Design and Evaluation of *iCare* App – A Persuasive mHealth App to Help Working-Class Indian Women to Manage Stress and Anxiety

by

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DEDICATION

This thesis is dedicated to my mom and dad
Mr. and Mrs. Reen
They have always inspired me to pursue my dreams.

I also want to dedicate this thesis to my life partner "Harpinder Singh" for his unwavering encouragement and attempts to fortify me and be by my side in all my decisions.

TABLE OF CONTENTS

Contents

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Persuasive Technologies (PTs) are widely used for improving mental health and well-being. The use of PTs contributes to the communal drive toward equality by making mental health care more accessible. PTs can be delivered in the form of mobile applications (apps). However, most existing apps focus on designing for people in developed countries. To address this gap, this thesis presents the design, development, and evaluation of *iCare*, a mobile health (mHealth) app for promoting mental health and well-being among an underserved population — the working-class Indian women. Specifically, we combined the power of mobile health and PTs. We used a User-Centered Design (UCD) approach to ensure that the needs of our target population are considered and included in the design of the *iCare* app. We divided our study into three phases, and in each phase, our target audience played an active role in the design process. This ensures that the *iCare* app is tailored to our target audience, truly helping them manage their stress and anxiety. In this study, stress and anxiety refer to day-to-day activities that can disrupt mental harmony and do not require an official psychological diagnosis. In Phase 1, we interviewed 31 working-class Indian women and investigated their mental health struggles, factors associated with mental health, strategies they use to manage their mental health, and their requirements for an app to help them improve their mental health. In Phase 2, we designed a prototype based on the main ideas gathered from Phase 1; we asked 40 working-class Indian women to use it, after which we interviewed them and recorded their suggestions and design recommendations. Finally, in Phase 3, using the main suggestions collected from Phase 2, we designed and developed the *iCare* app, which 30 working-class Indian women used for two weeks, followed by an optional one-on-one interview to investigate the effectiveness of the app for promoting awareness toward developing good mental health practices.

The final phase's evaluation results (N = 30), followed by an optional one-on-one interview with 22 participants, showed that the *iCare* app was perceived as highly motivational, persuasive, and useful. Also, results show that using the *iCare* app brought major positive changes in helping participants to manage their stress and anxiety better.

LIST OF ABBREVIATIONS USED

mHealth	Mobile Health
App	Application
UCD	User-Centered Design
UI	User Interface
HCI	Human-Computer Interaction
PT	Persuasive Technology
ARCS	Attention, Relevance, Confidence, Satisfaction
CBT	Cognitive Behavioural Therapy
PSD Model	Persuasive System Design Model
RO 1	Research Objective 1
RO 2	Research Objective 2
RO 3	Research Objective 3
RO 4	Research Objective 4
RQ 1	Research Question 1
RQ 2	Research Question 2
RQ 3	Research Question 3
RQ 4	Research Question 4
PTSD	Post-Traumatic Stress Disorder
PI	Principal Investigator
BMIS	Brief Mood Introspection Scale
PSS	Perceived Stress Scale
GAD	Generalized Anxiety Disorder
UEQ	User Experience Questionnaire
SUS	System Usability Scale

SD	Standard Deviation
MD	Mean Difference
Mdn	Median
M	Mean
AMD	Age-Related Macular Degeneration
p	Probability
df	Degrees of Freedom

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1 CHAPTER 1: INTRODUCTION

1.1 The Problem

In 2011 the American Psychological Association warned that stress is becoming a public health crisis [2]. "Stress" can be defined as "the nonspecific response of the body to any demand" [46], and "anxiety" can be defined as "the body's response to a perceived threat that exacerbates an individual's beliefs, feelings, and thoughts and increases blood pressure, respiration rate, heart rate, sweating, drowsiness, and chest pain" [17]. Both stress and anxiety are growing concerns, and those impacted by stress and anxiety require different treatments, as every individual is unique. In this study, stress and anxiety refer to day-to-day activities that can disrupt mental harmony, which does not require an official psychological diagnosis. Stress can lead to more severe issues, such as depression, if not addressed early [118]. Thus, getting help at an early stage is essential to treating stress and anxiety. However, in developing and low-resource countries, attending clinical sessions is not feasible for most people because most low- and middle-income countries have extremely limited resources and mental health care [142]. There are only 0.75 psychiatrists per 100,000 people in India, which is much below the required level of at least three psychiatrists per 100,000 people [168]. Other reasons can be that some individuals are uncomfortable sharing their thoughts with others, making reaching the root cause of stress more challenging.

In developing countries like India, discussing mental health topics openly is still looked at as taboo [169]. Thus, people going through mental distress ignore sharing it with their family members or life partners so as not to become the cause of their stress and cause panic [115]. Hence, most people in developing countries are skeptical about seeking help from a health professional due to its social stigma. In such communities, women are more vulnerable to mental health problems than men because of the many responsibilities they play in society, including work, childcare, housewife, and, particularly – gender roles [80]. Specifically, the second shift phenomenon (i.e., the housekeeping and childcare responsibilities that follow a workday outside the home) [40,81] is a major cause of stress and anxiety for working-class women, as a woman's life never has an "off" day. Furthermore, women lose many sleeping hours because they have busy work schedules [127], trying to meet work and home caring requirements, which are usually not considered work.

One of the challenges is figuring out how to create both helpful and acceptable interventions for women suffering from mental health issues, especially those from developing countries where there are still a lot of stigmas associated with mental health, and gender role is still a major issue.

1.2 Motivation

India is in a mental health crisis; resources are stretched thin, with only 43 government-run mental health hospitals serving a population of 1.2 billion [170]. Furthermore, mental health illness is extremely stigmatized in India, particularly among women, who are frequently sent to mental health facilities without legal rights such as making an appeal in court, subjected to involuntary treatment, and sometimes without a formal diagnosis [170]. One of the primary reasons for conducting the research presented in this thesis was to provide a means for Indian women to manage their stress and anxiety and gain more self-awareness in a setting where discussing mental health difficulties is not encouraged. The ubiquitous nature and the wide penetration of mobile phones have created an opportunity for designing interventions that people in low-resourced communities can easily access. As a result, mobile health (mHealth) has become more popular. mHealth is described as the "delivery of health care services using mobile phones and other wireless technology" [171]. Given the pervasiveness of mobile phones, mHealth apps have a huge potential to help people suffering from various mental health issues when needed. They are also affordable compared to conventional mental health treatments.

Nonetheless, there is a paucity of studies focusing on mHealth interventions for stress and anxiety among women [6] and, more specifically, those in developing countries and low-resourced communities. Despite the consensus that identifying the requirements and perspectives of targeted users is an important part of successful intervention, a User-Centered Design (UCD) approach, an iterative design approach where designers pay attention to the needs of the users at each stage [172], has not been frequently used in the designing of the mHealth applications (apps) [162]. Furthermore, very few UCD approaches aim solely at women's mental health [6]. Including users in the design process is critical to understanding and accommodating their needs and preferences.

Persuasive Technologies (PTs) can be delivered through mobile apps [85]. The effectiveness of PTs is frequently measured in terms of persuasiveness. Persuasiveness is a phrase for a system's ability to persuade people to change their behaviour [98] in a planned fashion in line with the PT's designer plans and design purposes. PTs have been widely used to improve mental health and well-being [91,100], contributing to the communal drive toward equality and making mental health care more accessible. According to Kolenik et al. [72], there are several benefits to PTs, such as:

- Low Cost (PT for mental health can practically be made free),
- 24/7 Availability (people with mental health issues requiring therapeutic help can use PT

irrespective of time, location, and sufficient money),

- Stigma (people using PTs can avoid feeling judged by others or the fear of sharing their issues with a human).

Despite all these benefits of PT, most existing apps focus on designing for people in developed countries. There is a lack of studies focusing on mHealth interventions for stress and anxiety management among women [6] and, more specifically, those in developing countries and low-resourced communities. Our study focuses on using this trio: mHealth, PT, and a UCD approach so that the needs of the underserved population are considered and included in our design.

1.3 Solution

Our research uses a UCD approach to fill the gap in supporting stress and anxiety management among working-class Indian women (people who are part of the workforce). This research presents the design, development, and evaluation of an app called *iCare*. The *iCare* app was specifically designed for this target audience. The app is for managing stress and anxiety among working-class Indian women. This mental health app helps Indian women to manage their day-to-day stress and anxiety by providing them with features like:

- keeping track of their mood;
- expressing themselves using a diary and voice recording feature;
- being a part of a social community so that they do not feel alone;
- expressing gratitude so that they do not forget how blessed they are;
- also, there is a feature named hobby corner, which helps the user to keep track of the time they dedicate to themselves, and
- finally, there is a self-awareness feature that allows users to self-educate.

All app features are designed using various Persuasive Strategies from the Persuasive System Design (PSD) framework adapted from Oinas-Kukkonen et al. [98] to motivate and spread awareness among Indian women regarding mental health. The behaviour change we hope to motivate in people is to address daily stress and anxiety-causing factors and not let them accumulate into something significant such as pathological stress and anxiety [66,157].

In total, we used 10 Persuasive Strategies, out of which two strategies (Goal Setting and Customization) are commonly employed in persuasive health applications [101,104], and the other

eight were from the PSD model. The User Interface (UI) of the app was designed to be easy to use so that users are not overwhelmed. This research was conducted over three phases:

- Phase 1: We interviewed 31 working-class Indian women (Appendix C) and investigated their mental health struggles, factors associated with mental health, strategies they use to manage their mental health, and their requirements for an app to help them with their mental health.
- Phase 2: We designed a prototype (Appendix F) using proto.io [173], the prototype used the ideas from Phase 1, and then we asked 40 working-class Indian women to use it, after which we interviewed them (Appendix D) and recorded their suggestions and design recommendations. In Phase 2, we had five participants who were also part of Phase 1.
- Phase 3: We designed and developed the *iCare* app based on the ideas from Phase 1 and Phase 2, which 30 working-class Indian women used for two weeks, followed by an optional one-on-one interview (Appendix E) to investigate the ability of the app to promote mental health and create awareness about good mental health. Twenty-two (22) participants volunteered for the interview.

All these three phases had ethics approval (Appendix G). In Phase 1, we randomly chose a participant and gifted her an Amazon gift card worth 50 CAD or 3000 Indian rupees. The rest of the phases did not include any compensation.

1.4 Contributions

The thesis made four major contributions to the field of Human-Computer Interaction (HCI) and mental mHealth apps:

1. We investigated the effectiveness of a mHealth app for managing stress and anxiety by conducting a two-week study in the wild, followed by one-on-one interviews.
2. We offer qualitative insights into the needs and specifications for creating a mental health app for the underserved population.
3. Based on the information received from our target audience, we offer design guidelines for mental health apps for underserved populations.
4. The results from Phase 1 of this study were published and presented in LBW CHI'22 (Appendix S).

1.5 Overview of Thesis

This thesis contains a detailed description of all the work carried out during the design, development, and evaluation of the *iCare* app in six more chapters.

CHAPTER 1 INTRODUCTION: This chapter introduces the thesis. It states the problem and the issues surrounding the problem addressed in the thesis.

CHAPTER 2 RESEARCH BACKGROUND: This chapter reviews research related to this thesis. We review our theoretical foundation and literature on Persuasive Strategies and deconstruct how they have been applied in persuasive mHealth apps. We also present the comparative effectiveness of Persuasive Strategies across multiple domains. Finally, we conclude with a review of work on personalizing persuasive mental health apps. It reviews 45 persuasive mHealth apps over 15 years (2008 – 2022) and classifies them into five major domains: 1. Mental health and well-being, 2. Physical activity, 3. Health Assessment and Healthcare, 4. Diet, 5. Pregnancy. It also analyses these apps by their year, country of research, and study details.

CHAPTER 3 iCare APP DESIGN AND IMPLEMENTATION: This chapter describes the iterative process of designing and developing the *iCare* app. We also present the details about the implementation of Persuasive Strategies employed.

CHAPTER 4 iCare APP PERSUASIVE mHealth APP PHASE by PHASE EVALUATION: This chapter details the evaluation of the *iCare* app. It also presents the research questions and the detailed user study process.

CHAPTER 5 STUDY RESULTS: This chapter presents the study's detailed data analysis and results.

CHAPTER 6 DISCUSSION: This chapter discusses the implications of the results.

CHAPTER 7 CONCLUSION: This chapter summarizes the work and presents future research directions.

2 CHAPTER 2: RESEARCH BACKGROUND

According to Fogg [49], persuasive systems motivate people to change their behaviours or attitudes without coercion or deception. A persuasive system comes in various forms. They could be websites, desktop apps, mHealth apps, or virtual reality/augmented reality. In a field that is increasingly dominated by commercial interests, smartphone apps and other eHealth ("eHealth is an emerging field of medical informatics, referring to the organization and delivery of health services and information using the Internet and related technologies." [22]) technologies are exploding as they may provide a solution by allowing research to be conducted using apps that prompt, collect, time stamp, and securely communicate user data. The previous decade has seen several PTs established to influence one or more facets of well-being and health [100]. From a global viewpoint, mHealth apps promise to increase availability, equitable distribution, and resources for health care [99]. Therefore, mHealth apps are increasingly becoming the preferred and popular medium to deliver persuasive content that motivates behaviour change. Also, mHealth apps can turn mobile and wearable devices into monitoring and therapy platforms capable of capturing real-time mental health symptoms and providing on-the-go mental health care [144]. Technology-enabled interventions' ability to scale up and reduce entry barriers like cost and stigma can help lessen the burden of mental health illness [90]. A randomized control experiment with an intervention and a control group was carried out by Moberg et al. [90]. This study demonstrated that widely used, commercially available guided self-help tools can aid individuals in controlling symptoms of stress, anxiety, and depression while also boosting self-efficacy.

To assess the efficacy of an app designed to encourage stress management and well-being among working women, Coelhoso et al. [32] conducted a randomized controlled experiment with 490 females (control (n = 240) and intervention (n = 250) groups). Over time, both groups demonstrated a notable rise in general happiness. However, only the intervention group saw a significant improvement in work-related satisfaction and a marked decline in work-related and overall stress. According to studies, it is critical to comprehend, accommodate, and build mHealth apps that satisfy the demands of target users [9,74]. The effectiveness of a mental healthcare app created for workers to self-manage stress and use mental healthcare programs such as meditation, music, and yoga through the app was tested by Hwang et al. [63] in a randomized control experiment with 56 nurses. The results showed that the stress management program greatly improved mental health. Also, mobile apps for mental health can monitor or treat symptoms of

several mental diseases, including anxiety, stress, alcoholism, sleep issues, depression, suicidal behaviour, and Post-Traumatic Stress Disorder (PTSD), according to Wang et al. [153]'s systematic analysis of 17 full-text studies detailing these apps.

Six focus groups with participants who self-diagnosed as having mental health issues were held by Alqahtani et al. [9]. The findings reveal that crucial design elements like the personalization of the app, tracking, live help, social network, and offering inspirational content and relaxing techniques are what users look for in a mental health app. Similar research was done by Kenny et al. [69], utilizing five focus groups to examine adolescents' requirements and issues with mental mHealth apps. The participants listed the following as crucial elements to consider in designs: "safety, engagement, functionality, social interaction, awareness, accessibility, gender, and giving young people control." To develop a mental health app that is both engaging and effective in promoting emotional well-being in male-dominated workplaces, Peter et al. [117] engaged in participatory research to learn about employees' opinions, preferences, and ideas. They discovered that people valued mental health apps with accessible languages, ease of use, attractive visuals, and offline mood.

Although there are benefits to using mHealth apps to manage mental health, there are also drawbacks to utilizing mobile apps as a tool for stress management, especially for people who work. For instance, Zakaria et al. [164] have criticized using mobile apps to manage mental health. Some of the limitations of the mHealth apps approach they highlighted were: The mobile strategy requires the user to install one or more specialized apps to control various mental illnesses. Only users motivated to receive assistance will likely employ mobile intervention to track or manage their health conditions. The mobile app approach is challenging to scale across a large user population and introduces self-bias. This refers to a typical practise of a person taking credit for successful outcomes while placing blame for failure on external reasons [20]. One of the obstacles of mHealth is figuring out how to establish beneficial and acceptable interventions for women suffering from mental health concerns, particularly those from developing countries like India, where stigmas about mental health still exist and gender roles are still a significant issue.

The limitations of mHealth apps do not suggest this approach to managing mental health and providing self-care is ineffective [42,119]. Rathbone et al. and Zhang et al. [121,165] highlighted some benefits of self-monitoring using technology. The benefits identified were: facilitating

interactions with clinicians or support, the discovery of unique patterns, symptom triggers, and effective recovery strategies, fostering self-compassion, and acceptance, promote a sense of self-control for a patient who may struggle with the feeling of being out of control due to a mental disorder like bipolar disorder.

However, there is very little research on designing and evaluating a user-centric mHealth app for managing stress and anxiety among working-class Indian women. Therefore, this study focuses on designing and evaluating the *iCare* app, a persuasive app for motivating Indian women to manage their mental health.

In this chapter, we review the theoretical foundations for designing mHealth apps. We also review the literature on Persuasive Strategies, deconstruct how they have been applied in mHealth apps, and present a comparative analysis to show the effectiveness of Persuasive Strategies across various domains.

2.1 mHealth Apps

According to Fogg [48], one of the steps to developing an effective persuasive system is finding relevant examples of PT. These instances would aid in understanding what has worked in the past and what has not, assisting scholars in the subject in avoiding earlier mistakes. The relevant examples of PTs for the current research are "Persuasive mHealth apps." Therefore, to fully understand the research area, we did a systematic review of the existing research in the area of persuasive mHealth apps. To collect relevant papers, we searched popular databases, including ACM Digital Library, IEEE Xplore Digital Library, and the Journal of Medical Internet Research. We chose these databases as they have many publications and conferences on HCI annually, providing us with a pool of papers to select from. We also searched Google Scholar as a secondary source for any papers we may have missed.

We used the keywords 'Design of mHealth apps,' 'Design of mobile health apps,' 'Persuasive strategies and mHealth apps,' 'UCD and mHealth apps,' 'mHealth apps for mental health,' and 'User study and mHealth apps.' Initially, we reviewed paper titles, abstracts, and introductions of each retrieved paper, for papers focusing on the design or study of a persuasive mHealth app. In total, we were able to extract 306 papers for this purpose. We skimmed through each selected paper to eliminate papers that did not meet our inclusion criteria. Our inclusion criteria were:

1. The paper is not a systematic review paper (identified from the title),

2. The paper is not a paper about the mHealth app (identified from the abstract),
3. If the paper is not a duplicate of an already chosen paper.

After going through all the papers, we removed 275 that did not meet the inclusion criteria, leaving us with 31 papers. From these 31 papers, we skimmed through their reference sections for papers (this is called snowballing, which refers to using the reference list of a paper or the citations to the paper to identify additional papers [161]) that also discussed the design or analysis of a persuasive mHealth app. We collected an additional 30 papers, and after applying the inclusion criteria again on these 30 papers, we excluded 16 papers from them, leaving us with an extra 14 papers. Therefore, we reviewed 45 papers on persuasive mHealth app design and evaluation.

We reviewed the 45 papers and coded them using the coding scheme developed and adapted by Orji et al. [100]. We analyzed each paper under the following categories: year of the research, the venue of publication, app name, targeted health domain, the duration of the study, persuasive strategies used, the method of evaluation, targeted age and group, the number of participants, study country, targeted behaviour, or psychological outcome. Figure 2.1 shows the process flow for including papers in our literature review.

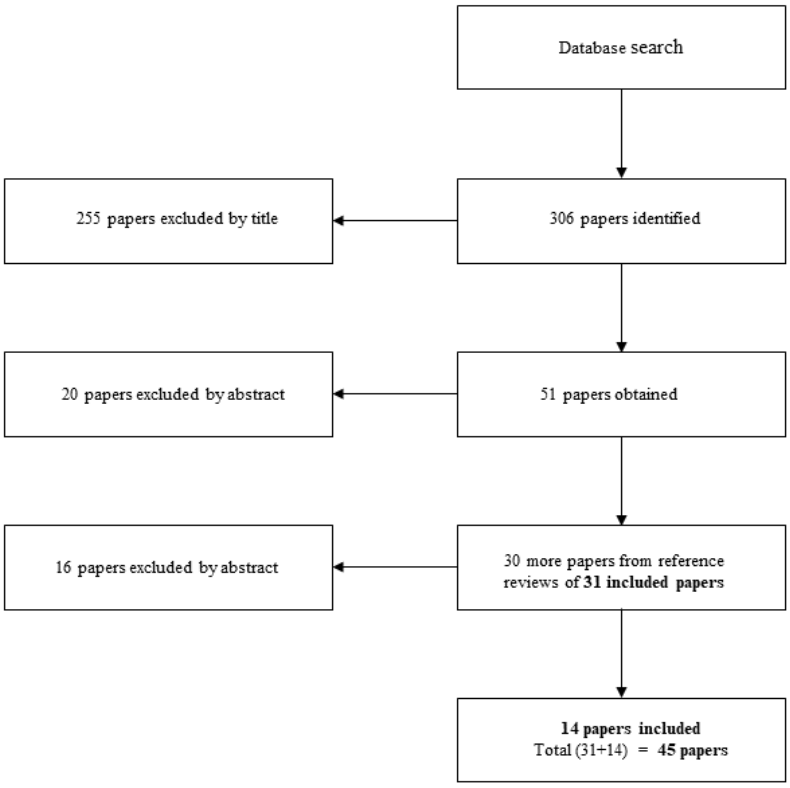


Figure 2. 1: Study identification papers

Our analysis classified persuasive mHealth apps into five major domains: 1. Mental health and well-being, 2. Physical activity, 3. Health Assessment and Healthcare, 4. Diet, 5. Pregnancy. In all these domains, we checked what Persuasive Strategies were employed and how they were implemented.

2.2 Persuasive Strategies Employed

Persuasion is achieved by employing a variety of Persuasive Strategies. Many researchers have presented various persuasive tactics over the years. For example, Fogg [47] proposed seven Persuasive Technology tools, Cialdini et al. [174] devised six principles of persuasion, and Oinas-Kukkonen et al. [98] defined 28 Persuasive Strategies, also known as the PSD model. Using our coding sheet, we identified the frequency of Persuasive Strategies implemented in the persuasive mHealth apps collected from our literature review, as shown in Figure 2.2. Our analysis results showed that self-monitoring (n=38) followed by personalization (n=24), reminder (n=16), customization (n=12), and tunnelling (n=12) are the most implemented Persuasive Strategies in the persuasive mHealth apps over the years to encourage behaviour change. Customization is one of the ten persuasive strategies commonly employed in persuasive health applications [103]. Table 2.1 defines the five most common Persuasive Strategies implemented in the persuasive mHealth apps adapted from Oinas-Kukkonen et al. [98] and Orji et al. [103].

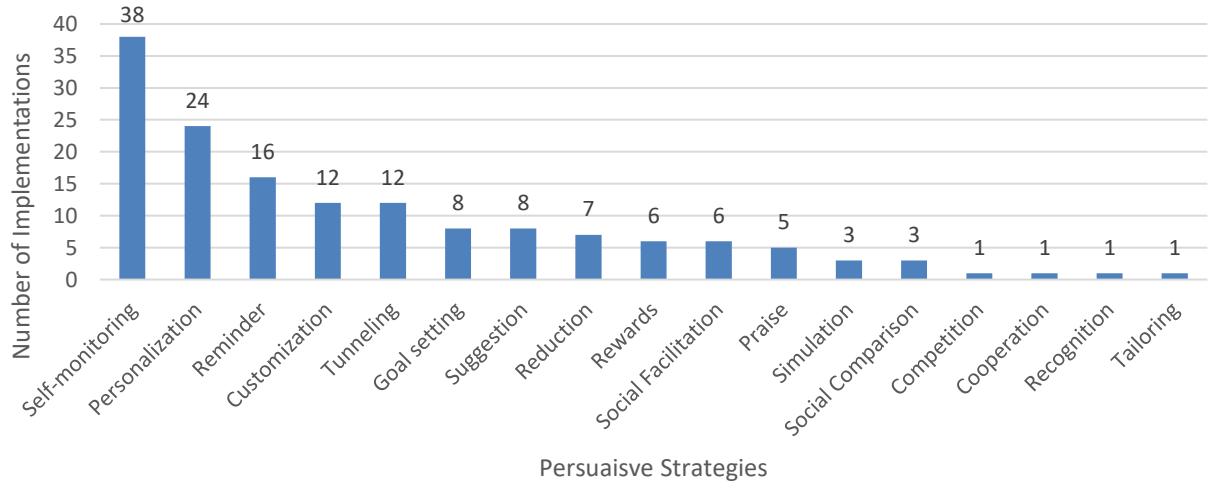


Figure 2. 2: Frequency of Persuasive Strategies implemented in the persuasive mHealth apps from the literature survey

Table 2. 1: Definition of Persuasive Strategies

Persuasive Strategy	Definition
Self-monitoring	A system that maintains track of one's performance or status aids the user in meeting their objectives.
Personalization	A system that provides individualized information or services has a higher persuasion capability.
Reminder	Users are more likely to attain their goals if a system reminds them of their desired behaviour.
Tunnelling	Persuasion opportunities arise when the system is used to lead people through a procedure or experience.
Customization	Allows users to customize a system's features and content to suit their needs and preferences.

2.3 Implementation of Persuasive Strategies in Persuasive mHealth apps

According to our evaluation of previous work, Persuasive Strategies have been implemented in mHealth apps in various ways across several domains. In the following section, we describe how researchers implement Persuasive Strategies (also considered in this thesis) in mHealth apps across multiple health domains.

