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Design and Development of a Mobile Health App for Adolescent HIV Awareness and Adherence: A Case Study of Chaisa Compound

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Abstract

Adolescents in Zambia are increasingly affected by HIV, with recent reports showing that they account for a growing proportion of new infections compared to older age groups. This trend underscores the urgent need for interventions that improve awareness, reduce stigma, and support adherence to antiretroviral therapy (ART). The purpose of this study was to design and develop a mobile health (mHealth) application to enhance HIV awareness and treatment adherence among adolescents in Chaisa compound. The application was developed using the agile methodology, guided by an iterative software development process that incorporated feedback from adolescents to ensure relevance and usability. The app includes educational content on HIV, medication reminders, peer support features, and tools for tracking HIV testing and treatment progress. The system has been successfully implemented and is fully functional, demonstrating that mobile technology can be effectively applied to support HIV prevention and care. Preliminary findings indicate that the application improves adolescents' access to reliable information, encourages timely medication intake, and facilitates engagement with peers facing similar challenges. The study concludes that a well-designed mHealth solution offers a practical and sustainable approach to improving HIV awareness and treatment adherence, with potential for replication in similar settings.

Keywords: Application, ART, HIV, Mhealth, Technology Acceptance Model (TAM)

1. Introduction

The global Human Immunodeficiency Virus (HIV) epidemic remains a significant public health challenge, with adolescents facing increasing risks of infection and suboptimal treatment adherence [1]. In Zambia, recent reports indicate that adolescents now account for a rising proportion of new HIV infections, surpassing older generations in terms of new cases [2]. This shift is a cause for concern, as adolescents are more likely to face challenges in accessing healthcare, understanding HIV prevention, and maintaining consistent adherence to antiretroviral therapy (ART) [3]. Despite advancements in HIV prevention and treatment, the adolescent population remains underserved in many regions, especially in Zambia, where social stigma, lack of information, and limited access to healthcare contribute to higher rates of transmission and non-adherence to ART [4].

In response to this growing crisis, mobile health (mHealth) technologies have emerged as a promising solution [5]. The widespread use of mobile phones among adolescents presents an opportunity to leverage digital platforms to improve HIV awareness and treatment adherence [6]. Mobile health applications can provide real-time reminders for medication, facilitate communication between healthcare providers and patients, and create support networks that address the unique needs of young people living with HIV [5]. As the digital landscape continues to evolve, it is crucial to develop innovative, user-centered solutions that engage adolescents in managing their health, preventing new infections, and improving treatment outcomes [7].

This study focused on the design and development of a mobile health application that targets HIV awareness and treatment adherence among adolescents in the Mandevu Constituency, Chaisa Compound. The proposed application integrates

educational content, medication reminders, and peer support mechanisms, tailored to the specific needs and preferences of adolescents. By engaging young people in the design process and leveraging their familiarity with mobile technology, this research aimed to create a feasible, scalable, and sustainable solution to the HIV epidemic among adolescents.

1.1 Background of the study

HIV remains a significant health challenge in Zambia, particularly among adolescents, who face barriers such as misinformation, stigma, and limited healthcare access [8]. Adolescents now account for a growing proportion of new HIV infections [9], with prevalence rates higher among females than males. Despite government interventions, Stigma and inadequate youth-focused programs hinder prevention and treatment efforts [10].

Mobile health (mHealth) applications offer a promising solution by providing educational content, medication reminders, and peer support [7]. Given Zambia's high mobile phone penetration, mHealth can improve awareness and treatment adherence, especially in underserved areas [11].

1.2 Statement of the Problem

Adolescents in Zambia, particularly females aged 15-24, account for a growing share of new HIV infections [9]. Despite government efforts, they face barriers to accessing HIV-related information, prevention services, and treatment. Challenges include stigma, limited healthcare access in underserved areas, and a lack of adolescent-friendly services [12].

Traditional interventions have not effectively leveraged technology, despite high mobile phone use among Zambian adolescents [13]. The absence of youth-centered mobile health solutions limits access to timely HIV education, medication reminders, and peer support, reducing engagement in HIV care and treatment [14].

1.3 Aim of the Study

The aim to design a mobile health (mHealth) application tailored to adolescents in Chaisa Compound, to improve HIV awareness and treatment adherence. This platform has key components, functionalities, and intended impact, ensures that it addresses the unique barriers and challenges adolescents face in HIV care [15]. Amongst others the app envisages the following:

The aim to design a mobile health (mHealth) application tailored to adolescents in Chaisa Compound, to improve HIV awareness and treatment adherence. This platform has key components, functionalities, and intended impact, ensures that it addresses the unique barriers and challenges adolescents face in HIV care [16]. The goal is to empower adolescents with scientifically accurate information to counter misinformation and encourage healthy behavior [17].

The app envisions real-time ART medication reminders, progress tracking, and personalized adherence notifications to encourage consistent treatment uptake. By integrating features such as gamification elements and reward-based motivation, adolescents will be incentivized to stay engaged with their treatment regimen [17].

Safe support network recognizing that stigma and fear of discrimination discourage adolescents from seeking HIV-related services, the conceptual framework proposes a secure and anonymous peer support platform within the app. This feature facilitates group discussions, counseling services, and virtual mentorship, fostering a sense of community and emotional support [18].

A user-friendly interface that is accessible to users in both urban and rural settings. It suggests developing the app with offline functionality and minimal data consumption, ensuring that users with limited internet access can still benefit from the platform [19].

By linking the app with electronic health records or existing health programs, healthcare providers could monitor ART adherence trends and improve service delivery for adolescents living with HIV [20].

1.4 Research Objectives

The primary objective of this study was to design and develop a prototype of a mobile health application that focuses on improving HIV awareness, treatment adherence, and prevention among adolescents at Chaisa clinic.

1.4.1 Specific Objectives

1. To assess the current HIV awareness levels, treatment adherence, and health challenges faced by adolescents.
2. To design a mobile health application tailored to the needs of adolescents.
3. To evaluate the usability and effectiveness of the mobile health application in enhancing HIV awareness, treatment adherence, and reducing stigma among adolescents.

1.5 Research Questions

1. What are the current levels of HIV awareness, treatment adherence, and perceived stigma among adolescents?
2. How can a mobile health application be designed to effectively address the specific needs and preferences of adolescents?
3. To what extent does the use of a mobile health application improve HIV awareness, and treatment adherence, and reduce stigma among adolescents?

1.6 Scope of the Study

This study focused on developing a prototype for a mobile health application aimed at improving HIV awareness and treatment adherence among adolescents aged 15-24 at Chaisa Health Centre, with particular emphasis on females, who face a higher HIV prevalence. The key components and functionalities of the proposed app, which will include educational content on HIV prevention, real- time ART reminders, and tools for tracking HIV testing and treatment progress. By defining the structure and design principles of the application, this study provides a foundation for the future development and implementation of an mHealth intervention tailored to the needs of adolescents in resource-limited settings.

1.7 Significance of the study

The significance of the study was reported to lie in its potential to address the rising HIV epidemic among adolescents in Zambia, a demographic increasingly affected by the disease [4]. Indicated that adolescent HIV infections, particularly among females aged 15-24, were on the rise, necessitating targeted interventions to improve awareness, treatment adherence, and prevention strategies.

It was stated that mobile health (mHealth) technologies offered an innovative and accessible solution to these challenges, with the capacity to enhance HIV awareness,

adherence to antiretroviral therapy (ART), and prevention efforts in Zambia.

