes the study site, the study population, the sampling method, and the recruitment procedure. In addition, this part covers how the FGDs were conducted, the focus group question guide, and how data saturation was achieved.

2.2.1 Study site

In Lagos State, the study was conducted in three public health institutions. Each public health institution belonged to a particular level of healthcare. There are three levels of healthcare: primary, secondary, and tertiary. The following gives a brief description of the three different levels of healthcare facilities.

Primary health facilities are patients' primary point of contact and operate at the community level (Roberts, 1998). In Nigeria's primary healthcare facilities, nurses and community health workers (CHEWs) provide most of the healthcare. These facilities provide fundamental medical treatments (preventive, promotive, curative, and rehabilitative), by delivering medical services as near as feasible to people's homes (Ekenna et al., 2020; WHO, 2021). Primary health facilities in Nigeria include community-based care, primary and comprehensive health centers, and private clinics (Second National Strategic Health Development Plan, 2018-2022). The local government mainly handles this level (Aregbeshola & Khan, 2017).

Secondary health facilities are intermediate facilities. In addition, secondary health facilities are hospitals and outpatient specialist clinics where patients are referred to by primary healthcare services to receive more specialized care (Roberts, 1998, p. 56). Furthermore, they typically offer "diagnostic services, such as X-ray and pathological laboratory services," as well as "specialized treatment options, such as operating rooms, radiation, and specific pharmacological regimens," that are not usually available in primary care settings (Roberts, 1998, p. 56). Various secondary health care institutions include general hospitals, district hospitals, specialized hospitals, and private clinics and hospitals. The state government is primarily responsible for this level.

Tertiary health facilities provide specialized care not available in primary or secondary health facilities, as well as services to patients referred from secondary care for diagnosis or treatment (Roberts, 1998, p. 61). Tertiary health facilities provide treatment for specific specialties, rare diseases, or situations in which it is difficult to find diagnostic or therapeutic facilities, or in which scarce combinations of resources are required (Roberts, 1998, p. 61). Federal Medical Centers (FMCs), specialist hospitals, University Teaching Hospitals, and private clinics and hospitals are examples of tertiary health facilities (Roberts, 1998; Flegel,

2015). In most cases, the federal government is responsible for this level of health facilities, although the state government may also be involved.

2.2.2 Study population

Healthcare workers with the profession as doctors, nurses, and community health extension workers (CHEWs) working at a public hospital in Lagos State, Nigeria, were eligible to participate in the study. A second criterion for inclusion was that the healthcare workers worked with pediatric patients. This was due to the fact that the study demonstrated how a mHealth device can be utilized to detect jaundice in newborns. Healthcare workers solely working in private healthcare facilities were excluded from this study.

To obtain diverse data, study participants were recruited from various public primary, secondary, and tertiary health institutions in Lagos State. This was done to determine whether or not there were significant differences between the different types of health institutions. The facility for recruitment was chosen based on the population size of the local government area, and whether or not the healthcare workers saw any pediatric patients.

2.2.3 Sampling strategy

In this study, a method of purposeful sampling was utilized. The strategy involves selecting study subjects that the researchers believe will yield data that is rich in information (Clarke & Braun, 2013, p. 56). According to Patton (2002, p. 46), "information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the research." In addition, he underlines that the cases should be selected "strategically and purposefully" (2002, p. 243). When deciding how many cases to include in the study, the purpose and available resources (e.g., budget and time) must be considered (Patton, 2002, p. 244). A total of 27 informants participated in this research, with the two researchers anticipating that each informant would provide data-rich insights regarding the topic under investigation (Patton, 2002, p. 230).

In contrast to the individual interview, a focus group discussion consists of a small group of people aiming to create a discussion among the interviewees about a particular topic (Patton, 2002, p. 385). According to Patton, the FGD allows participants to "consider their own views

in the context of the views of others" (2002, p. 386). because the interviewing technique permits participants to hear each other's responses. In addition, as exploratory studies, FGDs are ideally suited for individuals with similar backgrounds, as it can encourage a more interactive discussion between participants (Clarke & Braun, 2013).

In order to investigate the perceptions of a specific group of interest, namely healthcare workers, a homogeneous sampling technique was chosen for the current study. Healthcare workers were grouped according to their profession to create homogeneous groups in which they could express themselves freely and interact with one another more effectively (Patton, 2002, p. 236). Multiple healthcare workers were interviewed simultaneously in order to obtain multiple perspectives on the topic of mHealth. It was also done to stimulate ideas and permit participants to recall and reconsider as they interact. In addition, the healthcare workers were divided into three subgroups, including doctors, nurses, and CHEWs, in an effort to determine whether there were any differences between the subgroups. It was also done to make the healthcare workers feel more comfortable expressing themselves and relating to one another (Clarke & Braun, 2013, p. 113).

2.2.4 Recruitment process

The Primary Healthcare Board and Lagos State Commission Healthcare Board gave their approval for the data collection from the chosen health facilities. Through the secretary at each health facility, the master’s student delivered an approval letter to the Medical Directors (MD) and Medical Officers of Health (MOH), which she received from healthcare boards to be able to access the facilities and collect data. Then, the master's student was given the opportunity to meet the MDs and MOHs in person, where she was also able to present the project's purpose to them and to the heads of departments. The heads of departments relayed the information to the healthcare workers in the facilities. Potential informants received a letter of information in English via the heads of departments, which they were instructed to read before the focus group discussion. The information letter contained information on the goals, methods, advantages, dangers, confidentiality, and voluntariness of the study. The letter also gave contact details in case there were any inquiries or requests for clarifications relating to the study. The healthcare workers were given two weeks to decide if they wanted to partake in the study. Furthermore, healthcare workers who were interested in participating

in the study gave their verbal consent by informing their department heads. A day and place for the FGDs were decided upon after physically contacting prospective informants. Written consent was obtained from the healthcare workers on the day of the FGDs.

2.2.5 Conducting the focus group discussions

Due to the COVID-19 situation, preventing one of the primary researchers from traveling to Nigeria and attending the FGDs, debriefings were conducted via phone calls and Zoom meetings between the two primary researchers following each focus group discussion. During the debriefing, both researchers wrote down relevant findings of interest. This allowed the two researchers to examine both written and verbal forms of the data.

The data collection took place between January and February 2022. Clarke and Braun (2013) suggest that three to eight participants is a suitable number to include in FGDs and could result in a rich discussion. There were six focus group discussions with a total of 27 participants. Each group contained three to six participants, and the discussions lasted between 43 and 59 minutes. All FGDs were conducted face-to-face with study participants. Due to the Covid-19 pandemic, one of the primary investigators was unable to travel to Nigeria and therefore unable to participate in the FGDs. Consequently, only one of the two primary researchers attended the FGDs. All focus group discussions were held in a meeting room at the health facility where the participants were employed. The FGDs were held while the healthcare workers were on duty. This was done to gather as many healthcare workers as possible at the same time. Consequently, this resulted in some interruptions during the FGDs, as some of the healthcare workers had to leave the FGDs for some minutes to assist in the wards. Using a SONY IC Voice Recorder, all six focus group discussions were audio-recorded. The participants received both written and verbal information about the FGDs being audio recorded, and the primary researcher conducting the interviews received the participants' consent on this. The communication was held in English.

Moreover, there is one FGD conducted with CHEWs only. The reason for this is that CHEWs are typically only present in primary health institutions; therefore, only doctors and nurses participated in the FGDs in the tertiary and secondary health facilities. In addition, the researchers ought to include all three groups of healthcare workers (doctors, nurses, and CHEWs) in the primary health facility, however, only two groups were included (nurses and

CHEWs). As there were only two doctors available to participate in the FGD at the primary health facility, which was a small number, doctors were therefore excluded from this level of health facility. As illustrated in Figure 4, two FGDs were conducted at each health facility.

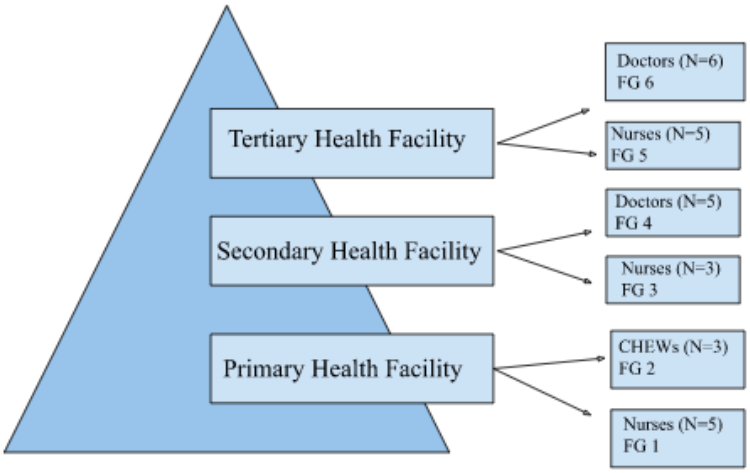


Figure 5. Division of healthcare workers included from each level of health facilities (source: revised model inspired by Pai et al. (2021).

On the day of the FGDs, prior to the start of the discussions, the primary researcher attending the FGDs provided verbal information to the participating healthcare workers. They were reminded that participation in the study was voluntary and that they could withdraw without consequences. In addition, the participants were informed of the confidentiality of the study and the importance of not disclosing the discussion's content to those outside the group. In addition, they were informed that they would have access to the research results prior to publication. The principal investigator who took part in the FGDs emphasized that she was not there to evaluate, test, or judge any of the healthcare workers. There were no correct or incorrect answers. Additionally, they were permitted to ask questions verbally. Before beginning the FGDs, the researcher obtained both verbal and written consent from the participating healthcare workers.

The focus group discussions began with two introductory questions regarding the healthcare workers' general thoughts on mHealth and what came to mind when thinking about mHealth. In addition, they were asked about their understanding, awareness, and experiences with mHealth. A question was posed regarding acceptance factors and how mHealth could support

the current health system. During the FGDs, the primary researcher conducted a demonstration of the mHealth application *Picterus* and posed questions to the healthcare workers regarding this demonstration. In addition, they were asked about their opinions on the proposed solution and how they currently assess neonatal jaundice in their setting. Then, healthcare workers were asked how they would use the app in their setting, the reactions of the patient's guardians, the app's responsibility, the pros and cons of the mHealth solution, and how the app might impact their current practice.

Probes are follow-up questions asked during interviews to elicit additional information, elaboration, or clarification from the person(s) being interviewed (Patton, 2002, pp. 372–374). For example, one of the questions in the interview guide was, 'have you ever used any form of mHealth before?' Please describe your experiences if this is the case. This question was followed by inquiries such as 'did it succeed?' and 'why did it succeed/why did it fail?' In addition, when the informant's statements were ambiguous, the moderator utilized clarification questions (Patton, 2002, p. 374). When additional explanations were necessary, the moderator prompted the participating healthcare workers with 'excuse me, what do you mean by that?' or 'could you please elaborate?' Even when participants provided answers to questions before they were asked, the moderator was accommodating and responsive to their needs. The focus group discussions were not necessarily conducted in accordance with the order of the question guide, to make the discussion flow, and as close as possible to a natural conversation.

2.2.6 Focus group question guide

A semi-structured question guide with open-ended questions (Appendix G) was used during the focus group discussions to get in-depth responses about the healthcare workers' perceptions of mHealth technologies working in public health facilities. Although the questions in the guide had already been formulated prior to the FGDs, the researcher allowed participants to raise additional issues that may have arisen during the discussion (Patton, 2002, p. 344). According to Patton (2002, pp. 343-344), "a guide is essential in conducting focus group interviews for it keeps the interactions focused while allowing individual perspectives and experiences to emerge." The guide addressed topics that the researchers desired to be discussed during the FGDs. Instead of answering directly to the moderator,

participants were encouraged to engage in discussion with one another through the questions (Clarke & Braun, 2013, p. 117).

During the first two focus groups, the primary researcher observed that some study participants provided brief responses to some of the questions. It was difficult to initiate a discussion among the participants; instead, they approached the moderator directly. In addition, they responded with a few words and brief sentences. Moreover, the duration of the first two FGDs was 22 minutes and 31 minutes. These discussions did not yield sufficient data, so they were used as pilots and excluded from the data analysis. The primary researchers decided to slightly modify the question guide in order to collect more information from the participants and stimulate a discussion between them. Three new questions were added to the guide. The participants were asked what they thought of when they heard the term mHealth, why some mHealth interventions succeed while others fail, and how they believe mHealth could support the current health system. In addition, some probes were incorporated into the questions.

As a result of the incorporation of new questions and probes into the question guide, the primary researcher who was present at the focus group discussions observed changes in the discussions. There was increased interaction among the healthcare workers, who elaborated on their previous statements. Additionally, the length of the discussions increased from 22 to 31 minutes to between 43 and 59 minutes. Despite the fact that these modifications were advantageous for the data collection, some of the healthcare workers still remained reticent and gave brief responses. Therefore, the moderator was required to play an active role in the focus group discussions by encouraging more reticent healthcare workers to share their perspectives and experiences (Clarke & Braun, 2013, p. 127).

2.2.7 Data saturation

The transcription and analysis process commenced immediately following the FGDs in order to make any necessary adjustments to the study while data were still being collected. According to Braun and Clarke (2013, p. 115), a saturation of data is reached when the “data collection does not generate anything new and the range of perspectives appears to have completely covered.” After six focus group discussions in three healthcare facilities, the primary researchers observed no new codes emerged from the collected data during analysis,

and responses from the informants were repetitive (Clarke & Braun 2013, p. 115; Braun & Clarke, 2021). The collection of data was then stopped.

2.3 DATA ANALYSIS

This section describes the data analysis process. It outlines how the data was transcribed, how the researchers became familiar with the collected data, how data was coded, and how the themes were formed.

2.3.1 Introduction to data analysis

When qualitative data are analyzed, the data are transformed into findings (Patton, 2002). The process involves searching for patterns within the data, and to put together "what is said in one place with what is said in another place and integrating what different people have said" (Patton, 2002, p. 380). The data obtained from the FGDs were analyzed using Braun and Clarke's (2006) six-step guide for thematic analysis (TA). TA is defined as a "method for identifying, analyzing, and reporting data patterns (themes) within data" (Braun & Clarke, 2006, p. 6). In addition, an inductive method was employed to identify the themes within the data, which implies that the identified themes are closely related to the data (Braun & Clarke, 2006, p. 12). According to Braun and Clarke (2006, p. 12), this type of TA is data-driven, as opposed to being driven by the researchers' theoretical interest in the investigated phenomenon.

TA is described as a flexible and easy-to-learn analysis technique, suitable for those with little experience within qualitative research, including student projects (Clarke & Braun, 2013, p. 177). Moreover, according to Clarke and Braun (2013, p. 177), TA is adaptable in that it can be used to analyze a variety of data types, and it has the potential to provide rich and detailed data (Braun & Clarke, 2006, p. 5). The six-step guide of Braun and Clarke (2006) for TA includes the following steps:

1) Familiarization with the data
2) Generating initial codes
3) Searching for themes
4) Reviewing themes

5) Refining, defining, and naming themes
6) Finalizing the analysis and producing the report

2.3.2 Transcription process and familiarization with the data

The transcription process involves converting verbal information into written form (Clarke & Braun, 2013, p. 134). According to Kvale and Brinkmann (2009, p. 186), transcription is the first step in the analysis process, during which the data is prepared for the rest of the analysis (Clarke & Braun, 2013, p. 134). On the same or following day as conducting the FGDs, audio recordings were transcribed verbatim by the researcher who did not attend the FGDs in Nigeria. Transcription on the same or following day is valuable because, as explained by Clarke and Braun (2013, p. 164), our memory after being involved in an FGD is frequently clear for only a few days, and then details fade. Transcription involves playing segments of 1-2 seconds from the audio files and typing what is heard (Clarke & Braun, 2013, p. 168). During transcription, QuickTime Player was utilized for playing the audio files. The process involved multiple playbacks to ensure that all verbal content was transcribed.

During the FGDs, there was some background noise (babies crying, traffic noises, and people talking in the hallway), and informants talking over one another in some of the audio recordings, leading to interruptions of the recordings. According to Kvale and Brinkmann (2009, p. 162), it is not uncommon that the transcriptions of FGDs appear a bit messy, as a result of group interaction. Consequently, this resulted in some unrecognizable words and sentences, which were transcribed as '((inaudible))'. Pauses in the recording were represented as ‘((pauses))’ in the transcripts. In addition to verbal communication, the transcripts also included nonverbal communication. Furthermore, audio recordings were listened to by both researchers at least twice. This was performed to get familiarized with the data and ensure that everything was included in the transcripts.

The researcher who did not transcribe the FGDs reviewed each transcript to verify the quality of the transcripts and to complete inaudible words and sentences encountered by the other researcher. Furthermore, after completing the transcription of each audio recording, both primary researchers compared the transcribed data to the audio recordings to ensure that all data was accurately and completely transcribed (Braun & Clarke, 2006). Then, both researchers read and reread the written materials thoroughly. Interesting findings pertinent to

the research question were either underlined or written down (Clarke & Braun, 2013). Moreover, transcribing the audio files allowed the researchers to become deeply familiar with the data (Clarke & Braun, 2013, p. 173).