2.3.1 Implementation of Persuasive Strategies in Mental health and Well-being mHealth Apps

This group of persuasive mHealth apps is designed to help people to manage their mental health issues and well-being. Our research problem is a subset of this category as we focus on the mental health management of working-class Indian women. The apps that we identified in this category are: 'Self-help' [110], 'REACH' [111], 'Chronicles' [57], 'Mobile Mood Scales' [71], 'Moodie' [10], 'SAM - Selfhelp for Anxiety' [143], 'Pocket Skills' [131]', 'NokoriMe' [78], 'recoverApp' [4], 'Sleepfit' [106], 'SmileTeq' [123], 'Brightself' [41], 'MindClimb' [97], 'Pacifica' [90], 'MoodHacker' [19], 'Oiva' [3], 'MoodRhythm' [86], 'mood sampling' [93], 'Connected for PTSD and anger' [16], 'Virtual hope box' [24], 'MindMax' [112], 'BroiStu' [37], and 'Battle Buddy' [94].

One of the apps is Self-help, a persuasive mHealth app for helping users cope with avoidance behaviour. Self-help employs *self-monitoring*, *customization, suggestion, and tunnelling* strategies. Users can single tap on a point on the map, and a critical place is added (*self-monitoring, customization*), and a notification is issued inviting the user to read a mindfulness hint with suggestions on how to control anxiety escalation and avoid (or minimize) a panic attack (*tunnelling*) (*suggestion)*. recoverApp was designed based on a comprehensive state-of-the-art

analysis and incorporated therapist feedback. This app employs *self-monitoring, reminders, and rewards* strategies. It has mood tracking and a diary feature which augments the mood tracking function by allowing the user to track activities and events (*self-monitoring*). Users also get reminders about therapies when they create a task to go to a therapy (*reminders*), and users can collect skill points by completing challenges (*rewards*). MindClimb is a mHealth app that adolescents can use during Cognitive Behavioural Therapy (CBT) (a type of psychological therapy that is useful for a variety of issues, such as depression, anxiety disorders, difficulties with alcohol and drugs, marital problems, eating disorders, and serious mental disease [175]) for anxiety and it employs *tunnelling, self-monitoring, reward, reduction,* and *reminders* as strategies. It has four coping strategies built into the app (e.g., audio clips of soothing sounds, text instruction and videos of relaxation techniques) (*tunnelling),* and users can review progress and activities (*self-monitoring)*. Points are awarded for event completion *(rewards)*, it has help session support to use in each content domain *(reduction)*, and it sends reminders to users to use the app *(reminders)*.

Another example is BroiStu, which was developed to understand better the impact of stuttering on the daily lives of people who stutter. It employs *self-monitoring, personalization, and tunnelling.* It allows user to self-monitor their speech as a means of controlling stuttering daily, mood, and emotions felt (*self-monitoring),* the app automatically adapts itself according to demographic data like age and gender (*personalization)*, and the user should follow different therapy techniques, e.g., pullout (tunnelling).

We believe recoverApp has design features close to our design ideas, such as mood tracking and diary features. Self-monitoring is the common Persuasive Strategy in these apps. This gives the user a visual picture of any behaviour change they are going through.

2.3.2 Implementation of Persuasive Strategies in Physical Activity mHealth Apps

Within this category, some apps motivate people to be physically active. The apps that we identified in this category are: 'Storywell' [125], 'Treecare' [107], 'ATOPE+' [92], 'MoveDaily' [60], 'CareFit' [43], 'Aide-Memoire Stroke' [88], 'UbiFit Garden' [34], 'GoalPost and GoalLine' [95], and there were two apps with no name [12,50].

Storywell is an app for promoting family physical activity (PA); this game employs social *rewards* (e.g., storybooks with interactive, reflective questions) and *self-monitoring* (step count, families tracking their progress on the adventure screen). TreeCare is a persuasion-based smartphone game

that encourages people to be more active. In this game, the growth of a tree is tied to the player's PA in the real world. They employed *rewards* as virtual trophies in the game, *self-monitoring* as a daily step counter for the player, and *competition/comparison* as a leaderboard. Another example is, CareFit, an app that integrates guidance for undertaking PA at home through educational, PA, and communication components. It employs *goal-setting* (users were able to set activities they wanted to perform), *reminders* (reminders for activities users had planned), *customization* (when users were unable to complete an activity as intended, they could move the activity to another date of their choice), *self-monitoring* (the weekly planner allowed planning of PAs for up to two weeks ahead. Users could also view activities planned and completed during the previous week), *tunnelling* (the education section). ATOPE+ is a mHealth system to support personalized exercise interventions in patients with cancer-based on workload-recovery ratio estimation. ATOPE+ enables the remote assessment of workload-recovery ratio to provide optimal exercise dosage using a knowledge-based system and to combine physiological data from heterogeneous data sources in a multilevel architecture (*personalization).*

Self-monitoring and Rewards Persuasive Strategies were common strategies in this domain. They are justifiable to make PA more exciting, motivate users to track their progress and reward them for their hard work.

2.3.3 Implementation of Persuasive Strategies in Health Assessment and Healthcare mHealth apps

Within this category, apps aid in assessing or diagnosing one's health and provide access to certified healthcare professionals. We have identified eight apps in this category: They are 'Aspira' [141], 'BRANCH' [89], 'ConCap' [105], 'Family Health' [67], 'iHAART' [124], 'OAB App' [126], 'Sleep Scheduler' [44], and 'Thought Journal' [147].

Aspira is a home-based strategy for improving clinical asthma outcomes in economically disadvantaged children. It enables households to check indoor air quality independently, potentially saving money. It employs r*ewards* (the child earned rewards for completing tasks and answering questions required by the clinical protocol), *customization* (the child may choose to change the space gear, name, and uniform the astronaut wears), and *self-monitoring* (assessment questions in the morning, for example, How did you sleep?). The monitoring and intervention activities were presented within an embedded astronaut-themed game to encourage user acceptability and compliance with the clinical protocol. Another example is BRANCH, this app

targets harmful drinking in young adults. It employs *self-monitoring* (a drinking diary for recording alcohol consumption), *social facilitation* (newsfeed enabling interaction between app users), *personalization* (personalized notifications), and *customization* (a feature in which the app users select their motivations for cutting down drinking when signing up), *goal setting* (users were able to set goals), *reminders* (reminders based on goals), *social comparison* (users could compare their progress against other users in their team and be awarded points for engaging with the app).

Since the apps in this domain focus on healthcare and health assessment, most apps employ self-monitoring as a Persuasive Strategy. It helped the end-users to monitor any progression or degression in their health.

2.3.4 Implementation of Persuasive Strategies in Diet mHealth apps

Within this category, apps target healthy eating, such as tracking diet or food intake. We only found three apps in this category: 'Diet Diary' [54], 'Healthy Shopping App' [18], and 'Snack Buddy' [129].

Diet Diary is for older adults with Age-Related Macular Degeneration (AMD) (it is an eye condition that may cause central vision opacity [176]). In this app, users can keep track of their daily calorie consumption, personal preferences, progress, personal comments, medical conditions, hated foods, level of activity, and the number of cigarettes smoked each day (*self-monitoring)*, *customization* (enabling users to individually tailor the app appearance in terms of background colour and font size to best serve their needs and maximize app-accessibility), *suggestions* ('recommendations' screen for accessing daily recommendations). Another example is the Healthy Shopping App, which shows supermarket shoppers the nutritional balance of their shopping trolley (*personalization, self-monitoring*). The visualization shows the user a plate with the proportions of the four main food groups that make up a balanced diet. Additionally, a tiny "reward" circle turns red once the advised number of high-fat and high-sugar foods has been chosen (*self-monitoring*).

The apps in this domain have the same aim as those in the healthcare and health assessment domain, which is to help users track their progress. The users were given visualization to see whether they were on the correct path to their goals or not.

2.3.5 Implementation of Persuasive Strategies in Pregnancy mHealth apps

This category contained only one app called 'Momlink' [28]. This app was designed to

complement and enhance the knowledge, resources, and services that prenatal care coordinators (PNCCs) arranged for the target population to increase their prenatal care participation. It employed *reminders* (for tracking health data), *self-monitoring* (track health data, allows to take selfies of baby bump and keep a journal to document personal stories), and *trustworthiness* (the multimedia educational resource section contains a set of categories where content is available in various formats such as videos, voice recordings or written articles).

Refer to Table 2.2 and Table 2.3 for the "Summary of Persuasive Strategies Implementation in Persuasive mHealth apps" and "Summary of Persuasive Strategies Implementation Across Domains," respectively.

Table 2. 2: Summary of Persuasive Strategies Implementation in Persuasive mHealth apps

Persuasive Strategy	**Implementations**
Self-monitoring	Health bar, Progress bar, Diary tracker.
Personalization	Personalized notifications, app adapting itself to the user's data.
Customization	Users could move the activity to another date, changing the app's appearance.
Reminder	Notifications for performing tasks.
Tunnelling	Coping strategies and therapies.

Table 2. 3: Summary of Persuasive Strategies Implementation Across Domains

Domain	Self-monitoring	Personalization	Reminder	Customization	Tunnelling
Mental health and Well-being	Daily diary/ journal and graphs of mood.	Options to change how the app looks.	Notifications about tracking mood, go-to therapies, and intake medicine.	Adding critical places and changing the look of the app.	Training modules and stress coping tools.
Physical Activity	Step count, tracking the progress of the physical activity performed.	Personalized prescriptions of activities.	Helping the player remember the exercises he has planned.	Move the activity to another date of their choice.	Education sections.
Health Assessment and Healthcare	Diary entry		Personalized notifications	Reminders based on health goals	Changing the look and feel of the app.
Diet	Users record their dietary intake and monitor their progress.	The app shows supermarket shoppers the nutritional balance of their shopping trolleys.	-	Enabling users to tailor the app appearance individually.	-
Pregnancy	Users track health data, take selfies, and keep a journal.		-	Users receive notifications to track health data.	-

The examples of the apps discussed above show how mHealth apps can be implemented using Persuasive Strategies to motivate various behaviours in the area of mental health and well-being, physical activity, health assessment and healthcare, diet, and pregnancy. However, most apps follow the "one-size-fits-all" approach in their design. The consequences of the "one-size-fits-all approach" can be [177]:

- Limitation to user's choice.

- Neglecting Human Science (It enlightens us regarding the manipulation of people and the kinds of flaws our species is susceptible to).

Making end users be a part of the various phases of your product can give the designer meaningful insight and personalize the whole experience for the user. Research has shown that using an

inappropriate strategy can constitute a significant barrier to behaviour change [65]. Empty cells in Table 2.3 show no implementation of that PS for the domain.

2.4 Discussion of Related Work

Based on the analysis of the 45 papers, we could draw some insights and conclusions on the trends in the Persuasive mHealth apps.

2.4.1 Persuasive mHealth Apps by Year and Country

We analyzed the persuasive mHealth apps implemented over the years to explore whether their implementation has changed. Further, we also examined the variation in implementing persuasive mHealth apps across different countries. Based on our analysis, of the 15 years, from 2008 to 2022, persuasive mHealth apps were implemented in various countries over the years. Figure 2.3 shows that the USA is the leading country with the most research at 38%, followed by the UK with 16%, and Canada with 9%. Australia, Austria, Finland, Japan, Netherlands, Philippines, Singapore, and South Africa share the fourth position with 2%, and nine papers did not mention the country. However, most of these countries are developed [178], and developing-underserved countries do not have a significant number of studies for mHealth apps. This brings us to the gap that this thesis is meant to cover — prioritizing the developing country over-developed country.

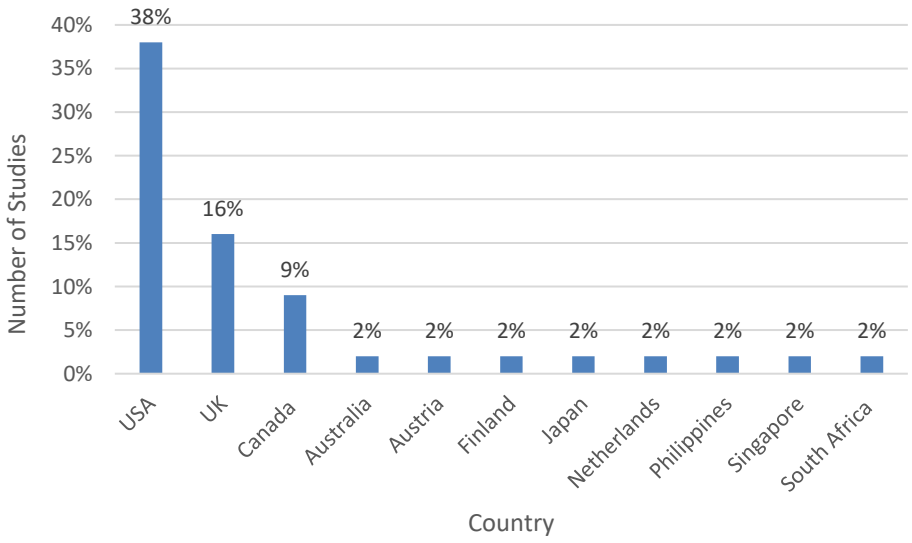


Figure 2. 3: Persuasive mHealth apps by country

Also, Figure 2.4 shows the count for the number of persuasive mHealth apps implemented over the years. This indicates that the persuasive mHealth apps for motivating behaviour change have

gradually increased their prevalence. Therefore, in line with previous works [55,56,100], we can say that from various available persuasive systems, persuasive mHealth apps are now among the most popular and effective tools for designing behaviour change interventions.

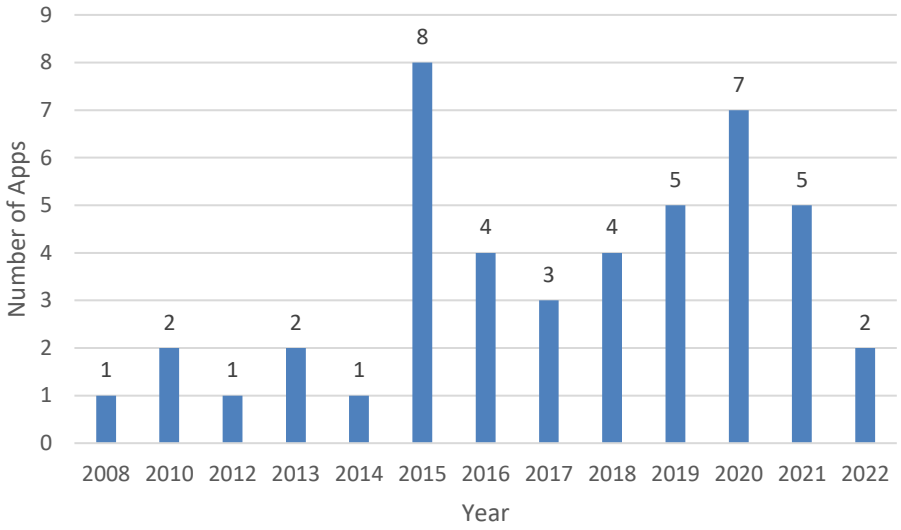


Figure 2. 4: Persuasive mHealth apps by years

2.4.2 Persuasive mHealth Apps by Evaluation Details

According to Figure 2.5, researchers used multiple study methods for persuasive mHealth app evaluations. Twenty-one (21) (out of 45) studies used a qualitative approach. For example, Peever et al. [112] used interviews as their evaluation tool to understand the initial experiences of seven users with the MindMax app.

Further, nine (out of 45) studies used only quantitative methods. For example, Khue et al. [71] used an evaluation survey for their Mobile Mood Scales app. Similarly, Francillette et al. [50] used surveys to understand how PA affects play progress and ergonomics, level of immersion, mental state, and willingness of the user to keep playing the game. Finally, ten studies used a mixed-method research approach (qualitative and quantitative). For example, Hamid et al. [57] used the mixed-method approach by employing pre- and post-test surveys (quantitative) to evaluate whether each intervention of their mHealth app had a significant effect on each of the four measures (depression, anxiety, automatic thoughts, perception and learning) followed by an exit survey at the end of the trial included a questionnaire with open-ended questions where participants were asked to reflect on their overall experience with the interventions (qualitative).

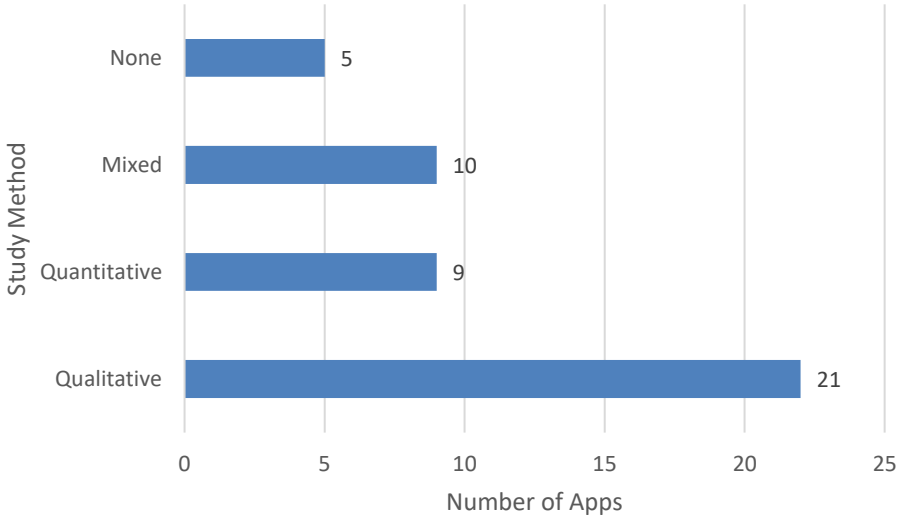


Figure 2. 5: Persuasive mHealth apps by study method

There were no studies that focused on the mental health issues of a working-class Indian woman. Out of 45 apps reviewed in the literature, 14 did not mention their targeted age or targeted group; seven mentioned only their targeted age, and 24 only mentioned their targeted group. Figures 2.6 and 2.7 show the target age and target group from these 45 reviewed apps in the literature.

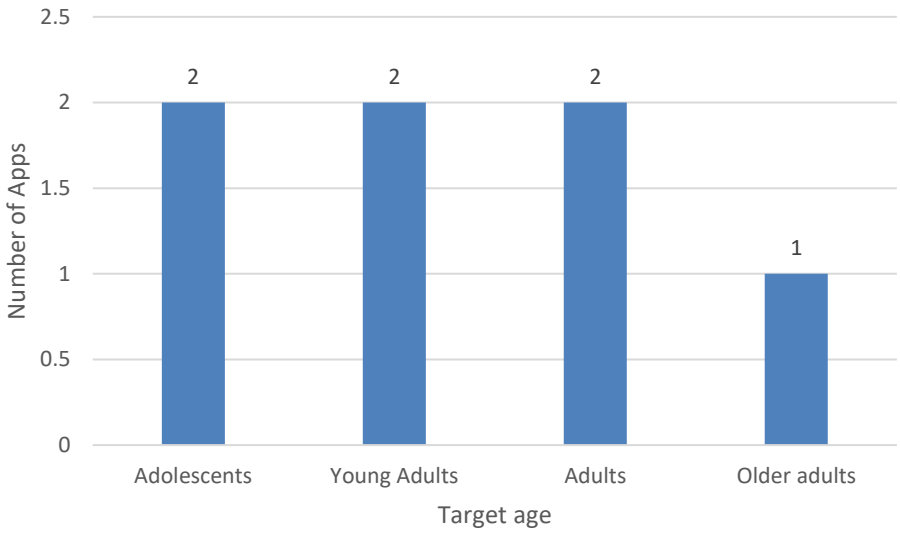


Figure 2. 6: Target age of the persuasive mHealth apps

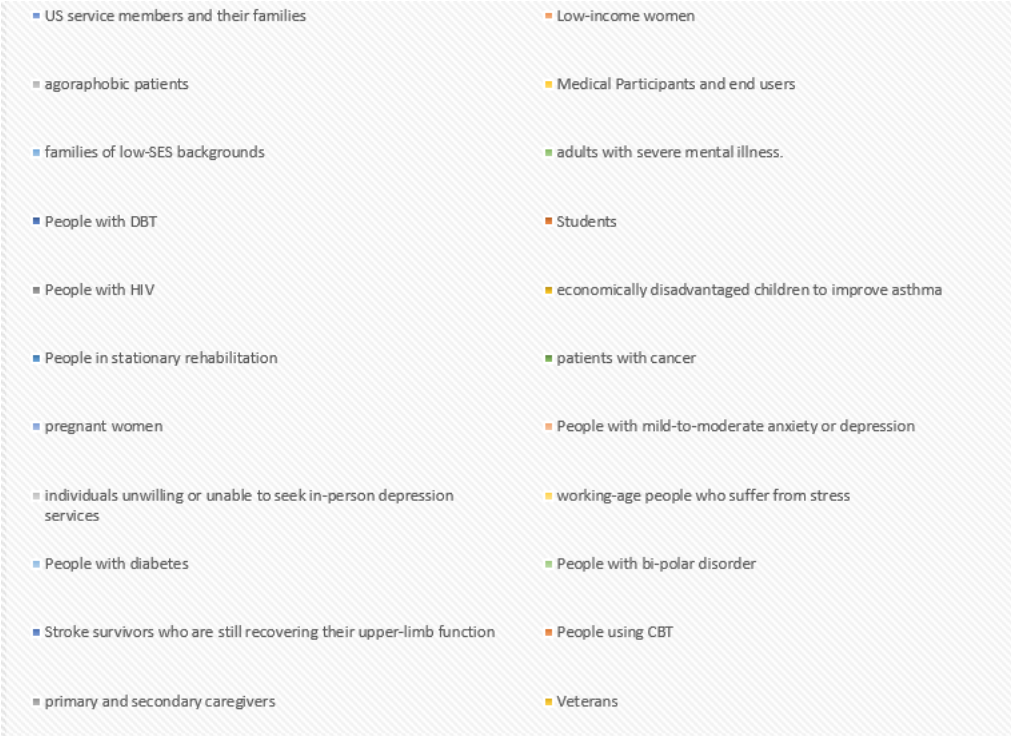


Figure 2. 7: Target groups of the persuasive mHealth apps in the literature

Regarding the analysis of the evaluation duration (Figure 2.8) of the persuasive mHealth apps, we found that 15 studies did not mention any duration. We also analyzed the number of participants involved in the evaluation (Figure 2.9). Two studies did not provide any number, and 17 studies had less than 10 participants.

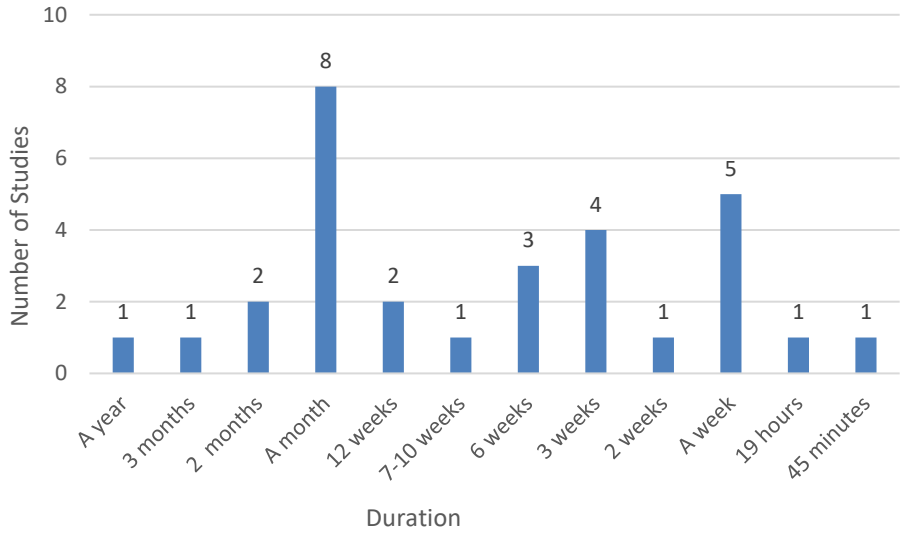


Figure 2. 8: Duration of evaluation of the persuasive mHealth apps

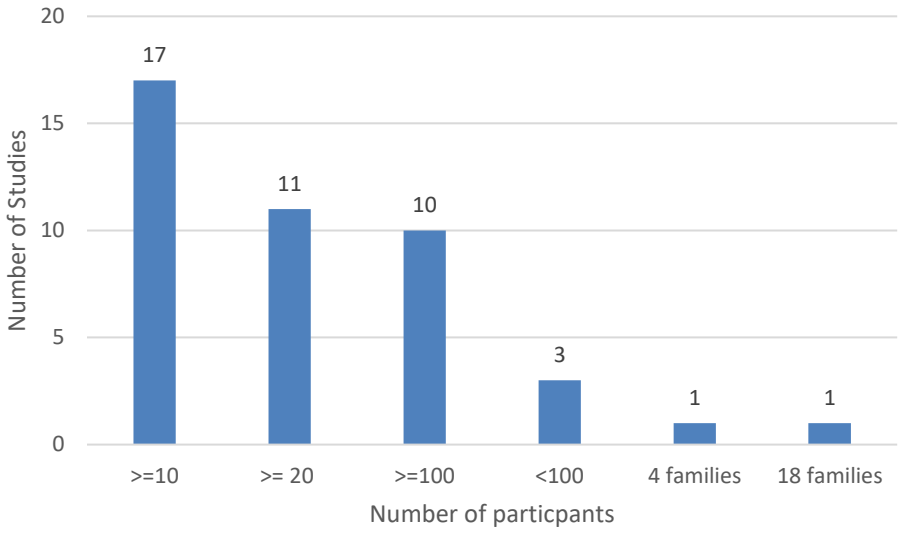


Figure 2. 9: Number of participants in the evaluation of the persuasive mHealth app

2.5 Persuasive Strategies in Mental Health Apps Deployed on App Store and Play Store

We searched on the App Store and Google Play Store using the keywords "mental health," "anxiety," "depression," "mood," "emotions," and "stress." We also used the conjunctions "OR" and "AND" to search for other combinations of the keywords. The initial list of 437 apps was revealed as a result of the search (258 apps from the App Store and 179 apps from the Play Store). We considered apps in our analysis whose primary objective, according to the app's description and demo, is to help people with mental health issues. In other words, apps that fall into these categories were excluded: (1) not focused on mental health, and (2) were not in English. In addition, for apps that appeared in both App Store and Google Play, we counted them as one instead of two. After applying the selection criteria, 105 apps remained eligible for coding (Figure 2.10). The following information was also extracted for each eligible app: name, platform (i.e., iPhone, Android, or both), developer, date of the last update, price (i.e., free, fee-based, and free with in-app purchases—where developers provide a free version and a paid version if users want to upgrade or unlock additional features in the app), Persuasive Strategies employed.