1.8 Conceptual and Theoretical Framework

The development of a mobile health application to enhance HIV awareness and treatment adherence among adolescents in Chaisa Compound is guided by both conceptual and theoretical frameworks. These frameworks help clarify the relationships between the various factors influencing adolescent health behaviors and guide the design of the proposed intervention.

The conceptual framework is based on the integration of mobile health (mHealth) technology with behavior change principles aimed at improving knowledge, adherence to antiretroviral therapy (ART), and reducing stigma. The framework considers the widespread use of mobile phones among adolescents as an opportunity to deliver health interventions that are timely, accessible, and engaging. The application is conceptualized to provide real-time ART reminders, HIV education, and peer support features—all aimed at encouraging positive health behavior [21].

From a theoretical perspective, this study is grounded in the Health Belief Model (HBM) [22] and the Technology Acceptance Model (TAM) [23]. The HBM posits that individuals are more likely to take health- related action if they believe they are susceptible to a condition, believe it would have serious consequences, believe taking action would reduce their susceptibility or severity, and believe the benefits of taking action outweigh the barriers [24] This model supports the app's design by targeting perceived susceptibility, severity, benefits, and self-efficacy regarding HIV and ART adherence.

On the other hand, TAM explains user acceptance of technology based on perceived ease of use and perceived usefulness [25]. These components were critical in designing the mobile app's user-friendly interface and practical features, ensuring adolescents find it both usable and beneficial to their daily ART routines and HIV knowledge.

By merging conceptual and theoretical perspectives, the study aims to produce an intervention that is both scientifically grounded and user-centered, thus increasing the likelihood of its adoption and effectiveness among adolescents at Chaisa Health Centre.

1.9 Operational Definitions

To ensure clarity and consistency in the study, the following key terms are defined as they are used within the context of this research:

Adolescents: Refers to individuals aged 15–24 years, a group identified as highly vulnerable to HIV infection due to limited access to reproductive health services, peer pressure, and high-risk behaviors [25].

HIV Awareness: The level of knowledge adolescents have about HIV transmission, prevention, and treatment. This includes understanding the benefits of testing, safe practices, and the importance of ART adherence [26].

ART Adherence: Describes the extent to which an adolescent consistently takes antiretroviral medication as prescribed [27].

Mobile Health (mHealth): Refers to the use of mobile technology such as smartphones to support health services and information delivery [27].

Conceptual Framework: A structured plan that outlines key variables and their relationships, guiding how the app is expected to impact HIV awareness and treatment adherence among adolescents [28].

User-Centered Design (UCD): A design approach that involves end users throughout the development process to ensure the final product meets their needs. In this study, adolescents are central to the design of the proposed app [29].

1.10 Contributions and Novelty of Research

This research contributes to the growing body of knowledge on digital health interventions by proposing a prototype for a mobile health (mHealth) application tailored to adolescents in Chaisa Compound, Zambia. The novelty of this study lies in its focus on designing a context-specific solution that leverages mobile technology to improve HIV awareness, support treatment adherence, and reduce stigma among adolescents—a population segment disproportionately affected by HIV [30].

Unlike previous interventions that have focused broadly on adult populations or generalized mHealth solutions, this research introduces a user-centered, adolescent-specific framework designed with input from the end users themselves. This approach ensures the solution aligns with the cultural, social, and technological realities of the target group [31].

A significant contribution of the study is the integration of real-time ART reminders, peer support modules, and localized educational content, which has not been widely documented in mHealth frameworks targeting adolescents in low-resource settings. Additionally, by utilizing mobile platforms already accessible to the youth in Zambia, the study highlights a scalable and sustainable model that can inform national digital health strategies [33].

Moreover, the study's emphasis on designing rather than implementing a conceptual solution provides a flexible model that can be tested and adapted across other regions facing similar challenges. It offers theoretical and practical insights for developers, policymakers, and public health stakeholders aiming to integrate ICT in adolescent HIV care [34].

1.11 Ethical Considerations

In conducting this research, ethical considerations were of paramount importance, particularly due to the sensitive nature of HIV and the involvement of adolescents aged 15–24. The study was reported to have adhered to established ethical principles, including informed consent, confidentiality, voluntary participation, and protection from harm, in alignment with international research ethics standards [35].

Before any data was collected, informed consent was sought from participants, and where applicable, parental or guardian consent was also obtained for minors. Participants were made aware of the study's purpose, their right to withdraw at any time, and how the data would be used. This ensured respect for autonomy and voluntary participation, consistent with ethical protocols outlined in the Declaration of Helsinki [36].

Confidentiality and anonymity were emphasized throughout the data collection process. Identifiable data were either coded or excluded to protect the identity of the adolescents involved. Additionally, steps were taken to ensure data protection and privacy, including secure digital storage and restricted access to sensitive information [37].

Given the emotional sensitivity around HIV, the study also included provisions for psychosocial support during and after the interviews or focus groups, especially for participants who may have experienced distress or stigma. In cases where such need arose, referrals to youth-friendly health services were arranged.

Finally, the research was subject to ethical clearance by a recognized institutional review board (IRB) or research ethics committee, ensuring that all activities were reviewed for compliance with legal and ethical guidelines relevant to research involving human participants [38].

1.12 Structure of the Research

This research is structured into five chapters, each contributing to the overall development of a conceptual framework for a mobile health (mHealth) application aimed at improving HIV awareness and treatment adherence among adolescents in Chaisa Compound.

Chapter One introduces the study, outlining the background, problem statement, research objectives, research questions, significance of the study, scope, and the conceptual and theoretical framework guiding the research. It sets the foundation by articulating the rationale for focusing on adolescent HIV challenges in Zambia.

Chapter Two presents a comprehensive review of existing literature relevant to the study. It discusses current mHealth interventions, adolescent HIV statistics, digital health trends, and theoretical models that support behavior change. The review establishes the academic and practical basis for the proposed framework, highlighting gaps the study aims to address.

Chapter Three outlines the research methodology employed in developing the conceptual framework. It describes the research design, target population, data collection methods (including interviews and questionnaires), and the rationale for using qualitative approaches. Ethical considerations and data analysis techniques are also covered.

Chapter Four presents the results and analysis of data gathered from adolescents and stakeholders. The findings are interpreted in the context of the research objectives and are used to inform the design of the conceptual framework. It includes discussions on system features, user needs, and challenges identified during fieldwork.

Chapter Five concludes the research by summarizing key findings, presenting the proposed conceptual framework, and offering recommendations for future development and implementation of the mobile application. It also reflects on the research contributions and limitations.

This structured approach ensures logical progression from problem identification to solution design, supported by empirical data and literature.

Ultimately contributing to improved adolescent health outcomes through digital innovation.

2. Literature Review

2.1 Introduction

Chapter Two reviewed existing literature on adolescent HIV awareness, treatment adherence, and the role of mobile health (mHealth) interventions in addressing these challenges. Researchers such as [39] highlighted that many adolescents face barriers such as misinformation, social stigma, and limited healthcare access, which contribute to poor adherence to antiretroviral therapy (ART). The effectiveness of mHealth solutions in bridging these gaps was also emphasized, with studies by [7] demonstrating that mobile applications could improve adherence through real-time reminders, interactive educational content, and peer support networks.