2.3.3 Creating initial codes

The next step, following data familiarization, was to code the collected data material. The software program NVivo was utilized for both the coding procedure and the remainder of the data analysis. The transcribed files were transferred to NVivo. The software program assisted the researchers in obtaining a proper overview and organization of the data, while also facilitating their ability to restructure and reorganize codes (Zamawe, 2015). A complete coding strategy was employed, which includes coding all information pertinent to the research question (Clarke & Braun, 2013, p. 206). According to Clarke and Braun (2013, p. 206), a code as is "a word of brief phrase that captures the essence of why you think a particular bit of data may be useful." They also refer to codes as "the building blocks of analysis" (Clarke & Braun, 2013, p. 206). Following the coding of data extracts, those data extracts with the same code were gathered (Braun & Clarke, 2006).

2.3.4 Searching for themes

Following the completion of the coding process, the codes and the collated data extracts relating to each code were assessed to determine the similarities and overlap between codes (Clarke & Braun, 2013). As the organizing principle for the formation of a theme, concepts related to multiple codes were utilized (Braun & Clarke, 2006). The primary researchers ensured that each grouping had a distinct central organizing concept captured by the data extracts. Not only did the themes identify the most prevalent aspect of the data, but they also conveyed something essential and important to answering the research question (Braun & Clarke, 2006). During the phase of searching for themes, both researchers frequently created mind maps with paper and pen, which assisted them in gaining a thorough overview of potential themes.

2.3.5 Reviewing themes

In this phase, potential themes were identified by both researchers. The identified themes were compared and discussed among the researchers, as well as together with the study's main supervisor. Throughout the analysis process, themes were continuously revised and refined in relation to the research topic (Braun & Clarke, 2006).

2.3.6 Refining, defining, and giving names to themes

To ensure that the identified themes were compatible with the dataset, they were compared to the codes and the compiled data (Clarke & Braun, 2013). The themes were slightly readjusted to create a better theme fit, and coded data was moved in and out of the themes (Clarke & Braun, 2013). The researchers finally realized that the identified themes captured the data's meaning and were coherent, distinct, and pertinent to the research question (Braun & Clarke, 2006). To capture the essence of the data set, the researchers attempted to be as concise and informative as possible when naming the themes (Braun & Clarke, 2006). In addition, the dataset was revisited with the themes to ensure precise contributions of the data to the research question (Braun & Clarke, 2006).

2.3.7 Finalizing the analysis and producing the report

After the primary researchers reached a consensus on the definitions of the main themes and the subthemes that followed, data extracts from the informants were chosen to describe each aspect of the themes (Braun & Clarke, 2006). The researchers used these excerpts to illustrate the various themes and subthemes when writing the projects' findings.

2.4 DATA MANAGEMENT AND STORAGE

This section describes the management and secure storage of the collected data.

2.4.1 Data security

The Practical Guide to the International Alignment of Research Data Management was utilized as a guide to ensure the proper management of the study's collected data (Science Europe, 2021). Audio files were encrypted with level 256 bits AES, which meets the required level of file encryption (NTNU, 2022). Only the two primary researchers knew the password and could decrypt the files. The encrypted files were uploaded to a private and secure OneDrive map, shared between the researchers of the current project. Names or other traceable, personal information was not required from the participating healthcare workers, and thus not mentioned in the FGDs. The identification of the healthcare workers was, in the transcripts, based on their profession and a number (e.g., nurse 1 and doctor 2). The audio recording device was stored securely in a locked cabinet, separate from other work with the thesis, and only accessible to the researcher conducting the FGDs in Nigeria. As soon as the transcripts were complete, and both primary researchers had thoroughly reviewed them, the recorded files were erased from the audio recording device (Datatilsynet, 2019).

The written consent forms will be kept in a locked cabinet and separate from other work with the thesis (Datatilsynet, 2019). The cabinet is only accessible to the researcher conducting the FGDs in Nigeria. The encrypted transcripts will be securely stored electronically. The written consent forms and encrypted transcripts will be kept until the completion of the research project, and then destroyed (Datatilsynet, 2019). A data transfer agreement was signed between each included health facility, and the master's student conducting the FGDs in Nigeria, in order to transfer collected data to the database of NTNU.

2.5 ETHICAL CONSIDERATIONS

This chapter describes the ethical aspects of the study, including study assessment, approvals, participant information and consent, and risk assessment.

2.5.1 Study assessment and approvals

Ethical approval was obtained from the Health Research and Ethics Committee of LASUTH (LREC) in Nigeria on October 18, 2021 (REF. NO.: LREC/ 06/10/1688). This is also the approval to conduct FGDs in the tertiary health facility (Appendix A). In addition, the Lagos

State Primary Health Care Board (Appendix D) and the Lagos State Health Service Commission (Appendix C) gave their approvals to conduct FGDs at the primary and secondary health facilities, respectively. Furthermore, permission was obtained from the Medical Directors, Medical Officer of Health, and Head of Department of each health facility included in the study.

A preliminary application was submitted to the Norwegian Regional Committees for Medical and Health Research Ethics (REC), Central Norway, for evaluation to determine whether or not a complete REC application was required for this project. REC determined that the project did not fall under the Committee's mandate because the study did not qualify as medical or health research as defined by the Health Research Act (Appendix B).

2.5.2 Participant information and consent

The Health Research and Ethics Committee of LASUTH first reviewed and authorized the participant information letter (Appendix E) and participant consent form (Appendix F). Before the data collection, the healthcare workers were provided written information regarding the project's purpose, procedure, potential risks, expenses, benefits, confidentiality, voluntarism, ethics, and contact information of the research team. The rights of healthcare workers to withdraw their consent and participation in the study were communicated to them. The researchers received written informed consent from every healthcare worker that participated in the study. Participation was entirely optional, as noted clearly on the participant information forms.

2.5.3 Risk assessment

Following NTNU's guidelines for risk assessment, the primary investigators and project supervisor conducted a study risk assessment (NTNU, 2022). mHealth is not a sensitive subject; however, the research team is responsible for respecting the privacy of, and any personal information shall be treated confidentially, as outlined in the preceding section (The Norwegian National Research Ethics Committees, 2019).

3 FINDINGS

This chapter begins with a brief description of the healthcare workers who participated in the study as informants. The chapter then presents the current research's findings.

3.1 DESCRIPTION OF THE INFORMANTS

All healthcare workers who participated in the study were citizens of Nigeria. The healthcare workers worked in pediatric wards at public health institutions, at eighter primary, secondary, or tertiary levels. The healthcare workers worked as doctors, nurses, or community health extension workers. As shown in Table 1, the participating healthcare workers varied by gender, age, and years of experience.

Table 1. Demographics of the informants.

Profession	**Gender**	**Age Range**	**Years of Experience**
Doctors	2 Males 8 Females	25 - 50 Years	3 Months - 16 Years
Nurses	13 Females	25 - 60 Years	6 Months - 34 Years
CHEWs	1 Male 2 Females	31 - 38 Years	2 - 3 Years

3.2 PRESENTATION OF THE FINDINGS

During thematic analysis of the current study's data, two main overarching themes emerged: (1) Perceived benefits that promote the use of mHealth, and (2) perceived barriers that limit the use of mHealth. Reported benefits included facilitating access to health-related information, enhancing patient-provider communication, saving time, the flexibility of mHealth, and developing the health system. The reported barriers were split into (1) barriers directed at the users of the mHealth technology, and (2) barriers posed by the requirements of the mHealth technology. Barriers directed at the user's included altering healthcare routine practices, skepticism and lack of trust, information overload, and lack of awareness,

knowledge, and skills. Barriers posed by the requirements of the mHealth technology included power supply, internet accessibility, network failure, absence of devices and maintenance of available devices, and costs. Each aspect and its accompanying sub-themes are detailed in greater depth in the following, along with statements from the healthcare workers who participated in the focus group discussions as informants.

Table 2. Schematic overview of the themes identified through thematic analysis.

Main overarching themes	**Sub-themes**
Perceived benefits that promote the use of mHealth	● Facilitating access to health-related information ● Enhancing patient-provider communication ● Saving time ● The flexibility of mHealth ● Development of the health system
Perceived barriers that limit the use of mHealth	**(1) Barriers directed at the users (patients and healthcare workers) of the mHealth technology:** ● Altering healthcare routine practices ● Disconnects face-to-face patient-provider relationships ● Skepticism and lack of trust ● Information overload ● Lack of awareness, knowledge and skills **(2) Barriers posed by the requirements of the mHealth technology:** ● Power supply ● Internet accessibility and network failure ● Absence of devices and maintenance of available devices ● Costs

In order to investigate the healthcare workers perceptions of mHealth, their general knowledge of mHealth technology was examined first. Focus group discussions revealed a variety of knowledge among the healthcare workers in the current study. Several healthcare

workers recognized what mHealth was, while others mistook it for eHealth. In addition, some believed mHealth entailed healthcare workers visiting patients' homes to provide various health services, while others were unsure of what mHealth was. Those healthcare workers, however, who at the beginning of the focus group discussions were uncertain about what mHealth included or what it was, changed their initial opinions and provided examples as other healthcare workers discussed the definition of mHealth technologies. For the vast majority of healthcare workers, their personal mobile phones were the only mHealth technology they had ever utilized. Accessing information online, making personal calls and sending text messages to others, and receiving calls and text messages were mentioned as mobile phone uses. In addition, some of the healthcare workers mentioned that they had heard of downloadable mHealth applications, such as apps that track women's ovulation periods and apps that measure blood sugar levels but had not used them themselves. None of the healthcare workers had used mHealth apps to assist them in the diagnosis of their patients, but many had heard of it.

3.3 PERCEIVED BENEFITS THAT PROMOTES THE USE OF mHEALTH

Through thematic analysis, seven sub-themes linked to the first main overarching theme were revealed, describing factors that the healthcare workers perceived as benefits of mHealth technologies. The following sub-themes include: facilitating access to health-related information; enhancing patient-provider communication; saving time; the flexibility of mHealth; and developing of the health system.

3.3.1 Facilitating access to health-related information

The majority of healthcare workers in the focus group discussions underlined how mHealth technologies could facilitate access to health-related information for both healthcare practitioners and patients. Healthcare workers reported how mobile phone access, for instance, makes it easier for people to stay informed about health-related concerns and obtain previously unavailable information:

> … *"Almost everyone has a mobile phone now… It makes information easily accessible… Diabetes and other [diseases]... the [blood]sugar, [people] can measure like 'ok this [value] is normal, this [value] is not normal… Oh, okay, this is what I should eat, this is what I shouldn't eat'… People have access to information, that is a positive thing. I think it has turned."* (FGD 6, Doctor 1)

> … *"Because of the advent of mobile phones, a lot of people are able to access information that we never had before."* (FGD 6, Doctor 3)

In addition, several healthcare workers shared the same perspective on how access to mobile phones could enable people who do not work within the health sector to access health-related information online through their mobile phones:

> *"You know, even people that don't work in the health setting... They'll search about… Like, if a person has a headache… [that person] can use the mobile phone and search about causes of headache and treatment of it… People that don't work in the health setting can search about diseases on their mobile phone."* (FGD 2, CHEW 2)

Moreover, many healthcare workers believed that accessing health-related material online and being better informed could have a positive impact on the health promotion of the general population. One healthcare worker demonstrated how access to health-related information could encourage individuals to seek assistance from health facilities at an earlier stage, hence reducing mortality:

> … *"With the increased information, people are more informed and that has helped reduce mortality. Look at its medical aspects… Mortality and morbidity has reduced because people are informed. [Information] would help [patients] to make early health-related decisions and has also helped people to have good health seeking behavior… [Accessing information] has improved [peoples'] health too."* (FGD 6, Doctor 2)

Healthcare workers discussed the significance of information availability in light of cultural considerations. Availability of and access to polite information was cited by one healthcare worker as crucial for discouraging individuals from using alternative medicine, which,

according to several healthcare workers was an issue in a number of regions and cultures and might potentially be harmful to patients:

> *"[Previously] you've had to come [physically] to the hospital on site to hear [the information], but now you can go on different apps, as long as they are certified and you won't get junk, you will get the real information you need… Like I was talking about febrile convulsions. Now people know you don't have to put your children's legs on fire for them to get well… You don't have to."* (FGD 6, Doctor 1)

Accessing health-related information online could have a favorable effect on patient engagement in healthcare, according to some healthcare workers. As one of the healthcare workers reported, this could result in improved disease status and treatment outcomes for patients:

> *…"We tell our patients to 'read about the case to know about the case,' so [the patients] also can help in the management of their diseases. By the time [the patients] are coming [to the health facility], especially for chronic illnesses like sickle cell anemia and seizure disorder…, we want [the patients] to be involved. This will result in better outcomes of the treatment and even the disease condition."* (FGD 6, Doctor 2)

3.3.2 Enhancing patient-provider communication

Online consultations

Multiple healthcare workers discussed mHealth in relation to online consultations. As a positive aspect of mHealth, some noted that online consultations could be advantageous for patients in that they would not need to visit a health facility for a physical examination every time they needed to see a health professional:

> *"If the consultations are online… Everything is online, so you don't need to go to the hospital, and the stress is gone..."* (FGD 5, Nurse 1)

"Leaving your house… One. Looking for a vehicle… Two. Even… The traffic alone… Three. And you don't even know whether the consultant is around [at the health institution], whether [the health worker] is available or not." (FGD 5, Nurse 4)

… *"I don't need to physically see a doctor… There are some things that I can do with these digital skills, online, without seeing my doctor… Without physical interaction with a doctor… Mobile health can be easily accessible anywhere I am, I don't need to start dragging myself to the hospital."* (FGD 3, Nurse 2)

"There's no need to feel that you need to visit the hospital… If you need to see a doctor, you can easily access your doctor by a mobile app." (FGD 3, Nurse 3)

"Mental health… There are actually psychologists or psychiatrists that have apps… That you can directly speak to them through… Digitally. You don't have to walk in [to the health institution]." (FGD 4, Doctor 1)

The healthcare workers agreed that the utilization of mHealth technologies, such as online consultations, would reduce their workload. Two of the healthcare workers discussed the reduction in workload for health workers as a result of fewer patients physically attending the hospital if they had the option to meet health workers online, thereby reducing the crowdedness of health institutions:

… *"[mHealth] usually reduces the workload in the hospital… Online assessment of the patients… [mHealth] reduces the workload of the health workers…"* (FGD 1, Nurse 1)

… *"[mHealth] will even reduce the crowd in the hospital… At least, people will stay at home, they will still be able to access health… [mHealth] will reduce the workload..."* (FGD 3, Nurse 1)

Moreover, some healthcare workers emphasized the COVID-19 pandemic and how mHealth has facilitated global communication despite the closed-off world:

"Another positive thing is in the area of COVID-19… The physical meetings are almost zero, but in this area, [mHealth] has helped information dissemination to still continue despite it being said that 'Physical meetings will reduce'... Education didn't stop. People are still informed, people are still getting knowledge. So, [mHealth] has helped us not to lose contact with our world, like a global village. I can talk with someone in the US and know what they are doing there… It is like [mHealth] has brought people closer, and has increased knowledge." (FGD 6, Doctor 2)

The potential for online consultations to reduce infections, particularly COVID-19, was another topic of conversation among the healthcare workers. Several healthcare workers viewed it as a positive aspect of mHealth that patients could stay at home and interact with healthcare professionals online, rather than traveling to the hospital where they could be exposed to various infections. This was demonstrated by the following statement:

"Online consultations can reduce infection… Like all these infections one can carry from the hospital… Nosocomial infection… Like with COVID-19 now… That is spreading. So, in the hospital, there will be a lot of infections there. So if you go [to the hospital] and meet somebody that has COVID-19…" (FG 2, CHEW 3)

Reaching more people with mHealth

The healthcare workers discussed how access to mobile phones could help them reach more individuals who struggle to attend health institutions due to factors such as distance, transportation, and inadequate infrastructure. Having access to mobile phones could allow patients to remain at home while still being able to call or chat with healthcare professionals when necessary:

"More people can be reached really, because where some people live it's actually really difficult to come out to town… Even to the next health center, for some, it is difficult. Where they live is really far, the roads are not very good. Or, if they have a mobile phone and they can call and chat up with the health workers or check something on it… You know, it actually really helps." (FGD 6, Doctor 1)

In addition, healthcare workers reported the difficulties caused by the overwhelming number of patients in hospitals. Such crowds frequently resulted in patients leaving health institutions

before seeing a health professional or completing their consultations. It was discussed how mHealth technologies could be utilized to reach patients who avoid hospitals due to crowd-related anxiety:

> *… "The crowd in the hospital is terrible. If you get to a general hospital… If you go to any government hospital. It's a whole day [spent there]. People run away from the hospital, just because of the crowd. That's one of the reasons why, even at the antenatal, delivering… [The patients] always have one reason or the other for not showing up. So, if there is mobile health, [the patients] will have access to more health."* (FGD 1, Nurse 3)

Moreover, several healthcare workers discussed how mHealth technologies such as mobile phones facilitate patients' access to health care professionals for health-related advice or in emergency situations, as one of the healthcare workers stated:

> *"With mobile phones, people can call in [to health institutions] to access information. You know, like 'Okay maybe my child is having a convulsion. What should I give him?' [Health workers can give] immediate advice for resuscitation… Like 'Lie the child down, put [the child] on the side, arrange on how to get the child quickly to the hospital…' Sometimes when people collapse in the house, 'Okay - what do you do?' 'Put your hand on this area of the pulse, is there any pulse, okay do this… Try to put the person lying with the face in a way that the person will not aspirate or something…' So, basically, the mobile phone allows [patients and health workers] to communicate."* (FGD 4, Doctor 1)

Healthcare workers discussed how mHealth facilitates global connections between patients and health professionals. In addition, they discussed how mHealth enables healthcare workers in one country to communicate with healthcare workers in other nations:

> *"[mHealth] makes it easier… You get to use doctors that are not even in Nigeria… It gives you the opportunity to interact with a whole lot of specialists. That is another advantage to both the professionals and the patients."* (FGD 4, Doctor 4)

"[mHealth] gives room for foreign consultations so far the [health worker] is qualified enough… You have scenarios where people are ill… They have relatives abroad, and they know a [health worker] that is very good… And they just connect the patient to the doctor." (FGD 6, Doctor 3)

3.3.3 Saving time

Saving healthcare workers' time

During multiple focus groups, healthcare workers discussed the benefits of utilizing mHealth technologies to save time for healthcare workers. One healthcare worker described saving time when measuring a patient's blood pressure using mHealth technology:

… "[mHealth] has saved my time when measuring [blood pressure]… Listen to the pulse rates by counting… One minute, two minutes, you understand… But with this mobile health, once you just place your hand on it, what we wanted to know about the patient, it will just come… Instantly…" (FGD 2, CHEW 1)

"[mHealth] makes me work faster… It reduces time consumption… It reduces stress… For the doctors, for the nurses, for the community… It reduces stress." (FGD 2, CHEW 2)

… "[Picterus] reduces that time for withdrawing the blood… It reduces that time to screening, to carry out the procedure… With [Picterus] now... With what you just did within a second [when demonstrating the application]… For the lab, they can spend more than one hour or thirty minutes… With [Picterus], it can go faster and reduce time consumption." (FGD 2, CHEW 1)

In addition, one healthcare worker stated that the existence of mHealth has made it easier for them to save time by using mobile phones. The healthcare worker explained that he believed mHealth had facilitated communication and collaboration between health institutions in a number of ways, as exemplified in the following statement:

… "Maybe the [health workers] want to do a procedure… Transfuse blood, do an exchange blood transfusion, or any of those things… Blood and blood products, we

don't, you know, when [It's not available], we have to liaise with both public and private hospitals and laboratories for you to get blood… If not for mobile things… You know, with [mHealth] you can quickly call any lab and ask 'Do you have this blood type?' Instead of moving around [looking for it]. I remember there was a time that this state was using bikes… Motorcycles and scooters to get blood… [Health workers went with] motorcycles and on scooters to go to the labs to get blood… And of course with this [mHealth] now, it makes, you know, it makes a lot more sense because you just go to where there is blood and pick it up and come back… Instead of wasting time searching." (FGD 6, Doctor 6)

Saving patients' time

In several focus groups, healthcare workers discussed how mHealth technologies save them time, but some also discussed how these technologies could benefit patients. Using mHealth as opposed to visiting a health institution in person saves patients time, according to the majority of the healthcare workers:

"Some other positive sides of mobile health… For example, if what the period tracker will help you do with my phone is faster compared to what I have to do when I go to see a doctor… [mHealth] saves time." (FGD 6, Doctor 3)

"*[mHealth] reduces wasting time at the health facility… It reduces wasting time… It saves patients time.*" (FGD 2, CHEW 2)

Saving patients' time in terms of transportation to the health facility was another factor mentioned by the healthcare workers:

"The waiting time because of transportation, stress to the hospital…" (FGD 5, Nurse 1)

Several healthcare workers discussed how utilizing a mHealth application like *Picterus* helps facilitate the diagnosis and prompt treatment for a baby due to its rapid measurement of the baby's bilirubin level in comparison to a blood test.

... "We can get immediate results. Instead of having to take samples and wait several hours before they get... Before you begin effective treatment. Some babies, before they come in, are already kernicteric. They already need [exchange blood transfusion]. But because you don't have value… You know, we practice evidence-based medicine. Because you don't have the value at hand yet, even though we think we are in the [exchange blood transfusion] range. You don't have the value at hand, so you can't go ahead. You still have to wait some hours before the lab releases the result before you start doing the exchange transfusion. But with something like the [Picterus app], you can get the results almost immediately and then begin treatment as appropriate immediately..." (FGD 3, Nurse 2)

... "[Picterus] is a welcomed idea... Instead of… It's a very welcomed idea here, we like it. The problem of [the current method] of collecting blood, at times you're taking the blood to the lab, [the people working at the lab] say it's an insufficient sample… With [Picterus], once you just [use the app], you get your answer quick, quick, bah, bah, bah... You start your treatment… I think [Picterus] is a very good solution." (FGD 3, Nurse 1)

3.3.4 The flexibility of mHealth

Some healthcare workers discussed the flexibility of mHealth technologies and found it to be a positive aspect of mHealth. mHealth enables patients to recover from the comfort and convenience of their own homes, rather than traveling to the hospital each time they need to see a care provider:

... "Taking the services to the patient's comfort zone… You are taking the services to… To their comfort zone." (FGD 1, Nurse 1)

... "Being able to access health care anywhere you are." (FGD 1, Nurse 3)

In addition, some healthcare workers mentioned that it was perceived positively when patients who had undergone a test at a healthcare facility and were awaiting the result did not have to return to the facility to receive the result physically. Instead, they could receive the result via mail or a similar method, as stated by one of the healthcare workers:

> ... *"You can have a certain investigation done at a certain place. Even if the result is not ready, you don't always have to physically go back to get your result. You know, when the result is ready, it can be sent to your mail… Via one platform or the other."* (FGD 4, Doctor 2)

Several healthcare workers discussed the adaptability of mHealth and the difficulties some patients face when hospitalized:

> *"I think patients do recover quickly from their own environment. That's why some people who come to the hospital don't find it easy staying in the hospital environment, but when they are in their own convenient setting, they get out of the sickness faster… I once had a patient like that… He discharged himself against medical advice from the health center… He said he was not comfortable with the environment of the hospital."* (FGD 3, Nurse 3)

Moreover, in four of the FGDs, healthcare workers highlighted the flexibility of the *Picterus* app, which they believed could be a useful tool in settings without laboratories and without the ability to draw blood from patients:

> ... *"[Picterus] could help CHEWs and all that... It can help… Outpatients and it can even help at home for educated parents you know."* (FGD 6, Doctor 1)

> *"In a setting where there is no lab, we can make use of [Picterus]… Like health posts."* (FGD 2, CHEW 3)

> *"[Picterus] is very acceptable during outreach."* (FGD 2, CHEW 3)

3.3.5 Development of the health system

Modernizing existing health practices

Several healthcare workers indicated that the implementation of innovative mHealth technology was favorable to the growth of the current health system. They agreed that such developments should be welcomed:

"[mHealth] is an advantage to the health setting… And to the community… And to the nation… The reason why I said it is an advantage to the nation… There will be beliefs from the community that we have already moved from one step to another. We are upgrading." (FGD 2, CHEW 1)

"The world is going global… A lot of the archaic and the traditional methods of doing things have already been upgraded… By modern technology, modern devices and you know… It can only get better from that point... So I think it's something that we should embrace." (FGD 3, Nurse 2)

... "Just like every other innovation, when it first started… People were skeptical about it, but as time goes on, they will see that 'okay, this is actually as effective as the other traditional methods.' People will embrace new innovations in the long term." (FGD 6, Doctor 2)

Moreover, some healthcare workers stated that mHealth can be a source of revenue for the country which can further increase Nigeria's GDP:

"mHealth will help improve the country's GDP because [the healthcare workers] can get paid from online consultations… For every call [the patients] make, there is a specific amount allotted and they pay taxes to the government… So that would help improve the country's GDP." (FGD 6, Doctor 1)

In addition, most healthcare workers acknowledged the success of other countries in implementing and utilizing mHealth technologies as inspiration and incentive to achieve the same:

"I think we are just trying to go global... We are going global too. We cannot always be backwards." (FGD 5, Nurse 1)

"If others are [using mHealth technologies]… And they are succeeding… We can do it too and we can succeed… I think that's just, we are moving with the trend… We cannot just remain… We will step up too." (FGD 5, Nurse 3)

Alternative to the current demanding solution

The healthcare workers agreed that any new mHealth solution to be introduced at a public health institution should be able to improve upon the current alternative. When healthcare workers were introduced to the *Picterus* app to assist in the detection of neonatal jaundice in newborns, they highlighted how this solution would be favorable compared to the current method of performing blood tests. The majority of healthcare workers considered *Picterus* as a valuable, easy-to-use solution for assessing neonatal jaundice in newborns because it was non-invasive and which did not require pricking the babies:

> ... *"I think if the efficacy of [Picterus] can be proven, I don't see any reason why it shouldn't be [implemented]… I mean, look at [Picterus]. It has a lot of advantages... You know, the fact that it is even non-invasive is already a huge plus… Already a huge plus."* (FGD 3, Nurse 2)

> ... *"It does not require anything from [the patients]. Now with the camera… You would not even use the person's face… And that is very simple, very easy… Well acceptable."* (FGD 2, CHEW 1)

> *"When [using Picterus], you are not collecting any blood sample… You just put the sticker on the baby and [the results] will show. It's very good. It makes the work easier... It makes us quickly diagnose the baby."* (FGD 2, Nurse 1)

According to many healthcare workers, the collection of blood samples from neonates was often problematic. They frequently encountered difficulties obtaining sufficient blood after pricking the neonates, as well as lab-related issues, such as excessive long waiting times for results and lost samples:

> ... *"One of the greatest challenges we have in dealing with these jaundice patients.... These neonates, at this moment is that… Collection of their samples… It's very… Very, very difficult…"* (FGD 3, Nurse 5)

> ... *"I think [Picterus] is a very welcomed idea. [The blood sample] which is given to the lab, the result might not even come after about two days. Or at times we go to the*

lab, [the people working there] will look for the result, and they have lost it… It will involve pricking this child again… But [Picterus] does not need pricking… You just put [the calibration card] on the child... I think it's a very good idea." (FGD 3, Nurse 1)

"A lot of times you prick and prick, and you are not able to get enough blood… So, it's difficult too. So, there's so many challenges with the [blood test]... And the waiting time for the results to come up to the labs. So, if it's something like [Picterus] that it is non-invasive." (FGD 5, Nurse 1)

... "There are times the [health workers] will send the sample to the lab, [the lab] will return the sample and say the sample is not enough. Because they use the serum basically for the test, so, if the sample is not enough, you won't get enough serum for the test. And there are times when the sample gets lost in transit…" (FGD 3, Nurse 3)

In addition, the healthcare workers in the various focus group discussions were unanimous in their belief that using *Picterus* would be beneficial for both themselves as healthcare workers, who would not have to struggle with pricking the babies, and the babies, who would be spared the pain associated with the pricking:

... "You keep taking [blood tests] until that patient is discharged. Now, that is not okay for the patient, and even for [the health worker], it can be very burdensome. So, if [Picterus] is proven, tested and found to be okay, of course it will… It will roll off all of those problems [with the blood tests]." (FGD 3, Nurse 5)

Some healthcare workers reported how they believed the infants' guardians would respond to *Picterus*. Due to the non-invasive nature of *Picterus*, the majority of healthcare workers believed that parents would prefer the *Picterus* solution over the current solution of blood tests:

... "A lot of [the babies' guardians] don't want pricking. When the doctors are coming [the parents will say];'They're coming to pick my baby again.' Cause the baby will be crying… So, if they'll have an alternative, I think they would be happy. Even [the health workers] would be happy... Uncountable bedsheets have had a lot of blood stains." (FGD 5, Nurse 1)

"I think people are becoming more aware, so they know, they would even prefer it if it does not involve blood and all of that." (FGD 6, Doctor 3)

3.4 PERCEIVED BARRIERS THAT LIMIT THE USE OF mHEALTH

According to the findings of the current study, there were several barriers associated with mHealth technologies that, from the perception of healthcare workers, limit the use of such technologies. The healthcare workers shared their thoughts and experiences regarding the utilization of mHealth. In addition, they discussed its applicability limitations and the challenges connected with its utilization. During thematic analysis, the perceived barriers were divided into two categories: (1) barriers directed at the users (patients and healthcare workers) of the mHealth technology, and (2) barriers posed by the requirements of the mHealth technology.

3.4.1 Barriers directed at the users of the mHealth technology

Concerns of healthcare workers regarding mHealth included the fact that they lacked the necessary training to use such technology. Additionally, many considered that it was time-consuming to use. Moreover, several questioned the usefulness of mHealth technologies. Numerous healthcare workers expressed concerns and uncertainty regarding the significance of in-person contacts, which they feared mHealth technologies could reduce or eliminate.

Altering healthcare routine practices

In four focus group discussions, the fear that mHealth technology will displace healthcare workers and render their jobs unchallenging repeatedly arose among the healthcare workers. One healthcare worker provided the following example of a mHealth application she had heard about. It was an app used by healthcare workers to test patients by inputting information in response to predetermined questions:

> *"[mHealth] could be a disadvantage to the medical personnel… It makes us lazy… We would no longer want to seek information as in… In-dept information… It just makes you do things monotonously. You keep doing the same thing, same time, the same rate, every day, and it becomes burdensome to you. So the medical personnel is no longer challenged to think, unlike when these [technologies] were not there. Then [the healthcare worker] needed to ask the questions, but for mobile health, [the questions] have been… They've been planned out. The questions are already there, so it is just for [the health worker] to pick, and it will no longer make us use the higher center of the brain."* (FGD 4, Doctor 2)

In addition, some healthcare workers discussed the use of technologies versus humans. One healthcare worker expressed concern regarding the technological replacement of the human workforce in clinical medicine by stating the following:

> *"I, I don't believe that technology can ever replace humans… [Technology] cannot take away clinical medicine, it cannot… Because [health workers] still need to examine their patients. [Technology] can never replace that… Machines can never replace humans. It has been said for years 'The robot replaces humans, this replaces humans'… [Machines] don't replace, they only assist humans. They still need that intellect… No, no machine can buy that [intellect]. [Humans] combination of intellect, emotional intelligence and all, no machine can buy that from us."* (FGD 4, Doctor 4)

Upon being introduced to new mHealth technology, several healthcare workers expressed concern that they would have to modify their current health practices and procedures. These healthcare workers identified concerns about adaptability as potential barriers to the use of new mHealth technologies. Several healthcare workers raised concerns in various focus group discussions about the necessity of learning to type on a mobile device after being used to typing by hand:

"You know, it's not easy to implement something new… A place where a lot of people have been used to writing… I hear [health workers] complain about having to type… So people are not used to it." (FGD 6, Doctor 4)

"Typing is time consuming. I can't imagine when there is an emergency, and I am typing… Or during the ward round. I don't even understand how it will work eventually… You know, normally during our ward round you have to write [by hand]." (FGD 6, Doctor 2)

"You will probably have to do it twice. After writing [by hand], then you will transfer [by typing] it." (FGD 4, Doctor 1)

Disconnects face-to-face patient-provider relationships

In some of the focus group discussions, the value of physically seeing patients was underlined by several healthcare workers. They argued that the healthcare workers' evaluations of the patients would be weak if patients were not physically examined. In addition, some healthcare workers believed that patients might be unable to effectively describe their symptoms without a physical examination. Moreover, by using a physical examination, the healthcare workers believed they could more precisely determine what was wrong with the patients:

"There are some things the patient may not be able to describe while talking through a phone or this app, so [the health worker] will not be able to really assess the patient fully." (FGD 3, Nurse 1)

"One of the disadvantages is that [the health worker] might not really be able to assess the patient very well, like when you see the patient." (FGD 3, Nurse 1)

In addition, several healthcare workers believe that patients may not be able to comprehend fully while getting instructions digitally, such as via mobile phone online consultations. In addition, a number of healthcare workers regarded physical examination as essential to the practice of clinical medicine:

... *"Even when [the health worker] instructs [the patient] through the phone. How are you sure that [the patient] is carrying out what [the health worker] said?"* (FGD 1, Nurse 1)

"I think one downside of [mHealth] is the fact that, you know, clinical medicine, you still have a lot of hands on what needs to be done… And when [the health worker] is observing the patients... [The health worker] auscultate, palpate and all those things. Sometimes face to face contact is needed. So, in a way [mHealth] may affect clinical medicine." (FGD 4, Doctor 2)

Several healthcare workers concurred that some patients believed that the best medical care could only be obtained by physically visiting a health institution, just as some healthcare workers believed that seeing a patient in person was necessary. They also mentioned how challenging it is to alter patients' norms:

... *"Some people feel like if the doctor has not touched you, they've actually not been to the hospital. So we need to rewire the psychology of people, that you can be somewhere and then you can talk to another doctor in another location leveraging on technology, and still get the best of that meeting as if you are physically present."* (FGD 6, Doctor 5)

"[The patients] believe in physical visits, even those that have chronic illnesses…" (FGD 6, Doctor 1)

Skepticism and lack of trust

Most healthcare workers emphasized the importance of trust and belief in various mHealth technologies, particularly those designed to facilitate screening (e.g., measuring blood sugar levels via mobile applications). Many healthcare workers raised caution over such applications. In addition, they highlighted the importance of healthcare workers' trust in mHealth technologies for them to provide health services to patients using such solutions:

... "If [the healthcare worker] does not believe that [the mHealth technology] is accurate, it will not be easily adopted." (FGD 4, Doctor 3)

Some healthcare workers reported hearing or reading about inaccurate mHealth applications to test and diagnose. After hearing or reading about these experiences, healthcare workers developed distrust toward such technologies.