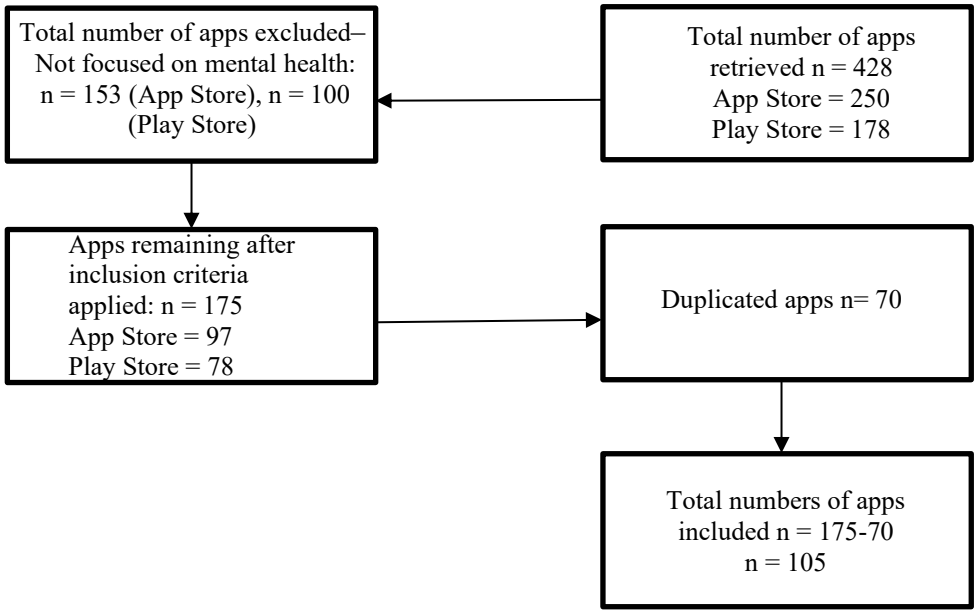


Figure 2. 10: Process of selecting mental health apps

We provide a summary of the app's description in Table 2.4. Approximately half (47%) of the apps had been updated within the past year (2021).

Table 2. 4: A summary description of 105 mental health apps

Persuasive Strategy	**Implementations**
Price	Free (27/105), fee-based (9/105), and Free with in-app purchases (69/105).
Developer	Unknown (20/105), Commercial (profit Organization) (72/105), Government (11/105), NGO (2/105).
Rating	3–3.9 (14/105), 4–4.9 (86/105), 5(5/105).
Platform	iPhone (9/105), Android (15/105), and both (81/105).

2.5.1 Persuasive Strategies Employed in Mental Health Apps

Overall, we found 11 Persuasive Strategies in the mental health apps reviewed. The number of strategies employed in each app varies and ranges between one and six. However, seven mental health apps did not employ any Persuasive Strategies. Interestingly, self-monitoring (n = 82), reminder (n = 50), tunnelling (n = 48), and customization (n = 23) emerged as the most employed strategies (Figure 2.11).

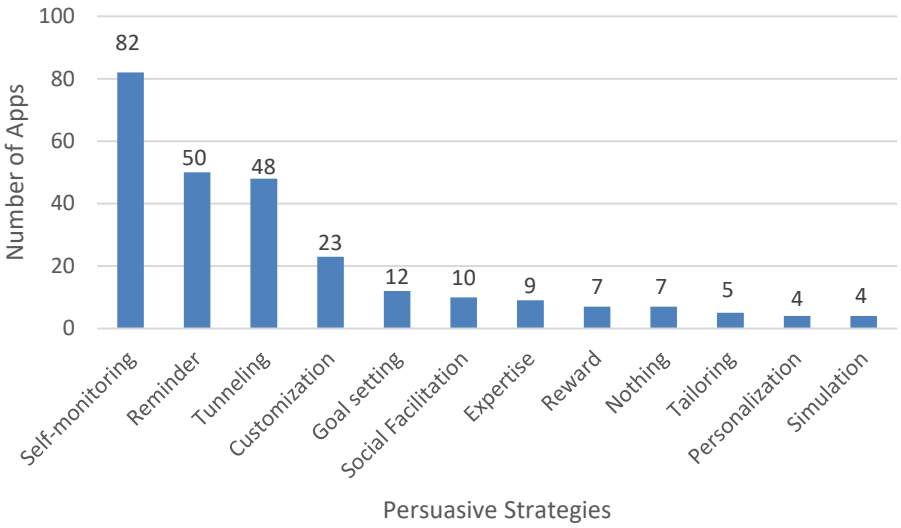


Figure 2. 11: Frequency of persuasive strategies implemented in the persuasive mHealth apps from App Store and Play Store survey

We also examined the Persuasive Strategies and the type of mental health issues the apps target. The apps mainly targeted stress, anxiety, and depression. However, apps that targeted stress employed the highest number of Persuasive Strategies, followed by anxiety and depression (Figure 2.12)

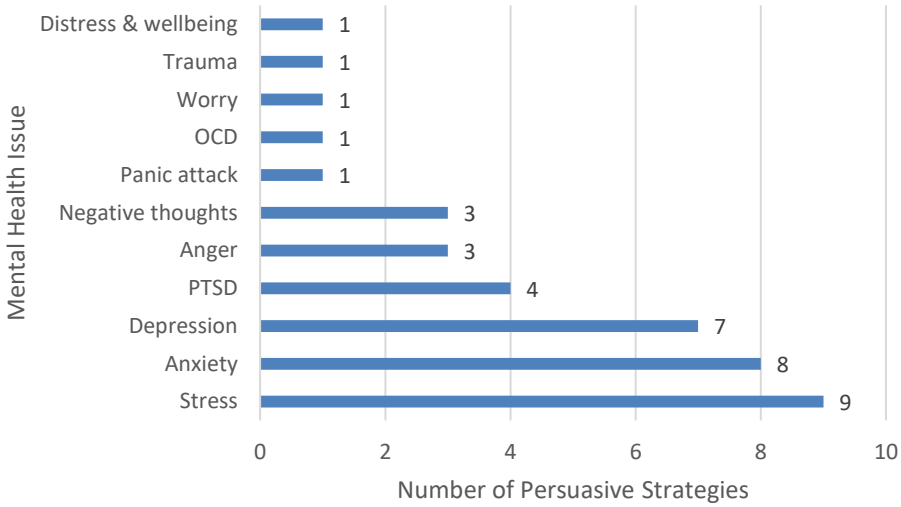


Figure 2. 12: Number of persuasive strategies employed in each mental health issue

All these apps aimed at various mental health issues and covered several Persuasive Strategies, but as far as we know, there is no evidence of a user study or even involvement of a UCD approach. Whether the use of these Persuasive Strategies is even effective for the target audience is questionable.

2.6 ARCS Motivation Model

The ARCS (Attention, Relevance, Confidence, and Satisfaction) model is a well-known and widely used motivational model [179]. It highlights four qualities that a system needs to have to motivate behaviour. The ARCS model of motivation implies that there are four main qualities of systems that build and sustain motivation in people: *Attention, Relevance, Confidence,* and *Satisfaction* [68]. It is also a simple and powerful macro theory that combines a wide range of prominent motivational theories [179–181], such as the Self-Efficacy theory [51], Expectancy-Value theory [179], Reinforcement theory [182], Social Learning Theory [183], and Cognitive Evaluation Theory [184]. Besides, the ARCS motivation model is associated with behaviour and behaviour change as it is a systematic approach to identifying and addressing learning motivation [52].

ARCS motivation model is widely used to inform the design and evaluation of the motivational appeal for the persuasive and behaviour change systems in various domains, such as health [5,137] and education [82,185]. Abdessettar et al. [1] applied the ARCS model in developing a persuasive, innovative mobile school for children. Another group of researchers, Zulkifli et al. [167], employed the ARCS questionnaire to evaluate the motivational appeal of an interactive persuasive system. Other persuasive system designers utilized one or more ARCS motivation model constructs to inform their intervention design. For example, Stockdale et al. [137] employed the Confidence construct of the ARCS motivation model in designing a persuasive intervention aimed at promoting breastfeeding among first-time mothers by helping them to develop confidence in their ability to breastfeed, while Yusoff et al. [163] employed the Attention construct to increase the motivational appeal of the persuasive elements embedded in their persuasive game. Also, the ARCS motivation model has been used as a scaffolding tool for persuasive and behaviour change systems [38,39,180]. Table 2.5 summarizes the four constructs of the ARCS motivation model adapted from Orji et al.[102].

Table 2. 5: Constructs of the ARCS model of motivation [102]

Construct	Definition
Attention	For a system to motivate users, it must arouse and sustain their attention.
Relevance	To motivate users, a system must reflect users' interests and goals. A system must be goal-oriented, motive-matching, and use familiar concepts to be relevant. A system perceived as helpful and valuable in helping users accomplish their goals is more likely to motivate users.
Confidence	Users' confidence levels are often correlated with their motivation and the amount of effort put forth toward achieving an objective. People do not like taking on a task with little or no probability of success. Although success is never guaranteed, and people like to be challenged, a challenge beyond a user's capability could demotivate them.
Satisfaction	To motivate users and sustain their motivation, they must derive some satisfaction and reward for their effort.

2.7 User-Centered Design approach

Kenny et al. [69] conducted a study using five focus groups to explore adolescents' needs and concerns with mental health mobile apps. The participants identified "*safety, engagement, functionality, social interaction, awareness, accessibility, gender, and giving young people control*" as essential factors to consider in the designs of mental health mobile apps. Similarly, Alqahtani et al. [9] held six focus group sessions with participants who self-diagnosed as having mental health problems. The results show that users seek essential aspects in a mental health app's basic design feature, such as "*personalization of the app, including tracking and feedback, live support, and social community; and providing motivational content and relaxation exercises*." Cheng et al. [30] investigated the best approach to arrange and showed a psychoeducational module delivery app. The authors conducted a participatory design workshop and user experience interviews with 40 and 15 participants. The results revealed that participants preferred activities that required active participation and provided opportunities to practice valuable skills. Participants also raised concerns about the presentation of material and wanted to personalize their app experience.

In a different study, Peter et al. [117] undertook participatory research to learn about workers' opinions, preferences, and ideas to create a mental health app that is both interesting and successful in enhancing emotional well-being in male-dominated companies. They found that accessible languages, simplicity of use, visual appeal, and offline mood were all important aspects of mental health apps that users wanted.

Evidence suggests that women suffer much more from mental health issues than men, even after

adjusting for perceived work circumstances and gender roles, which is not valid for physical symptoms [80]. Even though a significant amount of research has been done to understand users' impressions of mental health app design, the above-mentioned gender difference has not been considered broadly and, more importantly, among women in developing countries where significant gender differences exist. This study primarily focuses on understanding the strategies used by Indian women (who have experienced/experiencing mental health issues) to deal with mental health issues in their lives, their perspectives and opinions about popular mental health apps, and how these strategies and ideas could be leveraged in the design of a mental health app, all of which have received little attention in previous studies.

3 CHAPTER 3: THE DESIGN of the *iCare* APP and IMPLEMENTATION

This chapter discusses the design and implementation process of the *iCare* app. We have used the UCD approach so that our target audience is involved throughout the design process, and our design reflects their choices, which is why we did not design our study around an existing app. **Note:** The app was designed solely for experimental purposes and not by an expert in the mental health field.

3.1 *iCare* App

The *iCare* app is a mental health app designed to help working-class Indian women to manage their stress and anxiety. To develop an effective persuasive mental health app, we followed the iterative UCD approach. The app design process was divided into three phases. The phases are as follows:

Phase 1: First, we conducted one-on-one interviews with 31 working-class Indian women to learn and understand what they need in a mental health app designed for them.

Phase 2: Then, we designed a prototype based on all the recommendations and ideas we collected from the participants in Phase 1. We then interviewed 40 participants, asked them to use the prototype, and gathered their suggestions and new ideas.

Phase 3: Based on Phase 2, we designed the *iCare* app, invited 30 participants to use it for two weeks, and then conducted an optional one-on-one interview for which 22 participants volunteered.

Table 3.1 shows the outcomes of the stages, and the following sections explain what we did at each stage.

Table 3. 1: *iCare* app design phases and outcomes

Phases	**Outcomes**
Phase 1: Interviewing participants before the design	It helped to understand what the target audience needs.
Phase 2: Evaluation of the prototype	It helped slowly introduce the app concept to the users and collect design recommendations.
Phase 3: Evaluation of the main app	Refine the UI elements of the app.

3.1.1 Step 1: Interviewing Participants Before the Design

Following our ethics approval, we first advertised the study on LinkedIn, on various female groups on Facebook, and WhatsApp (Appendix K). Second, we disseminated a questionnaire (Appendix N) to collect demographic information and individuals' awareness of mobile apps for mental health and sent it to those women who showed interest. Third, based on the questionnaire results, we invited participants who met the inclusion criteria for one-on-one interviews (Appendix C). We asked questions about their mental health issues, events that trigger mental health issues, factors that contribute to mental health issues, and strategies used in managing their mental health issues. Finally, we asked their opinion about two popular mental health apps which they were asked to use before the interview (Headspace [186] and Happify [187]); the features and functionalities they liked and disliked. We interviewed 31 working-class Indian women. The interviews were recorded and transcribed with the permission of the participants. Then, we conducted a thematic analysis [140] of the collected data. Our results revealed that participants used the following strategies to deal with their mental health issues: doing something to distract themselves from their current negative mood, using relaxation exercises and methods to relieve symptoms, and trying to be alone. They also mentioned household chores and workload as significant stress and anxiety sources. Our analysis uncovered several features required in an app to promote mental health, including mood tracking features, social community, and social support features. Participants further explained that they had concerns with existing mental health apps, including privacy issues and the high fees charged for premium features.

3.1.2 Step 2: Evaluation of the Prototype

Following our ethics approval, we first advertised the study on LinkedIn, on various female groups on Facebook, and WhatsApp (Appendix O). Second, we disseminated a questionnaire (Appendix N) to collect demographic information and individuals' awareness of mobile apps for mental health and sent it to those women who showed interest. Third, based on the questionnaire results, we invited participants who met the inclusion criteria for one-on-one interviews. We conducted the study with 40 working-class Indian women who were experiencing or have experienced mental health issues like stress or anxiety or depression, or mood swings based on self-diagnosis. We invited them to use the prototype for at least 5-minutes after seeing the video on how to use the prototype emailed to them by the Principal Investigator (PI). After using the prototype, the participants were invited for a one-on-one interview which lasted for 30-minutes (Appendix D).

The one-on-one interview format allowed participants to share their design recommendations and prototype views. The interview questions focused on features like the ability to customize the UI colours, and we asked questions related to all the features in the prototype and whether they would want to have it modified, and their reasoning behind any changes

3.1.3 Step 3: Evaluation of the Apps' Effectiveness

Following our ethics approval, we first advertised the study on LinkedIn, various female groups on Facebook, and WhatsApp (Appendix L). Second, we disseminated a questionnaire (Appendix N) to collect demographic information and individuals' awareness of mobile apps for mental health and sent it to those women who showed interest. Third, based on the questionnaire results, we invited participants who met the inclusion criteria and sent them the link to the pre-test questionnaire and the Android version of the *iCare* app.

In our pre-test questionnaire, the participant responded to the Perceived Stress Scale (PSS) [188], which is a psychological tool for assessing stress perception and was developed by Cohen [33] with good test-retest reliability [150] (0.85). The scale was measured on a 5-point Likert Scale (ranging from 1 = "Definitely do not feel" to 5 = "Definitely feel"). A sample question is, "In the last month, how often have you been upset because something happened unexpectedly?" We also collected responses to the Generalized Anxiety Disorder (GAD) Scale [134], a tool for detecting Generalized Anxiety Disorder and evaluating its severity. It was developed by Spitzer et al. [134], and rising scores on the scale were strongly linked to several functional impairment domains. The scale has fair test-retest reliability (0.83). The scale was measured on a 5-point Likert Scale (ranging from 1 = "Definitely do not feel" to 5 = "Definitely feel"). A sample question is, "Over the last two weeks, how often have you been bothered by any of the following problems?" The PSS and GAD Scale were also included in the post-test questionnaire for comparison between the before and after effects of the app (Appendix H).

We asked the participants to use the designed app for two weeks. While participants were using the app for two weeks, we asked them to fill out the Brief Mood Inspection Scale (BMIS) [64] every day for two weeks (to ensure that the participants were using the app, we used Firebase Analytics [189], which shows users' activity over time). BMIS evaluated how they felt after using the app with terms such as: "Lively," "Happy," "Sad," and "Tired." BMIS measures mood in terms of adjectives and has 16 items assessed using a 5-point Likert Scale (ranging from 1 = "Definitely do not feel" to 5 = "Definitely feel"). It was developed by Mayer et al. [64], and the range of 0.76

to 0.83 for Cronbach's alpha reliabilities [190] was satisfactory.

After the study, participants also filled out the post-test questionnaire consisting of the System Usability Scale (SUS) developed by Brooke [23], and was used to evaluate the app's usability with questions such as "I imagine that most women would learn to use this app very quickly." The Cronbach's alpha value is 0.91. The User Experience Questionnaire (UEQ) developed by Laugwitz et al. [76] was used to evaluate the app's user experience with questions assessing things such as whether the app is "complicated or easy." The Cronbach alpha values were 0.85 (pragmatic quality) and 0.81 (hedonic quality). The Perceived Usefulness Scale was developed by Davis [35], and the questions were adapted from Warkentin et al. [154]. It evaluated the app's usefulness by assessing things such as "the app will help me improve my mental health." The Cronbach's alpha value is 0.97. The Perceived Aesthetics scale was proposed by Lavie et al. [77], and the questions were adapted from Oyibo et al. [108]. It evaluated the app's aesthetics with questions such as "the app is visual; the app is sophisticated." It has Cronbach's alpha value greater than 0.7. The Perceived Persuasiveness Scale was adapted from Orji et al. [102]. It evaluated the persuasiveness of the app with questions such as "the app would make me reconsider my mental health habits." It has a Cronbach's alpha value of 0.84. The Motivational Appeal Scale based on the Attention, Relevance, Confidence, and Satisfaction (ARCS) model was developed by Keller [68], and the questions were adapted from Orji et al. [102]. It evaluated the motivational aspect of the app with questions such as "the app would capture and hold my attention." The Cronbach's alpha value is greater than 0.7. All these scales were measured using 5-point Likert scales (ranging from 1 = "Strongly Disagree" to 5 = "Strongly Agree") (Appendix J).

Participants were offered the option to participate in a one-on-one interview (Appendix E) to share their experience and any improvements they deemed necessary. Of 30 participants who used the app and completed the questionnaire, 22 agreed to the interview.

3.2 *iCare* App Design

The *iCare* app was designed using the UCD approach and PSD model. We involved users in the design process of the app. Also, features such as privacy notice, setting up a fingerprint, and adding emergency contacts were employed in the app.

3.2.1 Self-Care in the *iCare* App

The app's main objective is to create awareness, teach users, and motivate them to maintain a good

mental health lifestyle for the underserved population, including day-to-day management of stress or anxiety-causing factors. The app comprises 12 features (Hobby corner, Meditation Music, Breathe, Mood tracker, Diary, Self-Awareness, To Do, Gratitude corner, Voice Memo, Social Community, Reminder, and Settings) (Figure 3.1). Apart from these features, the user had the option to set up a fingerprint to protect their privacy; they could also change their Avatar and username, as well as switch the theme of the app to the dark or light mode, which offers a more customized experience for the user. We chose to focus on only these features because these were preferred and recommended by our target Indian audience in Phase 1 [122] and Phase 2.

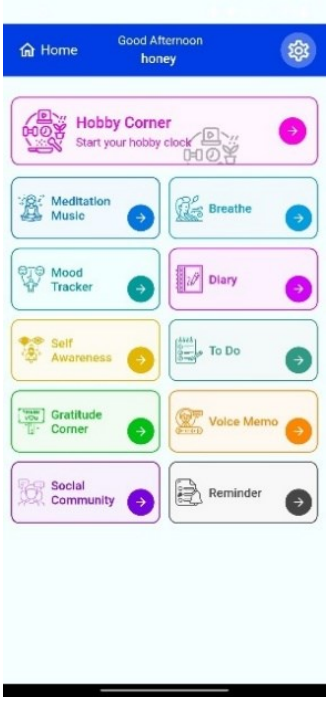


Figure 3. 1: Home Screen of the *iCare* app

3.3 Deconstructing the *iCare* App

The *iCare* app features are designed mostly from the findings of Phase 1 and Phase 2, which involved 31 and 40 working-class Indian women, respectively. The participants mentioned the key features required in a mental health app, such as: Being able to relax and practice meditation in their free time, learning task management, being able to express their feelings in the form of writing or voice notes, and dedicating time for their hobbies or activities, being able to change the theme of the app.

3.3.1 *iCare* App Features

The app promotes the management of stress and anxiety among working-class Indian women and adopts a good mental health lifestyle. To personalize the app to be accepted by the target audience, we used the features and suggestions they made. The following are the features of the *iCare* app:

1. **Hobby Corner**: This feature helps users track the hobbies they once lost or do not have time to perform. Users can select from three timers: five minutes, 10 minutes, and two hours; they can also enter their hobbies or activities to perform. At the end of each timer, the user receives praise and a congratulatory message (Figure 3.2a). We came up with this feature based on participants' comments (from Phase 1): *"I have such a busy schedule that I do not even remember what activities I used to perform to relax.* ***No one has ever asked me about my hobby****"* [P5].

2. **Meditation Music**: This feature provides a list of calming sounds, and music users can use to meditate and calm themselves. Users can also add their songs and sounds and create a personalized playlist containing soothing songs and sounds. Also, music has been shown by previous studies to have a relationship with social behaviour and may be indicative of emotional vulnerability [14]. There is also growing research on the use of music in treating mental health [79] (Figures 3.2b and 3.2c). We came up with this feature based on participants' comments (from Phase 1): *"Meditation relaxes me. I used to do it before the pandemic. I* ***would like to have it in this app****"* [P2].

3. **Breathe**: This feature allows users to control their breathing in difficult situations. Breathing exercises effectively manage anxiety, depression, and other mental health conditions [36,62,70]. This app offers five options of a human voice (two female and three male voices) in three different languages (English, French, and Dutch), which guides the user to breathe in, hold, and breathe out. This feature has a bubble that zooms in and out to help the user relax and focus (Figures 3.2d, 3.2e, and 3.2f). It also has four alternatives for nature sounds (Forest rain, Forest morning, Beach waves, and River stream). We developed this feature based on participants' comments (from Phase 1): "*Maybe* ***grounding can be there****. It is a great tool for helping with anxiety or any other stabilization exercise. There are tons out there like* ***breathing is one option***" [P18].

4. **Mood Tracker**: T2 Mood Tracker app [25] used a mood-tracking feature to study the effect

of feedback on military personnel suffering from deployment-related behavioural health issues, including PTSD, Head Injury, Stress, Depression, Anxiety, and General Well-Being. The app was seen as effective, and participants stated they would want to use the app to remoting their mood to the health provider. A similar trend is seen for health management apps with tracking features [26,120].

This feature allows the user to track their mood. There are four mood options: Calm, Happy, Sad, and Angry. This feature aims to give users a broad picture of their fluctuating mood and whether they should take action to make it stay on the positive end (Figure 3.2g). We added this feature for the users based on the literature, and our participants took it positively: "***A mood tracker would be something that will help me*** *to know myself, how am I doing, and how I react to things. So, if something can keep track of that, I will know myself better..."* [P2].

5. **Diary**: This feature allows users to make diary entries to express themselves. To give it a real-world feel, the pages of a diary are designed to look like a real one (Figure 3.2h). Participants (from Phase 1) suggested having a diary feature to vent out their feelings: *"I **would love to have a diary feature** so that I can **vent out my feelings** and be more expressive; I procrastinate when I have to write in a physical diary"* [P3].

6. **Self-Awareness**: Patient education has been shown to improve the health-promoting behaviour of patients [31]. Works by Hätönen et al. [59] showed that patient education in psychiatric hospitals is an important area to be developed and tested. In agreement with these views, we offer the self-awareness feature, allowing users to learn more about warning signs of stress, anxiety, relationships, and associated mental health conditions. These topics were chosen based on the frequency with which they were mentioned in Phase 1 of this research [122]. Information for the patient also has verifiable links to resource websites to assist patients in better understanding their condition and have trusted health information from recognized agencies (Figure 3.2i). Based on the literature, we added this feature for the users, and our participants took it positively: *"I will be **able to know myself** with the self-awareness feature"* [P23] (Phase 2).

7. **To Do**: According to Masicampo et al. [84], planning to complete the chores we have not completed will help us overcome the anxiety caused by these distractions. They found that people do poorly on chores if a warm-up exercise that ordinarily precedes the chores is skipped. However, performance on the following test significantly improved when individuals were free

to create and record specific plans to complete the warm-up activity. This feature allows users to help them with task management and give them the satisfaction of crossing the tasks once they are done (Figure 3.2j). Participants requested this feature (from Phase 1): *"**Option to have a To-Do list will be great** as it will help me in task management and it will give me immense happiness when I strike off the completed tasks"* [P20].

8. **Gratitude Corner**: Valikhani et al. [151] explored the relationship between gratitude, general well-being, and mental health. Their study shows that gratitude affects not only the quality of life but also perceived stress and mental health. Their finding was similar to that of Cheng et al. [29] and Felwah et al. [7], which shows that gratitude effectively reduces stress and depressive symptoms among healthcare practitioners. This feature helps the user express gratitude towards their life and others. This can lead to assisting users in counting their blessings and being more positive in life (Figure 3.2k). Based on the literature, we added this feature for the users, and our participants took it positively: *"**Gratitude corner is a wonderful feature** you added here because when we show gratitude, we feel good, and feeling good is the most important thing at the end of the day"* [P28] (Phase 2).