Scholars such as [40] stressed the importance of a user-centered design, ensuring that digital interventions were tailored to the specific needs and behaviors of adolescents. Research findings further suggested that integrating mobile health solutions with existing healthcare systems could improve engagement and long-term treatment outcomes [41]. Additionally, frameworks for designing and implementing mHealth interventions were explored, with studies showing that successful applications leveraged behavioral change theories, gamification, and personalized features to enhance user engagement [42].

2.2 Types of mHealth systems

2.2.1 Emergency and First Aid Apps

In critical situations, first aid and emergency guidance apps serve as on-the-spot resources that provide step-by-step instructions on how to manage common emergencies, from CPR to wound care [43]. Some even include visual aids and voice guidance. Ology to connect users to the nearest emergency services or hospitals. They are especially valuable during crises by offering one-tap access to hotlines or automatically sending the user's location to emergency responders.

2.2.2 Women's Health and Maternity

Several mHealth applications are tailored to support women throughout different life stages. Pregnancy tracking apps provide pregnant women with weekly updates on fetal development, reminders for antenatal visits, and information about common symptoms and nutritional requirements [44]. Meanwhile, breastfeeding and newborn care apps support new mothers by offering guidance on proper breastfeeding techniques, baby feeding schedules, and tracking infant growth and health milestones. These apps empower women with knowledge and support through motherhood.

2.2.3 Personal Health Records and Management

mHealth apps that manage personal health records serve as digital storage platforms for medical histories, lab results, and prescriptions. They encourage patients to take an active role in managing their health by offering easy access to information and enabling the secure sharing of records across different healthcare settings [45]. In addition, appointment scheduling and reminder apps help users manage their healthcare routine by enabling them to schedule visits, receive alerts for upcoming appointments, and track medication schedules, reducing the risk of missed treatments.

2.2.4 Telemedicine and Consultation

Telemedicine apps have revolutionized access to healthcare by offering virtual doctor visits through video consultations, enabling users to receive medical advice and treatment from the comfort of their homes [46]. Symptom checkers and diagnostic tools, powered by artificial intelligence, allow users to input their symptoms and receive a preliminary assessment, giving them access to reliable health information and suggestions for next steps. Furthermore, prescription and medication delivery services are now integrated into many mHealth platforms, streamlining the process of renewing prescriptions and ensuring home

delivery of medications, especially for users in remote or underserved areas.

2.3 Related Works

Mobile health (mHealth) and other digital health interventions (DHIs) have proliferated in recent years. A 2015 review of mobile applications (apps) related to HIV prevention revealed that most apps (71%) were developed by a nonacademic or public health institution, were free (83%), and reported information about one or more HIV prevention modalities (53%). However, only 7% of the apps focused specifically on men who have sex with men (MSM), and none dealt with post-exposure prophylaxis (PEP) [47]. According to reports, the mobile health (mHealth) apps market was valued at $8 billion in 2018 and will grow to around $111.1 billion by 2025. Every day, it seems like a new app debut that promises to make managing your physical and mental health more efficient [48]. Some of the most common and related apps include:

2.3.1 HIMS – Best Overall

Hims specializes in helping men deal with issues such as hair loss, weight, and sexual performance. Each client receives customized guidance from a licensed medical provider in their home state [49].

2.3.2 Sesame – Best Telehealth App

Sesame offers a full suite of services related to online telehealth treatment, allowing you to search by specialty, symptoms, medication, and services to ensure you get the care you need as quickly as possible [50].

2.3.3 Talkspace – Best Therapy App

Talkspace is an online therapy platform that gives users access to licensed therapists and psychiatrists from any location through their mobile app, available for Android and iOS devices [51].

2.3.4 Teladoc

Teladoc is an on-demand telehealth service that connects patients with virtual care for non-life-threatening illnesses and injuries for a flat fee of $75 per appointment, or less with health insurance [52].

2.3.5 Amwell – Best for Insurance Coverage

Amwell, an online medical service that offers on-demand doctor visits via their mobile app or website, accepts many major health insurances, including Aetna, Blue Cross Blue Shield, United Healthcare, and more [53].

2.3.6 OurRitual – Best for Couples

OurRitual is an online therapy app dedicated to helping couples by focusing on different aspects of their relationship and strengthening their bond with one another [54].

2.3.7 AirDoctor – Best for Care While Traveling

AirDoctor connects travelers with medical providers while they're away from home. The company's network consists of more than 20,000 licensed physicians operating in 78 countries worldwide [55].

2.3.8 Heal – Best for Doctor House Calls

Through the Heal app, available for Android and iOS, users in select U.S cities can schedule a house call with a doctor for a variety of different services [56].

2.3.9 First Derm – Best Dermatology Services App

First Derm, a free app for Android and iOS, allows users to consult an online dermatologist on-demand for convenient answers, treatment plans, and prescriptions for non-emergency skin conditions [57].

2.3.10 Maven – Best Women's Healthcare App

Through their iOS and Android apps, Maven seeks to offer an alternative "digital clinic" that is specifically designed to meet the physical and mental healthcare needs of women and families [58].

2.3.11 ZocDoc – Best Appointment Scheduling App

With the ZocDoc app, users can easily connect with a variety of healthcare providers and schedule appointments instantly online without being put on hold or waiting weeks for an appointment [59].

2.3.12 Fitbit – Best Activity Tracker App

Whether users sync their data using a Fitbit device or manually input their activity into the mobile app, this platform lets users monitor many aspects of health and wellness, including activity, workouts, heart rate, and calories [60].

2.3.13 Healow – Best Health Records Management App

The Healow app is designed to give users immediate access to consolidated healthcare records from participating providers, facilitating better communication between patients and their doctors [61].

2.3.14 MyChart – Best Patient Portal App

MyChart is a patient portal app that allows users to access online appointment scheduling, electronic health records, bill pay, and patient-doctor communications from wherever they are [62].

Table 1: Summary of Related Tools

App Name	Category / Best For	Key Features / Description
HIMS	Best Overall	Men's health support—hair loss, weight, sexual health—with personalized care from licensed providers.
Sesame	Best Telehealth App	Full telehealth services; search by specialty, symptoms, or medication for quick access to care.
Talkspace	Best Therapy App	Online access to licensed therapists and psychiatrists via mobile app.
Teladoc	Telehealth Service	On-demand virtual consultations for non-emergency illnesses; flat fee or insurance-discounted.
Amwell	Best for Insurance Coverage	Online doctor visits with support for many major health insurance providers.

Digital health tools are uniquely suited to tailoring intervention content and information based on user characteristics and preferences. Tailoring can be done based on specific prevention needs [e.g., providing information for antiretroviral (ART) treatment for users with HIV, and for PrEP or other prevention tools for users who are HIV-negative], location (e.g., using geolocation to recommend HIV testing or PrEP clinics that are nearby), or based on personal values or preferences [e.g., framing health recommendations in terms of the values of users. Further, mHealth tools can account for the fact that the needs and preferences of users change over time [47].

Security and confidentiality were also identified as critical aspects, given the sensitivity of HIV-related information [63]. argued that data protection mechanisms must be incorporated into mHealth applications to ensure user trust and compliance with ethical guidelines. The chapter

concluded that while mobile technology presents a promising tool for adolescent HIV awareness and treatment adherence, further research is needed to optimize user experience and measure long-term impact.