"For instance, recording patients' data and using mHealth for accessing information is okay but using [mHealth] for tests is not [okay]." (FGD 2, CHEW 3)

"The tests… That is what we are not believing in." (FGD 2, CHEW 1)

In addition, some healthcare workers were concerned that using mHealth technologies for tests and diagnosis would provide inaccurate results. Such inaccurate results could thereby influence the healthcare workers' decisions to manage their patients or the patient's decisions to seek medical care. Some healthcare workers explained that if their judgments were based on inaccurate information, the outcomes of their patients could be negatively impacted. As an example, one healthcare worker reported a patient whose digital blood pressure monitoring result was wrong:

... "Things in the environment can interfere with the accuracy of the apps… If you are trusting [the apps] one hundred percent… I mean, your [actual] blood pressure could be much higher than what you are seeing [on the apps], and then you will be relaxed at home until you faint or something. So, [the apps] are not so accurate, and then (FGD 4, Doctor 5)

"People rely on [the technologies] so much without even going for their regular check-ups and everything, and [their situation] just gets worse… Until it becomes an emergency…" (FGD 2, Nurse 1)

Furthermore, some healthcare workers worried that the accuracy of these mHealth technologies, such as the *Picterus* app, would be influenced by external factors in the environment of their setting, and that this was something they believed the implementors should take into account when introducing new mHealth technologies:

> *"... So, the places where [these technologies] are produced, [these places] may not put some things into consideration… Like if you keep this [devices] in a certain temperature, I can bet you that it will malfunction because some of [the devices] have sensors... It is physics… So, whoever is bringing these [technologies] will have to look at how these aspects can be addressed"* (FGD 4, Doctor 5)

> *"... If a patient is sick with severe perinatal asphyxia, a patient has cyanosis… Hypoxia? Will this affect [the results]? What will affect [the results]?"* (FGD 6, Doctor 2)

Finally, some healthcare workers discussed cultural and traditional factors, including how patients are accustomed to the 'natural way of doing things and how this is the preferred method:

> *"[Some people living in this area] are very indigenous… [This place] is a very… There's used a language. [The people] are very indigenous… That's why... They prefer the old way of doing things..."* (FGD 3, Nurse 1)

> *"[This place] is a rural area… So, there are some that… Even with their level of education… They still prefer to do things… The local way."* (FGD 2, CHEW 1)

Information overload

Several healthcare workers expressed concerns regarding the ubiquity of online information. Patients have access to both reliable and incorrect data, as well as necessary and unnecessary information. A number of healthcare workers stated that this could be extremely detrimental

to patients and believed that this could cause anxiety. One healthcare worker exemplified this with a patient who developed anxiety after reading online information about his condition:

> *"I remember one particular [patient] saying he was in the hospital and the doctor told him not to google his symptoms, but [the patient] went home and started searching online and then of course he was seeing all the wrong [information]… But of course, there is a way the doctors will exclude [the patients'] conditions based on the signs and symptoms, but that [internet page] was just giving all the information, so [the patient] became anxious, and in fact he ended up in the emergency room for psychiatric evaluation… So, the doctor would say [to the patient] 'I already told you not to go and check it up, because I know that the information there is uncensored, and you are going to have access to too much information.' So, too much information given to patients can lead to anxiety and other emotional trouble."* (FGD 6, Doctor 5)

Lack of awareness, knowledge, and skills

Training is necessary before using mHealth technology, as emphasized by most healthcare workers during the focus group discussions. According to the healthcare workers, this training should be available to everyone utilizing it. In many public health facilities, healthcare workers had not yet received mHealth training:

> *... "The most important thing that we are letting you know is that we have not been trained [to use mHealth technologies]."* (FGD 2, CHEW 1)

Even though some healthcare workers reported having coworkers who were knowledgeable with and able to operate various mHealth technologies, most healthcare workers were unfamiliar with the specifics of their use. Therefore, proper training is required for its successful utilization:

"You have to learn the skills also. Not everybody understands using IT." (FGD 4, Doctor 4)

Several healthcare workers agreed during the focus groups that patients must be educated and made aware when new technological solutions are adopted in the health system, just as healthcare workers require education. Patients do not always comprehend the benefits of mHealth or know how to access mHealth via mobile devices. The healthcare workers believed that patients often are limited to using mHealth technologies because of illiteracy and a lack of information about such technologies:

"If a patient is not well educated, that patient may not be able to use the app." (FGD 3, Nurse 3)

... "The percentage of our patients that are really educated… So, they have their phones… They can receive calls, but reading and studying to understand… It is a bit of a challenge…" (FGD 4, Doctor 1)

3.4.2 Barriers posed by the requirements of the mHealth technology

Power supply

Several healthcare workers explained that, when using mHealth, mobile devices would need to be regularly charged. Nigeria strives to maintain a steady electricity supply. Multiple healthcare workers stated that they believed lack of consistency would be a challenge for the implementation of mHealth in public health institutions in Nigeria:

"There's also challenges with power supply because… Technology thrives on constant adequate power supply." (FGD 6, Doctor 5)

Internet accessibility and network failure

The environment in which new technologies will be implemented plays a role in adopting mHealth technologies in public health institutions, according to healthcare workers in the current study. For mHealth to be widely adopted and thrive, many environmental variables must exist to encourage its use. The healthcare workers believed that several obstacles, including power supply, internet connectivity, network, and technical issues, would limit the use and widespread acceptance of mHealth in Nigerian public health institutions.

As they expected that most mHealth applications would require internet connectivity to function, most healthcare workers were concerned about network challenges. In order to optimize the benefits of mHealth, they highlighted that for these mobile technologies to be employed in health facilities in their context, mainly where there are emergencies, and a considerable number of patients, the internet connection of the health facility must be exceptionally reliable. The healthcare workers worried that challenges with network issues would disturb their use of mHealth technologies:

> *"What do you do if there is network failure? And this is Nigeria, where there is always network failure."* (FGD 3, Nurse 2)
>
> *... "Sometimes if there's no connectivity... Network... And I need to access mHealth, what do I do? If there is nothing I can do, I'll be paralysed for that moment that there is no network... So, if there is a technical issue, fault or anything, I won't be able to access mHealth..."* (FGD 4, Doctor 2)

In addition, some healthcare workers stated that mHealth may discourage patients from accessing healthcare due to network issues, as opposed to expanding access to healthcare services:

> *"The network will keep people waiting…"* (FGD 5, Nurse 2)
>
> *"If the patient goes to the hospital today and there is a network problem… And then tomorrow, there is also a network problem. And [the patient] is not able to see the doctor."* (FGD 5, Nurse 4)

Absence of devices and maintenance of available devices

To incorporate mHealth into their work, some healthcare workers insisted that the necessary devices must be readily accessible. Some of them believed that the primary reason they did not use mHealth technologies in their current practice was that they lacked the required equipment:

> ... *"What limits the availability and use in this place is that the government has never provided [devices to use mHealth]."* (FGD 2, CHEW 1)

Since the healthcare workers were aware of the advantages of mHealth and how it could benefit them and their patients, some of them accessed various mHealth technologies via their personal devices. Even so, they believed that their access to mHealth was restricted compared to what it would be if the government provided them with these tools. One healthcare worker described the devices currently utilized in the facility where she worked and how the provision of devices from the government would be appreciated:

> ... *"Available devices other than using personal devices… Right now, we don't have access to computers, tablets, Ipad, and all of that in the facility... So, [healthcare workers] come with their own devices… Laptops… So, we will appreciate [provision of devices in the facilities]."* (FGD 6, Doctor 5)

However, even if devices and data for internet access were available, the inability to maintain these devices, according to some of the healthcare workers, would prevent the long-term successfulness of mHealth technologies in public health institutions:

> ... *"The main problem is how [the devices] will be maintained. How will the gadgets be maintained? The technical know-how...."* (FGD 4, Doctor 4)

Costs

Healthcare workers characterized the use of mHealth technologies as novel and something Nigerians had not fully adopted. According to a number of healthcare workers, the costs associated with implementing and maintaining new technologies are significant. Some discussed how inadequate funding for mHealth could make purchasing, operating, and maintaining mHealth devices challenging:

> *"Since the patients barely pay for any of the services rendered to them, there isn't a lot of money coming in. Hence there needs to be extra funding to… Pay salary to health workers, to provide new equipment, and make sure that they are in good condition. Also, to bring expertise that can appropriately handle all this equipment. All these require money. So, if the funding is not there, it's going to affect the adoption of all these technologies even if they are available… Because you need money to access it in a way… So that's part of the challenges."* (FGD 6, Doctor 5)

> *"Any good thing requires money, so, continuous, adequate and timely funding. It's very important, it's a great limiting factor of mHealth."* (FGD 6, Doctor 6)

Moreover, despite the availability of devices to access mHealth, the internet or access to data was seen as an obstacle by many healthcare workers. They were aware that numerous mHealth technologies necessarily required internet connectivity or data. Consequently, healthcare workers cited data costs as a hindrance to the use of mHealth technologies:

> *"The costs of data is a hindrance… If you don't have data, you cannot [use mHealth]."* (FGD 5, Nurse 3)

> *... "If there's no data, there's no way [healthcare workers] can use [mHealth]."* (FGD 2, CHEW 2)

4 DISCUSSIONS

In this chapter, the study findings that emerged from the data collection and analysis are discussed in light of the research's aim and in combination with prior research and existing theory. In addition, the study's methodological considerations, including the study's trustworthiness and quality, are discussed.

4.1 DISCUSSION OF THE FINDINGS

This study aimed to explore the perceptions of healthcare workers working in public health facilities in Lagos State, Nigeria, regarding mHealth technologies. The data collection and thematic analysis results revealed a wide range of healthcare workers' perceptions, which were grouped as benefits that promote the use of mHealth technologies among healthcare workers and barriers that limit the use of mHealth technologies among healthcare workers. In addition, the current study explored healthcare workers' perceptions of a mHealth app (*Picterus*) as a screening tool, which the healthcare workers reported.

4.1.1 The balance of information

The current study's findings demonstrated that healthcare workers working in public health facilities in Lagos considered mHealth technologies to have numerous benefits, one of which is greater access to health-related information, for example, by using apps on mobile phones. According to the healthcare workers, this results in positive outcomes for both patients and healthcare workers. The healthcare workers believed access to health-related information would increase patients' involvement in their health, leading to better treatment and illness condition outcomes. In addition, the healthcare workers considered that extended access to health-related information would encourage consumers to have better health-seeking behavior, know when to contact health institutions when ill, and reduce overall mortality in communities. A study by Vo et al. (2019) focused on patients' perceptions of mHealth apps. They discovered that patients valued educational applications that supplied them with knowledge about their health, making them more aware and providing them greater control over their health situation, thereby empowering the patients. The United Nations (2005-2015) defined *empowerment* as "the process by which people gain control over the factors and decisions that shape their lives." After patients receive vital health-related information about their condition from a healthcare worker, the advent of mHealth enables patients to utilize

additional resources, such as mobile phones and digital platforms, to increase their knowledge (O'Donovan, 2020). Patient involvement was stated as favorable by several healthcare workers in the current study, and one stated: "... we want [the patients] to be involved. This will result in better outcomes of the treatment and even the disease condition." According to Krist et al. (2017), information is vital for patient engagement in decision-making, care, and self-management. The majority of the healthcare workers in the current study believed that mHealth technologies allowed them to stay informed on the latest health trends which can be used to provide proper care for their patients. This is also highlighted as a benefit of mHealth in the study by Coppock (2009).

Despite the fact that healthcare professionals in the current study and earlier research (Vo et al., 2019) emphasized information access as a useful aspect of mHealth, it is not always advantageous to have a wealth of information available. In the current study, healthcare workers were concerned that patients with access to an overwhelming amount of information may develop anxiety because they are unable to process it all. A similar finding was highlighted in the review by Vo et al. (2019), which indicated that certain patients, such as those who had survived cancer, were not opened to obtaining additional information or counseling about their diseases since it could trigger anxiety. Reading medical literature, watching television programs, and hearing about illness can all induce fear (Silver et al., 2004, p. 81). First-hand knowledge of a disease can be terrifying. Bawden and Robinson (2009) explained in their study that the concept of information overload is the result of having too much knowledge readily available, and that information anxiety is a result of information overload. Additionally, an abundance of relevant and potentially important information can hinder the information seeker, thus decreasing the material's potential value (Bawden & Robinson, 2009). According to Bawden and Robinson (2009), too much information can be harmful to health in extreme circumstances, acting as a burden rather than a help. This highlights the significance of education and communication between healthcare workers and patients. The healthcare workers cannot prevent the patient from reading about his or her diseases online but can provide direction on where to read and where to avoid reading when seeking additional information.

Nonetheless, some of the healthcare workers in the current study who were concerned about information overload also expressed concerns regarding the occurrence of incorrect information available online. With so much information available, it can be difficult for the

majority of individuals to determine what information is reliable and what is not. In fact, according to Sillence et al. (2007), concerns about the quality of health-related information that people, to date, are able to find online have grown alongside the volume of information available. Misleading or wrong information can be particularly problematic in the domain of health since this can put people's lives in danger by delaying or preventing adequate care (Wang et al., 2019). Similar concerns are also discovered in previous studies (Hesse et al., 2005; Klerings et al., 2015). In order for healthcare workers and patients to be able to sort what is relevant and polite information when searching for health-related material online, more effort needs to be put into establishing guidelines that will serve as information filters (Swar et al., 2017). Additionally, Tonsaker et al. (2014) underline the responsibility of healthcare professionals, as well as researchers, to make sure that patients have access to reliable and legitimate online health care resources. Furthermore, it is important that this information is understandable and user-friendly. According to Tonsaker et al. (2014, p. 408), it is vital that healthcare workers are educated in "current, up-to-date, and valid health resources," which they can further propose to their patients.

4.1.2 The balance of physical- and online consultations

Implementation of mHealth technologies was, by the healthcare workers, perceived as providing a favorable impact on patient-provider communication in the current study. The majority of the healthcare workers claimed that switching from exclusively in-person consultations to online consultations, facilitated by mHealth technologies, would be beneficial for both healthcare workers and patients. The healthcare workers believed that communicating with their patients online would reduce their workload. They also assumed that patients would value saving time by not having to attend physically to the health facility. Similarly to former studies, online consultations between patients and providers have been highlighted as positive outcomes of mHealth technologies (Vo et al., 2019). Moreover, the healthcare workers in the current research underlined the significance of online consultations so that the patients did not have to come to the health facilities each time, and risk getting various infections, especially during the COVID-19 situation. This was also highlighted as a benefit in a study exploring various stakeholders' perceptions of the mHealth technology "mConsulting," serving as a mobile phone consultation with healthcare workers (Feyehun et al., 2020). The study revealed that the solution would reduce patients' exposure to hospital-related threats, such as infections (Feyehun et al., 2020).

However, although eliminating the need for physical visits between healthcare workers and patients was perceived as a benefit of mHealth technology, some healthcare workers in the current study believed that this could be a disadvantage of mHealth due to the limited personal face-to-face connection between patients and providers. In addition, some of the healthcare workers reported that as many patients believe in in-person interaction with their health providers, they worried that it would become difficult for some patients to accept digital interaction with healthcare workers. Similarly, in the study conducted by Venkataraghavan et al. (2021), patients believed that all interactions with their doctors must take place in person and that nothing could replace physical consultations. The patients felt that it would be difficult to explain their situation to a doctor over the phone because they feared misinterpretation and a failure to receive required health advice (Venkataraghavan et al., 2021). Even while not all patients undergo physical examinations, clinical care significantly depends on in-person interactions (Mubaraki et al., 2021). There are instances in which the physical examination is crucial to the diagnosis and avoiding missing important findings that could be detrimental to the patient (Saljoughian, 2021). According to former research, healthcare providers rely solely on patients' self-reports, and patients may fail to mention symptoms that are only visible during patient visits (Smith et al., 2008). This could undoubtedly have a negative effect on treatment. In another study, results revealed that some informants expressed skepticism regarding online consultations and believed that physical interaction between healthcare workers and patients was the most credible and trustworthy method for evaluating a person’s health (Feyehun et al., 2020). Healthcare professionals in our study shared the same opinion, saying that until a patient enters the hospital, they do not believe they have received any worthwhile healthcare services.

According to the findings in the current study, healthcare workers believed that mHealth technologies, particularly mobile phones, could enable more people, including those living in remote areas, to access appropriate healthcare. Several other studies support this finding (Venkataraghavan et al., 2021), including the study by Odendaal et al. (2020) focusing on primary healthcare workers' views and experiences with mHealth technologies. The findings indicated various benefits of mHealth technologies, one of which was reaching people in hard-to-reach locations, thereby increasing the number of people with access to healthcare services. Similarly, a study conducted by Hampshire et al. (2017) highlighted the importance of mobile phones in distant regions, particularly during emergency situations, so that people could obtain health assistance quickly.