9. **Voice memo**: This feature helps users to express themselves if they do not want to write a diary. This way, they can get the burden out, feel more relaxed, and establish trust in themselves (Figure 3.2l). This was an alternative to the diary feature as, according to participants (from Phase 1), writing a diary can become tedious: *"I love the diary feature, but sometimes if I am tired, **I don't want to type so I can record an audio**, it will also help me to express myself and relax"* [P12].

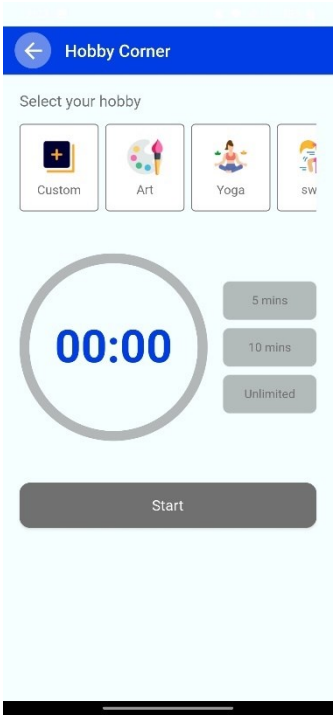
10. **Social Community**: Haslam et al. [58] designed an intervention, Groups 4 Health (G4H), based on the findings that social groups positively impact mental health. Their study showed that the social group intervention improved mental health and well-being. G4H also recorded stress, anxiety, loneliness, and life satisfaction improvements. Sartorius [128] investigated the relationship between social capital (public good that results from mutually supportive social groups) and mental health. They showed that an increase in social capital improves mental health. This supports other research findings on the community's role in positive mental health outcomes.

    This feature allows all the users to come together and support or even share their gratitude corner entries. This will let the user know that they are not alone and some people are in the

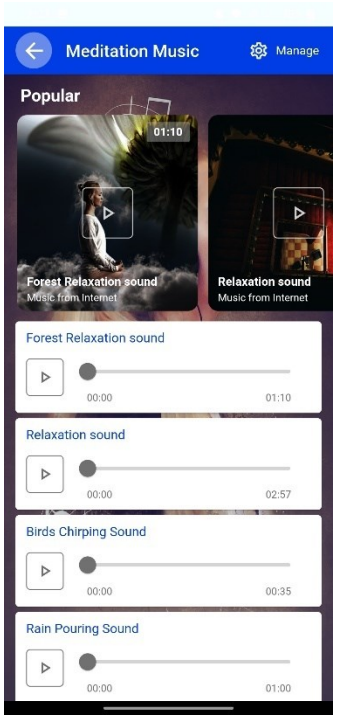
same situation and can learn from their experience (Figure 3.2m). Based on the literature, we added this feature for the users, and our participants took it positively: *"The social community where other people were interacting* ***will be like a safe space*** *for everyone"* [P6] (Phase 2).

11. **Reminder**: This feature allows users to set reminders to achieve their task or any desired activity (Figure 3.2n).

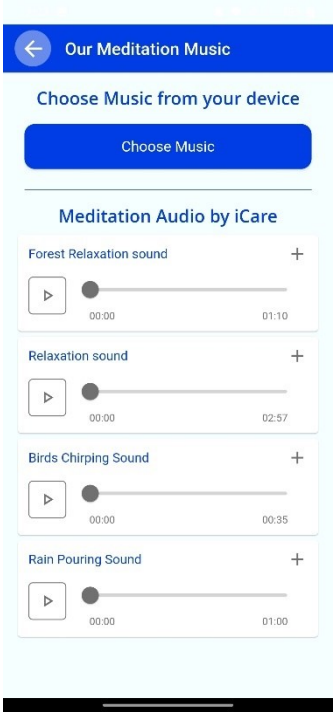
12. **Settings**: This feature has all the basic options like Profile, Setup Fingerprint, Change App Theme, Emergency Contacts, check your activity (allows users to see how much time they spent on each feature in a day), Privacy Notice of the app, log out, and Delete account (Figure 3.2o).



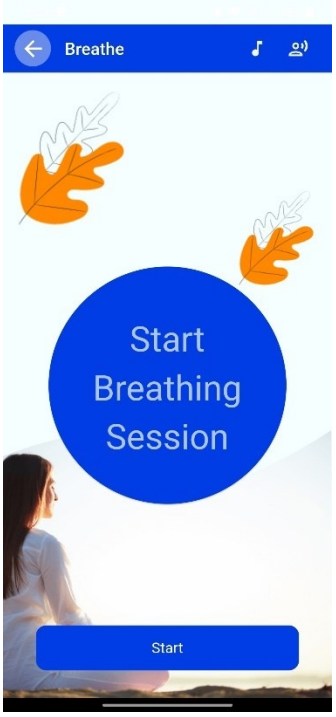
a) Hobby Corner



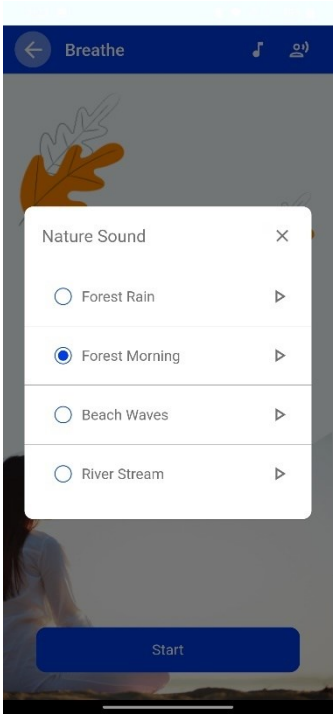
b) Meditation Music



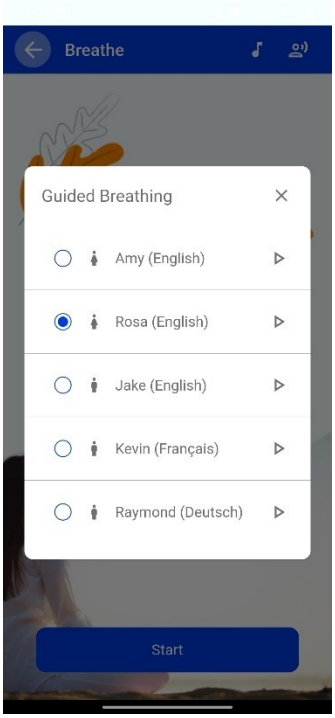
c) Adding own music



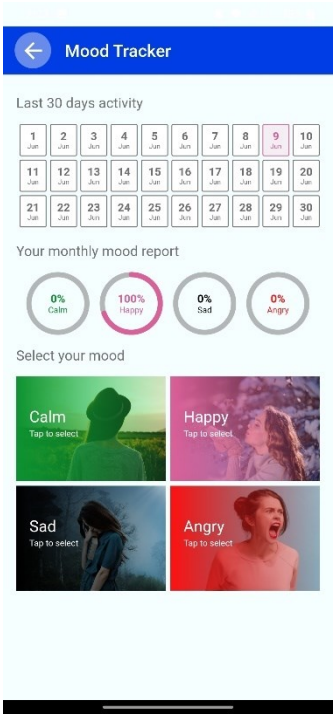
d) Breathe



e) Select nature sound

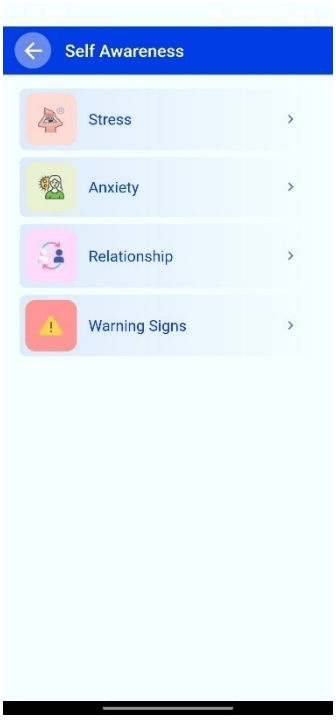


f) Select guided sound

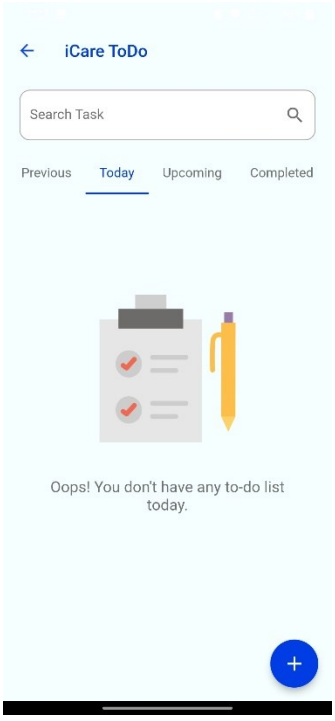


g) Mood Tracker

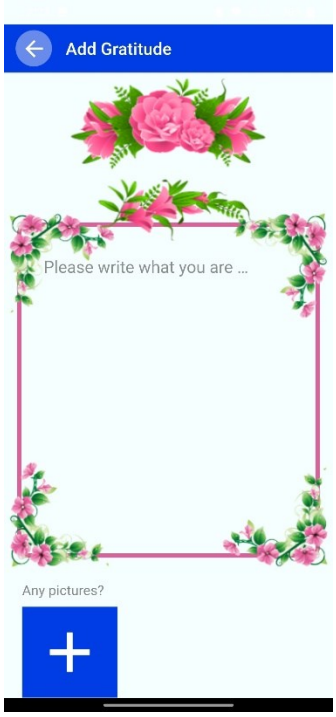
h) Diary



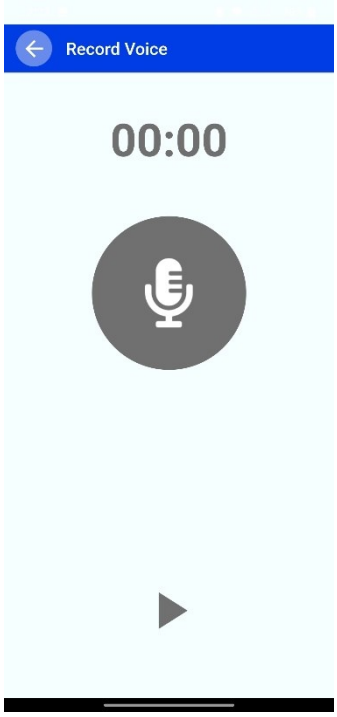
i) Self Awareness



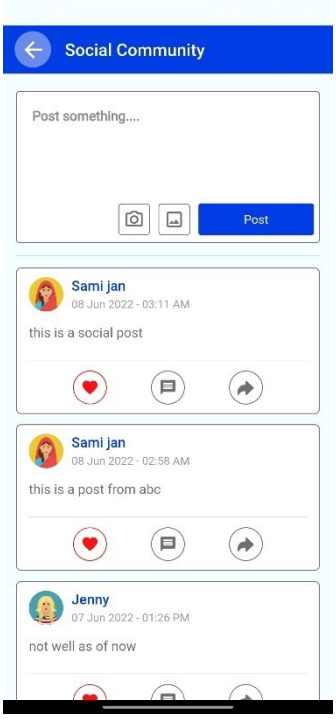
j) To-Do list



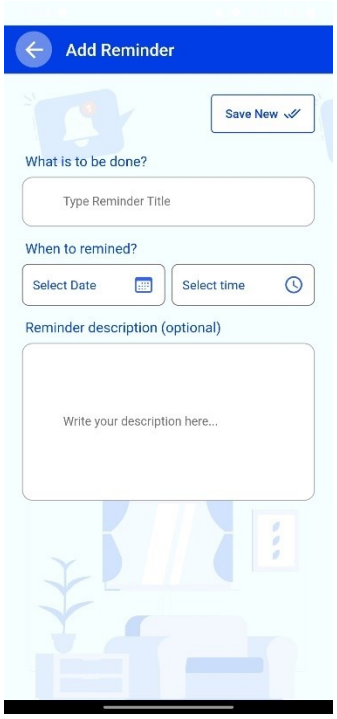
k) Gratitude corner



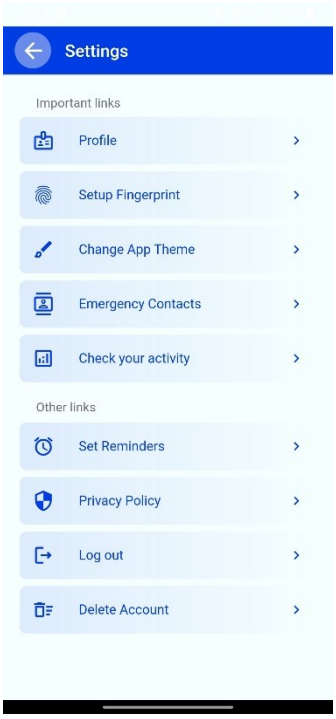
l) Voice memo



m) Social Community



n) Reminder



o) Settings

Figure 3. 2 Screenshot of the *iCare* app

3.4 Deconstructing Persuasive Strategies in the *iCare* App

The iCare app was designed using ten Persuasive Strategies commonly employed in persuasive health apps: Self-monitoring, Personalization, Customization, Praise, Tunnelling, Reminders, Social facilitation, Rehearsal, Goal Setting, and Suggestion [98,103] [39,42]. The strategies were adopted from the: PSD model developed by Oinas-Kukkonen in 2009 [98], mHealth apps from the literature, mental health apps on App Store and Play Store, Persuasive Strategies that are commonly employed in persuasive health applications [101,104], and interviewing the target audience. Table 3.2 summarizes the Persuasive Strategies Implementation for the *iCare* app.

Table 3. 2: Summary of the Persuasive Strategies Implementation for the *iCare* app

Strategy	**Implementation**
Self-monitoring	Mood tracker, Diary, Voice Memo, To-Do list, Gratitude Corner, Hobby Corner feature, and check your activity option.
Personalization	App automatically changes the theme according to the daytime or nighttime of the user.
Customization	Change Avatars, Profile names, reminders, and emergency contact, add hobbies to Hobby Corner, create their timers, and change the app theme.
Praise	After the hobby corner timer ends, the app praises the user.
Tunnelling	Meditation music and Breathe feature.
Reminders	Reminder feature, Notification.
Social facilitation	Social community feature.
Rehearsal	Gratitude corner feature.
Goal setting	To-Do list feature.
Suggestion	Notifications.

Our goal for making the *iCare* app was to create an app that could be persuasive and helps reduce stress and anxiety. To ensure that the app helps reduce stress and anxiety, we did a pre-and post-test using the Perceived Stress Scale (PSS) and the Generalized Anxiety Disorder (GAD) scale. To ensure that the app is persuasive, we implemented several persuasive strategies in the app. The following strategies were implemented in the *iCare* app:

1. **Self-monitoring**: This strategy states that "a system that keeps track of one's performance or status supports the user in achieving goals." It was implemented in Mood tracker, Diary, Voice Memo, To Do, Gratitude Corner, Hobby Corner feature, and check your activity option.

2. **Personalization**: This strategy states that "a system that offers personalized content or services has a greater capability for persuasion." It was implemented by changing the theme according to the user's time zone.

3. **Customization**: This strategy "allows users to adapt a system's contents and functionalities to their needs and choices." It was implemented by creating reminders, creating a To-Do list, and adding an emergency contacts option. Users can create their hobbies and timers to perform them. Create their playlist in meditation music and change the theme. User can also set up their fingerprints to lock the app.

4. **Praise:** This strategy states that "by offering praise, a system can make users more open to persuasion." It was implemented in the Hobby corner feature, where the user gets praised when the timer of the hobby corner is completed.

5. **Tunnelling**: This strategy states that "using the system to guide users through a process or experience provides opportunities to persuade along the way." It was implemented in the Meditation music and the Breathe feature.
6. **Reminders**: This strategy states that "if a system reminds users of their target behaviour, the users will more likely achieve their goals." It was implemented in the Reminder feature and in notifications to enter mood, make diary entries or post something to the social community.
7. **Social facilitation**: This strategy states that "system users are more likely to perform target behaviour if they discern via the system that others are performing the behaviour along with them." It was implemented in the social community feature.
8. **Rehearsal**: This strategy states, "a system providing means with which to rehearse a behaviour can enable people to change their attitudes or behaviour in the real world." It was implemented in the gratitude corner feature.
9. **Goal setting:** This strategy "requires users to set a clear behaviour goal." It was implemented in the To-Do list.
10. **Suggestion:** This strategy states that "systems offering fitting suggestions will have greater persuasive powers." It was implemented by sending notifications to users.

3.5 *iCare* App Implementation

In this section, we highlight the technical flow of the app design and some of the technical decisions we took while developing the *iCare* app.

The *iCare* app was developed using the Android studio [191] and VS code [192]. It was written in Dart programming language [193], and the framework used is Flutter [194]. Flutter and Dart allow for cross-platform development, meaning the developer does not have to write code for every platform.

In implementing the *iCare* app, the first step we took was to identify all the features asked by our target audience and their scope. We used Cloud Firestore [195] as our database. We also sourced a few open-access assets like meditation music, avatars, and breathe guiding sounds using keyword searches on the internet. Figures 3.3 and 3.4 shows an overview of the general flow of the app.

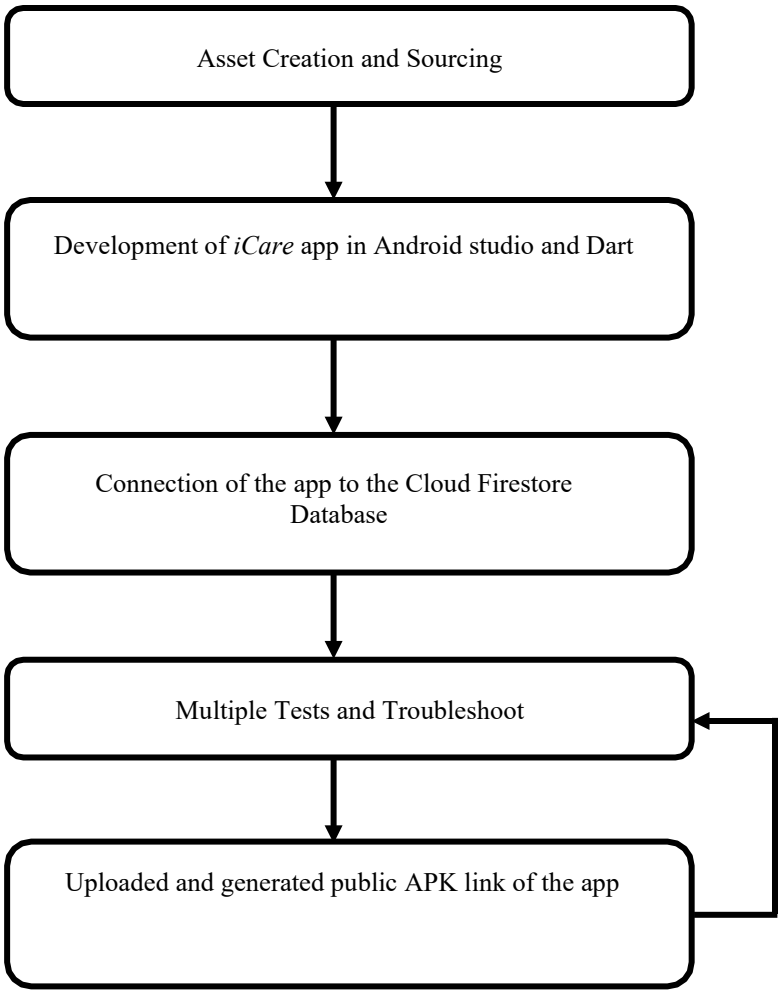


Figure 3. 3: High-level design process of the *iCare* app

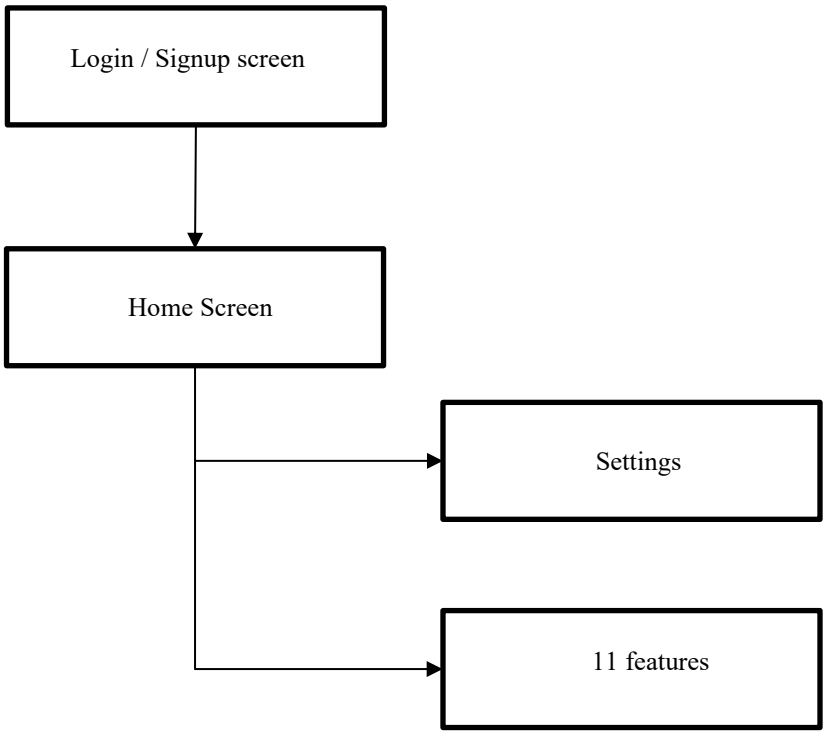


Figure 3. 4: High-level overview of the iCare app

When the user opens the app for the first time, they are prompted to sign up with their email ID and password; after successfully signing in, they can set up fingerprints to log in if they wish. The user can select an avatar and a pseudo-name to use in the social community. The Cloud Firestore database holds the user's information and data, which is deleted once the user deletes her account. The users were made aware of this storage policy in the consent form during the recruitment of the participants (Appendix M).

4 CHAPTER 4: *iCare* APP PHASE by PHASE EVALUATION

The *iCare* app is developed using a UCD approach and PSD model. We divided the development into three phases and involved the users throughout the design and development process:

- Phase1 validated the concept of the *iCare* app.
- Phase 2 used the ideas and suggestions of the users from Phase 1 and designed them into a prototype.
- Phase 3 used the main ideas from Phase 2 and designed and developed the *iCare* app to be used for two weeks by our target audience. After developing the *iCare* app, we needed to investigate if it was effective or not in motivating users to manage their day-to-day stress and anxiety.

For Phase 1, the research objectives (ROs) were:

RO 1: To understand users' mental health issues, needs, and concerns about mental health mobile apps (30 participants).
For this RO, we asked the participants whether they have had any mental health issues, the significant causes, how they tackle stress, and their views on how Indian society handles mental health.

RO 2: To learn about the users' perspective on Headspace and Happify mental health mobile apps.
For this RO, participants were asked about their views on the Headspace and Happify app, which they explored before the interview, design suggestions, the features they would want to see in the app for managing their stress and anxiety, and their motivation to use a mental health app.

For Phase 2, the ROs were:

RO 3: Develop a prototype that integrates the most important suggestions and ideas from Phase 1.
We developed a prototype based on the suggestions and new ideas from the participants of Phase 1.

RO 4: To validate the features of the prototype with a large audience than Phase 1 (40 participants).

We recruited 40 participants to test all the prototype features and take their suggestions and new ideas for the *iCare* app.

These ROs show how results from Phase 1 informed Phase 2. Finally, both phases resulted in Phase 3, where we recruited 30 participants to test the *iCare* app and validate all the features. Table 4.1 summarizes the ROs, what they measured, and the instruments used.

Also, we developed the following research questions (RQs) to guide our evaluation in Phase 3, as we did not define a RO for Phase 3. The overarching RQ for Phase 3 is:

Is the iCare app effective in promoting stress and anxiety management among working-class Indian women?

The issue revolves around the elements that influence behaviour change. To answer this Phase 3 RQ, we collected data from 30 participants via questionnaires three times. The first time was before using the app, the second time was while they were using it, and the third time was after they had used it for two weeks. The data collected helped us evaluate the app's effectiveness in reducing stress and anxiety. The results from analyzing the quantitative and qualitative data show that the *iCare* app effectively reduced stress and anxiety and that users had a positive user experience from using the app. To answer the overarching RQ, we divided it into four more specific RQs that measured close markers of stress and anxiety change in Phase 3:

RQ1: *How effective is the iCare app in promoting positive changes toward stress and anxiety management?*

RQ2: *How effective is the iCare app with respect to motivational appeal?*

RQ3: *How effectively is the iCare app promoting a positive user experience?*

RQ4: *How persuasive and useful is the iCare app in motivating users to manage stress and anxiety?*

Table 4.1 summarizes the RQs, what they measured, and the instruments used.

