

# Development of Mobile Application for Sickle Cell Anemia Treatment Support System

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## Abstract

**Back ground:** Sickle Cell Disease (SCD) is prevalent in various parts of India, particularly in states with a high tribal population states. Chhattisgarh is the second largest state in terms of tribal population as per 2011 census. Within the state, certain tribal communities have a higher prevalence of the SCD disease due to a greater frequency of the genetic mutation. SCD is a significant health concern, particularly among certain tribal communities. Additionally, urban areas with migration from tribal regions also see a significant number of SCD cases. Main cause of spread of this disease is lack of awareness in marriage of SCD patients.

The prevalence of SCD in Chhattisgarh is relatively high in tribal populations due to a higher frequency of the genetic mutation that causes the disease. SCD is also prevalent in other than tribal i.e.; OBCs and other communities. As the doctors and facility related to SCD is not available in the villages and undeveloped areas therefore this technology based tool may act as self-management asset.

**Objective:** This study considers disseminating the information about the SCD to the families living in urban and country communities and supporting the patients for their medications and also supports the society to restrict the spreads of SCD by marriage counseling through the versatile app.

**Result:** Few themes incorporated in the application, including the desired information about SCD for self-management as well as doctor's recommendations and support for challenges of disease management.

In addition, the marriage counseling theme has been included to make selective marriage of SCD patients to restrict the spreads of SCD.

**Conclusion:** This application enhances our awareness on the use of app technology to increasing the access of resources and reduces the myth related to the SCD. Overall this is the SCD support and awareness system for the patients with SCD residing in rural communities and their families.

**Keywords:** SCD, sickle cell disease, mutation, anemia, SNP

## 1. Introduction

Any information support system successfully improves overall health [1, 2]. For patients with chronic situations, who are dwelling in rural or medically underserved groups, self-management is important because of their confined get right of entry to health care offerings and distinctiveness care [3]. Advancement in the technology creates a prospect for patients to get right of entry to sources and health care providers to facilitate ailment self-management. Past research has verified that technology-based totally self-management are effective systems for

enhancing conversation with fitness care experts, for patient education and self-monitoring, for health care and for affected person engagement [4-6]. Furthermore,

Fitness care corporations sell the use of technology-to minimize the prevalence of disease amongst susceptible populations to amplify the attention towards care [7-12]. Technology-based interventions needs doubtlessly enhance self-management in individuals with sickle cell disorder (SCD), especially for those dwelling in rural areas with confined access to acceptable care. Sickle cell anemia become first defined in south Indian tribals organizations [13] and it became also eventually identified in central India [14]. The frequency of sickle cell trait in India is 4.3% [14]. In Odisha and Chhattisgarh frequency of sickle cell anemia are about 9 and 10 % respectively [15, 16]. Chhattisgarh is shaped from south eastern components of Madhya Pradesh in the year 2000 and its 32 % of population is tribal origin [16].

People with SCD may additionally revel in acute and chronic headaches because of ongoing vaso-occlusion crises secondary to hypoxia-brought about suckling [17]. Acute pain is a hallmark of vaso-occlusion crises [18]. However, these People can develop stroke, priapism, and acute chest Syndrome. Over the years, acute vaso-occlusion episodes can result In continual sickness manifestations in cease organs, such as terrible Renal, cardiac, pulmonary, and vascular disorder [19]. Consequently, disease management with a multidisciplinary knowledge is important for managing SCD.

Despite the fact that disease management is essential, get right of entry to specialists isn't readily available to all sufferers with SCD. Moreover, education and interactive techniques that prepare patients with SCD to put in force self-care strategies to control their disorder also are confined. Therefore, having access to self-control should result in better information of ailment control, accelerated adherence to self-care behaviors, and better control of physical signs and symptoms amongst individuals with SCD. Evidence of powerful SCD self-control includes regular medication, attention to appropriate food consumption & hydration, and mild exercise etc. [20, 21].