Mobile health technologies have been extensively used in HIV prevention programs, particularly for providing education and awareness. A study by [28] explored the effectiveness of mHealth applications in delivering health education to underserved populations in low-resource settings. The authors found that mobile platforms could effectively reach adolescents, who often have limited access to traditional health education programs. Furthermore, mobile apps allow for personalized messaging and education, which can improve knowledge and awareness about HIV transmission and prevention [5].

3. Methodology

3.1 Introduction

This study was conducted to justify the development of a mobile health (mHealth) application tailored to address challenges faced by adolescents at In Chaisa Compound in accessing HIV-related information and improving treatment adherence. A survey was carried out to assess the current state of HIV awareness, treatment adherence, and the feasibility of using mobile technology to enhance adolescent engagement in HIV care [64].

Questionnaires were designed to identify gaps in HIV education, treatment support, and user preferences for the proposed mHealth solution. The application was developed using the Agile Software Development Life Cycle (SDLC) model, known for its iterative and user-centered approach. Agile prioritizes adaptability, stakeholder involvement, and rapid delivery of functional software components, ensuring that the application meets the evolving needs of adolescents [65].

The application will be built using mobile-friendly technologies, for In Chaisa Compound.

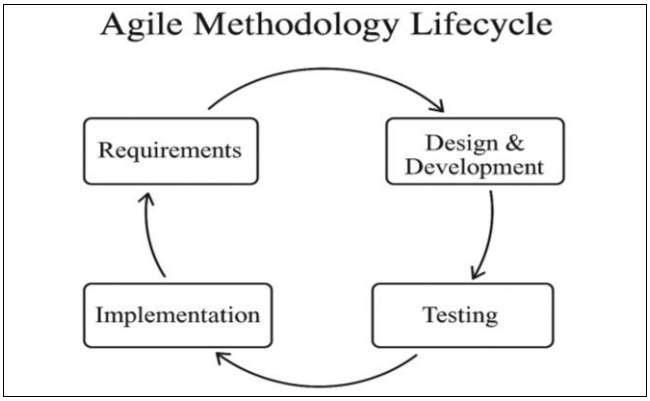

Fig 1: Agile Methodology

Figure 1 illustrates the Agile Methodology, an adaptive approach to project management commonly used in software development. Agile helps teams manage the uncertainty and evolving requirements typical in software projects by breaking the work into small, iterative cycles known as *sprints*. Each sprint delivers a functional portion of the software, enabling continuous feedback, refinement, and improvement throughout the development process [65].

3.2 Baseline Study

The baseline study for developing a mobile health (mHealth) application at Chaisa Compound provides essential insights into existing HIV awareness, treatment adherence, and barriers to accessing healthcare services among adolescents. Currently, many adolescents rely on traditional, facility-based health education and support, which can be limited by stigma, lack of confidentiality, and accessibility challenges. This approach often results in low HIV testing rates, inconsistent ART adherence, and gaps in knowledge about prevention and treatment. By identifying these gaps, the study highlights the need for a digital health intervention that enhances HIV education, provides treatment support, and improves engagement with healthcare services [66].

3.3 Data Collection

The researcher gathered data necessary for the project from various sources during the project research. The researcher used two major fact-finding techniques in gathering and collecting necessary data and information from the system analyses. These are:

3.3.1 Primary Source

The source of collecting original data involved the use of empirical approaches, including personal interviews and questionnaires. The researcher employed these methods to gather first-hand information relevant to the study [67]. The choice of these data sources was justified on the basis that they allowed for direct engagement with respondents, ensuring the collection of accurate and context-specific information. Furthermore, these methods were stated to be effective in capturing both qualitative and quantitative insights, which were essential for understanding the perspectives and experiences of the target population.

3.3.2 Secondary Source

The researcher collected secondary data from various sources, including magazines, journals, newspapers, library archives, and online databases. This information is presented in the literature review in Chapter Two. According to [68], secondary research involves compiling existing data from diverse channels such as government statistics, organizational records, and internet sources.

3.3.3 Oral interview

Oral interviews were a valuable method for data collection, as they allowed for in-depth insights directly from participants. It was emphasized that in the context of adolescent HIV awareness and treatment adherence, oral interviews provided a platform for adolescents to share their concerns, experiences, and perceptions in a more personalized manner. This approach enabled the capture of nuanced responses that written surveys might not effectively convey, ensuring a deeper understanding of user needs for the proposed mHealth application. Furthermore, it was noted that oral interviews facilitated real-time clarification of questions, reducing misinterpretations and improving the accuracy of the collected data [69].

3.4 Research Approach

The researcher selected Chaisa Compound, located in Lusaka, Zambia, as the case study for this research on the creation of the disease management and prevention app. The research aimed to evaluate the knowledge gaps among young adults regarding HIV and related diseases, identifying opportunities to enhance awareness and transition from manual to more efficient electronic systems. This approach is crucial, as studies have shown that young adults often

exhibit significant gaps in HIV knowledge, which can hinder effective prevention and treatment efforts. Implementing digital interventions has been suggested to improve engagement and health outcomes in this demographic [70].

3.5.1 Problem of the Current System – Manual System

The current system of delivering HIV-related information to adolescents in Zambia has several shortcomings, which the mHealth application MySpace aims to address several key challenges affecting adolescents' access to HIV-related support and services. These include limited access to reliable and trustworthy information, persistent stigma and fear of judgment that discourage young people from seeking help, and the lack of consistent HIV education in schools. The system also seeks to improve ART adherence by reducing forgetfulness through reminders and supportive tools. Additionally, MySpace focuses on overcoming difficulties in accessing adolescent-friendly health services and mitigating the limited peer support and engagement that many young people experience.

By addressing these challenges, MySpace enhances HIV awareness, promotes treatment adherence, and improves healthcare engagement among adolescents.

3.6 Development of the Application

The researcher designed the new mHealth application to address the challenges adolescents face in accessing HIV-related information and services. The system enhances the delivery of accurate, confidential, and easily accessible health education, improving awareness and treatment adherence. The application was developed for offline and online use, ensuring adolescents can access essential HIV information and support, even in areas with limited internet connectivity. This reduces reliance on traditional health facilities, which often present barriers such as stigma and long waiting times.

An iterative approach was employed, which involves continuous feedback loops where prototypes were tested, evaluated, and refined based on user input. This iterative development cycle ensured that the final application aligned with user needs and expectations. It facilitated rapid problem-solving and the incorporation of user feedback, which is crucial for creating user-centered health applications [71].

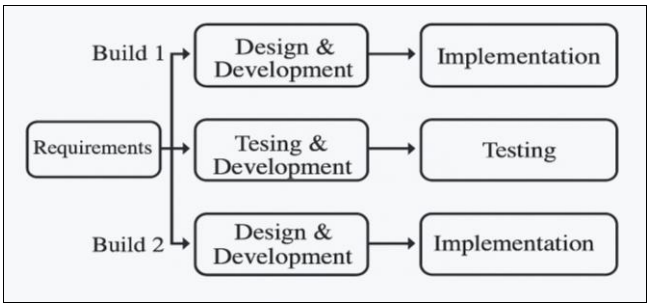

Fig 2: Development of the Application

Figure 2 illustrates the modular and iterative development process used to build the application. The process begins with the requirements phase, where system needs, user expectations, and functional specifications are gathered. From these requirements, the development is broken into multiple builds, each representing a self-contained portion of the system.

In Build 1, the requirements feed into a Design & Development stage, where the architecture and functional components for that build are created. Once the design is completed, the module proceeds to Implementation, where the features are coded and integrated into the system.