Table 4. 1: Research objectives and questions and their corresponding investigations

Research Objectives	**Measure**	**Instruments**
RO 1 and RO 2	Interviewed 31 working-class Indian women	Interview
RO 3 and RO 4	Interviewed 40 working-class Indian women	Interview
Research Questions	**Measure**	**Instruments**
RQ1	The ability of the app to promote positive change toward stress and anxiety management.	PSS and GAD pre-and post-test, BMIS during the study, and optional one-on-one interviews.
RQ2	Effectiveness of the *iCare* app with respect to the motivational appeal.	ARCS model of motivation.
RQ3	The ability of the app to promote a positive user experience	SUS, UEQ, and Perceived Aesthetics Scale
RQ4	Persuasiveness and Usefulness of the app	Perceived Persuasiveness and Perceived Usefulness Scale

4.1 Study Design Overview

We conducted the study in three phases to answer these ROs and RQs. The study design is as follows:

For Phase 1, we conducted one-on-one interviews with 31 working-class Indian women. We asked all participants to explore two mental health apps (Headspace [186] and Happify [187]) before the interview as using these two apps familiarized them with mental health apps (the majority of the participants had never used mental health apps) and with our study. We selected these two apps because they are popular. They have been downloaded l0M+ and 500K+ times and are highly rated (4.3) over Play Store and App Store for Headspace and Happify, respectively. Also, they have been vetted by mental health specialists and are available on the website of the Anxiety and Depression Association of America [196]. We advertised the study on LinkedIn, various female groups on Facebook, and WhatsApp (Appendix K). Thirty-seven (37) Participants completed a demographic questionnaire (Appendix N) (Oct 2021), among which 31 met the inclusion criteria. Our inclusion criteria were as follows:

1. Working-class Indian women living in India.
2. Knowing basic English (must be able to read and understand English).
3. Age must be at least 18 years.

4. Based on self-diagnosis, those experiencing or have experienced mental health issues such as stress, anxiety, depression, or panic attacks, i.e., with no official psychological diagnosis.

The interview questions were divided into two sections. In the first section, we asked the participants questions such as whether they have or had any mental health issues, the significant causes, how they tackle stress, and what are their views on how Indian society handles mental health (for answering RO 1: "to understand users' mental health issues, needs, and concerns about mental health mobile apps (30 participants)"). In the second section of the interview, participants were asked about their views on the Headspace and Happify app, which they explored before the interview, design suggestions, the features they would want to see in the app for managing their stress and anxiety, and their motivation to use a mental health app (for answering RO 2: "to learn about the users' perspective on Headspace and Happify mental health mobile apps").

For Phase 2, we also conducted one-on-one interviews. This time around, we interviewed 40 working-class Indian women. Before the interview, the participants watched a video on the prototype and used the prototype for at least 5 minutes to explore it thoroughly. We advertised the study on LinkedIn, various female groups on Facebook, and WhatsApp (Appendix O). Forty (40) participants completed a demographics questionnaire (Appendix N) (Dec 2021) and met the inclusion criteria. Our inclusion criteria were as follows:

1. Working-class Indian women living in India.
2. Knowing basic English (must be able to read and understand English).
3. Age must be at least 18 years.
5. Based on self-diagnosis, those experiencing or have experienced mental health issues such as stress, anxiety, depression, or panic attacks, i.e., with no official psychological diagnosis.

The interview questions focused on the app features like the ability to customize the UI colours, and we asked questions related to all the features in the prototype and whether they would want to have it modified, and their reasoning behind any changes (for answering RO 3: "develop a prototype that integrates the most important suggestions and ideas from Phase 1", and RO 4: "to validate the features of the prototype with a large audience than Phase 1 (40 participants)").

In Phase 3, to understand the effects of the *iCare* app on user experience, persuasiveness, and

decrease in stress and anxiety, we asked the participants to fill out the Perceived Stress Scale (PSS) [188] and Generalized Anxiety Disorder (GAD) Scale [134] pre-and post-test. Participants were also invited to participate in an optional one-on-one interview to elaborate on their experiences while using the app. We gathered 30 participants from advertising the study (Appendix L) and asked them to fill out the demographic questionnaire (Appendix N) (May 2022). Our inclusion criteria were as follows:

1. Working-class Indian women.
2. Reside in India.
3. Age must be at least 18 years.
4. Based on self-diagnosis, those experiencing or have experienced mental health issues such as stress, anxiety, depression, or panic attacks, i.e., with no official psychological diagnosis.
5. Should own an Android phone.
6. Must know basic English (must be able to read and understand English).

Afterward, links to fill out the PSS, GAD Scale (Appendix H), and BMIS (Appendix I) were sent to the participants. We requested the participants to fill out Brief Mood Introspection Scale (BMIS) after using the app at the end of each day. We also sent them the link to download the app to use it for two weeks, at least 10 minutes per day (May 2022). At the end of the two weeks, they were asked to fill out the post-test questionnaire (Appendix J) (June 2022). To ensure participants were using the app, we also tracked the average time spent on the app. On average, participants spent approximately eight minutes using the app each day. After the post-test questionnaire, we conducted an optional one-on-one interview with 22 participants to get deeper insights into participants' experiences (June 2022). Figures 4.1, 4.2, and 4.3 show the flow of the processes in the user study. The following sections present the study design, data collection, study instruments, and participants' demographics.

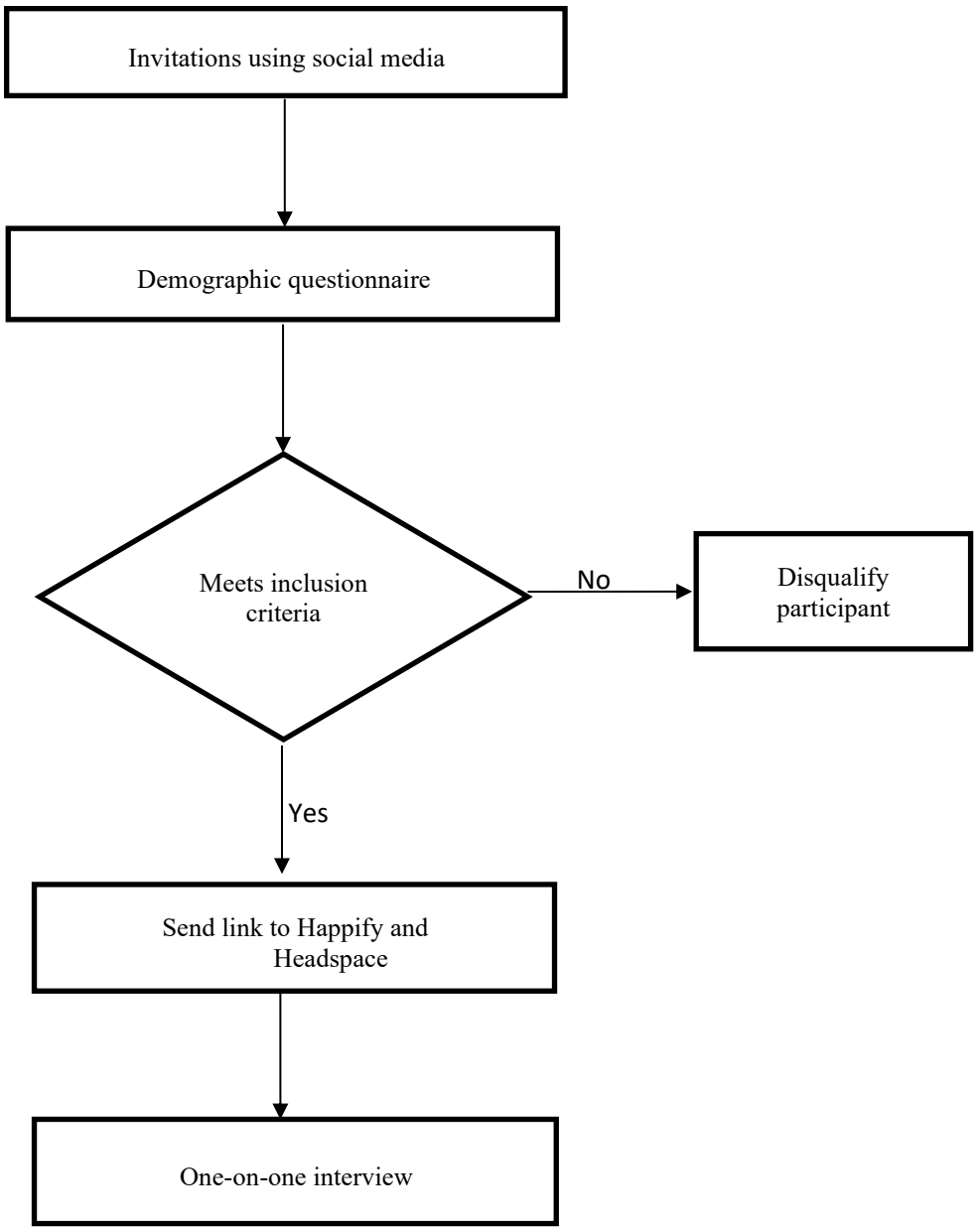


Figure 4. 1: Flow of processes in Phase 1 user study

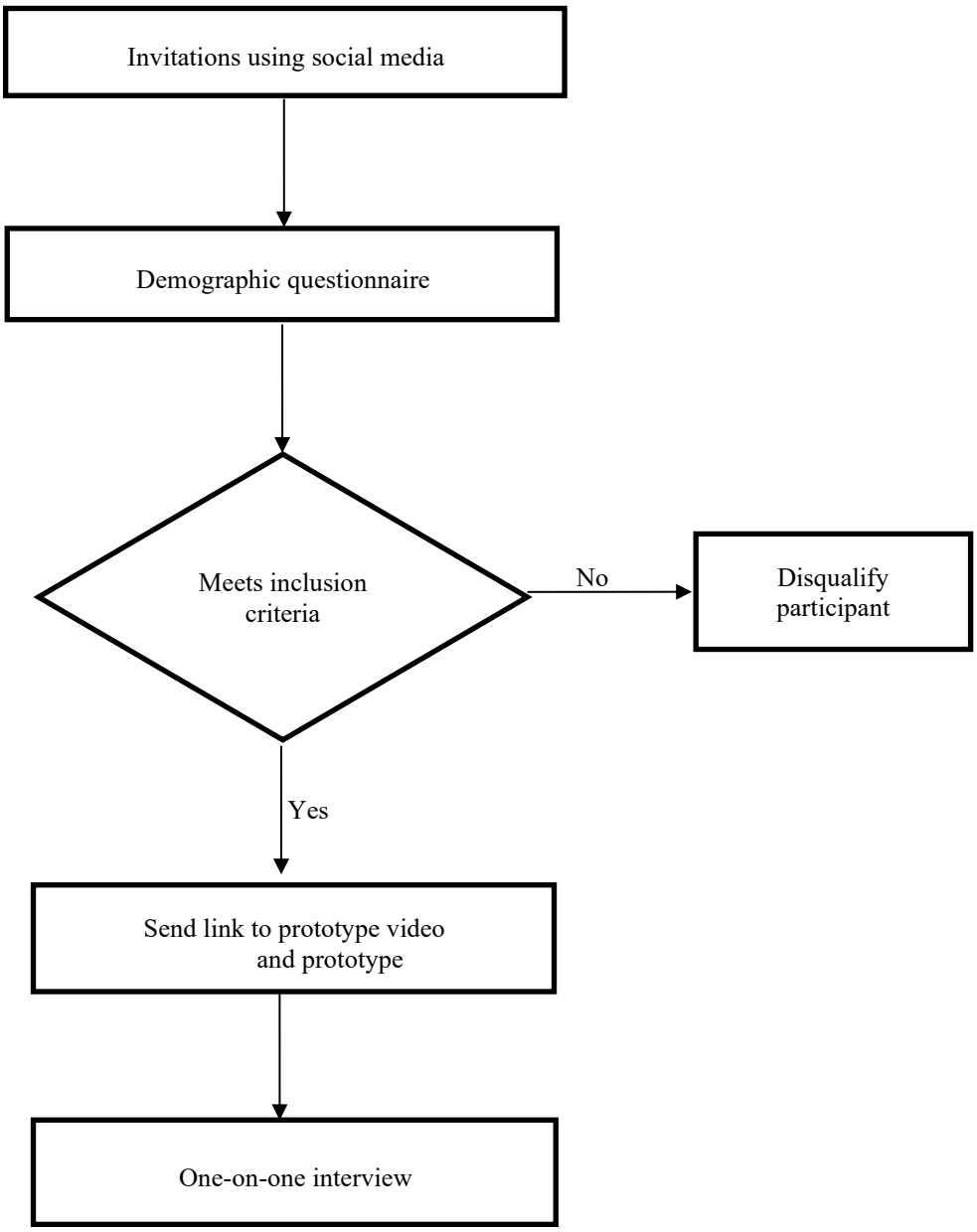


Figure 4. 2: Flow of processes in Phase 2 user study

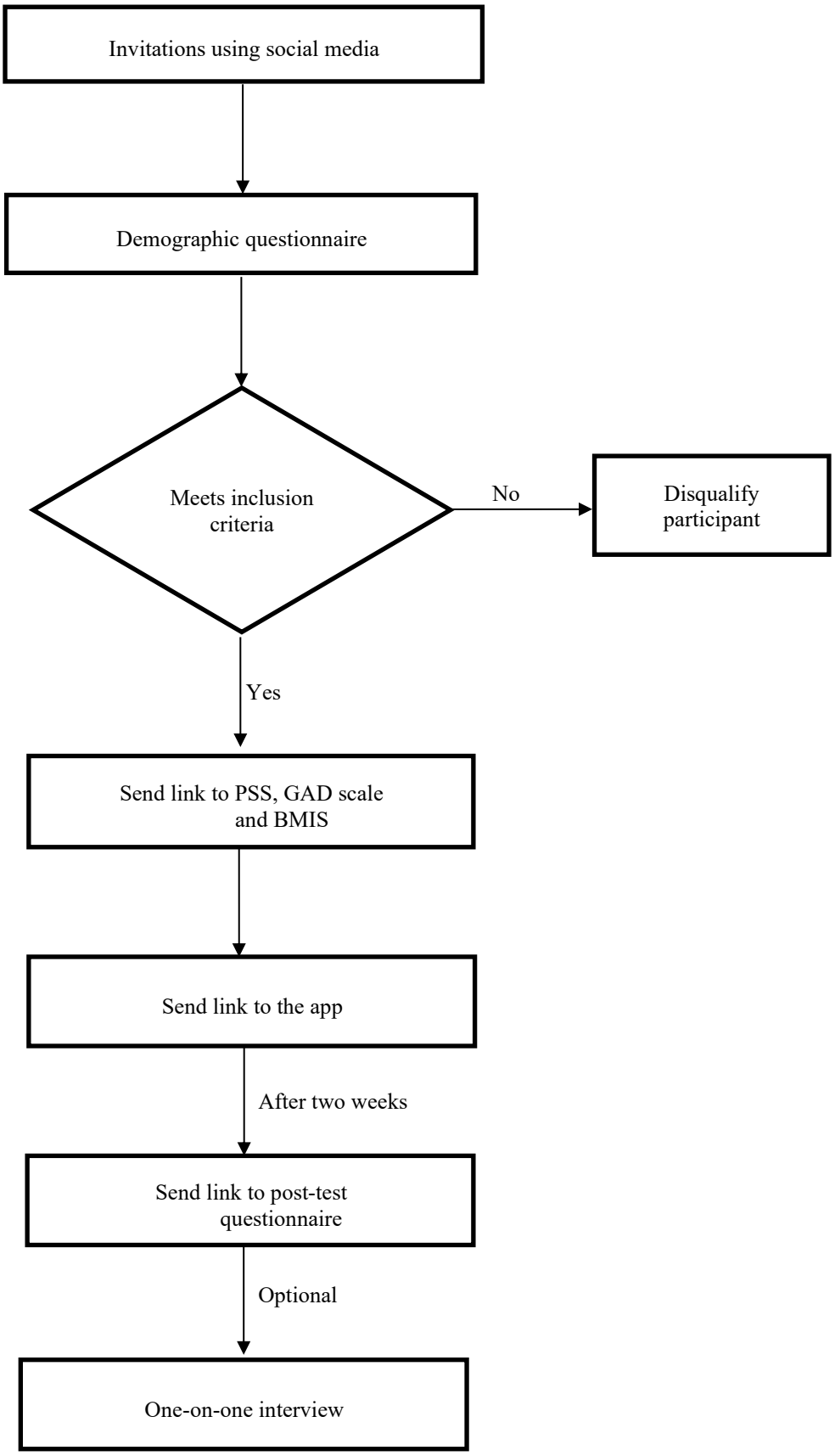


Figure 4. 3: Flow of processes in Phase 3 user study

4.2 Study Design

To answer the ROs and RQs specified above, we divided the study into three phases that would collect data about how working-class Indian women view their mental health issues, what they expect from a mental health app, and how they perceive the *iCare* app, respectively. We interviewed our target audience in all three phases. In our final phase, our pre-test questionnaire collected participants' stress and anxiety levels. Participants used the app for two weeks and reported changes in their mood every day after using the app on the Brief Mood Introspection Scale. At the end of the study, participants completed a questionnaire that was composed of the following scales:

1. Perceived Stress Scale (PSS) [188].
2. Generalized Anxiety Disorder (GAD) Scale [134].
3. System Usability Scale (SUS) [15].
4. Attention, Relevance, Confidence, and Satisfaction (ARCS) Scale [102].
5. User Experience Questionnaire (UEQ) [197].
6. Perceived Persuasiveness Scale [102].
7. Perceived Aesthetics Scale [108].
8. Perceived Usefulness Scale [154].

Our Phase 3 was divided into five stages:

We used the same scales and questions that were used before the study, i.e., PSS (replaced the timeline "one month" to "two weeks" in the questionnaire) and the GAD Scale. First, the participants completed a demographic form, and we identified whether they fit the inclusion criteria. Secondly, they completed the PSS and GAD Scale (pre-test questionnaire). Thirdly, they completed the BMIS, which helped us identify participants' moods after using the app daily. Fourthly, after using the app for two weeks, they completed a post-test questionnaire, which helped us identify the change in participants' stress and anxiety levels (for answering RQ1: "*How effective is the iCare app in promoting positive changes toward stress and anxiety management?*"*).*

Moreover, we included questions measuring Attention, Relevance, Confidence, and Satisfaction for measuring ARCS constructs adapted from Orji et al. [102] (for answering RQ2: "*How effective is the iCare app with respect to motivational appeal?*"). Additionally, to measure the app's ability

to promote a positive user experience, we used the SUS, UEQ, and Perceived Aesthetics Scale (for answering RQ3: "*How effectively is the iCare app promoting a positive user experience?*"). Also, we measured the persuasiveness and usefulness of the overall app by using the Perceived Persuasiveness Scale and Perceived Usefulness Scale (for answering RQ4: "*How persuasive and useful is the iCare app in motivating users to manage stress and anxiety?*").

Finally, to collect the qualitative data, we conducted an optional one-on-one interview online with 22 participants who used the app and completed the pre-and post-test questionnaires. Each interview lasted for about 15-20 minutes. All 22 interviews were audio-recorded with the participant's permission. The interview helped us to collect rich qualitative feedback from the participants about their experience with the app, its impact on their behaviour concerning promoting good mental health, what they like or dislike about the app, and their thoughts on the persuasive features used in the app, and any suggestions for improving the app. Figure 4.4 shows the methodology stages of Phase 3 of the research.

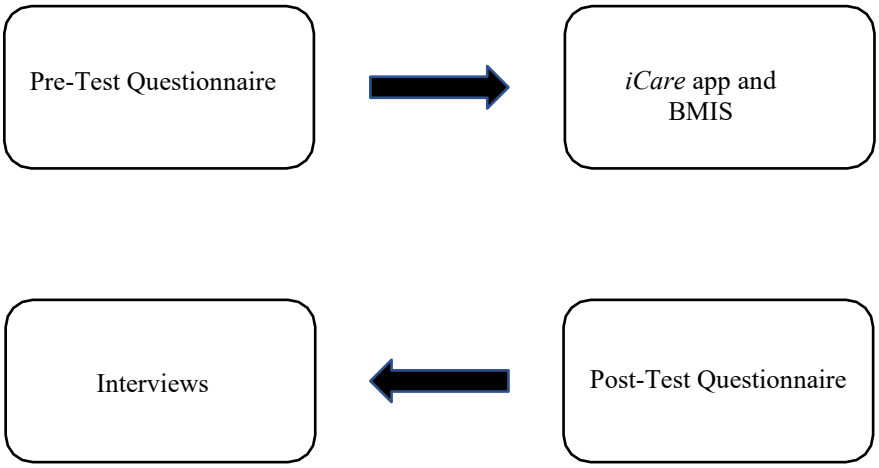


Figure 4. 4: Phase 3 methodology stages

4.3 Data Collection

4.3.1 Phase 1

We sent participants a Google Form [198] (the ethics department approved the use of Google Forms) to collect their demographic data (to check if they fit the inclusion criteria or not). Google Form was used instead of Opinio because the target audience was familiar with it. Participants were recruited by advertising to the public using various channels such as Facebook [199] and WhatsApp [200]. We also used word-of-mouth and snowball sampling [214] techniques that allowed participants to recruit more people. All the eligible participants were invited for a one-on-

one interview, and all the interviews were recorded and transcribed over Microsoft teams [201]. The interview questions were divided into two sections.

- In the first section, we asked the participants questions such as whether they have or had any mental health issues, the significant causes, how they tackle stress, and what are their views on how Indian society handles mental health.

- In the second section of the interview, participants were asked about their views on the Headspace and Happify app, which they explored before the interview, design suggestions, the features they would want to see in the app for managing their stress and anxiety, and their motivation to use a mental health app.

4.3.2 Phase 2

We sent participants a Google Form to collect their demographic data (to check if they fit the inclusion criteria or not). Participants were recruited by advertising to the public using various channels such as Facebook and WhatsApp. We also used word-of-mouth and snowball sampling techniques that allowed participants to recruit more people. All the eligible participants were invited for a one-on-one interview, and all the interviews were recorded and transcribed over Microsoft teams. The interview questions focused on features like the ability to customize the UI colours. We asked questions related to all the features in the prototype, whether they would want to have it modified, and their reasoning behind any changes.

4.3.3 Phase 3

We sent participants a Google Form to collect their demographic data (to check if they fit the inclusion criteria or not). Participants were recruited by advertising to the public using various channels such as Facebook and WhatsApp. We also used word-of-mouth and snowball sampling techniques that allowed participants to recruit more people.

There were two separate forms for our pre-test questionnaire hosted on Google Forms. The first form contained the questions from the Perceived Stress Scale, such as how often they have been upset in the last month or how often they have felt things are out of their control. The second form contained questions from the Generalized Anxiety Disorder scale, such as how often they felt anxious or unable to stop or control worrying in the last two weeks. While participants used the app for two weeks, we asked them to fill out the BMIS daily for two weeks, which asked

participants to respond on a 5-point Likert Scale (ranging from 1 = “Definitely do not feel” to 5 = “Definitely feel”) and questions evaluated how they felt after using the app with terms such as: “Lively,” “Happy,” “Sad,” “Tired.”

The post-test questionnaire of our study consisted of questions measuring the change in stress and anxiety levels which are the same as those used in the pre-test questionnaire. Further, the post-test questionnaire also included questions measuring Attention, Relevance, Confidence, and Satisfaction (ARCS), consisting of 12 items measured on a 5-point Likert scale (ranging from 1 = “Strongly Disagree” to 5 = “Strongly Agree”). The validated scales and questions for measuring ARCS constructs were adapted from Orji et al. [102]. Furthermore, the post-test questionnaire measured the User Experience, Perceived Persuasiveness, Perceived Aesthetics, and Perceived Usefulness of the entire app. We also included the questionnaire from the System Usability Scale. Finally, the last section of the post-test questionnaire asked two-open ended questions allowing the participants to provide any suggestions they might have for improving the app and a comment box to share more of their thoughts.

4.4 Study Instruments

Below is the list of instruments used in this study for collecting data:

- Demographics Form (Appendix N).
- Pre-test questionnaire (Appendix H).
- *iCare* app.
- Brief Mood Introspection Scale (Appendix I).
- Post-test questionnaire (Appendix J).

- One-on-one interview (Appendix C, D, and E)
- Firestore Database

The instruments used in this study for analyzing data were:

- Nvivo [202]
- IBM SPSS 28.0 and MS Excel

4.5 Participants' Demographics

4.5.1 Phase 1

Thirty-seven participants completed the demographic questionnaire, among which 31 met the inclusion criteria. Of these 31 participants, 73% mentioned that they had never used any mental health app to support themselves, and only 27% used such apps (Figure 4.5).

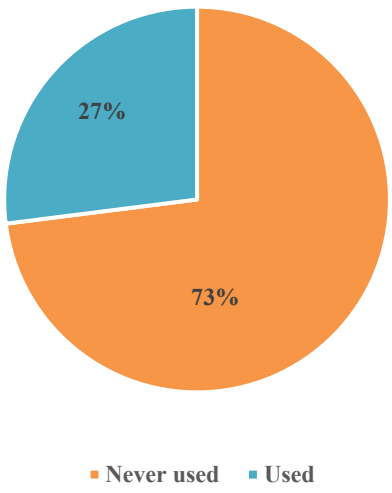


Figure 4. 5: Demographics by 'never used mental health apps' vs. 'used mental health apps'

Participants ages were between 18 and 54 years old, distributed as follows: 18-24 (3.4%), 25-34 (74.1%), 35-44 (19.3%), and 45-54 (3.2%) (Figure 4.6).

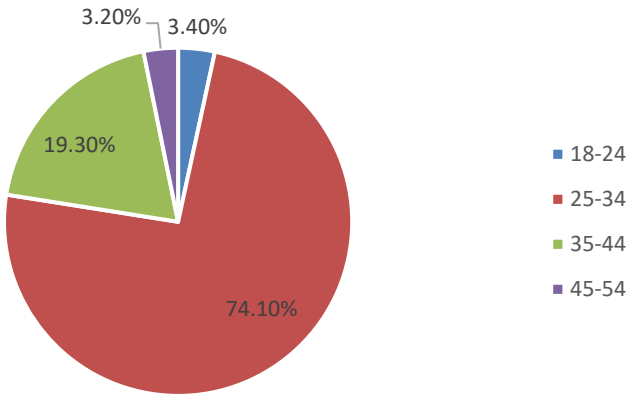


Figure 4. 6: Demographics by age groups

Of most participants, 81% self-identified as married, while 16% were single, and 3% were widowed (Figure 4.7). 81% of the participants had a Master's degree, and 19% had a bachelor's degree (Figure 4.8). All the participants were employed.