## 2. Objectives:

To create a mobile application-based information assistance system that includes marriage counseling for SCD patients. As the Number of SCD patients are increasing, hence, it is very essential to motivate the patients to practice self-care (such as automated notifications about medications and checkups, and interaction with healthcare specialists in case of pain crises or other concerns), because doctors are not easily available everywhere. Additionally, the marriage counseling component of this programme will serves as a barrier to the SCD's spread [22]. This work is not limited to the specific age group; it is for all concerned with SCD.

## 3. Materials and Methods:

### Overview

The mobile application "Sickle Smart" has been created using the Flutter framework and Firebase platform [23]. It aims to address the management and educational needs of the sickle cell disease population in Chhattisgarh. The development process encompasses the entire journey from conception to deployment.

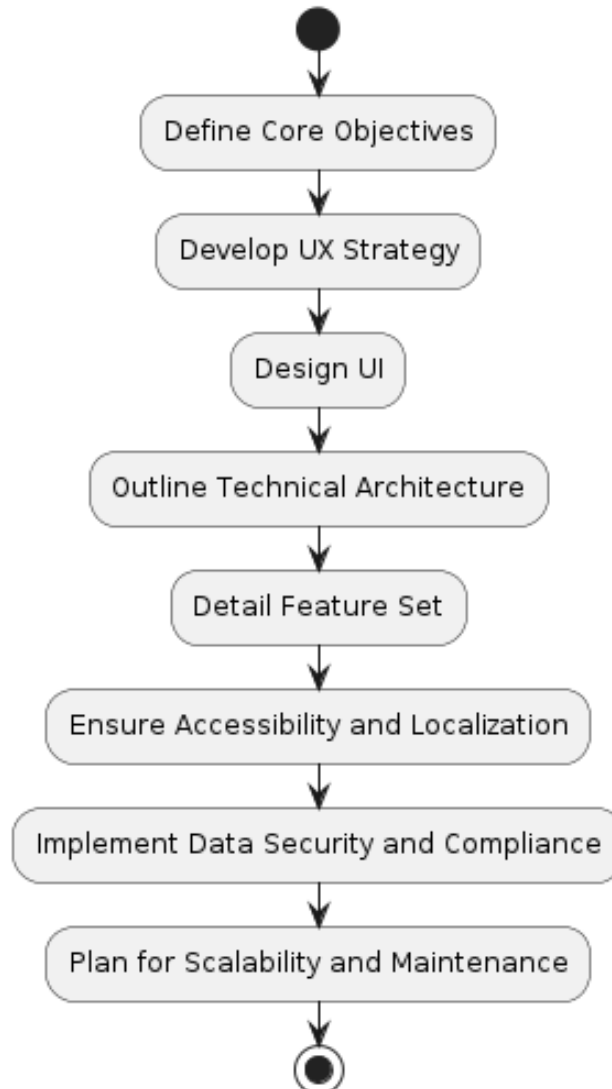
**Research Phase:** The research plan was carried out by comprehensive examination on the frequency of sickle cell disease in Chhattisgarh, the requirements of patients, and the existing deficiency in digital health innovations.

**Target Audience Analysis:** The target audience has been recognized as the residents of Chhattisgarh, specifically focusing on individuals with sickle cell disease and their caregivers.

## Design and Development

- Conceptualization:

### Conceptualization Phase - Sickle Smart App



During the conceptualization phase, was dedicatedly formulated the vision and functional blueprint for the "Sickle Smart" application. The process was guided by our team's extensive knowledge in mobile health applications, user experience design, and technical architecture [24].

### Defining Core Objectives

The first step taken was to establish the fundamental goals of "Sickle Smart." These goals encompassed:

- Delivering a tailored health management experience for individuals with sickle cell disease.
- Enhancing user knowledge regarding sickle cell disease management.

- Streamlining access to healthcare resources and support.

## User Experience (UX) Strategy

A plan was crafted centered on simplicity, inclusivity, and interaction. The user experience was tailored to be user-friendly for our specific audience, taking into account literacy levels and providing support in local languages.

- User Personas: Elaborated on comprehensive user personas that reflect the varied user demographics, such as patients, caregivers, and healthcare professionals.
- User Journeys: Outlined user journeys to illustrate the user experience with the application from the initial introduction to frequent usage.