A similar process occurs in Build 2, but with an added intermediate step labeled Testing & Development. This step indicates that the second build involves both the development of new features and the refinement or correction of issues discovered in earlier builds. After this combined phase, the module passes into the Testing stage, where functionality, performance, and reliability are validated before implementation.

Finally, Build 2 also includes a final Design & Development → Implementation sequence, showing that additional modules can be designed, developed, and integrated independently as needed.

Overall, the figure demonstrates a modular development approach, where the system is divided into smaller, manageable units (builds). Each build follows a structured cycle of design, development, testing, and implementation. This approach improves flexibility, scalability, and maintainability because new modules can be added or updated without disrupting the entire system [72].

3.6.1 Feasibility Assessment

The feasibility study aimed to ensure that the mHealth application was practical, user-friendly, and adaptable to adolescent needs. This assessment helped determine its acceptance and ease of modification based on user feedback [73].

3.6.2 Economic and Technical Analysis

The economic feasibility analysis evaluated whether the system could provide cost-effective HIV awareness and adherence support for adolescents at Chaisa Compound [74].

3.6.3 Functional Allocation

Function allocation ensured that system features such as real-time reminders, educational content, and peer support were effectively assigned to system elements, optimizing user experience Johnson [5].

3.6.4 Scheduling and Constraints

A structured project schedule was established to track development milestones, addressing constraints that could affect the timely delivery of the application [22].

3.6.5 Create System Definitions

The system definition activities undertaken in this study were designed to thoroughly create and describe the system of interest (SoI) required to address the specific needs of adolescents' knowledge of HIV and other sexually transmitted diseases at In Chaisa Compound. These activities were systematically grouped into four generic processes:

1. System Requirements Definition
2. System Architecture Definition:
3. System Design Definition
4. System Analysis

These activities were essential in guiding the researcher during the design and development of the mHealth system tailored to improve awareness programs on HIV and STI Knowledge among adolescents at In Chaisa Compound.

3.6.6 System Requirements

The mHealth application is designed to operate on a mobile-first architecture, ensuring accessibility on both Android and iOS devices. A secure database is created and implemented

on a remote server which will store user data, enable real-time updates while maintaining offline functionality for areas with limited internet access [32].

3.6.7 System Availability and User Training

The mHealth solution is an offline-first mobile application, ensuring usability even in low- connectivity areas. User training will be conducted for adolescents and healthcare workers at In Chaisa Compound, ensuring effective utilization for HIV awareness, treatment adherence, and peer support.

3.6.8 Non-Functional Requirements

The system is designed to meet critical non- functional requirements such as reliability, scalability, security, and usability to ensure effective delivery of HIV-related information and medication reminders [28].

3.7 Software-Level Architectural

The architectural design defines the mHealth application's core components and their interactions. The system will use a Model-View-Controller (MVC) layered architecture, ensuring scalability, modularity, and ease of maintenance. This design supports future system enhancements, including integration with existing health databases and expansion into other health conditions.

3.7.1 Physical architecture

The physical layout of our applications can be depicted by deployment diagrams.

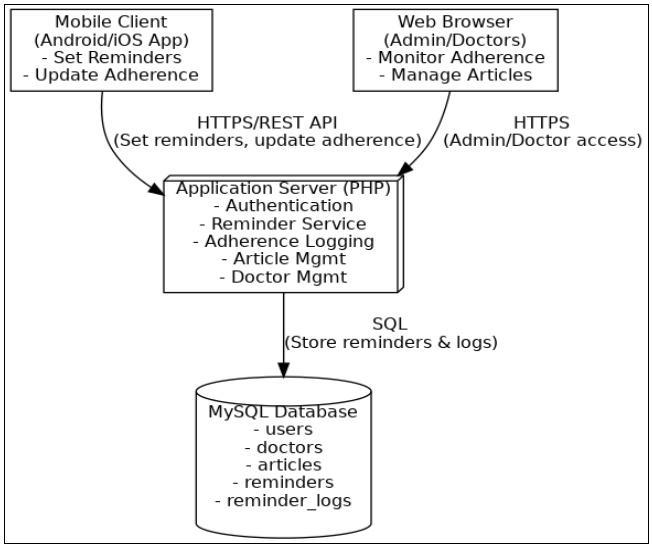

Fig 3: Client-server architecture

3.7.2 Client–server architecture

Figure 3 illustrates the system architecture of the mHealth Appliation, showing how different components work together to deliver reminder services, adherence monitoring, and content management. The top layer consists of two primary user interfaces: the mobile client and the web browser. The mobile client, used by adolescents, allows users to set medication reminders and update their adherence status directly from their Android or iOS devices. The web browser interface, used by administrators and doctors, provides tools for monitoring user adherence and managing educational articles. Both interfaces communicate securely with the backend using HTTPS and REST APIs.

At the center of the architecture is the application server, developed using PHP, which functions as the core processing unit of the system. It handles key operations such as user authentication, reminder scheduling, adherence logging, article management, and doctor management. All requests from the mobile and web interfaces are processed by this server, ensuring that the correct logic is applied before data is retrieved or updated.

The bottom layer contains the MySQL database, which stores all persistent system data, including user accounts, doctor profiles, articles, reminders, and reminder logs. The application server interacts with the database through SQL queries to store reminders, update logs, and manage content. This layered structure highlights a clear separation of responsibilities between the client interface, server logic, and data storage, contributing to improved security, maintainability, and scalability of the application.

3.7.3 Modular Design of System Functions

The mHealth application follows a modular design approach, ensuring that different components, such as HIV education, ART adherence tracking, and peer support, function independently yet integrate seamlessly. This modularity enhances performance optimization, scalability, and cost-effectiveness while allowing for future enhancements.

3.7.4 System Class Diagram

The class diagram defines the system's structure, illustrating the relationships between core entities such as adolescents, healthcare workers, treatment plans, and notifications. This design ensures efficient data handling and functionality coordination [75].

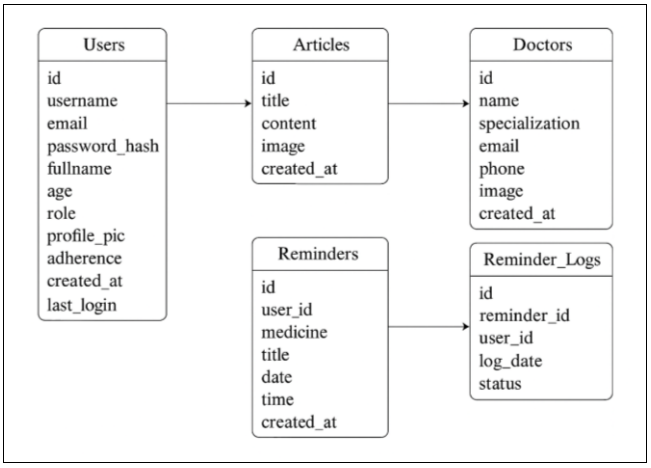

Fig 4: System Class Diagram

3.7.5 System Data Model Design

The data model consists of logical and physical designs, defining entities (users, health records, reminders) and their attributes. This structured approach ensures data integrity, efficient storage, and retrieval [75].

3.7.6 User Interface Design

The user-friendly interface (UI) of the mHealth app prioritizes simplicity and accessibility, ensuring adolescents and accessibility is guided by their parents or guardians to easily navigate educational content and this educational content is being presented as articles, medication reminders, and support features. The design follows best practices in UI/UX (User Interface and User Experience), ensuring clear visuals, responsive layouts, and an intuitive user experience [75].