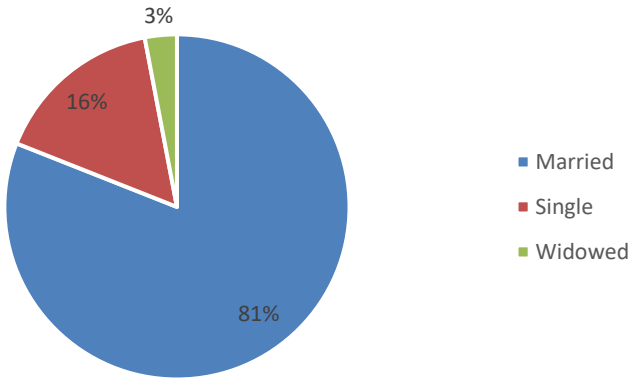


Figure 4. 7: Demographics by their marital status

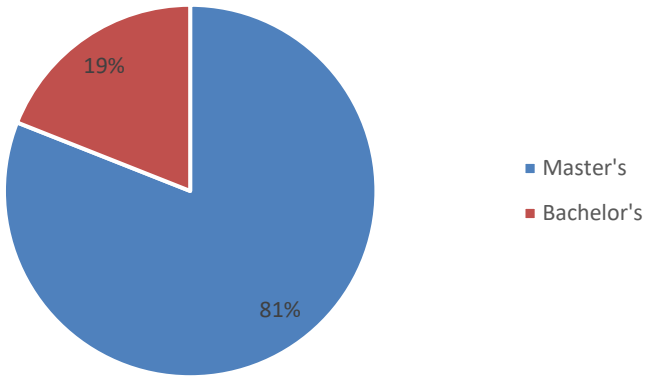


Figure 4. 8: Demographics by the level of education

4.5.2 Phase 2

Forty (40) participants completed the demographic questionnaire and met the inclusion criteria. Of these 40 participants, 72.5% mentioned that they had never used any mental health app to support themselves, and only 27.5% used such apps (Figure 4.9).

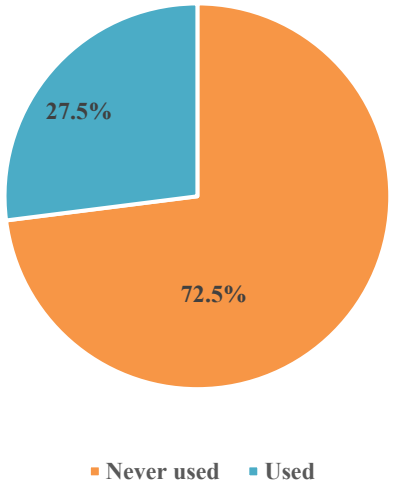


Figure 4. 9: Demographics by 'never used mental health apps' vs. 'used mental health apps'

Participants' ages were between 18 and 44 years old, distributed as follows: 18-24 (40%), 25-34 (45%), 35-44 (15%) (Figure 4.10).

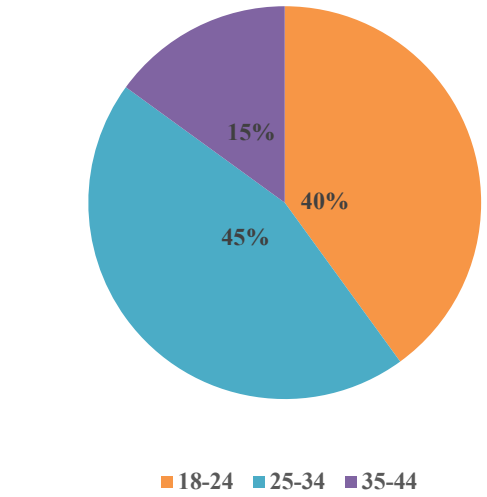


Figure 4. 10: Demographics by age groups

Most participants (62.5%) self-identified as single, while 32.5% were married, 2.5% were divorced, and 2.5% were widowed (Figure 4.11). 50% of the participants held a master's degree, and 50% had a bachelor's degree (Figure 4.12). All the participants were employed.

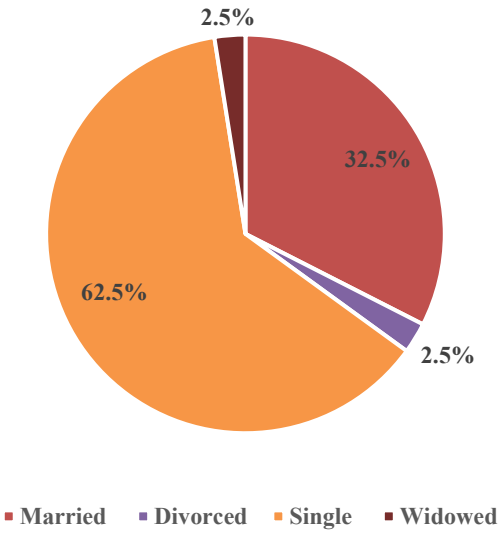


Figure 4. 11: Demographics by their marital status

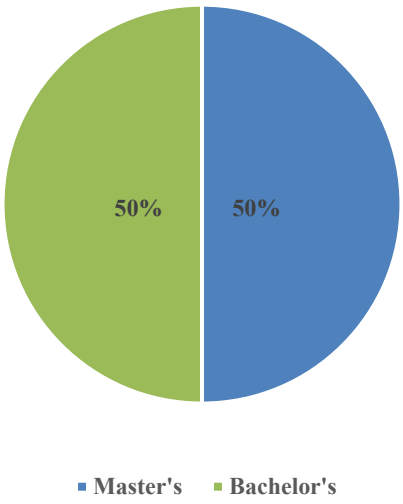


Figure 4. 12: Demographics by the level of education

4.5.3 Phase 3

Thirty participants completed the demographic questionnaire and met the inclusion criteria. Of these 30 participants, 66.7% mentioned that they had never used any mental health app to support themselves, and only 33.3% used such apps (Figure 4.13).

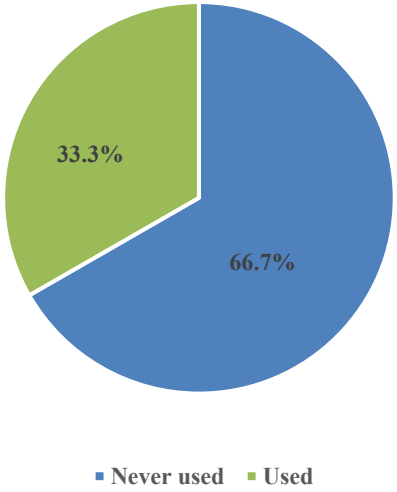


Figure 4. 13: Demographics by 'never used mental health apps' vs. 'used mental health apps'

Participants' ages were between 18 and 44 years old, distributed as follows: 18-24 (46.7%), 25-34 (40%), 35-44 (13.3%) (Figure 4.14).

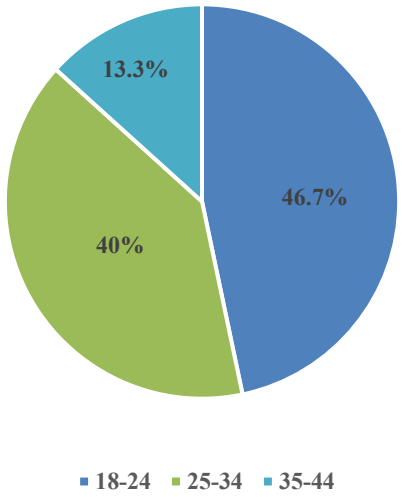


Figure 4. 14: Demographics by age groups

Most participants (66.7%) self-identified as single, while 30% were married, and 3.3% were widowed (Figure 4.15). 50% of the participants had a master's degree, 46.7% had a bachelor's degree, and 3.3% had a doctoral degree (Figure 4.16). All the participants were employed.

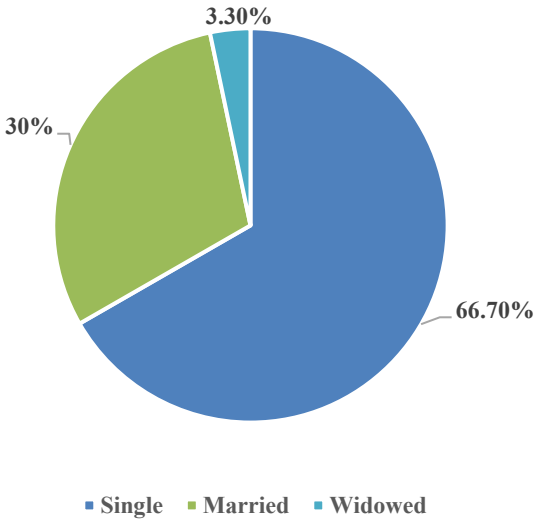


Figure 4. 15: Demographics by their marital status

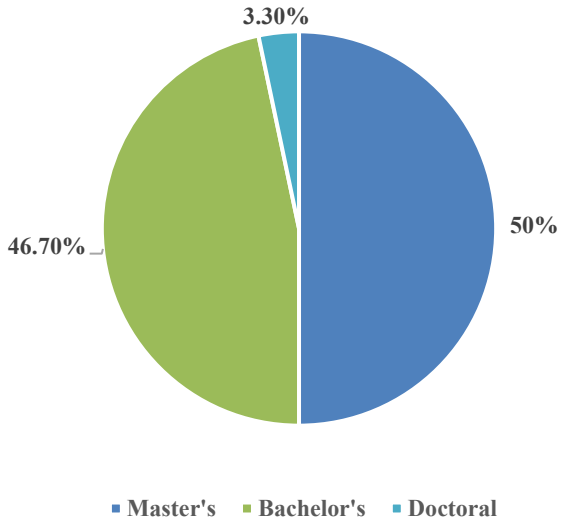


Figure 4. 16: Demographics by the level of education

4.6 Data Analysis

To analyze the qualitative data for Phase 1, Phase 2, and Phase 3, we performed a thematic analysis [140] on interview responses. We used an inductive approach [21] to generate the codes, which means that we began with a collection of observations and worked our way up to a broader set of themes regarding those observations. A thematic analysis was chosen because it allows us to evaluate a big data set methodically, revealing patterns in the text while considering the context of what participants said, allowing us to interpret the data more precisely. A thematic analysis was undertaken as outlined by Green et al. [53] (1) understanding the data, (2) creating initial codes, (3) looking for themes, (4) defining themes, (5) iteratively reviewing themes, and (6) putting up the findings.

Interviews were voice recorded and transcribed using Microsoft teams, and all the transcribed data were corrected (grammatically and spelling-wise) using the recordings. Then all the corrected answers were fed into NVivo 12 Pro, a qualitative and mixed-methods research software used to analyze the unstructured text, audio, video, and picture data, such as interviews, focus groups, and questionnaires [202]. Data were scattered into different sections, and Nvivo further aided the thematic analysis.

We used well-known analytics methods via IBM's SPSS (version 28.0) to analyze the quantitative data and answer our RQs. To answer our RQ1: "*How effective is the iCare app in promoting positive changes toward stress and anxiety management?*" we first conducted a Wilcoxon signed-rank test [203] on the overall participants' responses (N = 30) for PSS, GAD scale and BMIS. To

answer our RQ2: "*How effective is the iCare app with respect to motivational appeal?*" we ran a One-Sample t-test [204] on ARCS constructs to measure the motivational appeal of the app overall as well as across four dimensions of motivation (attention, relevance, confidence, and satisfaction). To answer our RQ3: "*How effectively is the iCare app promoting a positive user experience?*" we ran a One-Sample t-test for the Perceived Aesthetics scale, UEQ, and SUS, and to answer our RQ4: "*How persuasive and useful is the iCare app in motivating users to manage stress and anxiety?*" we ran a One-Sample t-test for the Perceived Persuasiveness scale and Perceived Usefulness scale.

5 CHAPTER 5: STUDY RESULTS

In this chapter, we present the results from the qualitative evaluation of the three phases and the quantitative evaluation of the final phase of the *iCare* app development. Specifically, in the following subsections, we present the motivational appeal of the *iCare* app across four dimensions of motivation (Attention, Relevance, Confidence, and Satisfaction), results from the Perceived Stress Scale (PSS), Generalized Anxiety Disorder (GAD) Scale, and Brief Mood Introspection Scale (BMIS). We also present the results of the overall usability, aesthetics, and user experience of the *iCare* app. Moreover, we also present the results of the overall perceived persuasiveness and perceived usefulness of the *iCare* app. The reliability analysis showed that all the scales demonstrated good internal consistency, with Cronbach's alpha (α) [190] values above the recommended threshold of 0.70 (Table 5.1).

Table 5. 1: Cronbach's alpha (Appendix P) for all scales used in this study

Scale	**Cronbach's alpha (α)**
Perceived Stress Scale	0.78
Generalized Anxiety Disorder Scale	0.77
User Experience Questionnaire	0.82
System Usability Scale	0.73
Perceived Usefulness Scale	0.94
Perceived Aesthetics Scale	0.89
ARCS	0.92
Perceived Persuasiveness Scale	0.91
Brief Mood Introspection Scale	0.84

5.1 Qualitative Results

5.1.1 Phase 1

The interview questions were divided into two sections. In the first section, we asked the participants whether they had any mental health issues, the major causes, how they tackled stress, and their views on how Indian society handles mental health. In the second section of the interview, participants were asked about their views on the Headspace and Happify app, which they explored before the interview, gave design suggestions, the features they would want to see in the app for

managing their stress and anxiety, and their motivation to use a mental health app.

5.1.1.1 Section 1

In this section, the results based on a thematic analysis uncovered three major themes: (1) Events that Trigger Stress/Anxiety, (2) Habits/Activities to Manage Stress/Anxiety, and (3) Social and Personal Factors that Play Major Roles in Mental Health. The following subsections present each theme and provide examples of sample quotes.

- **Events that Trigger Stress/Anxiety:**

This theme reflects the events or activities that triggered the participants' stress or anxiety, such as having a hectic schedule. Based on our analysis, all participants highlighted household chores, workload, taking care of kids, and when things go unplanned as a source of stress and anxiety. For example, one participant mentioned:
*"In my day-to-day life, I think I get most stressed when my **kids have exams** or when there is some **deadline** or if they have some projects as now **everything revolves around the kids**..."* [P5].

Another participant mentioned that not having stable work-life balance stress her out:
*"I have a **hectic schedule**, even working from home. Still, I cannot have a proper work-life balance"* [P11].

Two participants found themselves highly stressed out when things were not going as they planned, and they were unable to handle work pressure:
*"A very stressful thing I have noticed is when something is **not going according to the plan**"* [P13].
*"I am deficient in managing pressure. **I cannot work under pressure**. Given my current situation, I have some things that are causing anxiety and inability to function as I should"* [P17].

- **Habits/Activities to Manage Stress/Anxiety:**

This theme reflects the habits or activities that help the participants to calm themselves, such as listening to music or staying alone. Based on our analysis, few participants try to ignore the mental health issues altogether, few watch entertainment, and others prefer staying alone. For example, participants mentioned that they take the support of entertainment to calm themselves:
*"When I am in such a state of mind, I **prefer to be alone.** I lock myself up in a room and **listen to music** or read something. which cheers me up"* [P6].

*"I do not seek help very easily, so **I talk to myself,** cool myself down, and **watch stand-up shows** to pull myself and come back to normal. That is what I do"* [P7].

One participant mentioned that she ignores anything that bothers her:
*"**I usually ignore the things** which are bothering me..."* [P30].

- **Social and Personal Factors that Play Major Roles in Mental Health:**

This theme reflects the various social and personal factors that play a significant role in our participants' mental health, such as supporting partners. Based on our analysis, support from family or life partners, salary and work appraisals, and the view of Indian society about mental health play a significant role in people's mental health. For example, participants mentioned that getting rewards in the form of salary makes them happy and having a supporting life partner makes a major difference in their mental state:
*"I think one feels at ease when you see you are **credited with some amount of salary** on a particular date. It makes you happy whenever you get some appraisals"* [P2].
*"I say if you **have a supporting partner,** there is nothing like it. I mean, if you have somebody you can rely on to help you with your chores, be it a small thing. It **makes a lot of difference** in a woman's life"* [P6].

On the other side, participants also mentioned that not having a supportive family or society can become one of the reasons for their stress:
*"I think most women are not getting a job that they expect right, and **many families are not supporting women**"* [P9].
*"..it's very **easy for people to judge,** and they just say it's because if she cannot do anything, **let her stick to the household boundaries**.."* [P12].

5.1.1.2 Section 2

In this section, the results based on a thematic analysis resulted in identifying three themes: (1) Participants' Views About Popular Existing Mental Health Apps - Headspace and Happify, (2) Views About Features of These Apps, and (3) Motivation to Use Mental Health Apps. The following subsections define each one of these themes and provide direct quotes to support each of the themes extracted from the interviews:

- **Participants' Views About Popular Existing Mental Health Apps - Headspace And**

Happify:

As mentioned in the last chapter, 73% of participants have never used a mental health app to support themselves. Therefore, making them go through these two apps gave them an idea of what to expect from a mental health app. This theme reflects what their first impression of these two apps was. In summary, participants find the apps appealing and easy to use. Participants also liked that the apps provided relaxation exercises and revealed and provided opportunities for them to reflect on things that may be a source of stress. However, they also complained and felt disappointed that most of the essential features in the app require premium subscriptions, which require payment. They also highlighted the need for guidance on how to do meditation, which is essential for beginners. For example, one participant said:

"So, about the headspace app, when I first opened it, I thought it had a wonderful UI. That is what I want; it is very appealing. It feels very realistic. Also, it was straightforward to log in. However, ***most of the things required the premium****..."* [P3].

While another participant mentioned that:

"There are questionnaires in these apps which make you think about the different stress points in your life. So, reading those ***questions revealed a lot about me****, even things I did not know could be the reason for stress" [P6].*

"I did choose happify. I have tried it. Yes, ***I like the breath-in and breathe-out part****. So that is good. I thought it was relaxing for me"* [P9].

However, few participants were disappointed as they did not expect mental health apps to charge them for managing their stress and anxiety. For example,

*"I installed the headspace app long ago but could not cope with it. The reason was that again and again****, it was asking for payment****; secondly, I was not able to meditate because this topic was not that easy. So,* ***lengthy meditations are very tough for a beginner****, and it did not work like that for me"* [P13].

- **Views on Features of the Apps:**

This theme reflects participants' views on the features of the two mental health apps based on their requirements and expectations. Participants appreciated mostly the Mood tracker and the Social community features of the apps. For example, one participant found the mood tracker helpful:

"Mood tracker would be something that ***will help me to know myself****, how I am doing, and how I*

react to things. So, if something can keep track of that, I will know myself better..." [P2].

Similarly, one participant mentioned how social community will benefit them: *"...I might always be active in the forums, and **I like when women work together, they do wonders**. I love that..."* [Pl].

Participants also found that voice memos are more attractive than writing. For example,
*"**Voice memos are attractive**. Some people do that religiously, writing a diary or a journal, but **most people do not write these days, so** the voice memo might be a good feature for today's generation"* [P6].
*"Nowadays, you do not have many people with whom you can speak, or sometimes you shy away because you do not want to share your problems with those you know. It is good to know that **you can vent your emotions or feelings, even when nobody is listening**..."* [P8].

Finally, privacy is a primary concern for most users, especially regarding mental health issues. The data collected shows that participants have concerns about sharing their information. For example,
*"I won't share my details here; I think **I will go for hiding my identity** because these days, you know how much our **privacy is getting invaded**"* [P15].

- **Motivation to Use the Mental Health App:**

This theme reflects why people think they would be motivated to use the mental health app designed in this study. In general, we found that people are motivated to use the app to help them with various mental health issues. The following are some quotes from the interviews showing participants' negative experiences; explaining why participants will be motivated to use the app, such as having a bad day or doing something recreational:
*"You know, **having a bad day**, but I do not necessarily need to have a bad day to open this app. It could be anything. It could be something **recreational that I want to do,** just another pastime activity that makes me **feel happy by the end of the day**"* [P1].
*"Whenever **I feel stressed or a bit low or unhappy, I will automatically go to the app and** just start using it..."* [P4].

5.1.2 Phase 2

Based on the comments from the participants of Phase 1, we designed a prototype to be used by 40 working-class Indian women. We did this because it is a major step in our User-Centered Design approach, and we wanted to keep our target audience involved throughout the design and

development process. The participants were asked to use all the features of the prototype designed before the interview; that is how they were able to report what they liked or disliked and how they needed the actual app. The interview questions concentrated on what the participants felt about each feature, whether they would use the app or not, and how they would use it, with a justification for their answers. Participants shared their views and a variety of design suggestions. Based on all the responses of the participants, we identified nine core themes: (1) Importance of Aesthetics, (2) The Benefits of Being Anonymous, (3) The Power of Customization, (4) The Power of Personalization, (5) Effectiveness of the App for Stress and Anxiety Management, (6) The Usefulness of Feedback Provided by the App, (7) User Interface, (8) Finding a Safe Space, and (9) Suggestions.

- **Importance of Aesthetics:**

Aesthetics is "the study of a thing's mind and emotions concerning the sense of beauty" [205]. In the context of UI, aesthetics can be defined as a fundamental design principle that makes a design appealing [206]. Aesthetics comprises elements like balance, colour, movement, pattern, scale, shape, and visual weight in terms of the visible world. The notion of beauty does not only apply to artworks but is seen to play an important role even in persuasive apps. In one study, Türkyilmaz et al. [145] compared functionality versus aesthetics and highlighted three key facts about aesthetics which includes:

- Aesthetics brings trust, as a study shows a correlation between aesthetics and credibility.
- Aesthetics create positive feelings.
- Aesthetics may considerably affect system acceptability.

Oyibo et al. [109] showed how good user experience design or aesthetics improved the overall user's receptiveness to a fitness app by employing Persuasive Strategies. Their findings suggest that benefits (usefulness, aesthetics) and hedonics (beauty and enjoyment) should be prioritized in designing fitness apps to support behaviour change. We attempted to achieve aesthetics in our app design using colour, font types, images, and whitespaces (It is white areas surrounding a page's content and useful features. White space's primary purpose is to create breathing room for your design by minimizing the quantity of text and functional items people view at once [207]). Our study shows that participants highlighted aesthetics as an important factor in the stress and anxiety management app. For instance, users' comments on Breathe, Mood tracker, Hobby corner, and Setting features had comments relating to aesthetics. One participant mentioned that allowing them

to change the app theme in the setting feature can change their mood. For example:
*"I think these are all **great features in settings**. Maybe one day I do not want to see blue, I can pick another colour and **change the background theme**, which **can lift my mood**"* [P1].

Many participants were impressed by the change of colour in the breathe feature and tried it even though it was a prototype. As one participant mentioned, "*...I am personally looking forward to using this feature*" [P3], while other participants got attracted by the colour "*I like the colour change with zooming in and zooming out…*" [P4], "*longest time I stayed on any screen… the change of colour attracted me a lot…*" [P6].

Also, participants mentioned that they liked the interface of the app. For example:
*"I **liked the confetti falling** from the message in the hobby corner..."* [P10].
*"I **liked the colour schemes** in Mood tracker..."* [P12].
*"Mood tracker's **colour palette is a good option**, and it made me smile"* [P13].

- **The Benefits of Being Anonymous:**

Anonymity is "the state or quality of being anonymous" [208]. Previous studies on anonymity have shown that it affects users' reporting on mental health conditions. Fear et al. [45] researched anonymity's effect on reporting veterans' mental health. Their work shows that anonymity in a psychological questionnaire affects mental health screening. They found an increase in the prevalence of Post-Traumatic Stress Disorder (PTSD) and stigmatizing beliefs when using an anonymous compared to an identifiable questionnaire. Kenny et al. [69] explored adolescent needs and concerns regarding mobile apps for mental health. According to participants, apps should have user control over privacy, so users can decide whether to share their personal information or keep it private or anonymous.

Given these, developers of mobile intervention should consider providing some level of anonymity in their design for mental health conditions that are stigmatized in their target society. Our prototype allowed users to access a social community feature anonymously while sharing information and seeking support. We believe that allowing users to be anonymous will help users to be more confident in sharing their problems freely. Comments from our participants support our design decision. For example, participants mentioned that they would feel safe sharing their feelings with others without the fear of judgment and knowing that people are also in the same situation:
*"Our **identities will be anonymous**; **this will give us strength** because when we will be able to see*

we are not the only one suffering with the same problem; there are ***other women out there as well suffering****"* [P18].
"It ***will be anonymous,*** *and we can* ***share without the fear of judgment****"* [P22].

One participant said being anonymous will help her "*...find solutions to our problems as we may find someone who may have the same issues…*" [P27].

However, participants mentioned that apart from being anonymous, they should be able to report any danger:
"It is ***good to talk and be anonymous in the social community and share ideas****. Just users' needs to be legitimate, and* ***I should be able to report any user*** *I do not feel I am safe talking to or something like that"* [P24].

- **The Power of Customization:**

Customization allows users to specify their preferences, and the website produces tailored services based on the set preferences [166]. In one research, Melcher et al. [87] identified customization as one of the main drivers of students' engagement in mental health apps. Studies have shown that customization gives users a sense of autonomy, and HCI researchers have emphasized the need for customizable and flexible mHealth technologies [165]. As an example, Marathe et al. [83] researched factors that drive customization and explored if users were motivated by a sense of control (autonomy) or a sense of personal choices (identity) when they customize an interactive product. Orji et al. [100] also conducted an extensive study with 660 individuals to investigate how various persuasive strategies affect people with different personalities. People with higher degrees of extraversion and agreeableness enjoy customization because they feel it adds a personal touch and offers them a sense of freedom and control. Also, Orji et al. [102] conducted a large-scale study with 543 people to examine how various user types reacted to 10 Persuasive Strategies shown in persuading game-based health systems. According to their research on stronger socializer and disruptor tendencies, customization would encourage behaviours as it gives users a sense of control, choice, and personal touch.