## User Interface (UI) Design

A strong emphasis was placed on creating a clean, easily navigable, and visually comforting aesthetic for the UI design.

- To achieve this, wireframes were meticulously crafted for each screen, offering a schematic representation of the app's layout.
- Furthermore, interactive prototypes were developed to thoroughly test and refine the navigational flow and the positioning of elements.

## Technical Architecture

The technical architecture was outlined while simultaneously working on the UX and UI design.

- To ensure a consistent experience across Android and iOS, Flutter was chosen. The Flutter framework for its cross-platform capabilities.
- For efficient communication between the app and backend services, RESTful APIs were designed. Additionally, Firebase was selected as our backend solution for its real-time database, authentication, and analytics services.

## Feature Set

The functionalities of the application were outlined according to the requirements identified during our research stage:

**User Profile Management:** Personalized forms and secure login systems for personal and medical data.

**Health Education:** Interactive systems for distributing educational content such as brochures and flyers.

**Medical Monitoring:** Sections for entering and monitoring medical data, medication plans, and test outcomes.

**Resource Finder:** Utilization of geolocation features to locate testing facilities and healthcare professionals.

## Accessibility and Localization

During the research phase, we have identified the requirements have been identified and outlined the functionalities of the application has out there as follows:

**User Profile Management:** The application will provide personalized forms and a secure login system to manage personal and medical data effectively.

**Health Education:** Interactive systems will be implemented to distribute educational content, including brochures and flyers, to enhance health awareness.

**Medical Monitoring:** The application will include dedicated sections for entering and monitoring medical data, medication plans, and test outcomes, ensuring efficient healthcare management.

**Resource Finder:** Utilizing geolocation features, the application will enable users to easily locate nearby testing facilities and healthcare professionals for convenient access to healthcare services.

These functionalities have been carefully designed to meet the identified requirements and provide a comprehensive solution for users' healthcare needs.

## Data Security and Compliance

Data security and adherence to healthcare regulations were given utmost priority:

**Data Encryption:** End-to-end encryption was successfully implemented to safeguard data during storage and transmission.

**Compliance Checks:** Thorough reviews were conducted to ensure that the app complied with both HIPAA and local healthcare regulations.

## Scalability and Maintenance

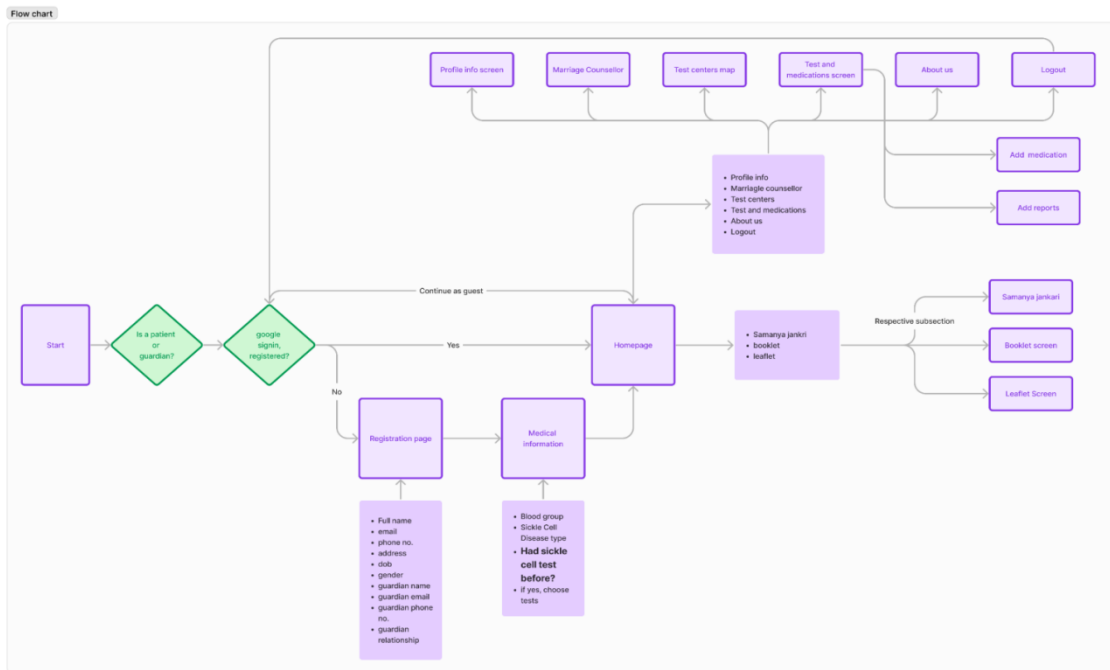
The application was treated with scalability and maintenance in mind.