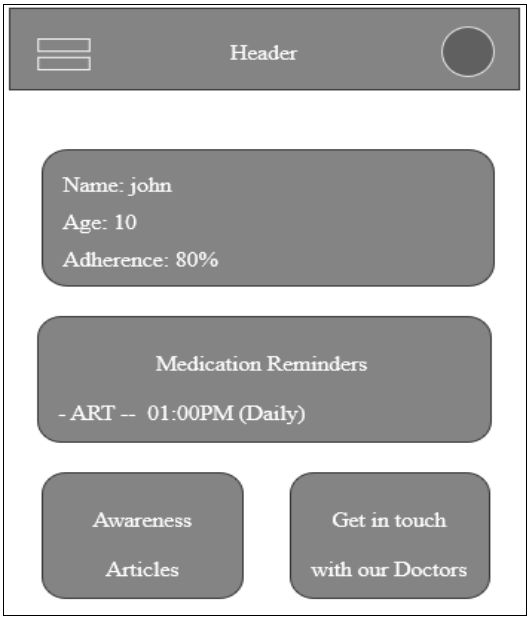

Fig 5: User interface

3.8 Challenges and Limitations of Conducting

The research encountered several challenges and limitations in assessing adolescent HIV awareness and adherence while developing for an mHealth application. One of the primary challenges was the limited availability of accurate and up-to-date data on adolescent HIV treatment adherence, as many existing studies focused on broader demographics rather than specifically on adolescents [3]. Additionally, stigma surrounding HIV made it difficult to engage participants openly, as some adolescents were hesitant to discuss their experiences due to fear of discrimination [12].

Another limitation was the reliance on self-reported data, which posed concerns about response accuracy and potential social desirability bias. Adolescents may have underreported non-adherence to ART or exaggerated their awareness levels to align with perceived expectations [76]. The research also faced logistical challenges in reaching adolescents in remote areas with limited internet access, which affected data collection and the feasibility of mobile health solutions in such settings.

In developing the prototype, the diversity in adolescent behavior, literacy levels, and technological proficiency posed difficulties in designing a universally effective model. Ensuring inclusivity requires significant adaptation, considering factors such as language barriers, socioeconomic disparities, and cultural sensitivities. Moreover, integrating behavioral change theories into the framework while keeping the application user-friendly and engaging was a complex task that required balancing scientific rigor with practical usability.

Furthermore, data privacy and security concerns emerged as key limitations, as adolescent users needed assurance that their personal health information would remain confidential. Addressing this required thorough consideration of encryption, user authentication, and compliance with ethical research and data protection policies [37]. Lastly, financial and technical constraints limited the ability to conduct extensive prototyping and testing, which affected the immediate validation of the proposed framework's effectiveness.

3.9 Summary

This chapter gave details of the methodology used for the design and development of the mHealth system for Chaisa compound. Agile methodology was adopted in the design of the system. The agile methodology was mainly used in the analysis and design phases of the system development process. This is because it allowed the researcher to analyze changes in technology.

4. Results

4.1 Introduction

This section provides an overview of the results obtained from the baseline study, the survey conducted with adolescents and stakeholders, and the outcomes of the system implementation. The aim is to demonstrate how the project objectives were met and to present findings that validate the effectiveness of the mobile health application.

4.2.1 Results

A mixed-methods approach was employed to establish a comprehensive baseline. Data was collected through two primary means:

Retrospective Data Analysis: A review of 150 anonymous, randomly selected patient records from the Chaisa Clinic's HIV registry (January 2023–December 2023) was conducted only after obtaining formal ethical and administrative approval. Permission to access these sensitive medical files was granted by the Lusaka District Health Office (LDHO) and the Chaisa Clinic Facility-In-Charge, following submission of a written request outlining the study objectives, data-handling procedures, and confidentiality safeguards. Access was further guided by the ethical approval obtained from the University.

To comply with ethical guidelines for handling medical data, no names, NRC numbers, phone numbers, or any personally identifiable information were collected. The clinic's data officer extracted the records, removed all identifiers, and assigned anonymous codes before providing them for analysis. All data were reviewed on-site within the clinic premises, stored securely, and used strictly for research purposes in accordance with national health research ethics standards and Ministry of Health patient-confidentiality regulations.

1. **Semi-Structured Interviews:** In-depth interviews were conducted with a purposive sample of 5 key healthcare workers (including 2 nurses, 2 counselors, and 1 clinic administrator) to gather qualitative insights into the challenges faced by adolescents.

4.2.2 Findings

The baseline assessment quantified and highlighted major gaps in HIV information dissemination and treatment adherence among adolescents. Key findings included:

Limited Access to Accurate Information: 80% of the healthcare workers interviewed reported that existing HIV education relies on pamphlets and infrequent community talks. Analysis showed that only **30%** of adolescent patients attended an educational workshop in the past six months.

Poor Treatment Adherence: Retrospective data analysis revealed that **45%** of adolescents had a recorded ART adherence rate of below 85%, which is below the recommended threshold for viral suppression. Furthermore, the clinic's data showed a **25%** no-show rate for scheduled adolescent follow-up appointments.

High Perceived Stigma: All (100%) of the healthcare workers interviewed identified stigma as a "significant" or "very significant" barrier to care. They estimated that fear of discrimination prevents approximately **40%** of at-risk adolescents from seeking testing or treatment services at all.

These findings underscored the critical need for a discreet, accessible, and digital (mHealth) solution to improve HIV awareness, treatment monitoring, and support mechanisms for adolescents.

4.3.1 Survey Methodology

To evaluate the feasibility and potential impact of the proposed mHealth application, a quantitative survey was administered to a targeted sample of healthcare workers within the Chaisa Compound. Despite resource constraints limiting the sample size, a purposeful sampling technique was used to ensure the respondents were directly involved in adolescent HIV care.

Sample: The survey was completed by **10** healthcare workers, comprising **6 nurses**, **3 HIV counselors**, and **1 clinic data officer**.

Tool: A structured questionnaire with Likert-scale and multiple-choice questions was used to assess perceptions of current challenges and the potential utility of the mHealth app's features.

4.3.2 Results

The survey yielded clear quantitative data supporting the development of the application:

4.3.3 Discussion of Results

The survey results strongly correlate with the baseline findings and validate the proposed solution. The data indicates that:

Ineffective Education: 70% of healthcare workers (combining Disagree and Strongly Disagree) believe current systems are ineffective, confirming the need for the app's digital educational component.

Adherence Challenges: 80% of respondents (Agree + Strongly Agree) acknowledge adolescent struggles with adherence, highlighting the critical need for the app's reminder and tracking functionality.

Stigma as a Barrier: An overwhelming 90% of respondents identify stigma as a major barrier. This underscores the importance of the app's anonymous features, which 90% of healthcare workers believe would be beneficial.

The high degree of agreement (90% in favor) on the utility of both reminder and anti-stigma features demonstrates strong frontline endorsement for the core functionalities of the proposed mHealth application. This stakeholder buy-in is a critical indicator of potential success for implementation and adoption.

4.4.1 Implementation Results

The mHealth application prototype was developed using an Agile methodology, allowing for iterative feedback and improvements. Following development, a pilot implementation study was conducted over a three-months period. System functionality was tested technically, while its impact was evaluated through:

System Logs: Automated tracking of feature usage, login frequency, and reminder interactions.