Participants' feedback indicated that customization is important for stress management apps targeted at working-class Indian women in our interview. Comments relating to the need for a customization mechanism in the app attributes were raised across multiple features, including Diary, Meditation music, Mood tracker, and the app's colour scheme. Comments indicated that users perceived the

customization feature positively. For example, participants wanted to change colours when they said:

"Blue is like a neutral colour. But you can also give options; some might like green or pink. You can also have ***a feature where user can choose their screen colours****"* [P1].

Another participant was interested in changing the shade of the colour:
"I think something in a ***pastel shade*** *or something very light which* ***can give you a warm feeling*** *to the whole app, so maybe something in peach or yellow but not too bright like a lighter shade"* [P4].

Participants considered the option to create their playlist in the meditation music feature as a symbol of their touch to the app:
"Meditation music is good, and ***allowing users to add their music*** *would be a great option"* [P12].
"I think music is very subjective. So, while you could have all these pre options of music, I think if I were to use a feature like this, ***I would like to have my playlist****"* [P5].

One participant mentioned how they see the colour representation in the mood tracker and being able to change that would be preferred by them:
"I like the colours of the mood tracker, but one thing that strikes my mind was that green was being used to indicate anger. But when I think of anger, I think of the colour red. So, ***if there is an option to change the colour*** *theme of moods, it would be a good idea"* [P23].

- **The Power of Personalization:**

Personalization does not require users' inputs to provide personalized services [166]. Pelletier et al. [114] conducted a pilot study on the personalization of healthcare for psychiatric patients. One hundred twenty (120) patients were requested to provide their views on the design and utility of a mobile app. Other attempts have also been made toward personalizing health care [139]. For example, Alqahtani et al. [9] showed that users prefer apps with various options, functionalities, features to select content, and the ability to adapt app features to their preferences. The author found that lack of personalization is one of the main pitfalls of the apps.

Further, Orji et al. [104] conducted a large-scale study on 1,108 gamers to examine the persuasiveness of 10 Persuasive Strategies. They found out that conquerors were a group of gamers who were more convinced to use solely the default features provided by personalization. Further,

Orji et al. conducted large-scale studies to examine the persuasiveness of 10 Persuasive Strategies. They found that most people like systems that are personalized [101], and people were more inclined to use the default features provided by personalization [104]. Some people place a high value on personalization because of its ability to boost the utility, relevance, credibility, and user confidence and trust in the system [103].

In our project, we received suggestions from participants to provide features that allow them to provide data that can help the app personalize its content and feedback. Feedback from participants shows that personalization is essential to target users. For example, a few participants wanted the app to change its appearance according to their moods:

"Giving people the liberty to enter ***how are they feeling today*** *so* ***they can have their avatars****. So, I think I like the idea of it"* [P13].
"That change avatar option makes us feel good like we need a change. So, ***we can change according to our moods****"* [27].
"It would be great if the ***theme of the app changes according to the mood entered****"* [P32].

On the other hand, one participant wanted to receive positive affirmation based on their app activity:
"I would feel good if ***I get positive notifications based on my activity in the app****"* [P16].

- **Effectiveness of the App for Stress and Anxiety Management:**

Effectiveness is the degree to which something successfully produces the desired result. This theme shows that participants perceived that this app would help them achieve the desired behaviour. Alqahtani et al. [8] explored persuasive approaches in the mental health app, and they found that motivation types significantly influence the perceived persuasiveness of different features. In our design, we adopted features that let the user feel more in control of their mental state. For example, the Gratitude feature will allow users to focus their thoughts on people, things, or experiences that invoke feelings of happiness and gratitude. Participants deemed these features to be effective and in order. For example, our participants consider having a To-Do list will be a good reminder to keep their tasks on track:
*"****To-Do list is very helpful to me*** *because I decide the day before what I'll be doing, but when the day comes, I just forget"* [P4].
"Being stressed makes us lose interest in what we are doing. So, To-Do List will be a great ***feature***

to give a reminder*"* [P9].

"I think a To-Do list is fantastic, and ***having something to remind you****, especially for women,* ***is a great tool****"* [P23].

Further, participants considered having a gratitude corner will affect their mood, as it will "*...bring positivity*" [P37] and "*enlighten our mood whenever we are sad ...*" [P34].

- **The Usefulness of Feedback Provided by the App:**

Previous research has shown the need for health literacy and providing patients with information regarding their current health status [96,156,209]. Stormacq et al. and Wittink et al. [138,160] stated that individuals with limited literacy have higher rates of illness and more hospitalizations and recommended that efforts be made to enable patients with limited reading abilities to access health information in a way they can interpret and relate to the given information. Equally important is the need to provide patients with relevant information on their medical condition and progress [113]. Musiat et al. [96] recommended personalized patient feedback to improve disease prevention and management. Personalized feedback was seen as a factor that can increase motivation, highlight risks, change attitudes, and counterbalance the lack of personal contact in computerized health interventions.

In our design, we provided features such as the Hobby Corner and Mood tracker to give users an overview of their hobbies and mental and emotional state over time. Comments from participants indicate that these features were perceived as effective. Participants' responses show that users were glad to see how these features provide feedback. For example, two participants mentioned that they would be excited to see how their mood was throughout the month and how they could reflect on it:

"Mood tracker is impressive, and this is a very interesting thing. I ***would be excited to see*** *how many days I* ***was happy and sad or calm or tired****"* [P2].

"I feel that the mood tracker will ***help a person gauge how many days they were angry*** *and what was the reason for being angry or getting angry so that they* ***can work on those things and get over with it****"* [P6].

One participant mentioned that having the ability to track their mood can help them during their consultation with their doctor:

"This way, I will have a ***picture*** *of the mood tracker. If you know how things are going and* ***consult your doctor,*** *you could show the chart, and they can see* ***what I was like for the past month****. So, this*

is a good thing" [P9].

Many participants appreciated having a hobby corner as they believed that it is a reminder for them to dedicate time for self-love, "*I forget to have my own "me" time…these reminders which are affirming is great.*" [P24], "*help us analyze that we have some time for ourselves*…" [P18].

- **User Interface:**

Shirazi et al. [133] investigated the UI pattern in mobile apps using the 400 most downloaded free apps from the Android store. They found that the complexity of mobile interface differs between app categories (Tools, Communication, Entertainment, Efficiency, Social Networks, and so on). The study shows that developers use a combination of layouts and visual components to structure the app UI. The Scrollable View with Linear Layout was the most used layout, with Text and Image being the two most-used components. Interactive elements such as buttons (radio buttons, checkboxes, buttons) were less used, implying mobile apps have lower interactivity when compared to the display of information.

Although automated user-experience tools were not used in designing the prototype, we made efforts to understand the target users and study their preferences concerning the display of information during Phase 2 of the study. The comments from participants of Phase 2 demonstrated that the design was well-received by the target audience and that having an organized screen makes the users feel good and in control of their app. For example, one participant clearly understood the app when they said:
"Every option is ***so clear*** *that* ***you can understand by reading the name*** *and directly start with the application. It is very clear"* [P15].

One participant mentioned that having all the options organized on the home screen made them feel relaxed, as "*it is simple and properly organized…it made me feel calm*" [P22].

Further, a participant mentioned how the functionality of this app would replace various apps on her phone, "…*very impressed by the number of elements…you just brought everything together in one home screen…makes me feel better*" [P27].

- **Finding a Safe Space:**

Pernice-Duca [116] highlighted family support's positive role in recovering patients with mental

health issues. From her research, interactions of family members through periodic contact are important dimensions of a support network related to recovery. Avasthi [13] noted that the family is a key resource for patients with mental health problems in India — because of: (1) the Indian tradition of interdependence and concern for a family member in adversities and (2) the lack of trained mental health professionals required for the large population. Indian psychiatry care integrates family support into patient care. Uchino et al. [146] reviewed research linking social support and mental health outcome. The review showed that social support is perceived to influence mental health positively. Therefore, having a secure means by which patients can share information about their condition, experience, or concerns within an appropriate context could help with faster recovery. Given this and based on feedback from participants, the features such as the Social Community and the Gratitude corner were designed. The comments from participants show that they felt these features provided them with a space where no one would judge them. For example, one participant mentioned that this is their safe space:

*"This is a good way of **providing people with a safe space or corner** where they can have some **positivity in their day-to-day life**"* [P17].

On the other hand, one participant mentioned that no one would judge them if they boasted about their lives in the gratitude corner:

*"**No one will judge** that you are feeling proud"* [P20].

Moreover, participants think that the gratitude corner will help them realize that there are good parts in their lives as well:

*"Sometimes, we feel grateful for certain things, but **we take them for granted**. So, we normally do not mention that, but I think **it is a good practice to be grateful for certain things**"* [P23].

The idea of being a part of a social community brought a sense of togetherness to our participants:

*"I think Social Community **will give people a sense of belongingness** when we share the stress and feel **we are not alone** so that itself can provide a lot of help"* [P30].

*"Being a part of a community **is like a family**. It is always good to have a **community of like-minded people**. If people are going through the same thing, they can **encourage other people**"* [P39].

- **Suggestions:**

One of the main goals of our study is to design a persuasive user-centric app. In the UCD approach, it is very important to involve users in the design process and include the important suggestions they

made. This ensures that user needs are taken into consideration. Also, users would feel they have been an essential part of the process. The participants in Phase 2 actively participated in providing suggestions. For example, a few participants wanted more control over timers, "*In breathe feature add a timer which the user can pause…*" [P7], "*countdown speed can be reduced in the breathe feature*" [P14].

Users also felt that customization is important to them:
"If there is an ***option to change the colour theme in the mood tracker,*** *it would be a good idea"* [P22].
"Some people like me ***prefer a dark theme****. Most people are accessing mobile late at night, and there is a great strain on eyes when the screen is too bright"* [P25].

Many users suggested an alternative positioning of the options, "*putting the gratitude corner in the upper columns…*" [P33], making things more graphic, "*…changing the background of meditation music based on music…*" [P2], "*make the To-Do list more pictorial*" [P25], and receive intensive feedback/suggestions:
*"****Add affirmation reminders****, if possible, to the gratitude corner"* [P27].

5.1.3 Phase 3

After asking the participants to use the prototype and interviewing them in phase 2, we took all the main suggestions and implemented them into our *iCare* app. We did this because it is a major step in our User-Centered Design approach, and we wanted to keep our target audience involved throughout the design and development process of the *iCare* app. After designing the app, we asked 30 working-class Indian women to use the app for two weeks, of which 22 participants agreed to an interview. The interview questions were structured to capture the participants' overall experience with the app, design suggestions, and likes or dislikes. Some of the questions asked were: "What did you think about the app; Do you think you can trust the app? Why or why not?"

From the thematic analysis of the responses from the 22 participants in the interview, we identified seven core themes: (1) Effectiveness of the App for Stress and Anxiety Management, (2) User Interface, (3) Discovery About Oneself, (4) Element of Surprise in the App, (5) Using the App in the Long Run, (6) Expectations and Suggestions, and (7) Overall Experience. Below, we present the themes in detail with a sample supporting quotes from our participants' interviews.

- **Effectiveness of the App for Stress and Anxiety Management:**

This theme helped us identify whether the app was effective for the participants or not. We received positive comments from our participants about their experiences while using the app. For example, one participant mentioned that the app helped her to check in with herself daily:

"*I was **checking in with myself daily**. So, when I went to the mood tracker feature, I **assessed what I was feeling right now** and how has my day been. It helped me gauge my experience, and **regulating my emotions,** I witnessed my feelings*" [P1].

Another participant described the experience as a "*self-reflection journey*" [P5] and that it was like "*Everyday interaction with someone you know…*" [P7], another participant represented the app as the "*peace corner, and it was so relaxing…*" [P10].

Further, one participant mentioned that *iCare* "*stimulated me to be happy*" [P6].

After using the app for two weeks, most participants highlighted that they noticed positive changes in how they handled things and situations in their life. For example:

"***I have started remembering things**; I used to forget the things that I must complete in a day, and now **with the help of the To-Do List** and the **reminders,** I can remember and complete my task on time. **I feel different***" [P3].

***I do feel some difference** because I could self-reflect and observe how I felt and what I felt every day. So, it did help me, and I can continue using this app as I **think I now have a habit of mood tracking every day**.*" [P4]

*"**To-Do list is beneficial** because I decide the day before what I'll be doing, but when the day comes, I just forget."* [P7]

*"I think a To-Do list is fantastic, and **having something to remind you**, especially for women, **is a great tool**"* [P24].

*"**I trust this app** because I have seen very positive things in my daily life, like being punctual for the yoga session. It is very peaceful and **allows me to complete things** on time."* [P30]

Another participant mentioned that she feels good after expressing gratitude, "*I think you are counting your blessings…. it is tough to feel any negative feelings*" [P7].

Further, one participant felt she is now committed to dedicating time to self-love. For example:

"*I feel **I am obligated to spare 5 or 10 minutes** or how much I want with the activities that I like to*

do, be it meditation or hobbies or anything for that matter" [P11].

This theme provides more insights that support our quantitative findings for RQ1: "*How effective is the iCare app in promoting positive changes toward stress and anxiety management*?" The comments from the users in this theme support that the *iCare* app brought a positive change in their routine that led to better stress and anxiety management.

- **User Interface:**

This theme helped us determine whether the design and the features were acceptable to the target audience. Participants generally found the app easier to use compared to other apps they had used. For example:

"*The **interface of this app is beautiful**! **There are multiple other third-party applications** whose **interfaces are not up to the mark,** and there is so much lag that users come across. But with this app, there **were no difficulties that I faced***" [P1].

Few participants highlighted that gratitude and hobby corner features were new to them, and they motivated them to fix positive goals and customize their experience. One participant mentioned that they "*have not seen gratitude corner in any other app…*" [P6], and "*the mood tracker is so easy to use…*" [P6]. Another participant mentioned she was "*attracted to the hobby corner feature… we can expand and customize to our use*" [P12].

Participants also mentioned how having icons and themes attracted them to the feature. For example:

"*I liked the hobby corner and the mood tracker. Also, **I like the icons** you used, which were **very interesting. I liked the themes**, like how you can change to white and black theme*" [P13].

All these comments support the quantitative results of the Perceived Aesthetics Scale, as the app was considered attractive by the users.

- **Discovery about Oneself:**

This theme reflects how the app helped participants discover several things about themselves and their lives. One participant mentioned how she used to see herself as an angry person, but this app changed that perspective. For example:

"*I saw that in the **past two weeks, I had not selected angry** even once in the mood tracker, and **I think of myself as a person who gets angry easily**, but then I noticed that when I go to the app, and I assess my day, anger is not the prominent feeling. **It means other things I think of myself might***

not necessarily be true" [P6].

Participants mentioned how the app helped them to gain confidence and calmness. For example:

"***I thought I did not have what it takes to complete all the targets*** *in one day. But now I feel I can do it if I give proper time to everything.* ***I am good at task management now***" [P7].
"***I believed that I was not a big fan of meditation****, but I think the sounds in the meditation music were very relaxing, and I felt like* ***I would keep aside 5 or 10 minutes in a day*** *to refresh myself before I get started with my day*" [P10].
"*It helped in increasing my self-awareness.* ***I did not know that breathing exercises could work so well personally*** *to calm me down;* ***that was new***" [P13].

All these comments show that participants positively responded to app features and had a good user experience.

- **Element of Surprise in the App:**

This theme uncovered how the app surprised the participants, as one participant mentioned, "*In the social community section, I was not expecting replies from people…*" [P13]. Another participant defined her experience as effortless "*…I thought I would need a demo to use the app, but to my surprise, it was effortless*" [P15].

Participants also mentioned how having a finger lock and the playlist of meditation music surprised them. For example:

"*I* ***did not expect it to have a finger lock*** *system. But that* ***helped*** *me as I always used to* ***lock it after writing in the diary***" [P20].
"*The one thing that surprised me was the* ***meditation music playlist, as it kept getting better daily****. For example, the last music I listened to while I was happy is automatically selected by the app when I am not in a good mood*" [P22].

All these comments support the quantitative results of the System Usability Scale, as the app was considered usable by the users.

- **Using the App in the Long Run:**

This theme highlights how the users were optimistic about making this app a part of their lives. For example, one participant mentioned that this app is a *"one-stop for various features…"* [P3], another

participant mentioned that *"I can use it daily or whenever I want to… I have felt major differences in my life"* [P10]

Participants saw the *iCare* app as a reminder to practice self-love. For example:

"*This app is a **constant reminder** that I need to **take time for myself** and **helps me with stress management**. I am **going to continue using it***" [P17].
"*This is the only app among the 20 to 30 apps on my phone which **will be constant**, as it has the **features that will improve me in different ways**, whether physically or spiritually*" [P19].

- **Expectations and Suggestions:**

This theme shows what other things/features participants expected from the app and their suggestions. For example, one participant mentioned being able to "*doodle or add pictures in the diary…*" [P3], other participants wanted to integrate "*physical exercise options*" [P4].

Participants wanted more mood options for the mood tracker and a personalized self-awareness feature. For example:

"***Increasing the number of emotions in the mood tracker** could help. I think four emotions were mentioned. So maybe we could mention the six prominent emotions we generally talk about in psychology*" [P10].
"*I think there are articles on stress, anxiety relationship, and warning signs under **self-awareness**. But if it **could be personalized**. So, if there is a stress scale and I fill it out of 10 questions, I feel an eight, so I **get personalized suggestions on managing my stress**…*" [P7].

One participant suggested that we should "*…add more sounds to mediation music*" [P12], and another participant mentioned having a "*recurring reminder option…*" [P18].

- **Overall Experience:**

This theme summarized the overall experience of the participants with the app. One participant shared that her "*experience was good…hobby corner helped me keep track of the hobbies…*" [P3], another participant mentioned, "*…the app is very user-friendly… it helps in improving the mood…*" [P6]. Other participants mentioned her experience as "*a journey to self-reflection…*" [P9]

Participants highlighted that they enjoyed the app overall, and it helped with stress management. For example:

"*I **enjoyed using the app** and every part of it, recording the voice memo, and using the gratitude corner or reminders. So, I **did not find anything which was not helpful***" [P11].

"*Overall, I liked the app and **would 100% recommend it to more people**. It has great features that **help build healthy habits and stress management***" [P25].

"*It was a **great pleasure to use this app**. It made me **feel happy**, and I could dedicate time to myself in such a busy schedule. This eventually **allowed me to explore more about myself**. I would love to use this app forever*" [P30].

Table 5.2 summarizes all the themes that emerged from this study.

Table 5. 2: Summary of themes that emerged from this study

Phase 1	Events that Trigger Stress/Anxiety, Habits/Activities to Manage Stress/Anxiety, Social and Personal Factors that Play Major Roles in Mental Health, Participants' Views About Popular Existing Mental Health Apps - Headspace And Happify, Views on Features of the Apps, Motivation to Use the Mental Health App.
Phase 2	Importance of Aesthetics, The Benefits of Being Anonymous, The Power of Customization, The Power of Personalization, Effectiveness of the App for Stress and Anxiety Management, The Usefulness of Feedback Provided by the App, User Interface, Finding a Safe Space, and Suggestions from the Participants.
Phase 3	Effectiveness of the App for Stress and Anxiety Management, User Interface, Discovery About Oneself, Element of Surprise in the App, Using the App in the Long Run, Expectations and Suggestions, and Overall Experience.

5.2 Quantitative Results

First, we computed the descriptive statistics (means and standard deviations) for our pre- and post-test Perceived Stress Scale (PSS) and Generalized Anxiety Disorder (GAD) Scale results. Before conducting a comprehensive analysis, we performed the Shapiro-Wilk normality test [210] to determine the distribution of pre-and post-test data. Table 5.3 summarizes the results of the descriptive statistics and the Shapiro-Wilk test results. The results show that our data is not normally distributed for the PSS and GAD Scale. Therefore, we conducted the Wilcoxon signed-rank test [203] to compare pre-and post-tests for our dependent measures, the PSS and GAD Scale. Pre-test results of PSS (Mean = 2.19, Median = 2.10) and GAD Scale (Mean = 1.52, Median = 1.29) were greater than post-test results PSS (Mean = 1.70, Median = 1.70), GAD Scale (Mean = .97, Median = .93). (Mean = .97, Median = .93).

Table 5. 3: Summary results of the descriptive statistics and the Shapiro-Wilk test (M= Mean, SD= Standard

Deviation, W= Statistics, *df* = degrees of freedom, *p* = probability), N= 30

	Pre-test						**Post-test**					
	Descriptive statistics			Shapiro-Wilk test			Descriptive statistics			Shapiro-Wilk test		
Measures	**M**	**Median**	**SD**	**W**	***df***	***p***	**M**	**Median**	**SD**	**W**	***df***	***p***
PSS	2.19	2.10	.54	.97	30	.50	1.70	1.70	.63	.92	30	.02
GAD	1.52	1.29	.65	.89	30	.01	.97	.93	.81	.91	30	.02

From Table 5.3, we can notice that the pre-test means are greater than the post-test means, giving us an initial impression that our intervention successfully reduced stress and anxiety among participants.

5.2.1 Effects of the *iCare* App on the Levels of Stress and Anxiety

The results of the Wilcoxon signed-rank test answer RQ1: "*How effective is the iCare app in promoting positive changes toward stress and anxiety management?*"

A Wilcoxon signed-rank test showed that, after using the *iCare* app for two weeks, participants showed a statistically significant decline in their stress level ($Z = -3.00$, $p < 0.001$) and their level of anxiety ($Z = -2.21$, $p = 0.03$). In this study, stress and anxiety refer to day-to-day activities that can disrupt mental harmony, which does not require an official psychological diagnosis. Table 5.4 summarizes the results of the Wilcoxon signed-rank test for PSS and GAD Scale pre-and post-test.

Table 5. 4: Wilcoxon signed-rank test results for PSS and GAD Scale Pre- and Post-test, N= 30

Measures	**Z**	***p***
PSS	-3.00	<.001
GAD	-2.21	0.03

To further support our results, we plotted the mean values of the agreement for the PSS pre-and post-test, respectively (Figure 5.1). Similarly, we generated the same type of plot for the GAD scale (Figure 5.2).

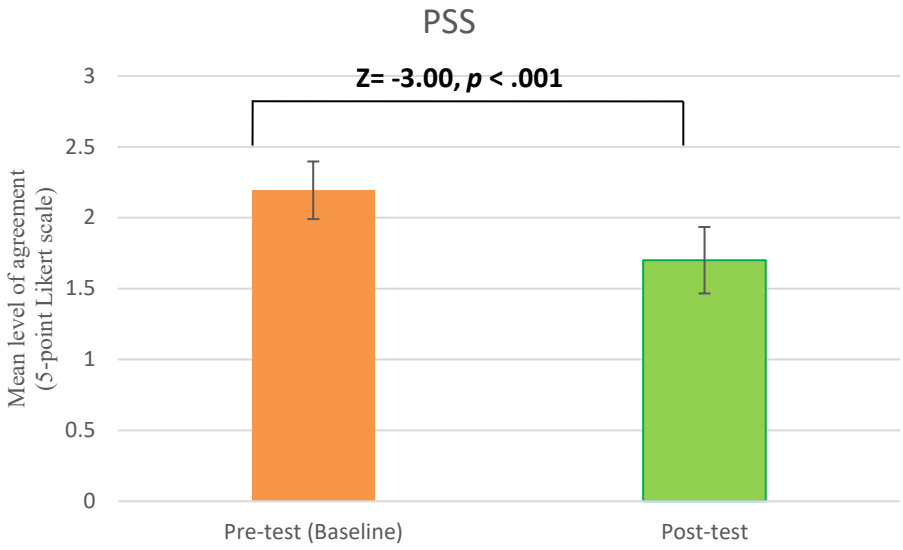


Figure 5. 1: A bar chart showing the mean level of agreement for PSS (pre and post). Error bars represent a 95% confidence interval

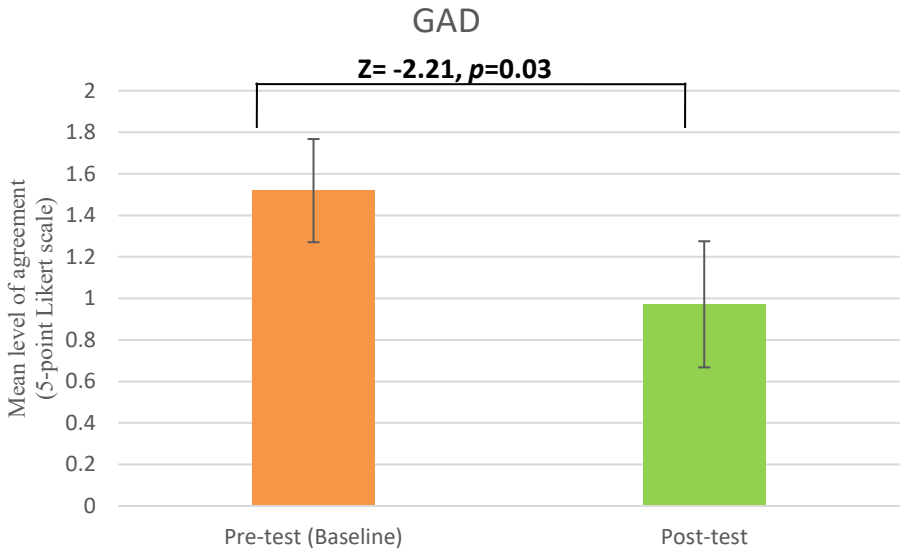


Figure 5. 2: A bar chart showing the mean level of agreement for GAD (pre and post). Error bars represent a 95% confidence interval

5.2.2 Determining the Results of BMIS

We analyzed the results of the Brief Mood Introspection Scale (BMIS) over two weeks. The scale was a 5-point Likert scale with three as a neutral value. We divided the scale into two moods based on the scoring techniques for the BMIS for Pleasant-Unpleasant Moods [211]: Pleasant (Lively, Happy, Caring, Content, Peppy, Calm, Loving, Active) and Unpleasant (Sad, Tired, Gloomy, Jittery, Drowsy, Grouchy, Nervous, Fed up). We had 420 entries (14 per participant for two weeks) and 210 per mood: Pleasant and Unpleasant The participants had the option to choose from:

1. Definitely do not feel
2. Do not feel
3. Neutral
4. Slightly feel
5. Definitely feel

We calculated the Mean, Median, and Standard Deviation (SD) for our week one and week two Unpleasant mood (Sad, Tired, Gloomy, Jittery, Drowsy, Grouchy, Nervous, and Fed up) and Pleasant mood (Lively, Happy, Caring, Content, Peppy, Calm, Loving, Active). To determine the distribution of week one and week two for choosing an appropriate statistical method, we performed the Shapiro-Wilk test of normality [210] and significance values were not greater than .05, indicating that the distribution is not normal for the unpleasant and pleasant moods. As a result, we performed the non-parametric Wilcoxon signed-rank test [203] to compare weeks one and two for our dependent measures, the unpleasant and pleasant moods.