**Modular Design:** The application was developed using modular design principles, allowing for easy updates and the addition of new features.

**Performance Monitoring:** To ensure smooth operation and quick issue resolution, performance monitoring tools have been seamlessly integrated into the app.

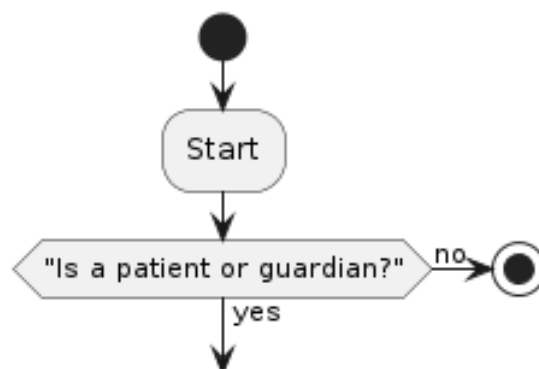
- **Flowchart Creation:** A comprehensive flowchart was created to illustrate the structure of the application, the flow of navigation, and the connections between various components.
- **Start:** It is initial screen of the application where the user selects their role as either a patient or a guardian.

- **Registration:** It is a method for fresh users to input their personal and medical particulars.
  - **Homepage:** It is the central hub which serves as a gateway to different sections within the application.
- Utilized Flutter to develop a versatile user interface that works across multiple platforms, while leveraging Firebase for backend functionalities like database administration and user authentication.
  - Below is a thorough breakdown of the flow chart.



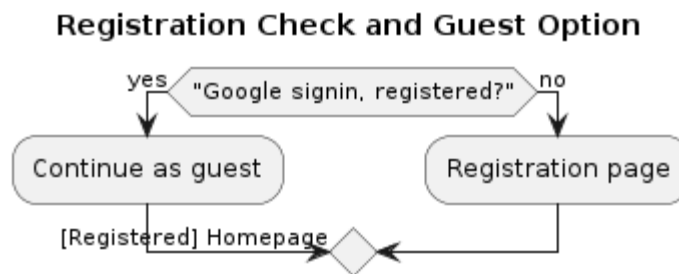
**Start:** The starting point of the flow chart where a user initiates their journey.

### Start and User Type Decision

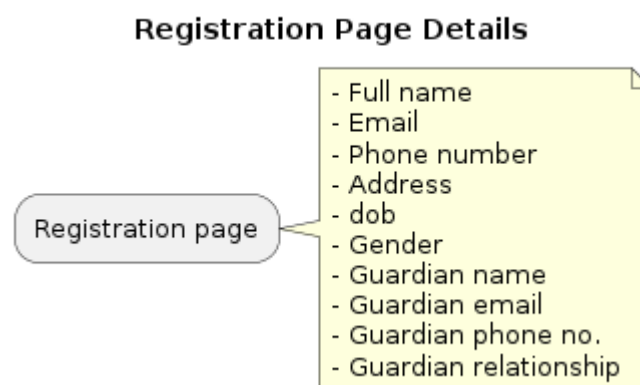


**Is a patient or guardian?:** This decision point inquires about the user's role, whether they are a patient or a guardian. This determination will play a crucial role in determining the specific access privileges or information needed.