Furthermore, it was underlined by the healthcare workers in the current study how mHealth technology has particularly assisted in communication during COVID-19 and made people all over the world keep in contact with each other, as a global village, despite minimal physical contact. According to Alzahrandi et al. (2022), COVID-19 has altered the way people use online services worldwide. Many countries have placed emphasis on the use of mobile technology during COVID-19 in order to provide adequate healthcare services to most affected areas (Adetunji et al., 2022, p. 158). Moreover, during COVID-19, many nations have prioritized the use of mobile technology in order to deliver essential healthcare services to the most impacted areas (Adetunji et al., 2022, p. 158). For example, in Nigeria and other African nations, individuals received daily, weekly, or monthly SMS messages regarding disease awareness and COVID-19 guidelines, due to the advent of mHealth technologies (Adetunji et al., 2022, p. 158).

4.1.3 Saving time

The study's findings indicate that mHealth was perceived as a time-saving solution. Many healthcare workers recognized that mHealth not only saves time for healthcare providers but also for patients. The processes involved in providing healthcare frequently involve a large number of individuals, technologies, and rules (Varshney, 2014). Increasing the efficacy and quality of healthcare procedures and outcomes is one of the primary goals of mHealth (Varshney, 2014). mHealth provides easy access to a patient's medical history, current information, and updated medical knowledge. With the usage of mHealth, efficiency can be raised by means such as quicker task completion and access to historical data (Varshney, 2014). Health providers can perform procedures and duties that were previously time-consuming and laborious quickly and more efficiently thanks to mHealth technology. With the use of mobile devices, it is easy and quick to communicate with other healthcare experts who are located elsewhere, allowing for the speedy and effortless execution of essential judgments. Similar to prior research, mHealth reduces the requirement for prompt replies by successfully linking doctors who need support or information with their colleagues, making lab test results immediately available, and recording or retrieving patient information at the bedside (Haroon et al., 2010). The consensus among healthcare workers in the study by Gagnon et al. (2016) was that mHealth saves time over other technologies by facilitating quicker interaction and communication.

During the focus group discussions in the current study, healthcare workers highlighted how mobile apps such as *Picterus* can save time and have a significant impact on patients' prognoses. In most health facilities in Nigeria, neonatal hyperbilirubinemia is identified by measuring the serum bilirubin concentration. For conventional testing to occur, a blood sample must be collected, which can take considerable time, particularly in circumstances where veins are difficult to locate. The blood sample must then be taken to the laboratory where the test will be conducted. There may also be a delay at this stage if there is a power outage or if samples are returned for inadequate quantity. All of these delays caused by the turnaround time can have a significant impact on the patient's prognosis. The lengthy turnaround time may have contributed to cerebral palsy or in worst cases, death. On the other hand, using *Picterus*, patients can be screened in under two minutes, and treatment can be initiated immediately. It has been demonstrated that using mobile devices considerably accelerated task completion (Mitsa et al., 2007)

With mHealth, time management in the delivery of healthcare services can be improved. Patients and hospitals can save time and effort if mHealth applications generate and store individualized health check-up results. Using a unique identification number, for instance, mHealth can collect data from "all points of patients' visits, i.e., from the outpatient department to the operation theater, emergency, in-patient department, imaging, pathology, microbiology, and post-hospital follow-up at home" (Sharma et al., 2022, p. 39). Since all patient information is contained in one location, patient data can be quickly evaluated, and timely decisions may be made. This is faster than traditional techniques where, each time healthcare is sought, applications ask patients for biographical information and health history to establish an accurate diagnosis, resulting in a complicated and time-consuming procedure (Nguyen et al., 2022, p. 274). Patients can have rapid and easy access to healthcare providers via their mobile phones, hence reducing the amount of time spent traveling to the hospital to seek medical assistance. Especially in unwarranted instances or when patients live a great distance from the nearest health facility.

4.1.4 Development of the health system

Each activity, mechanism, and resource that aids in promoting, restoring, or maintaining health is referred to as a health system (Arteaga, 2014). It has been said mHealth is a technology that enables better health and has a favorable impact on the healthcare system in

terms of better access, treatment quality, and cost (Fortuin et al., 2016). During the study healthcare workers discussed how the use of m Health would positively influence the Nigerian health system. They emphasized how mHealth can offer substitutes for the present, more labor-intensive methods to promote, restore, and maintain health. Adding to that, they might have a more advanced system as they move up the ladder to catch up with other nations by utilizing mHealth. MHealth was also seen as a way for the Nigerian economy to generate income and, as a result, increase GDP. MHealth has the potential to have a significant impact on the health system because it can improve health outcomes and generate revenue for the nation. Economic growth encourages an increase in health expenditure to strengthen the healthcare system (Niu et al., 2021)

In the current study, some healthcare workers stated that they believed the community, among others, would value the adoption and utilization of mHealth technologies in healthcare because it would reflect that the health system is developing and upgrading. A similar finding was highlighted in a review by Agarwal et al. (2015), which discovered that healthcare workers utilizing mobile phones while providing healthcare increased the credibility of healthcare workers among community citizens. Moreover, a similar result was also emphasized in the study by Medhi et al. (2012), which focused on using a phone-based approach to prevent child malnutrition. The vast majority of the healthcare workers included in the study underlined how using the phone-based system had allowed them to “earn social respect and recognition from the community” (Medhi et al., 2012, p. 641).

4.1.5 Accepting changes and the process of it

Relationship of perceived threats, acceptance, and resisting change

According to the findings of the current study, several healthcare workers feared losing their clinical skills due to the implementation of new mHealth technologies. Concerns that the use of mHealth technologies in clinical practice would make the healthcare workers lazy were addressed, as concerns that their work would become monotonous and unchallenging, thereby making them burdensome. Several healthcare workers expressed fears related to utilizing mHealth technologies in their practice would make their work too easy and that it would eliminate the need to utilize the brain to think, which would be unchallenging and

uninteresting in the long term. In other words, using mHealth technologies could be seen as a threat to their current practices (Bhattacherjee & Hikmet, 2007). A similar point was made in the study by Zuzelo et al. (2008), examining the impact of technologies on the work of nurses. They discovered that nurses feared losing skills as a result of technological advancements and that the deployment of various devices would "affect their clinical judgment and hands-on assessment skills" (Zuzelo et al., 2008, p. 139). Odendaal et al. (2020) discovered in their study that several healthcare workers felt that using mHealth technologies as decision support threatened their clinical expertise. Fleming (2022) emphasizes the connection between fear and resistance to change, which can, for instance, stem from a fear of losing control.

Moreover, with the deployment of new technologies, current health practices and the routines of healthcare workers will be modified (Craine, 2007). According to Bhattacherjee and Hikmet (2007), perceived threats cause resistance to change, which is found to be a significant obstacle to successfully implementing mHealth technologies (Scott Kruse et al., 2018). This is also highlighted in the study by Walter and Lopez (2008). They explain in their study that if the user of a product perceives or discovers that the intention is to restrict autonomy, the user may not want to utilize the product. Resistance can be defined as the "refusal to accept" (Brooks, 2019) and is the opposite of acceptance. Acceptance is defined by Sekhon et al. (2017, p. 4) as "a multi-faceted construct that reflects the extent to which people delivering or receiving a healthcare intervention consider it to be appropriate, based on anticipated or experienced cognitive and emotional responses to the intervention."

Prior research has shown that acceptance is necessary for scaling and maintaining mobile technologies in healthcare (Mitchell et al., 2012; Sekhon et al., 2017; Walter & Lopez, 2008). However, creators of new technologies consider technology acceptance as a significant challenge (Nadal et al., 2020). Walter and Lopez (2008) argue that users' acceptance of new technologies is closely linked to their willingness to make changes and incorporate new technologies into their daily work activities. Moreover, according to Sekhon et al. (2017), if health workers regard the delivery of an intervention to patients to have low acceptability, the intervention may not be delivered as intended, which may have an effect on the intervention's overall effectiveness. Safi et al. (2018) underlined the importance of understanding the healthcare workers and patients fears and insecurities regarding technologies, because if

people resist change, even the most effective technological strategies are unlikely to work (Craine, 2007).

According to Haslam and Pennington (2010), it is not uncommon for people to be too comfortable with current practices and with old behaviors since they are familiar with and used to them. Even though these old behaviors are not the most productive, many people would resist changing because changing into something that is new and unknown would make them uncomfortable and threatened (Haslam & Pennington, 2010; Fleming, 2022). Nonetheless, Haslam and Pennington (2010, p. 4) characterize resisting change as a "natural defense mechanism" and thus, emphasizes the need for caution when entering unknown territory. This is also highlighted by Craine (2007).

Knowledge, training, and acceptance

Most healthcare workers in the current study feared that their lack of knowledge regarding mHealth technology would limit their use of it. The healthcare workers were not particularly familiar with mHealth technologies and stated that they had not received enough information regarding such solutions. Former studies have highlighted the importance of both patients' and healthcare workers' understanding of what mHealth is, how to use it, and how it would benefit them in order to be willing to use it (Agarwal et al., 2015; Kenny et al., 2017). Also, healthcare workers who will use such technologies must receive proper training on mHealth to feel comfortable with them (Agarwal et al., 2015). Rajak & Shaw (2021) suggest in their study that resistance to change can occur due to a lack of knowledge and information about new technology, leading to fear of using technology. Therefore, adequate training and support for healthcare workers are essential for the utilization of mHealth technology.

Moreover, in the current study, it was discovered that most healthcare workers found the *Picterus* app intriguing and would want to integrate the solution into their daily practice. However, according to the healthcare workers, implementing such a solution would require proper training and available tools. The solution must be less expensive and more effective than the current method. A systematic review by Agarwal et al. (2015) examined the viability and efficacy of mHealth techniques in developing countries. They found that with the correct training, all healthcare workers were able to learn how to use mHealth technologies, such as mobile phones (Agarwal et al., 2015). Additionally, they discovered that healthcare

professionals regarded mobile phone-based technologies as valuable for enhancing patient care (Agarwal et al., 2015). Similarly, the study by Kenny et al. (2017) exploring primary healthcare workers' views toward adopting mHealth, utilizing an app to assess sick children, found that after receiving proper training, the healthcare workers felt secure using the app. This can also be linked to the TAM model, whereby perceived ease of use influences perceived usefulness. When healthcare workers are properly trained and supported, they will find mHealth technology easy to use (Odendaal et al., 2020). Easy-to-use mHealth tools will be perceived as useful (Rajak & Shaw, 2021). Moreover, this consequently influences healthcare workers' attitudes and behavioral intentions regarding the use of mHealth, creating an overall positive attitude toward mHealth technology and a more efficient adoption process (Rajak & Shaw, 2021).

When healthcare workers in the current study were asked if they believed there would be any cultural barriers associated with mHealth technologies being implemented in their health facility or if they anticipated patients' guardians would deny using the *Picterus* app on their infants, they responded 'no.' However, the healthcare workers believed that the education of the patients and parents (in the instance of *Picterus* solution) was essential. Moreover, they believed that after the patients' guardians are counseled and informed on the usage of mHealth, they will be opened to accepting the *Picterus* app. In addition, the healthcare workers emphasized that they believed the parents would accept the mobile technology regardless of whether they were illiterate or not, as long as they were well-informed about it. According to Khatun et al. (2015), knowledge regarding awareness of mHealth serves as predictors of the community's readiness to adopt mHealth. In addition to training healthcare workers who will use mHealth technology, it is essential to raise awareness about mHealth (Odendaal et al., 2020). Patients should be well informed about the technology, its application, and its benefits. It is vital for the patients to be included to make the adoption process easier (Silva et al., 2015).

Additionally, several healthcare workers in the current study emphasized the importance of taking time to accept change. They believed that reactions and mistrust from healthcare practitioners and patients were normal when introducing new mHealth technology into the healthcare system. However, they stated that they thought skepticism was most significant at the beginning of the implementation of new technologies, but that as time goes on, people

will realize that the technology is there to help improve existing systems and will, with time, education, and more knowledge, accept new innovations in the long run.

4.1.6 Trust and acceptance

According to the current study's findings, healthcare workers recognized the *Picterus* app as an effective mHealth device for early assessment of neonatal jaundice, which could assist them in the screening jaundice in newborns, and result in prompt treatment. In the study by Zuzelo et al. (2008), the impact of technology on the job of registered nurses was examined. Findings suggested that nurses were pleased with technological instruments such as blood glucose monitoring, automatic blood pressure monitors, and pulse oximetry. In addition, they emphasized that such digital technologies facilitate early patient assessment, allowing nurses to treat patients faster than if they were unavailable (Zuzelo et al., 2008).

Nevertheless, despite the perceived advantages of using mHealth technologies in screening, lack of trust in the accuracy of mHealth technologies, particularly mHealth devices used for screening, was a major concern for most healthcare workers in the current study. They were concerned about placing too much faith in a mobile screening device used in patient care to discover later that the result was inaccurate. During the FGDs, a comparison was made between the traditional method of doing blood tests and the *Picterus* app used for digital screening. The healthcare workers were worried that the blood test might yield a completely different result from the technological screening device and were concerned about trusting the mobile app. Some healthcare workers shared previous experiences with similar discrepancies between automatic and manual blood pressure monitoring. They claimed that the manual method had yielded more accurate results than the automatic device, which differed significantly. This finding is also consistent with previous research (Zuzelo et al., 2008). A review by Odendaal et al. (2020) found that healthcare workers reported that some citizens trusted them when they used mHealth technologies in patient care, whilst others were skeptical of its use and did not trust it. It's also vital to note that behavioral intention to utilize the technology is likely to be influenced by trust in the mHealth app (Schnall et al., 2015). Perceived ease of use is correlated with trust in mHealth technology, since it requires less work to oversee the mHealth technology's correct operation (Schnall et al., 2015).

The precision of mHealth devices is crucial, especially when used as screening tools in healthcare. Furthermore, it is necessary for these mHealth devices to be accurate and trustworthy because healthcare workers rely on the results to make critical decisions as regards patients (Lewis & Wyatt, 2014). Inaccurate and misleading data will have the opposite effect and can result in medical errors (Smolij & Dun, 2006), harming patients. Sadly, studies have demonstrated the existence of mHealth applications that pose threats to patient safety and may be harmful to use (Lewis & Wyatt, 2014). For example, numerous smartphone screening applications already exist to detect melanomas. A case-control study conducted by Wolf et al. (2013) revealed the low accuracy of smartphone applications assessing melanoma which may lead to delays in diagnosis and treatment that could result in unfavorable outcomes for the users of such applications (Wolf et al., 2013). Furthermore, Haffey et al. (2013) studied the dependability of smartphone apps for opioid switching to assist health workers in decision-making in their practice. Significant concerns were found regarding the accuracy and dependability of the information healthcare workers received from the various opioid switching applications investigated, which could endanger patient safety (Haffey et al., 2013). Consequently, some healthcare workers, as shown in the current research results, were skeptical of such mHealth devices for screening. Healthcare workers with former knowledge or experience with mHealth devices providing inaccurate information were more resistant to using technological tools in healthcare, particularly in the screening domain. Moreover, the current study's findings revealed that some healthcare workers' motivation to use the *Picterus* app for detecting neonatal jaundice in newborns was negatively impacted by their prior exposure to inaccurate mHealth devices used for screening. The app's accuracy was a major recurrent concern among all healthcare workers. As a result, some healthcare workers would rather use a time-consuming, inconvenient traditional method than a quick, simple, and inaccurate device. Moreover, this concern will likely hinder some healthcare workers from utilizing such screening devices in their clinical practice.

However, even though skepticism is seen as a limitation to using mHealth technology, it could also benefit society. It is almost always expected that new technology has to be accepted, and people must make changes to accommodate the new technology. Maybe there are benefits to not changing and benefits of being skeptical about new technology. This skepticism stems from worries about the accuracy of the new technology and the adaptability of the technology to the new environment. Therefore, this calls for implementers and

developers to consider the importance of the accuracy of new technology and ensure that these technologies are adaptable to the environment in which they will be used. mHealth technologies are directed to the health of an individual or a society. Hence it is paramount that this technology goes to proper quality check. During the current study, most healthcare workers repeatedly stressed their concerns about the accuracy of *Picterus*. Inaccurate measurements or unreliable mobile apps may result in the technology being abandoned or even harmful to the patients. Hence, proper quality checks are needed. In addition, another thing that stirred up skepticism regarding mHealth technologies was its adaptability to the environment in which it will be used. Many healthcare workers in the current study were keen to know if *Picterus,* an app made in Norway, would be adaptable to the Nigerian conditions and environment.

> *"... So, the places where [these technologies] are produced, [these places] may not put some things into consideration… Like if you keep this [devices] in a certain temperature, I can bet you that it will malfunction because some of [the devices] have sensors... It is physics… So, whoever is bringing these [technologies] will have to look at how these aspects can be addressed"* (FGD 4, Doctor 5)

It is usually expected that the people and environment make changes to accommodate the new technologies. However, what would be even better is for the creators of new technology to consider the environment in which the technology will be used and make the required modifications to make the technology more versatile and effective in that area.