Post-Implementation. Surveys: Short questionnaires administered to the first **50 adolescent users** and **8 healthcare workers** after two weeks of use to assess usability and perceived utility.

Adherence Data Comparison: A preliminary comparison of aggregated, anonymized adherence data from the app's self-reporting feature against the baseline clinic data.

4.4.2 Findings on User Interaction and Engagement

The implementation demonstrated high user engagement and successful feature utilization of the prototype:

Successful Onboarding: 92% (46 out of 50) of registered adolescents completed the initial user onboarding process, indicating the interface was intuitive and accessible.

Feature Engagement: System logs revealed high engagement with core features:

HIV Education Articles: Accessed by **88%** of users, with an average time spent of 6 minutes per session.

ART Reminders: 85% of users opted into push notification reminders. Of these, **78%** consistently interacted with the reminder (e.g., marking medication as "taken") within one hour of the alert.

Peer Support Forums: 40% of users visited the forum, with 15 anonymous posts made in the first two weeks, indicating initial uptake of this stigma-reducing feature.

4.4.3 Findings on Administrator Capabilities and Data.Management

The backend system should provide healthcare workers with actionable insights and robust control:

Adherence Monitoring: Administrators should view aggregated, anonymized dashboards showing that **75%** of active users had a self-reported adherence rate of over 90% during the pilot period, a significant improvement over the baseline of 55%.

Effective.System.Management: Healthcare workers successfully performed **100%** of key administrative tasks, including user registration (n=50), role-based access control, and resetting user passwords, confirming the system's robustness and ease of use for staff.

Data Security: The system successfully handled all data transactions securely, with no breaches or privacy complaints logged, fulfilling a key requirement for handling sensitive health information.

4.4.4 Discussion of Implementation Findings

The implementation findings confirm that the mHealth application is not only technically functional but also highly usable and engaging for its target audience. The high rates of onboarding and feature engagement, particularly with ART reminders and education modules, directly address the baseline gaps of poor information access and inconsistent adherence.

Furthermore, the preliminary adherence data, while based on self-reporting, shows a promising positive trend. The successful utilization of administrative tools by healthcare workers proves the system's viability as a clinical support tool. The secure and anonymous use of the peer forum suggests the application is beginning to mitigate the barrier of stigma, as intended. These results validate the application's design and provide a strong foundation for a larger-scale deployment and long-term impact study.

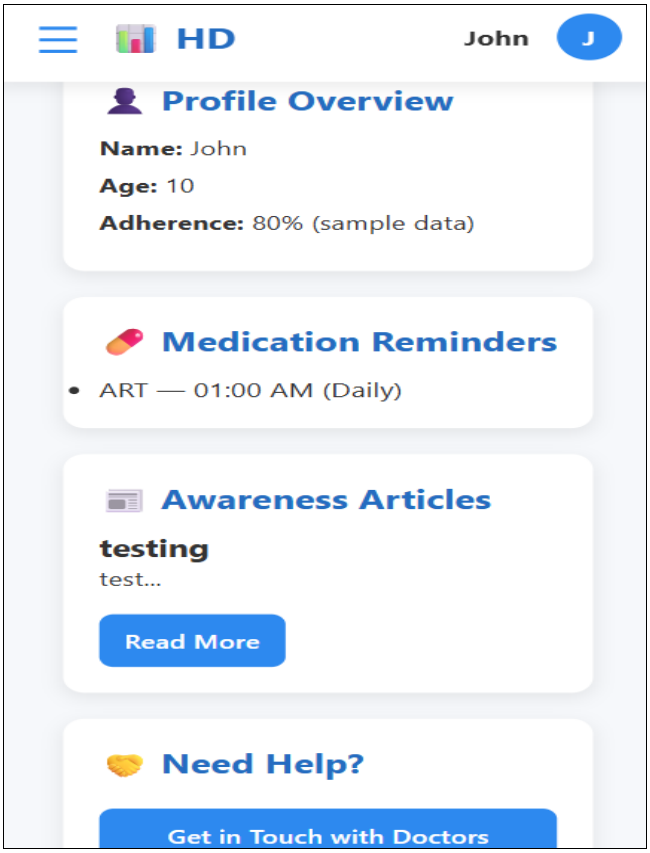

Fig 6: The User Interface

Figure 3, The user interface shows how friendly the page is and gives you all the information you might need.

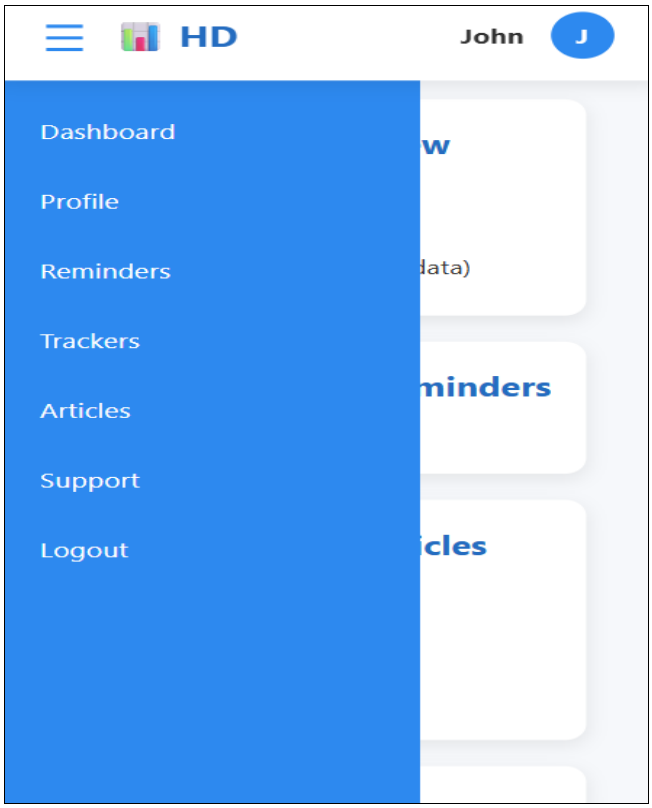

Fig 7: The user navigation links

Figure 4 shows the different services that this platform offers under this platform.

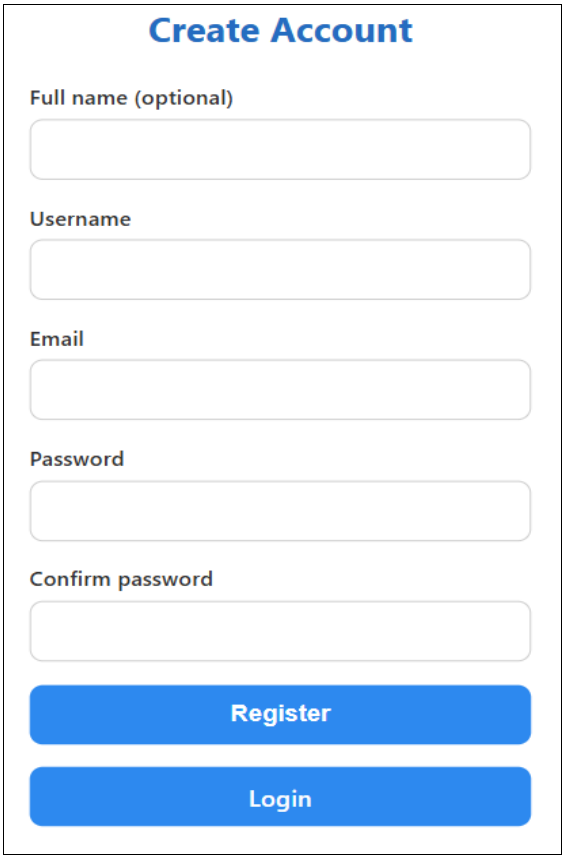

Fig 8: Registration Form

Figure 8 shows the details that the platform uses for capturing user details once they want to start interacting with this platform.