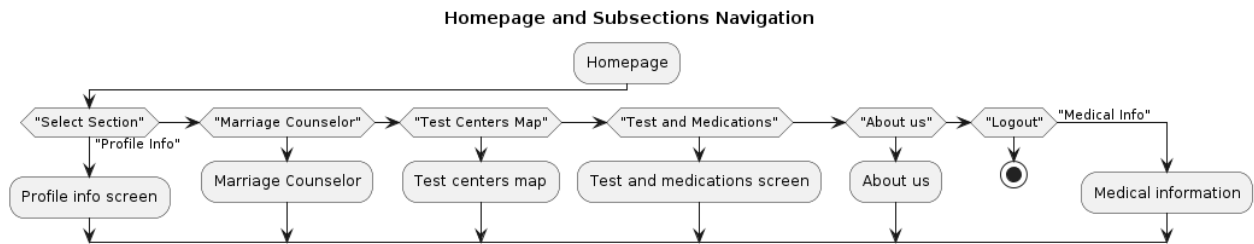
1. This decision node verifies whether the user has already registered with the service by utilizing the Google sign-in feature.
  - If "Yes", the user proceeds to the "Homepage".
  - If "No", the user is directed to the "Registration page".



2. **Continue as guest:** Users can choose to continue as a guest without the need to register or log in.
3. **Registration page:** This page necessitates new users to provide their personal details, including:
  - Full name
  - Email
  - Phone number
  - Address
  - Date of birth (dob)
  - Gender
  - Guardian name, email, phone no., and relationship (if the user is a guardian or has one)

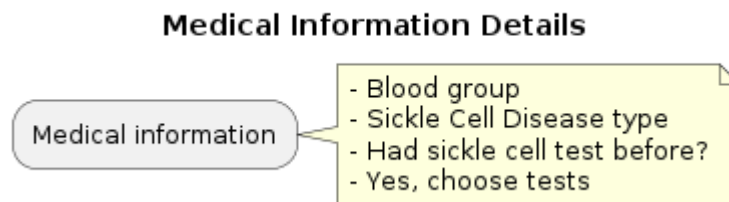


4. **Homepage:** Upon logging in or opting to proceed as a guest, users will be directed to the primary page of the service. From this point, users have the ability to access different sections through navigation:
  - Profile info screen
  - Marriage Counselor
  - Test centers map
  - Test and medications screen
  - About us
  - Logout



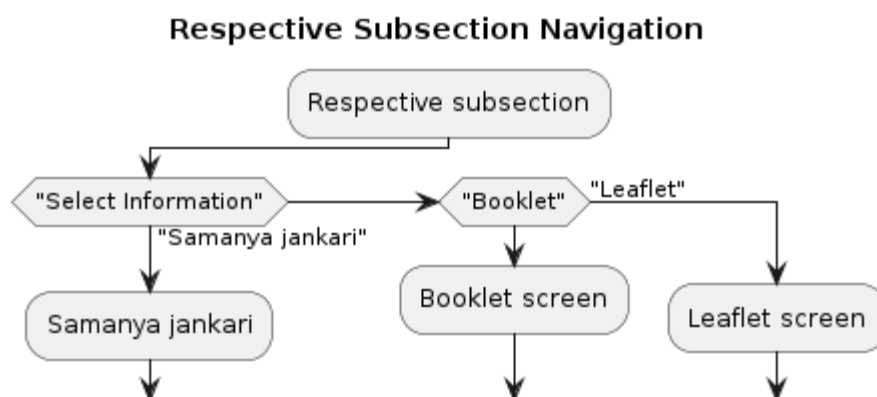
5. **Medical information:** A section that seems to be reachable from the main page. It includes:

- Blood group
- Sickle Cell Disease type
- History of sickle cell test
- Options to choose tests



6. **Respective subsection:** From the "Homepage", users can also navigate to sections like "Samanya Jankari", "booklet", and "leaflet" screens.