4.1.7 Infrastructural and technological limitations

According to the study's findings, most healthcare workers expressed concerns about the lack of power supply and internet access if they were to use mHealth technologies in their day-to-day practice. According to the healthcare workers, unexpected power failures frequently occurred at the various healthcare facilities in Lagos, Nigeria. Without electricity, they feared they would be unable to utilize the *Picterus* app to scan a newborn baby for jaundice. They also mentioned that many modern mHealth technologies, such as the *Picterus* application, require an internet connection, which could be a significant problem given Lagos's public healthcare facilities' unstable internet infrastructures. In prior research, one of the top three

barriers to implementing mHealth technologies in healthcare was identified as a lack of infrastructural components, such as power supply and internet connectivity (Kruse et al., 2019). Prior studies in developing countries perceived the availability of internet access and electricity as major barriers to implementing and sustaining mHealth technologies (Kenny et al., 2017). Additionally, it has been noted that a major barrier to the widespread adoption of mHealth technology is poor infrastructure, according to a report published by the WHO (2011). Moreover, the majority of mHealth research, according to Betjeman et al. (2013), is conducted in high-income countries with advanced telecommunications infrastructure, which is still uncommon in developing regions of the world, such as Sub-Saharan Africa. This is particularly true of broadband internet access, which poses a significant challenge in many situations (Betjeman et al., 2013), as expressed by the healthcare workers in the current study. However, Betjeman et al. (2013) explain that the internet infrastructure offers numerous difficulties for viability, particularly regarding more advanced mHealth initiatives utilizing, among other things, smartphones.

Among the obstacles to the wider adoption of mHealth technologies in LMICs, is the lack of infrastructure, which affects the accessibility and coverage of technologies in these areas (Latif et al., 2017). In Nigeria, the use of mHealth is hindered by a lack of electricity, internet access, network failure, a dearth of mHealth devices, and inadequate maintenance of existing devices (Fox et al., 2020). According to a systematic review by Aranda-Jan et al. (2014), the availability of infrastructure in the region where a mHealth project is deployed significantly impacts its implementation. Therefore, access to a dependable network, the internet, and electricity are prerequisites. Although mobile phone access is widespread in LMICs, it is not always reliable. For instance, the *Picterus* app, a quick and simple method for detecting neonatal jaundice, requires a reliable mobile phone and internet connection. Without a network and connection, this application can be frustrating and time-consuming. Care providers will be forced to abandon the application in favor of the conventional laboratory test utilizing serum bilirubin. In addition, these facilities must have a reliable power supply to charge mobile phones. Lastly, the management must provide mobile devices and routine maintenance. All of these limitations could hinder the adoption of mHealth because healthcare workers, who are one of the most important stakeholders, may be unwilling to use mHealth technologies because it may not be seen as an easy-to-use tool.

4.2 METHODOLOGICAL CONSIDERATIONS

This chapter presents the study's methodological considerations. Considerations regarding the study design, data collection, analysis, and findings are presented and discussed. In addition, the following chapter reflects and discusses the study's research team and the study's trustworthiness, strengths, and limitations.

4.2.1 Considerations on research design and data collection

This study aimed to explore the perceptions of healthcare workers working in public health facilities in Lagos State, Nigeria, regarding mHealth technologies. However, it would have been interesting to consider the patients' perspectives of mHealth technologies. In addition, as the study featured a demonstration of the *Picterus* app, the perceptions of newborns' parents' may have been included. Furthermore, the current study may have included alternative data collection methods, such as individual interviews, which could have yielded additional information. However, this master's thesis is confined by factors such as a limited time frame and limited finances. Therefore, this could not be done at this time, although alternatives could be studied in future research.

This study included selected groups of doctors, nurses, and CHEWs from primary, secondary, and tertiary public health facilities. The primary investigators intended to examine if there were differences between the different occupations and the various health care facilities. The researchers found no distinctions between occupational groups and health facilities through data analysis. Furthermore, the findings might have been different if other healthcare professionals with different demographics from those in the current study had been included. Also, if the study site of the research project was a rural area as opposed to the metropolitan area that was used, the perceptions of healthcare workers might have yielded different results. Following the current study's inclusion criteria, the selected healthcare workers worked in public health institutions with pediatric patients. According to the two primary researchers, the healthcare workers selected for the study have yielded vital information on the investigated phenomenon (Bengtsson, 2016).

Before the FGDs, the two master's students evaluated the focus group question guide and practiced asking each other the questions through Zoom, as they were located in separate

countries. In addition, a pilot FGD was conducted face-to-face between the Nigerian-based master's student and the Nigerian local supervisor to get the necessary experience to lead the larger focus group discussion. This prepared the master's student conducting the FGDs to commence data gathering. She was initially unfamiliar with FGDs, but after practicing with a fellow master's student and the co-supervisor, she felt more confident and excited to get started. The first two FGDs lasted 22 and 31 minutes and produced minimal information. In both FGDs, healthcare workers delivered brief responses to the majority of questions, and little or no conversation or discussion occurred between them. The co-supervisor was also present during the FGDs to assist the master's student. Moreover, both FGDs resulted in limited data. Therefore, these FGDs acted as pilots and were excluded from the data analysis. In addition, the primary researchers decided to slightly modify the question guide to elicit in-depth responses from the healthcare workers and encourage discussion among them. As a result, the interview guide was modified slightly before the continuation of subsequent FGDs.

For the study's researchers to ensure that each FGD included the desired number of healthcare workers to get enough data, the discussions were held at the various health facilities where the healthcare workers were employed. At the time of data collection, most healthcare workers were busy, mostly due to the COVID-19 outbreak. In addition, due to considerable travel distances, because healthcare workers were living far away from the health facilities, it was impossible for most of them to attend FGDs outside of their working hours. Consequently, all FGDs were conducted in private meeting rooms within the various healthcare facilities during the working hours of the healthcare workers. According to Braun and Clarke (2013, p. 121), it is important that the researcher creates a safe environment for the informant. They suggest choosing a place in which the informants are familiar (Braun & Clarke, 2013, p. 121). The primary researchers carefully evaluated the location of the FGDs. They determined that a meeting room at the various health facilities would be a suitable location for conducting the FGDs, as it was a familiar location for all the participating healthcare workers. Before the FGDs, the healthcare workers gave verbal approval of the location. In addition, before and throughout the FGDs, the researcher observed that most healthcare workers were engaged and eager to discuss the topics under investigation and that there was a pleasant atmosphere within all the discussions. However, a few healthcare workers were shyer and reserved. That is, according to Braun and Clarke (2013, p. 130), not uncommon within a focus group. Nevertheless, it slightly alters the role of the moderator, who must take a more active role in the discussion to engage those who are silent (Braun and

Clarke, 2013, p. 130). In several of the FGDs, the moderator did this by carefully asking silent healthcare workers about their opinions and views on the topic under discussion and attempting to engage them by making eye contact. However, some remained silent after attempting these strategies and provided brief responses. There could be various reasons for this, such as the individual's discomfort in the group setting, reluctance to speak because the moderator was a stranger or inability to contribute to the discussion (Braun and Clarke, 2013, p. 116). Yet, participation in an FGD is highly voluntary, and no one should be forced to speak if they do not wish to, which was not the case in any FGDs (Braun and Clarke, 2013, p. 116).

4.2.2 Considerations on data analysis and findings

Braun & Clarke (2013, p. 90) state the environment "should be as quiet as possible, with little or no background noise." Despite the FGDs being held in meeting rooms among multiple healthcare facilities, common to all three health facilities, there was traffic outside and poor insulation inside the buildings. In addition, the healthcare workers worked in pediatric units where infants were crying in the background. As a result, when the transcription process started, in some FGDs, background noise in the audio recordings made it a bit challenging to hear what some healthcare workers were saying. The principal researcher in charge of transcribing the audio recordings sometimes found it difficult at times to understand the accents and slang used by several healthcare workers during the focus group discussions. In addition, another limitation that interrupted the transcription was that some of the healthcare workers frequently spoke over one another. This often happened when they got very interested in a certain inquiry or felt obligated to share their viewpoint on certain topics. As a result of the above-mentioned, transcription took a long time to complete. However, all transcriptions were quality checked by the Nigerian researcher who conducted the FGDs as they were completed.

Because there are two primary researchers on this project, the initial analysis steps (familiarization, generating initial codes, and searching for themes) were conducted independently. Following this, the analyses were compared via Zoom meetings, during which similarities and differences were discussed (Patton, 2002, p. 464). According to Patton (2002, p. 464), two distinct perspectives on the same data can lead to valuable insights and comprehension of the data and is referred to as "a form of analytical triangulation." Braun

and Clarke (2013, p. 338) define triangulation as “using two or more data sources, methods, or researchers to try to gain a fuller or multi-faceted understanding of a topic.” The two master’s students of the research project had different professional, cultural, and experiential backgrounds. Therefore, having two researchers undertake the analysis diminished individual biases and preconceptions surrounding the findings (Stahl & King, 2020), which supported the study’s quality. Moreover, due to the different perspectives and experiences of the two researchers, it is essential to note that there were differences in coding and analysis (Braun & Clarke, 2006). However, these distinctions were minor. The two primary researchers and the project supervisor discussed the identified themes. Furthermore, both researchers had a critical view of their study findings, which according to Kvale and Brinkmann (2009, p. 254) is essential for the validity of the study.

4.2.3 Reflections of the research team

Both master's students were inexperienced with qualitative research and thematic analysis before this research project. Despite this, they were motivated and strongly driven to actively participate in the process of acquiring new knowledge. Their understanding has been increased by methodological theory, methodological subjects in the master's program, and additional theory. Clarke and Braun (2013, p. 177) characterize TA as the ideal method for those unfamiliar with qualitative research because of its flexibility. In addition, the master’s students had a strong working relationship with the principal supervisor of the study and the local co-supervisor, both with qualitative expertise. They have supported and guided both master's students throughout the process, from the study's preliminary work to the report's completion.

Furthermore, the research project was performed during the COVID-19 period, while there were still many restrictions in many countries worldwide. Although most countries had recently removed their restrictions, certain countries still had travel restrictions. Despite this, the two master’s students could collect data through FGDs in Nigeria for the current study because one of the master's students was living in Nigeria at the time. The master's student who conducted the FGDs is a doctor who has worked at various levels of Nigerian public health institutions. She was, therefore, familiar with the general routines and protocols required to conduct research in public health facilities. Since she is from Nigeria, she could readily relate to others, comprehend Nigerian culture, and contextualize local life

experiences. In addition, when some of the healthcare workers shifted to the local language to communicate during the FGDs, the master's student was able to continue the FGD due to her fluency in this language. Furthermore, the above-mentioned have facilitated a better understanding of the participating healthcare workers, the data, the analysis, and the interpretation (Stalmeijer et al., 2014). Due to the impersonal nature of the topic of conversation, which was perceptions of mHealth technologies, the healthcare workers could freely express themselves without inhibitions, contributing to rich data.

The local co-supervisor, a pediatrician with extensive medical experience, was a research assistant during the FGDs in the current study. During the FGDs, he assisted the master's student, took notes, and contributed his excellent observational skills. The research team determined who to recruit, where to recruit, and the interview guide. The current study's research team comprises diverse healthcare experts, including some with qualitative research expertise, others with pediatric experience, and some with mHealth experience.

4.2.4 Trustworthiness of the study

The healthcare workers and the health facilities included in the current study were chosen using predetermined criteria based on the research question. The included informants were doctors, nurses, and CHEWs working at pediatric wards in public health facilities in Lagos, Nigeria. As a result, their responses yielded rich data regarding the phenomena under investigation (Kvale & Brinkmann, 2009, p. 251).

The principal investigator has worked in a different public health facility in Nigeria, and therefore spent time in the research environment. Some of the questions during the FGDs were repeated using reframing questions. For example, today's topic is mobile health. What are your thoughts about it?' and 'what is the first thing that comes to mind when you hear the word "mHealth/mobile health?' This enabled the researcher to determine whether the informants provided accurate information and consistent answers. Moreover, the researcher conducting the FGDs also questioned the informants to find out if what she understood from their answers matched with what the informants were attempting to say (Kvale & Brinkmann, 2009, p. 254). Furthermore, the data was examined by both of the project's primary researchers. Data were transcribed verbatim and accurately, and raw data from the informants were used to generate quotes to demonstrate the findings. The study supervisor, who has

expertise in qualitative research, also conducted a peer examination. Since two master's students were conducting the current research study together, this supports the study's credibility (Clarke & Braun, 2013, p. 338).

5 CONCLUSIONS

This study examined the perspectives of healthcare workers working in public health facilities in Lagos State, Nigeria, regarding mHealth technology. To address the study's research question, which was to identify the factors influencing healthcare workers' use of mHealth technologies, a qualitative approach utilizing thematic analysis was employed to analyze the collected data. This provided insight into the benefits that promote the use of mHealth and barriers that limit the use. The perceived benefits that promote mHealth technology include facilitating access to health-related information, enhancing patient-provider communication, saving time, mHealth's flexibility, and health system development. In addition, the healthcare workers believed that the *Picterus* app would be a helpful technological solution to the current, at times, demanding solution of blood tests.

In contrast, despite several benefits promoting the use of mHealth, results revealed perceived barriers that limit its use. There were both user-specific (directed at healthcare workers and patients) and technology-specific barriers. These barriers included altering routine healthcare practices, disconnecting face-to-face patient-provider relationships, skepticism and lack of trust, information overload, and a lack of awareness, knowledge, and skills. Additionally, power supply, internet accessibility, network failure, absence of devices, and maintenance of available devices, as well as costs, limit healthcare workers' use of mHealth in this study.

The results of this study can be disseminated to developers and implementers of various mHealth technologies, who can use them to create new mHealth technologies or improve existing solutions to better meet the needs of diverse LMIC health settings, such as Nigeria. Using such valuable information from the perspectives of those who are expected to use such technology daily may result in improved mHealth solutions, which can help improve the health of people around the world and save lives, particularly in the global problem area of neonatal health.

5.1 STUDY IMPLICATIONS

The current study's findings reveal valuable information from the perspective of public healthcare workers regarding mHealth technologies, which are information that should be considered by various stakeholders when introducing new mHealth technologies in low- and middle-income settings. Additionally, the results of this thesis can offer creators of new technologies knowledge that can be applied to enhance current or upcoming mHealth solutions to guarantee that they deliver high-quality healthcare to all patients in compliance with the UHC. In addition, the study results will be sent to the Nigerian collaborators in Lagos. Furthermore, the primary researchers of the current study are planning to arrange a meeting with Nigerian collaborators to give them a presentation of the study and have a discussion, and exchange ideas.

5.2 FURTHER RECOMMENDATIONS

In this study, the viewpoint of healthcare workers was emphasized. Future research should address the perspectives of both patients and, in the instance of *Picterus*, neonates' parents towards mHealth technologies. By addressing the perspective of patients and their parents, developers can use this to gain a deeper understanding of the elements that influence their acceptance of mHealth technology, enabling them to design products that promote high-quality healthcare more effectively.

In addition, since the current research only explored the perspectives of healthcare workers on the *Picterus* application based on a brief demonstration of the solution, future research should investigate the perspectives of healthcare workers after they have had the opportunity to utilize the application in practice for a period of time, which may reveal additional, valuable information.

Additionally, we suggest the potential of an exchange program in which healthcare workers from Nigeria could temporarily work in hospitals in Norway and vice versa. Then, healthcare professionals could benefit from the chance to share knowledge in various settings and environments. Nigerian healthcare professionals might work in a setting where mHealth is flourishing, but Norwegian healthcare employees might work in a setting where mHealth is

limited. Exchanging experiences, may broaden the horizons of healthcare workers and help them understand the importance of mHealth technologies in Nigeria.