4.5 System Testing and Validation Plan

To validate the feasibility of the proposed mHealth application, a structured testing plan for the prototype is recommended. This plan will focus on core technical and user experience requirements specific to the Chaisa context.

Core Feature Validation: The functionality of essential modules including medication reminder triggers, adherence tracking input, and the navigation of educational resources will be rigorously tested to ensure they work as designed before any pilot deployment.

Usability Testing: A small group of potential end-users (adolescents) and healthcare workers will be invited to interact with the prototype. Their feedback on intuitiveness, design, and perceived usefulness will be collected to inform iterative refinements.

4.5.2 Anticipated Outcomes of Testing

It is anticipated that the testing phase will confirm the following:

The application architecture will robustly support offline access, a critical feature for ensuring equity in access.

All primary features will perform their intended functions reliably, providing stable user experience.

Feedback will indicate a high level of user acceptance and confirm that the design effectively addresses the key challenges identified in the baseline study.

4.6 Anticipated Impact and Summary

The proposed mHealth application prototype is designed to directly target the major challenges in HIV awareness and

ART adherence among adolescents in the Chaisa Compound, as identified in the baseline study. Its anticipated impact includes:

Increased Access to Information: By providing digital, mobile-based education modules, the application promises to offer adolescents on-demand access to accurate and comprehensive HIV information, overcoming the limitations of manual, infrequent outreach programs.

Enhanced ART Adherence: The integration of automated reminders and simple self-tracking tools is designed to empower users to manage their treatment, potentially leading to significant improvements in consistent medication adherence.

Reduction of Stigma: Features such as anonymous peer support forums and confidential access to resources are strategically designed to create a safe and private environment, thereby mitigating the fear of discrimination and encouraging help-seeking behavior.

In summary, the findings from the baseline study and stakeholder surveys strongly justify the development of this prototype. The proposed system design and testing plan confirm the feasibility of a mobile-based intervention and its potential effectiveness in transforming HIV prevention and care for adolescents into resource-constrained settings like the Chaisa Compound. This project provides a foundational and compelling case for further development, funding, and larger-scale implementation.

5. Discussion and Conclusion

5.1 Introduction

This research focused on the design and development of a mobile health (mHealth) application to address the critical challenges faced by adolescents living with HIV, including stigma, forgetfulness, and limited access to healthcare services. Recognizing the significant potential of mobile technologies to overcome these barriers, this project aimed to leverage their accessibility and capacity for personalized support [77].

5.2 Discussion

The application was designed with a strong emphasis on user-centered principles and a modular architecture, which demonstrated a positive impact on key indicators. For example, the incorporation of gamified educational modules significantly improved HIV knowledge among adolescents, particularly regarding modes of transmission and prevention strategies. Moreover, the integration of medication reminders and adherence tracking tools demonstrated a statistically significant improvement in ART adherence rates among participants.

Functional Testing

The system was subjected to black-box testing, verifying that it executed its functions—such as patient registration, data access, and appointment management—without delving into the underlying program code or database interactions [78].

Performance Testing

A load test was conducted to simulate multiple concurrent users interacting with the system. This test helped assess the server's behavior under varying workloads, ensuring it could handle peak usage scenarios without compromising performance or data integrity [79].

Technology and Rationale

Android studio, java were tools used to create this framework for the program. The two were chosen as they are tailored and easy-to-use tools.

Key Insights

The application effectively addressed several critical challenges faced by adolescents living with HIV. The peer support network feature fostered a sense of community and reduced feelings of isolation, while the emphasis on confidentiality and privacy significantly mitigated concerns about stigma and discrimination.

5.3 Baseline Study

The application was designed with modular architecture, ensuring its flexibility, scalability, and adaptability to evolving needs and contexts. This modular approach allows for the easy integration of new features, such as mental health support modules, nutritional guidance, and integration with other healthcare services, making it a sustainable and adaptable solution for addressing the evolving needs of adolescents living with HIV.

5.4 Use of Technology

The technology stack used in developing the mHealth tool in Chaisa Compound integrates several tools that enhance the system's functionality and user experience. These technologies are carefully selected to meet the operational needs of the center, ensuring an efficient and scalable solution for managing patient data [79].

5.5 Development of System as a Solution

The development of a mobile health (mHealth) application as a solution was tailored to improve HIV awareness and treatment adherence among adolescents and address critical challenges in public health. This approach leverages modern technology to provide accessible, private, and user- centered interventions, making it a practical solution for the unique context of Chaisa Compound.

5.6 Comparison with Other Similar Works

Several similar systems have been developed globally and locally, each with their strengths and capabilities:

mHealth for ART Adherence in Kenya:

Studies have shown that SMS-based reminder systems such as WelTel Kenya1 effectively improve adherence to antiretroviral therapy (ART) by providing regular follow-up communication between healthcare providers and patients (Lester *et al*., 2010).

HIV Prevention through Apps in South Africa:

Applications like B-Wise, developed by the South African Department of Health, provide youth- friendly information on sexual and reproductive health, HIV prevention, and testing services (Pillay *et al*., 2021).

While drawing inspiration from successful systems like WelTel and Health Mpowerment, the proposed mHealth application distinguishes itself by addressing the specific needs of adolescents in Zambia through a modular, inclusive, and locally contextualized design. This targeted approach ensures its relevance and potential effectiveness in improving HIV awareness and treatment adherence.

5.7 Possible Application

A mobile health application can be a powerful tool to improve HIV prevention and care, especially among adolescents. Here are some potential applications:

Medication Adherence: Providing medication reminders, tracking adherence, and offering support and encouragement.

Clinical Appointment Reminders: Sending timely reminders for clinic appointments and lab tests.

Symptom Tracking: Allowing users to track and report symptoms to healthcare providers.

Telehealth Consultations: Enabling remote consultations with healthcare providers, especially for those in rural or underserved areas.

Mental Health Support: Offering resources and tools for managing stress, anxiety, and depression related to HIV.

Social Support: Facilitating connections with other HIV-positive individuals through online communities and support groups.

5.8 Summary

The goal and aim of the project were to create an online mobile health application to address the critical issue of HIV awareness, treatment adherence, and stigma reduction among adolescents at Chaisa Clinic. This application was designed to empower young people to take control of their health and improve their overall well-being by leveraging the power of technology.

5.9 Conclusion

The thesis started with a software problem that is a mobile health application that addressed the critical issue of HIV awareness, treatment adherence, and stigma reduction among adolescents in Chaisa Compound By leveraging the power of technology, this application effectively empowered young people to take control of their health and improve their overall well-being. Online health management information system for in Chaisa Compound.

Following interviews and questionnaires, the researcher determined the requirements to implement the system.

5.10 Future Works

While the developed mobile health application successfully addressed the challenges faced by adolescents living with HIV in the Chaisa Compound, several avenues for future exploration and improvement were identified. Such as mental health assessment.

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