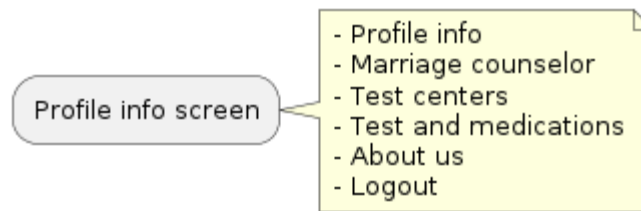
- Samanya Jankari: Likely means 'general information'.
- Booklet screen
- Leaflet screen



7. **Profile info screen:** A section with detailed profile information.

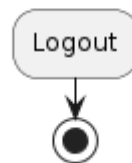


## Profile Information Screen and Options



8. **Marriage Counselor:** It is dedicated section offering access to professional marriage counseling services.
9. **Test centers map:** It is interface for mapping out the locations of test centers.
10. **Test and medications screen:** Users have the ability to obtain information or avail services pertaining to tests and medications, and potentially include medication or reports.
11. **About us:** It is dedicated area where users can acquire additional knowledge about the service or organization.
12. **Logout:** It enables the user to terminate their session.

## Logout Process



## Features

1. **Profile Management:** It allows users to create and manage their profiles with personal and medical information.
2. **Educational Material:** It provides educational resources like booklets and leaflets on sickle cell disease.
3. **Health Tracking:** Users can add medical information, medications, and reports for ongoing health management.
4. **Resource Location:** Features like the test centers map help users find nearby medical resources.

## Testing and Iteration

1. **Prototype Testing:** An initial prototype was created and conducted user testing sessions to gather feedback on usability and functionality.
2. **Iterative Development:** It uses feedback to iterate on app design and a feature, ensuring the app was user-friendly and met the needs of the target audience.

## Deployment and Monitoring

1. **Deployment:** It is launching of the sickle smart app on appropriate platforms for the target demographic.
2. **Monitoring and Updates:** This is an established system for monitoring user engagement and feedback, allowing for periodic updates and improvements based on user input and technological advancements.

## Community Engagement

1. **Awareness Campaigns:** Collaboration was done with local health organizations to promote the app and educate the community about sickle cell disease.
2. **Feedback Loops:** It was implemented in-app feedback mechanisms to encourage user input and foster a community-focused approach to app refinement.

## Results:

This app serves to improve our understanding of app technology's role in expanding resource accessibility and dispelling misconceptions about SCD. It functions as a comprehensive support and awareness system for SCD patients and their families living in rural communities. Every participant who registered with this application possessed a smart phone to utilize mobile technology. The majority of participants owned an android smart phone, and was at ease when it came to accessing the internet on their device. Out of the total participants, to whom informed about this app, expressed their willingness to utilize an app that provided information on SCD self-management and marriage counseling.

After the completion of programming part, the application of GUI shown in the figures 1 to 5. The graphical interface of starting page of application is shown in Figure-1. After the starting page sign in page appears for login in the application shown in figure 2.

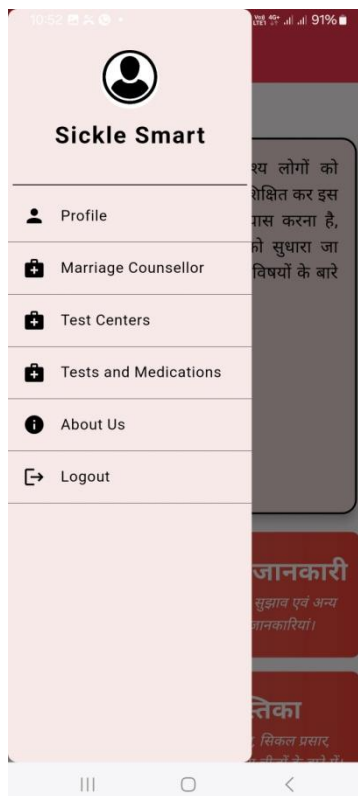


Figure 1. Starting page of the application



**Figure 2. Sign in page of the application**

Few modules are included in the application, which is shown in the Figure3 and general information available in the app is given in the figure 4. This app is also work as marriage councilor for sickling patients and give the appropriate decision for marriage, the user interface shown in figure 5.