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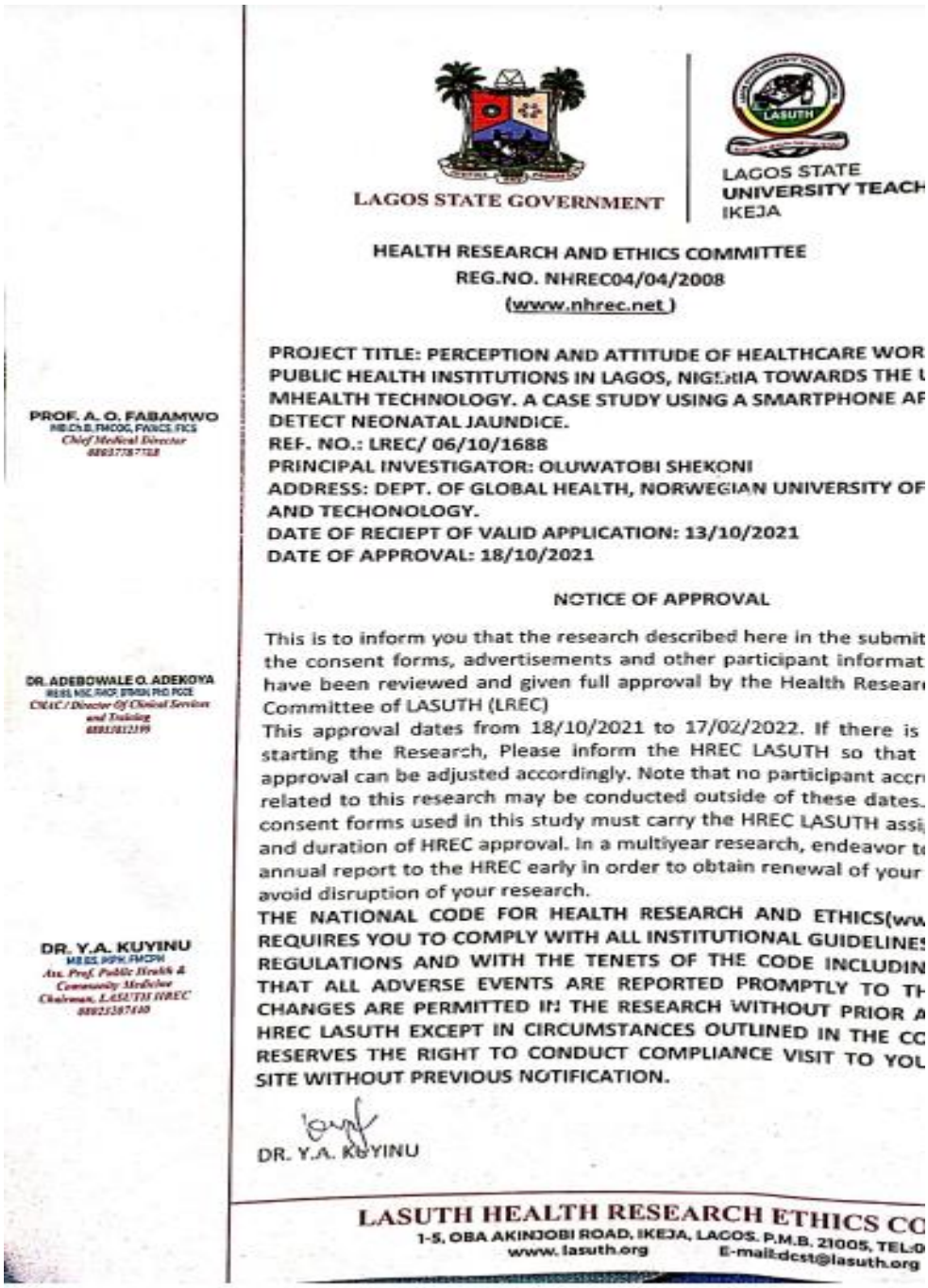
APPENDICES

A. ETHICAL APPROVAL HEALTH RESEARCH AND ETHICS COMMITTEE OF LASUTH (LREC), NIGERIA



LAGOS STATE GOVERNMENT

LAGOS STATE UNIVERSITY TEACH
IKEJA

HEALTH RESEARCH AND ETHICS COMMITTEE
REG.NO. NHREC04/04/2008
(www.nhrec.net)

PROJECT TITLE: PERCEPTION AND ATTITUDE OF HEALTHCARE WOR
PUBLIC HEALTH INSTITUTIONS IN LAGOS, NIGERIA TOWARDS THE U
MHEALTH TECHNOLOGY. A CASE STUDY USING A SMARTPHONE AP
DETECT NEONATAL JAUNDICE.
REF. NO.: LREC/ 06/10/1688
PRINCIPAL INVESTIGATOR: OLUWATOBI SHEKONI
ADDRESS: DEPT. OF GLOBAL HEALTH, NORWEGIAN UNIVERSITY OF
AND TECHONOLOGY.
DATE OF RECIEPT OF VALID APPLICATION: 13/10/2021
DATE OF APPROVAL: 18/10/2021

NOTICE OF APPROVAL

This is to inform you that the research described here in the submit
the consent forms, advertisements and other participant informat
have been reviewed and given full approval by the Health Researc
Committee of LASUTH (LREC)
This approval dates from 18/10/2021 to 17/02/2022. If there is
starting the Research, Please inform the HREC LASUTH so that
approval can be adjusted accordingly. Note that no participant accr
related to this research may be conducted outside of these dates.
consent forms used in this study must carry the HREC LASUTH assi
and duration of HREC approval. In a multiyear research, endeavor t
annual report to the HREC early in order to obtain renewal of your
avoid disruption of your research.
THE NATIONAL CODE FOR HEALTH RESEARCH AND ETHICS(ww
REQUIRES YOU TO COMPLY WITH ALL INSTITUTIONAL GUIDELINES
REGULATIONS AND WITH THE TENETS OF THE CODE INCLUDIN
THAT ALL ADVERSE EVENTS ARE REPORTED PROMPTLY TO TH
CHANGES ARE PERMITTED IN THE RESEARCH WITHOUT PRIOR A
HREC LASUTH EXCEPT IN CIRCUMSTANCES OUTLINED IN THE CO
RESERVES THE RIGHT TO CONDUCT COMPLIANCE VISIT TO YOU
SITE WITHOUT PREVIOUS NOTIFICATION.

DR. Y.A. KUYINU

PROF. A. O. FABAMWO
Chief Medical Director

DR. ADEBOWALE O. ADEKOYA
CMAC / Director Of Clinical Services and Training

DR. Y.A. KUYINU
Assoc. Prof. Public Health & Community Medicine
Chairman, LASUTH HREC

LASUTH HEALTH RESEARCH ETHICS CO
1-5, OBA AKINJOBI ROAD, IKEJA, LAGOS. P.M.B. 21005, TEL:0
www.lasuth.org E-mail:dcst@lasuth.org

B. REC CENTRAL NORWAY REPLY TO PRELIMINARY APPLICATION

REK

REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK midt	Magnus Alm	73559949	09.12.2021	387057

Jon Øyvind Odland

Prosjektsøknad: Perception and attitude of healthcare workers in public health institutions in Lagos, Nigeria towards the use of mHealth technology. A case study using a smartphone app to detect neonatal jaundice.
Søknadsnummer: 387057
Forskningsansvarlig institusjon: Norges teknisk-naturvitenskapelige universitet

Prosjektsøknad vurderes som utenfor helseforskningslovens virkeområde

Søkers beskrivelse

Globally, more than 93% of the world's population is covered by mobile phone networks, and more than 87% of people living in the developing world are mobile phone subscribers. Since mobile phone penetration has exceeded other advancements in infrastructure development in low- and middle-income countries (LMICs) and virtually 97% of the world's population live within reach of a cell phone signal, mHealth is seen as a promising approach to promote health in this area. To capitalize on this widespread use of mobile phones, researchers and implementers have used them as a catalyst for healthcare change. This can be used to address disparities and inequalities in health service access and delivery especially in cases of geographical barriers, shortage of health care providers, and high healthcare costs.

There are many areas in healthcare where mHealth can be used, one of which is diagnostics. A new mobile application (app) called Picterus® can detect neonatal jaundice by using a digital photograph of a newborn and colors from a calibrated card which is then compared with a large database of color and bilirubin pairs. The aim of the developers was to provide a cheaper and more accessible alternative to the current methods of diagnostic methods for hyperbilirubinemia. Severe hyperbilirubinemia, with or without bilirubin encephalopathy, is associated with substantial amount mortality and longterm morbidities in low- and middleincome countries (LMICs). Adoption of apps like this can potentially reduce the burden of neonatal hyperbilirubinemia and its complications by identifying neonates at risk at an early stage so that treatment can be started earlier.
Despite heightened attention to the effects and the enormous benefit associated with the use of mHealth technologies in LMICs, there is limited penetration of these tools and suboptimal use of mHealth in these settings most especially in public hospitals. This study aims to explore the perceptions, understandings, and attitudes of healthcare professionals on the use of mHealth in public health institutions in Nigeria using Picterus® as a case study.

REK midt
Besøksadresse: Øya Helsehus, 3. etasje, Mauritz Hansens gate 2, Trondheim
Telefon: 73 59 75 11 | **E-post**: rek-midt@ntnu.no
Web: https://rekportalen.no

A qualitative study design will be used to explore health care practitioners' perceptions and attitudes towards the use of mobile health (mHealth) in selected public health institutions in Lagos State. Doctors, Nurses, and community health extension workers are the healthcare practitioners that would be interviewed. These participants will be recruited from tertiary, secondary, and primary health centers in Lagos and the facilities will be selected according to size. We plan to recruit study participants from not more than 6 healthcare facilities in Lagos State. Data will be collected by using focus groups discussions (FGDs) with about 6 to 10 healthcare workers. During the focus group discussion, demonstration of the use of (Picterus®) to detect neonatal jaundice on mannequins and participants will be asked questions on the acceptability, their opinion of the app, and mHealth in general. The interview will be recorded, transcribed verbatim, and thematically analyzed. Key themes and patterns will be identified in all the data, sorted, and coded into categories. The investigator will also reflect on the analysis and coding process and will then write memos that will help her in critical thinking and challenge her assumptions. Themes will be related to existing literature and any relevant theories on perception on mHealth.

We refer to your application for prior approval of the above-mentioned research project. The application was reviewed by the secretariat of the Regional Committee for Medical and Health Research Ethics, Central Norway, by authority under the provisions of Section 7 of the Regulations on Ethics in Research [forskningsetikkforskriften]. The evaluation was conducted in accordance with Section 10 of the Health Research Act [helseforskningsloven].

REKs vurdering

The Committee's project summary: The aim of the study is to explore the perceptions, understandings, and attitudes of healthcare professionals on the use of mHealth in public health institutions in Nigeria, using the mobile app Picterus as an example. A demonstration of Picterus will be done on mannequins, not on neonates. 84 doctors, nurses, and community health extension workers in public health institutions in Lagos will be recruited. Data will be collected through focus group discussions with 6 to 10 participants. Written and verbal consent will be obtained.

The mandate of the Health Research Act

According toour understanding, the purpose of the project is to study Nigerian healthcare workers' perception and attitude towards the use of mHealth technology. While we perceive the project to be research, we do not consider it to be medical or health research as defined by the Health Research Act. The project will not generate new knowledge about health and medicine, and therefore falls outside the Committee's mandate.

Decision: The Regional Committee for Medical and Health Research Ethics, Central Norway finds that the project falls outside the Committee's mandate; see Section 2 of the Health Research Act.

Vedtak

Rejected - Outside the Committee's mandate:

Klageadgang
Du kan klage på REKs vedtak, jf. forvaltningsloven § 28 flg. Klagen sendes på eget skjema via REK portalen. Klagefristen er tre uker fra du mottar dette brevet. Dersom REK opprettholder vedtaket, sender REK klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag (NEM) for endelig vurdering, jf. forskningsetikkloven § 10 og helseforskningsloven § 10.

Best regards,

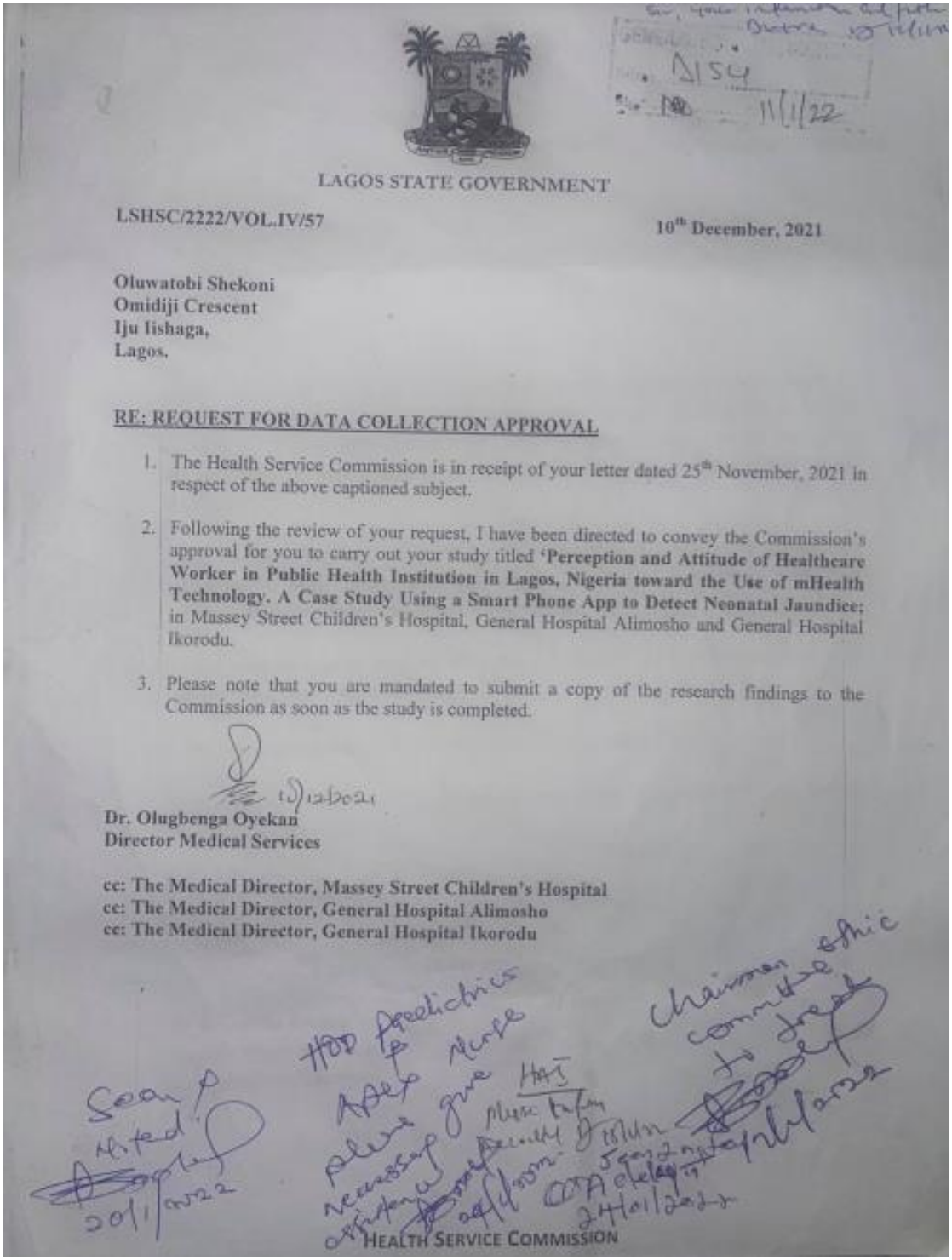
Hilde Eikemo
Secretariat leader, REC Central Norway

Magnus Alm
advisor, REC Central Norway

Kopi til:

Norges teknisk-naturvitenskapelige universitet

C. APPROVAL HEALTH SERVICE COMMISSION, LAGOS. SECONDARY HEALTH FACILITIES



LAGOS STATE GOVERNMENT

LSHSC/2222/VOL.IV/57

10th December, 2021

Oluwatobi Shekoni
Omidiji Crescent
Iju Ishaga,
Lagos.

RE: REQUEST FOR DATA COLLECTION APPROVAL

1. The Health Service Commission is in receipt of your letter dated 25th November, 2021 in respect of the above captioned subject.

2. Following the review of your request, I have been directed to convey the Commission's approval for you to carry out your study titled **'Perception and Attitude of Healthcare Worker in Public Health Institution in Lagos, Nigeria toward the Use of mHealth Technology. A Case Study Using a Smart Phone App to Detect Neonatal Jaundice;** in Massey Street Children's Hospital, General Hospital Alimosho and General Hospital Ikorodu.

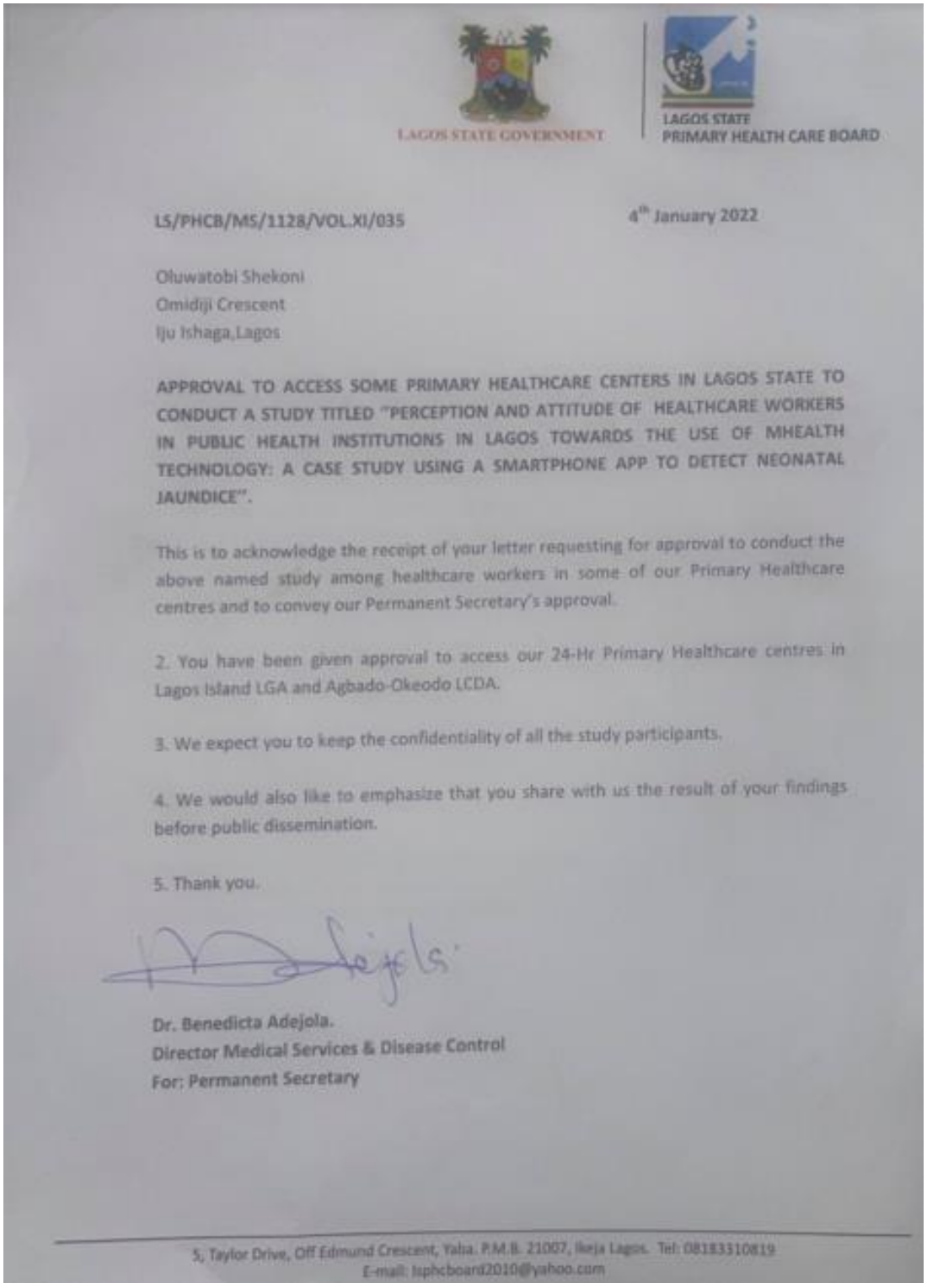
3. Please note that you are mandated to submit a copy of the research findings to the Commission as soon as the study is completed.

Dr. Olugbenga Oyekan
Director Medical Services

cc: The Medical Director, Massey Street Children's Hospital
cc: The Medical Director, General Hospital Alimosho
cc: The Medical Director, General Hospital Ikorodu

HEALTH SERVICE COMMISSION

D. APPROVAL PRIMARY HEALTH CARE BOARD, LAGOS



LAGOS STATE GOVERNMENT

LAGOS STATE
PRIMARY HEALTH CARE BOARD

LS/PHCB/MS/1128/VOL.XI/035

4th January 2022

Oluwatobi Shekoni
Omidiji Crescent
Iju Ishaga,Lagos

APPROVAL TO ACCESS SOME PRIMARY HEALTHCARE CENTERS IN LAGOS STATE TO CONDUCT A STUDY TITLED "PERCEPTION AND ATTITUDE OF HEALTHCARE WORKERS IN PUBLIC HEALTH INSTITUTIONS IN LAGOS TOWARDS THE USE OF MHEALTH TECHNOLOGY: A CASE STUDY USING A SMARTPHONE APP TO DETECT NEONATAL JAUNDICE".

This is to acknowledge the receipt of your letter requesting for approval to conduct the above named study among healthcare workers in some of our Primary Healthcare centres and to convey our Permanent Secretary's approval.

2. You have been given approval to access our 24-Hr Primary Healthcare centres in Lagos Island LGA and Agbado-Okeodo LCDA.

3. We expect you to keep the confidentiality of all the study participants.

4. We would also like to emphasize that you share with us the result of your findings before public dissemination.

5. Thank you.

Dr. Benedicta Adejola.
Director Medical Services & Disease Control
For: Permanent Secretary

5, Taylor Drive, Off Edmund Crescent, Yaba. P.M.B. 21007, Ikeja Lagos. Tel: 08183310819
E-mail: lsphcboard2010@yahoo.com

E. PARTICIPANT INFORMATION LETTER

INVITATION TO PARTICIPATE IN RESEARCH PROJECT

We hereby invite you to participate in a research project in which we intend to investigate the perceptions and utilization of mobile health (mHealth) technologies by healthcare workers at public health facilities in Lagos. In addition, the participants in this project will be shown a mobile health app that can be used on a smartphone, and a few questions will be asked concerning this app. You are invited because you work in a pediatric ward at a Lagos public healthcare facility. Participation in this project is entirely voluntary, so your decision to participate is entirely up to you. Before deciding, please review the following information, which describes the project and what your participation would entail. Please do not hesitate to use the contact information at the bottom of the invitation if you have any questions or if anything is unclear.

TITLE OF THE PROJECT:

The perceptions of mHealth technologies among healthcare workers in public health facilities in Lagos State, Nigeria.

PURPOSE OF THE PROJECT:

The purpose of this project is to investigate how doctors, nurses, and CHEWs at public health facilities in Lagos perceive mHealth technology and its use.

mHealth technologies have proven to be a promising approach for enhancing healthcare, particularly in low- and middle-income countries such as Nigeria, among others. Additionally, mHealth solutions have the potential to aid in the reduction of Nigeria's neonatal mortality problem. However, it had been discovered that implementing sustainable mHealth solutions in healthcare is challenging, and it is determined that healthcare workers' perceptions are important to investigate further; therefore, we plan to conduct this study in Lagos, Nigeria.

PROCEDURE OF THE PROJECT AND WHAT IT INVOLVES:

The project involves group discussions in which various groups of healthcare workers (doctors, nurses, and CHEWs) will be grouped according to their profession. Each discussion group will consist of six to ten healthcare workers. The interviewer will ask a few questions about mHealth technology, and there will be an open discussion on the subject. Approximately halfway through the session, there will be a demonstration of a mHealth technology solution; a mobile application designed to aid healthcare workers in the detection of neonatal jaundice in newborns. This application will be displayed on mannequins. There will be questions regarding this demonstration. The group discussion is expected to last no longer than 90 minutes, but its duration may vary. The discussions will be audio-recorded, which the researchers will use for transcribing the discussions from verbal to written form. This will only occur with your consent.

The group discussion is held by one of the two primary investigators of the project, which is a doctor from Nigeria. In addition, a research assistant will be present. The discussions will be held in English.

RISKS OF THE PROJECT:

Participating in this research involves minimal risk. Your personal details such as your name, or any other personal information are not required.

COSTS OF THE PROJECT:

Participation in this focus group discussion is without costs.

BENEFITS OF THE PROJECT:

You will have no direct benefit of your participation in this project. However, this study may provide valuable information regarding healthcare workers' perceptions of mHealth technology, which can be used by developers of mHealth solutions and other various stakeholders to improve current or future mHealth technologies, so that they can be more effectively implemented in various health settings and improve patient care.

CONFIDENTIALITY:

Your name or other personal identification are not required and will not be used in this project. The audio recordings and the completed transcriptions will be encrypted, and only the two primary researchers and the project's primary supervisor will have access to any of the data collected. The recorded audio files will be deleted from the audio recording device as soon as the transcripts are complete and both primary researchers have thoroughly reviewed them. Only the primary researcher in charge of the group discussions will have access to your written consent form if you agree to participate, which will be kept in a locked cabinet. In addition, the audio recording device will be stored in a separate locked cabinet. After the completion of this project in August 2022, the consent form will be destroyed, while anonymized and encrypted transcripts will be stored for a maximum of five years (until August 2027) before being erased.

VOLUNTARINESS:

Participation in this research project is entirely voluntary. You may choose to withdraw from the study without repercussions, unless the collected data have already been anonymized and incorporated to the study.

WHAT WILL THE COLLECTED DATA BE USED FOR?

The collected data will be incorporated into the master's thesis of the primary researchers. In addition, we intend to present this study's findings at seminars and conferences.

APPROVALS:

A preliminary application was submitted to the Norwegian Regional Committees for Medical and Health Research Ethics (REK), Central Norway, for evaluation to see if a complete REK application was necessary for this project. December 9th, 2021, REK determined that the project was not within the Committee's mandate, as the study was neither medical nor health research as defined under the Health Research Act (REF.: 387057). Furthermore, Ethical approval was obtained from the Health Research and Ethics Committee of LASUTH (LREC) in Nigeria on the 18th of October 2021 (REF.: LREC/ 06/10/1688). Approval was also granted from The Lagos State Primary Health Care Board and Lagos State Health Service Commission. Permission was obtained from The Medical Directors, Medical Officer of Health, and Head of Department of each health facility invited to the study.

NAME(S) AND AFFILIATION(S) OF APPLICANT(S):

This project is conducted by Dr. Oluwatobi Shekoni and Synne Iversen from the Norwegian University of Science and Technology (NTNU), as a dissertation for a master's degree in Global Health. The project will be supervised by the main supervisor, Professor Beate Andre and the co-supervisor, Professor Jon Odland from NTNU, Dr. Anders Aune and Gabriela Jimenez Diaz from Picterus AS Norway, Dr. Peter Ubuane and Dr. Zainab Imam from Lagos State University Teaching Hospital, Ikeja, Lagos, Nigeria.

DETAILED CONTACT INFORMATION INCLUDING CONTACT ADDRESS, TELEPHONE, E-MAIL, AND ANY OTHER CONTACT INFORMATION OF RESEARCHERS, INSTITUTIONAL HREC, AND HEAD OF THE INSTITUTION:

The Health Research Ethics Committee of LASUTH has approved this research, and the committee's chairman can be reached through the Research Ethics Office at LASUTH. The number to dial is 08023207440. In addition, if you have any questions regarding the participation in this project, please do not hesitate to contact the two researchers in charge:

Name: Shekoni Oluwatobi - E-mail: Oluwatos@stud.ntnu.no - Phone nr.: +23 4705526786

Name: Synne Iversen - E-mail: synnei@stud.ntnu.no - Phone nr.: +47 93831318

You can also contact the project's main supervisor:

Name: Beate Andre - E-mail: beate.andre@ntnu.no - Phone nr.: +47 91692871

F. PARTICIPANT INFORMED CONSENT FORM

INFORMED CONSENT FORM

STATEMENT OF THE PERSON OBTAINING INFORMED CONSENT:
I confirm that I have fully explained all components of the project to the participant and have given the information required for the participant to make an informed decision.

Dr. Oluwatobi Shekoni
Synne Iversen

Person Obtaining Consent: _____

Signature: _____

Place and Date: _____

STATEMENT OF THE PERSON GIVING CONSENT:
I have read the description of the research and I understand it. I understand that my participation is voluntary. I know enough about the purpose, methods, risks, and benefits of the research study to judge that I want to partake in it. I understand that I may freely withdraw from the study without repercussions, unless the collected data have already been anonymized and incorporated to the study. I agree that taking part in the group discussion implies my consent to participate and that the data can be used.

Name of Participant: _____

Signature: _____

Place and Date: _____

G. FOCUS GROUP QUESTION GUIDE

FOCUS GROUP QUESTION GUIDE

Welcome to this focus group discussion. Thank you for your participation. I am, together with my research team interested in your perceptions on the use of mobile health technologies and I will ask you questions regarding this. The questions are related to mHealth technologies in general, whilst the other half is related to a diagnostic app on a smartphone assessing jaundice in neonates. I will give you a demonstration on how this works a bit later. Feel free to ask questions, and interrupt if there is anything that is unclear. I would also like to remind you that you can withdraw your participation at any time.

Before starting, I would like to share some short information and ground rules:

- The discussion is estimated to last from approximately 60 to 90 minutes.
- Try to talk to each other, and create a discussion rather than just answering the moderator
- We are seeking your perceptions, experiences, thoughts and opinions - meaning there are no right and wrong answers
- We will appreciate that only one person speaks at a time: Please try to not talk over the top of each other, this will make the transcription part difficult - as we do not want to miss any of your comments

I will now start the recording.

STARTING QUESTIONS

1. What is the first thing that comes to mind when you hear the word "mHealth/mobile health?"

MOBILE HEALTH

2. What do you know about mobile health?
3. Have you ever used any form of mobile health before? If so, please tell me about your experiences.
   Probes: Positive/Negative? Did it work out? Why/Why not? Issues/Concerns?
4. In what ways are you aware of mobile health being used in your health facility setting?
5. What factors do you think must be in place for acceptance of mobile health?
   Probes: More knowledge/information/education? Evidence/research? Support from stakeholders? Cost effective solutions?
6. Some mobile health interventions work out, while others do not - why do you think that is?
   Probes: Costs? Too expensive? Funding? Internet connection? Was the solution too advanced? Skepticism?
7. In what way do you think mobile health could support the current health system?

DIAGNOSTIC SUPPORT: PICTERUS APP

8. What are your thoughts about this idea/app after seeing the demonstration?
9. How are you currently assessing neonatal jaundice?
   Probes: Does it work out? Why? Why not? Costs?

10. How would you use this solution in your setting?
11. How would your patient/patient guardian respond to the use of this app?
12. What do you think are the pros and cons of this solution/app?
13. In what way do you think this app could affect your current practice in assessing neonatal jaundice?
    Probes: Positive? Negative? Could you please elaborate?

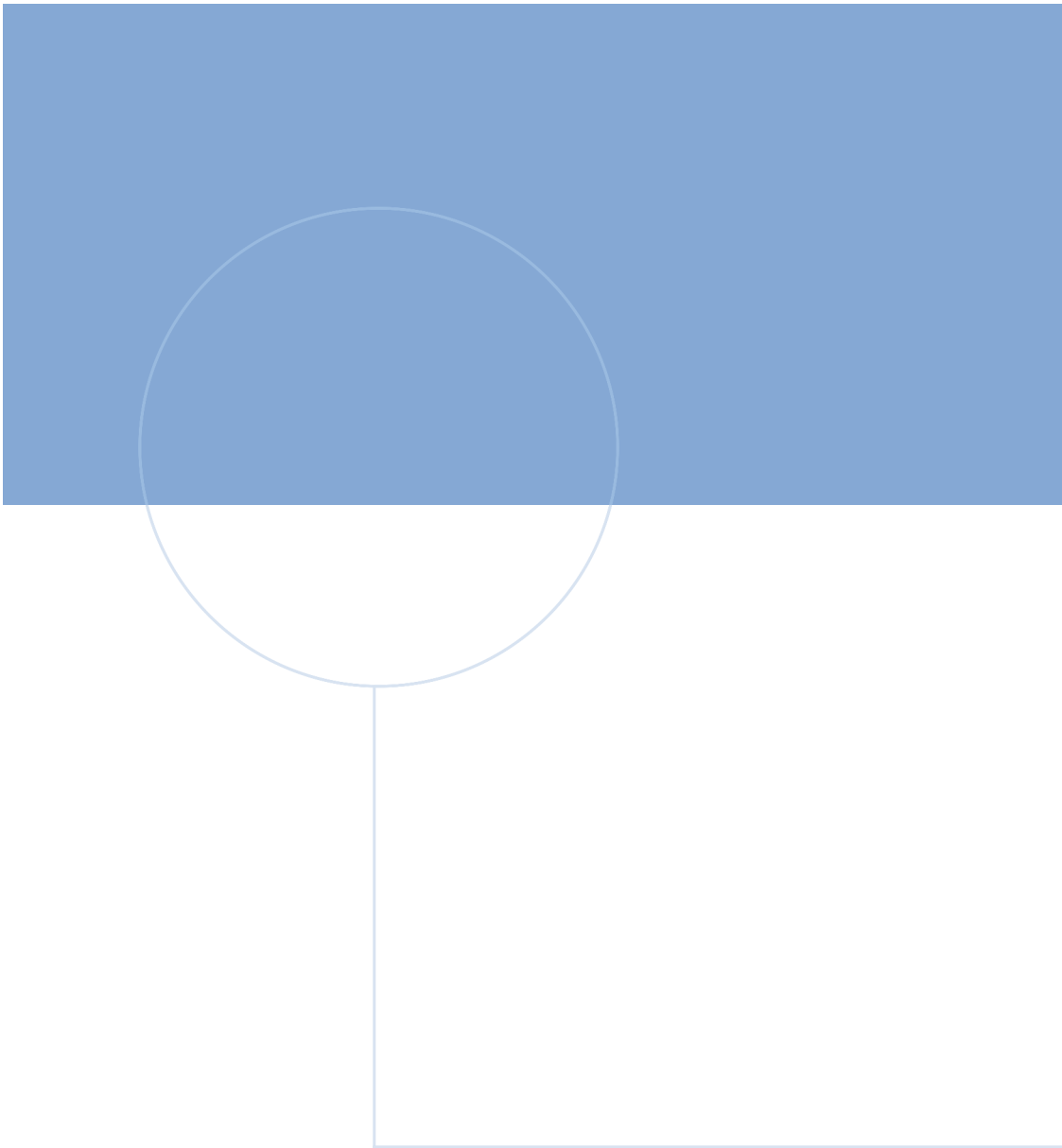
CLOSING QUESTIONS

14. Is there anything other than the already discussed questions that you would like to share or talk more about?

Thank you for participating in this focus group discussion. I will now stop the recording.

LIST OF FIGURES

LIST OF TABLES



NTNU

Norwegian University of
Science and Technology