**Figure 3. Different modules of application**

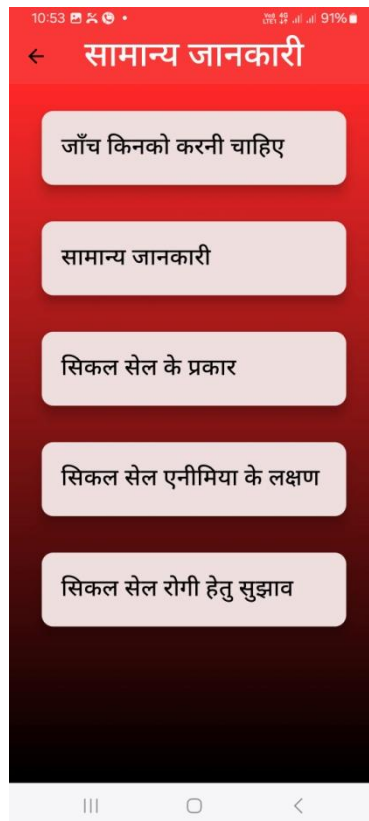


Figure 4. General Information of Sickle cell

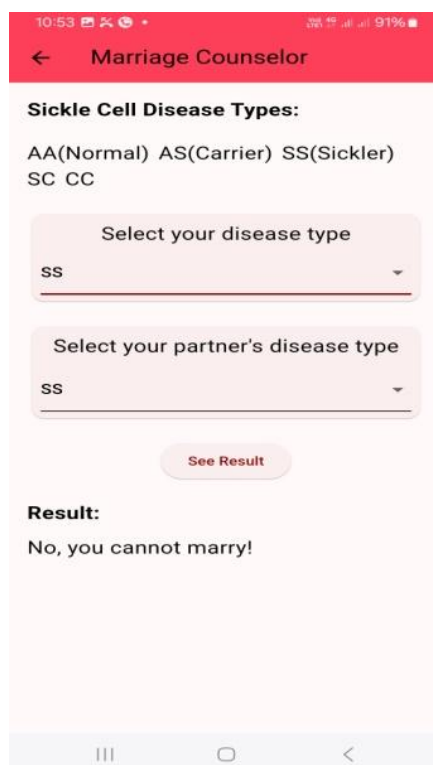
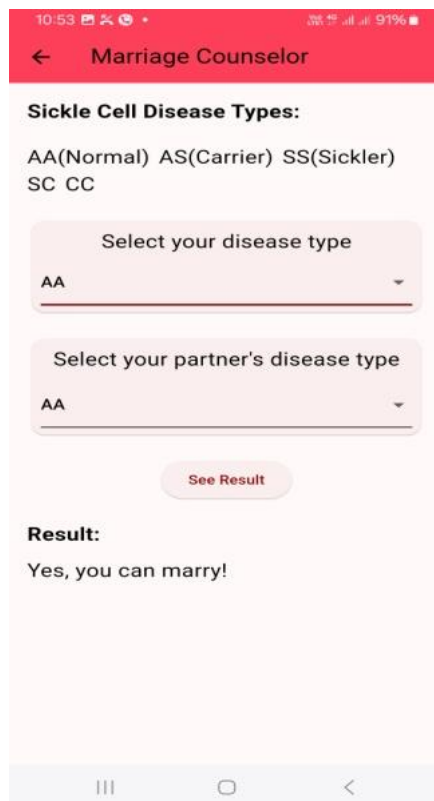


Figure 5(a). Marriage counseling module



**Figure 5(b). Marriage counseling module**

### **Conclusions:**

Patient and guardian preferences play a crucial role in determining the features of this app technology that should be included in disease self-management to cater to patient requirements. This research stands out as one of the pioneering studies to consider the perspectives of individuals with SCD and their caregivers residing in rural areas. The ongoing development of technology-driven solutions will help to improve healthcare accessibility in underserved rural communities, it is imperative to take into account the insights of community members. Subsequent research endeavors would evaluate the availability of technological resources for SCD patients living in rural regions. These insights can inform the creation and improvement of patient-centric, user-friendly applications that address information access barriers and support disease self-management without imposing additional challenges on patients and their caregivers.

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