Tables 5.5 and 5.6 summarize the results of the descriptive statistics and the Shapiro-Wilk test for unpleasant and pleasant moods.

Table 5. 5: Summary results of the descriptive statistics and the Shapiro-Wilk test of Unpleasant mood (M= Mean, Mdn = Median, SD= Standard Deviation, W= Statistics, *df* = degrees of freedom, *p* = probability), N= 30

	Week 1						**Week 2**					
	Descriptive statistics			Shapiro-Wilk test			Descriptive statistics			Shapiro-Wilk test		
Measures	**M**	**Mdn**	**SD**	**W**	***df***	***p***	**M** [a]	**Mdn**	**SD**	**W**	***df***	***p***
Sad	28.70	28.00	4.50	.90	30	.01	31.03	33.50	5.16	.79	30	<.001
Tired	24.50	23.50	7.41	.93	30	.05	29.03	31.50	6.86	.79	30	<.001
Gloomy	27.27	27.00	5.28	.95	30	.14	30.80	32.50	5.17	.81	30	<.001
Jittery	28.53	30.00	5.88	.90	30	.01	30.93	33.00	5.12	.80	30	<.001
Drowsy	25.67	26.00	7.26	.93	30	.04	30.00	33.00	5.77	.83	30	<.001
Grouchy	29.07	30.50	5.64	.89	30	.01	31.80	34.00	4.54	.74	30	<.001
Nervous	28.57	28.50	5.50	.91	30	.02	30.80	32.50	5.03	.82	30	<.001
Fed up	28.70	30.00	5.63	.90	30	.01	31.33	33.50	4.94	.76	30	<.001

[a] Mean for the second week is higher because the scores were reversed.

Table 5. 6: Summary results of the descriptive statistics and the Shapiro-Wilk test of Pleasant mood (M= Mean, Mdn = Median, SD= Standard Deviation, W= Statistics, *df* = degrees of freedom, *p* = probability), N= 30

	Week 1						Week 2					
	Descriptive statistics			Shapiro-Wilk test			Descriptive statistics			Shapiro-Wilk test		
Measures	**M**	**Mdn**	**SD**	**W**	***df***	***p***	**M**	**Mdn**	**SD**	**W**	***df***	***p***
Happy	31.27	33.00	4.01	.84	30	<.001	32.57	35.00	3.75	.70	30	<.001
Active	27.77	29.00	6.13	.88	30	<.001	29.67	31.50	5.49	.85	30	<.001
Peppy	27.87	29.50	6.42	.86	30	<.001	30.03	31.50	5.26	.86	30	<.001
Caring	30.20	30.00	3.63	.93	30	.04	32.03	33.00	3.18	.84	30	<.001
Lively	30.93	33.00	5.13	.75	30	<.001	32.00	35.00	4.77	.69	30	<.001
Loving	30.17	31.00	3.57	.91	30	.02	31.13	33.00	4.32	.79	30	<.001
Calm	30.10	30.00	3.73	.93	30	.05	31.93	33.50	3.94	.78	30	<.001
Content	28.50	30.00	5.74	.87	30	<.001	30.87	33.00	5.27	.78	30	<.001

5.2.3 Wilcoxon signed-rank test for BMIS

The Wilcoxon signed-rank test's results helped us answer our RQ1: "*How effective is the iCare app in promoting positive changes toward stress and anxiety management?*" Since the unpleasant and pleasant moods are from the Brief Mood Introspection Scale, we had to reverse the score of unpleasant mood results [211] i.e., 1 = 5, 2 = 4, 3 = 3, 4 = 2, and 5 = 1, to make our results consistent for both mood entries.

The results of the Wilcoxon signed-rank test show our participants experienced improvements in their mood after using the *iCare* app. A Wilcoxon signed-rank test showed that, after using the *iCare* app for two weeks, the participants showed a statistically significant positive change in their unpleasant and pleasant moods except for lively and loving, where although there was a change, they were not significant. Tables 5.7 and 5.8 summarize the results of the Wilcoxon signed-rank test for week one and week two for unpleasant and pleasant moods. Frequency represents the number of times the emotion was chosen each week.

Table 5. 7: Wilcoxon signed-rank test results for week 1 and week 2 Unpleasant mood, N= 30

Measures	**Z**	***p***	**Frequency week 1**	**Frequency week 2**
Sad	-2.77	.01	20	5
Tired	-3.41	<.001	23	5
Gloomy	-2.97	<.001	21	6
Jittery	-2.01	.04	19	8
Drowsy	-3.20	<.001	24	5
Grouchy	-2.75	.01	18	6
Nervous	-2.16	.03	17	10
Fed up	-2.96	<.001	20	7

Table 5. 8: Wilcoxon signed-rank test results for week 1 and week 2 Pleasant mood, N= 30

Measures	Z	*p*	Frequency week 1	Frequency week 2
Happy	-2.11	.04	5	16
Active	-1.99	.05	7	19
Peppy	-2.30	.02	7	19
Caring	-2.35	.02	8	20
Lively	-1.58	.11	6	19
Loving	-1.29	.20	8	16
Calm	-2.42	.02	7	21
Content	-2.95	<.001	4	23

To further support our results, we calculated the number of times (frequency) participants selected any given option (for example, 1 for "definitely do not feel"). Figure 5.3 shows the frequency comparison of answers for unpleasant mood during the first and second weeks.

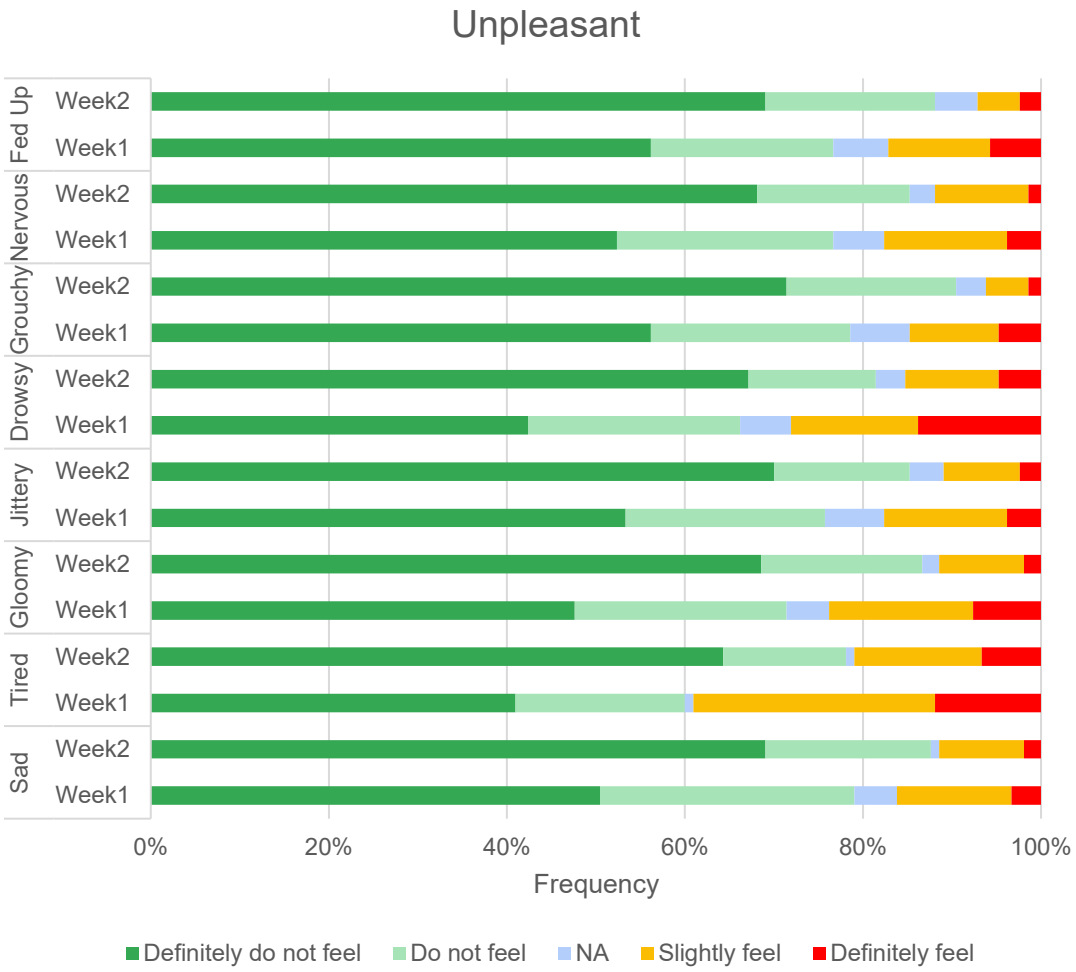


Figure 5. 3: A bar chart showing the frequency comparison of answers during the first and second week for unpleasant mood

Similarly, to the unpleasant mood, we calculated the number of times (frequency) participants selected any given option (for example, 1 for "definitely do not feel"). Figure 5.4 shows the frequency comparison of answers for pleasant mood during the first and second weeks.

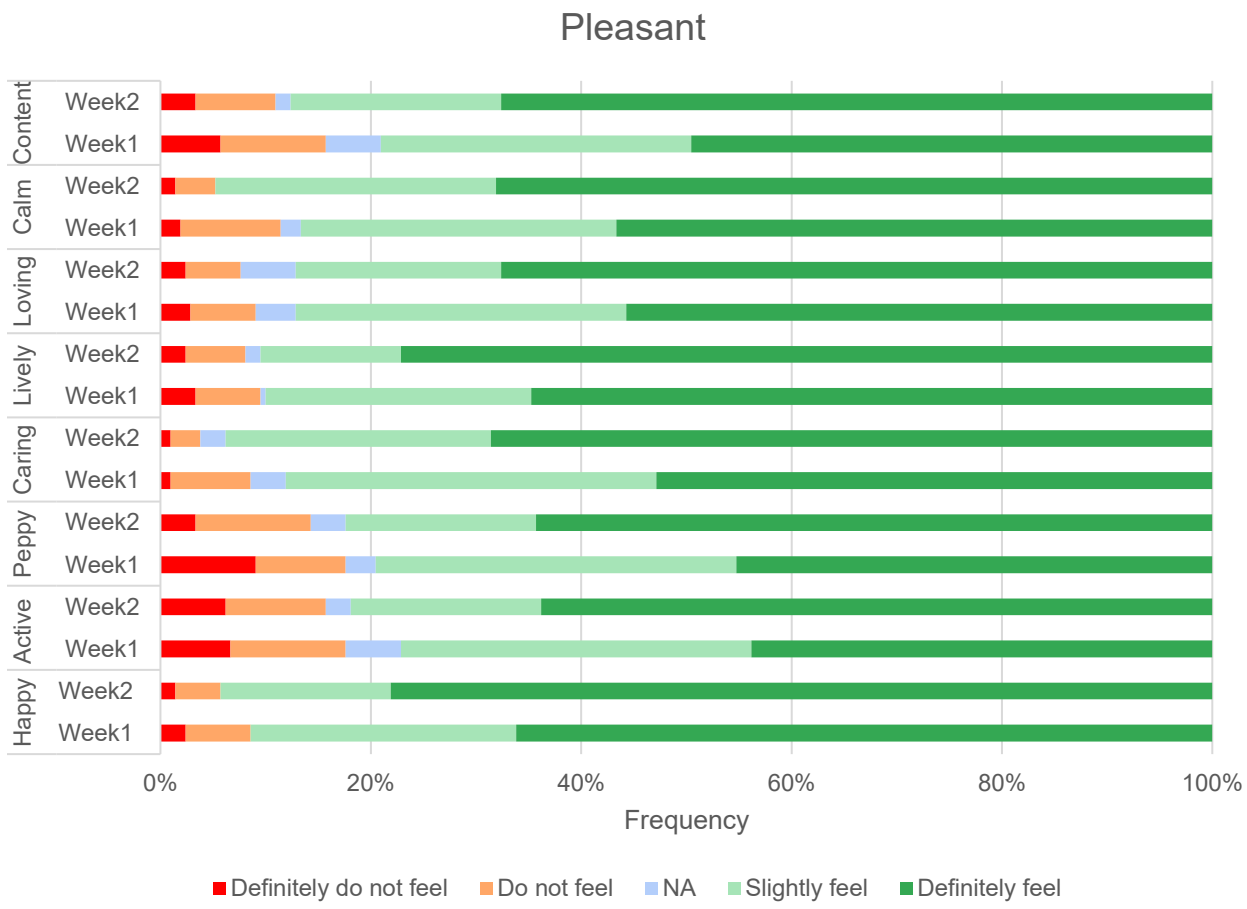


Figure 5. 4: A bar chart showing the frequency of answers during the first week for pleasant mood

We can deduce from these bar charts that the *iCare* app successfully changed or maintained our participants' mood to pleasant. Therefore, it could promote positive change toward stress and anxiety management (RQ1: "*How effective is the iCare app in promoting positive changes toward stress and anxiety management?*"). We believe we could see much better results in three to six weeks, which is a positive sign for conducting a longitudinal study with a larger sample size. According to Lally et al. [75], individuals can take, on average, 66 days to change habits into behaviour, with a range of 18-254 days.

5.2.4 Motivational Appeal of the *iCare* App

We investigated the motivational appeal of the *iCare* app by performing a One-Sample t-test [204] on the data. We compared the data against a neutral rating of 3 on a 5-point Likert ARCS motivation

scale (1 = Strongly Disagree to 5 = Strongly Agree). The results show that all four constructs of the ARCS motivational model significantly differ from the neutral point ($p < .001$). The One-Sample t-test shows that the *iCare* app is effective with respect to motivational appeal (Table 5.9). Overall, the app is effective and could motivate our participants to manage their stress and anxiety by answering our RQ2: "*How effective is the iCare app with respect to motivational appeal?*"

Table 5. 9: Total participants (N), Mean (M), Standard Deviations (SD), Median (Mdn), Mean Difference (MD), t-values (t2), and significance levels *(*p*)* on a scale from 1(low) to 5(high) for motivational appeal, N= 30

Measures	**Mean**	**SD**	**Mdn**	**MD**	**t2**	***p***
Attention	4.18	.65	4.00	1.18	9.98	<.001
Relevance	4.49	.47	4.38	1.49	17.52	<.001
Confidence	4.53	.43	4.50	1.53	19.75	<.001
Satisfaction	4.49	.54	4.67	1.49	14.97	<.001

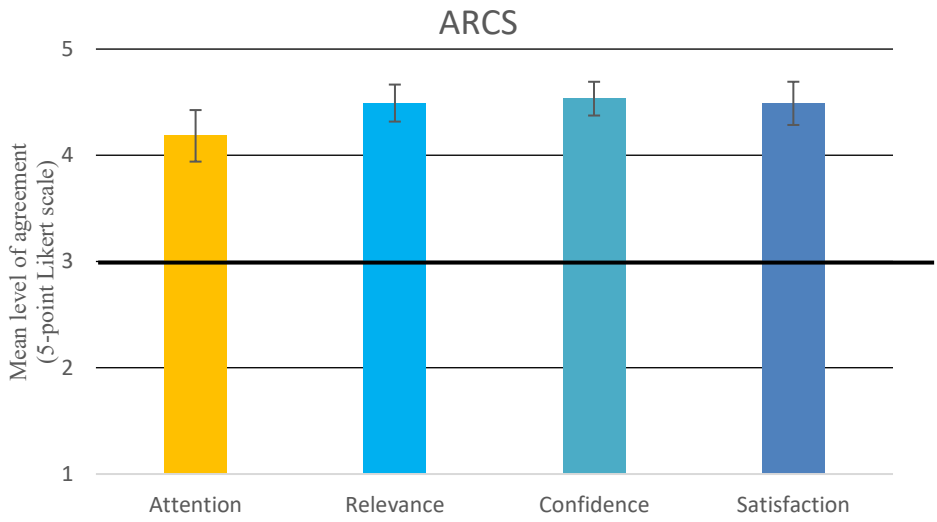


Figure 5. 5: A bar chart showing the motivational appeal of the app on a scale ranging from 1 to 5. The horizontal line indicates a neutral score of 3

5.2.5 User Experience and Aesthetics of the *iCare* App

To find whether the user had a positive experience using the app and whether the app was aesthetically pleasing, we conducted a One-Sample t-test on the System Usability Scale (SUS), User Experience Questionnaire (UEQ), and Perceived Aesthetics Scale.

We compared the data against a neutral rating of 3 on a 5-point Likert scale. In general, the results show that the app is effective in terms of usability and aesthetics (Table 5.10). All three scales (SUS, UEQ, and Perceived Aesthetics) are significantly higher than the neutral value ($p < .001$). Overall,

the app can promote a positive user experience, which answers RQ3: "*How effectively is the iCare app promoting a positive user experience?*"

Table 5. 10: Total participants (N), Mean (M), Standard Deviations (SD), Median (Mdn), Mean Difference (MD), t-values (t2), and significance levels (*p*) on a scale from 1(low) to 5(high) for System Usability Scale, UEQ, and Perceived Aesthetics Scales, N = 30

Measures	**Mean**	**SD**	**Mdn**	**MD**	**t2**	***p***
SUS	3.58	.35	3.60	.58	9.05	<.001
UEQ	4.63	.40	4.75	1.63	22.33	<.001
Perceived Aesthetics Scale	4.41	.51	4.41	1.41	15.21	<.001

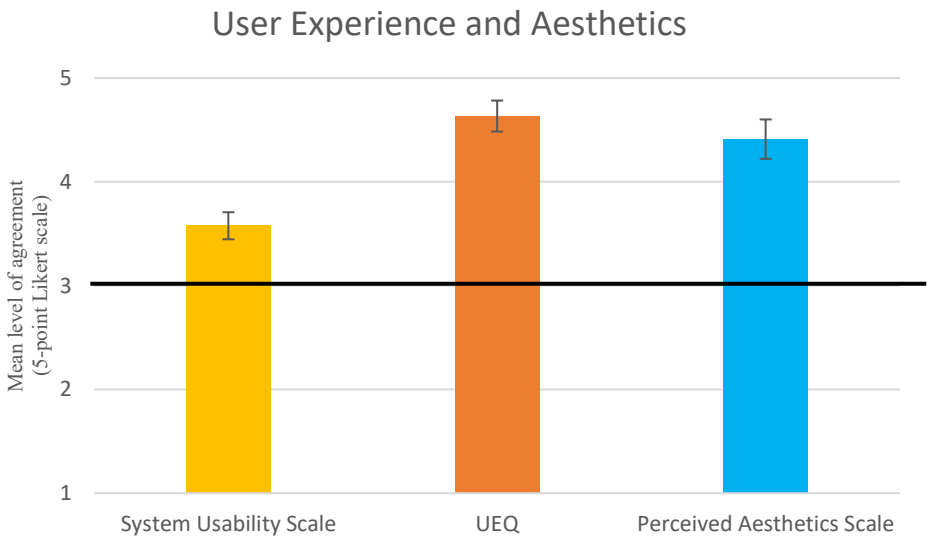


Figure 5. 6: A bar chart showing the user experience and Aesthetics of the app on a scale ranging from 1 to 5. The horizontal line indicates a neutral score of 3

5.2.6 Perceived Persuasiveness and Usefulness of the *iCare* App

To answer RQ4: "*How persuasive and useful is the iCare app in motivating users to manage stress and anxiety*?" We investigated the persuasiveness and usefulness of the *iCare* app by performing a One-Sample t-test on the scale data. We used the Perceived Persuasiveness and Perceived Usefulness Scales as our measurement instruments. We compared the data against a neutral rating of 3 on a 5-point Likert scale. In general, the results of the One-Sample t-test show that the app is effective in its persuasiveness and usefulness (Table 5.11); the results show that both the scales (Perceived Persuasiveness and Perceived Usefulness) are significantly different from the neutral point ($p < 0.001$). The higher the persuasiveness and usefulness of the intervention, the more the likelihood of the intervention causing the desired behaviour change. Overall, the app can be

persuasive and useful in motivating users to manage stress and anxiety.

Table 5. 11: Total participants (N), Mean (M), Standard Deviations (SD), Median (Mdn), Mean Difference (MD), t-values (t2), and significance levels (*p*) on a scale from 1(low) to 5(high) for Perceived Persuasiveness and Perceived Usefulness Scales, N = 30

Measures	**Mean**	**SD**	**Mdn**	**MD**	**t2**	***p***
Perceived Persuasiveness	4.33	.521	4.13	1.33	13.91	<.001
Perceived Usefulness	4.44	.511	4.38	1.44	15.44	<.001

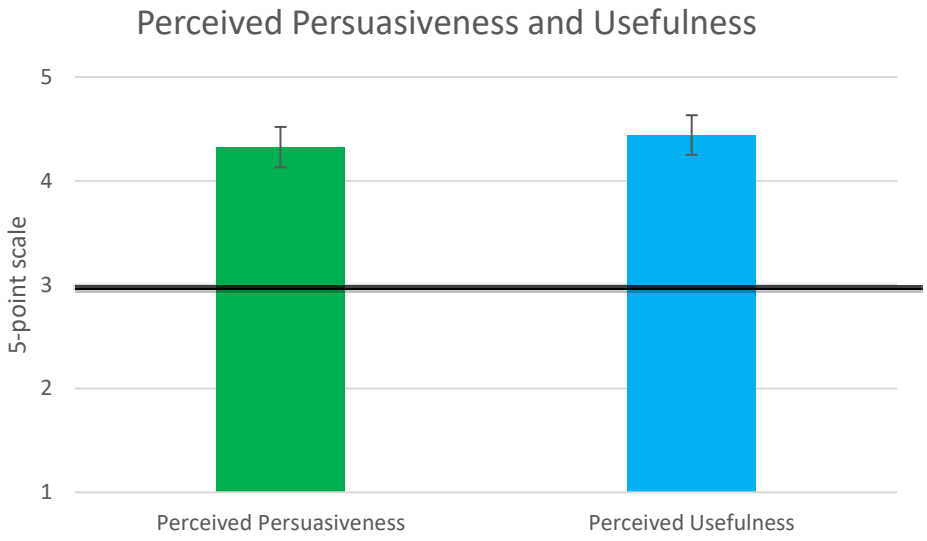


Figure 5. 7: A bar chart showing the perceived persuasiveness and usefulness of the app on a scale ranging from 1 to 5. The horizontal line indicates a neutral score of 3

6 CHAPTER 6: DISCUSSION

This research aimed to evaluate the effectiveness of the *iCare* app explicitly designed to aid in managing stress and anxiety among working-class Indian women. The two-week in-the-wild evaluation results answered our overarching RQ: "*Is the iCare app effective in promoting stress and anxiety management among working-class Indian women?*" Recall that the four RQs we developed to answer our overarching RQ were:

RQ1: *How effective is the iCare app in promoting positive changes toward stress and anxiety management?*

By answering RQ1, we could determine the effectiveness of the *iCare* app in promoting a reduction in stress and anxiety levels.

RQ2: *How effective is the iCare app with respect to motivational appeal?*

Previous studies [1,167] have employed the Attention, Relevance, Confidence, and Satisfaction (ARCS) motivation model [179] to evaluate the motivational appeal of an interactive persuasive system. Moreover, the ARCS motivation model is widely used to inform the design and evaluation of the motivational appeal of persuasive systems. Therefore, we used the ARCS motivation model to determine the overall motivational appeal of the *iCare* app across the four dimensions of motivation: (1) Attention, (2) Relevance, (3) Confidence, and (4) Satisfaction by answering RQ2.

RQ3: *How effectively is the iCare app promoting a positive user experience?*

One reason people use mHealth apps in the first place is to experience a change in their lives and have a positive experience [132]. For users to keep using the app, it must hold the user's interest and not become monotonous. Hence, we examined whether users had a positive user experience by answering RQ3.

RQ4: *How persuasive and useful is the iCare app in motivating users to manage stress and anxiety?*

Finally, we also examined the perceived persuasiveness and usefulness of the app concerning its ability to motivate the desired behaviour change to manage stress and anxiety, hence the final RQ4.

The evaluation's quantitative and qualitative results show that the app effectively achieved the design goal. Given the well-documented challenges of engaging individuals in mental health

promotion, insights from this study are critical for designing and developing successful mental health apps, especially those targeting working-class women from underserved communities. A careful examination is especially important for applications that claim to improve mental health. However, given the mHealth industry's speedy development and the regular release of new applications or updated versions of existing ones, research should ideally be quick and affordable. In this section, we discuss our findings and the implication of our results for designers and researchers.

6.1 *iCare* App and Persuasive Strategies

Individuals experiencing mental health problems typically want assistance from someone who will not judge or stereotype them. As a result, including an anonymous social community in the app matches the strategy participants used to deal with their challenges in real life. Because of the stigma associated with mental health among our target community, participants stated that contacting and talking to an anonymous person who has no way of knowing them would be preferable to getting and talking to someone who knows about them. They also viewed certain features like the gratitude corner (a feature to express what an individual is thankful for in her daily life) as a safe space and a peace corner. This supports our decision to include social facilitation and rehearsal Persuasive Strategies in the app. With this feature, entries made in the gratitude corner can be shared in the social community with other users (anonymously if users want). This is an example for others to learn from (social facilitation), and entries in the gratitude corner also make the user rehearse how to be thankful for every small thing (rehearsal).

Participants wanted to keep control of their lives as one of the significant sources of stress and anxiety is being overwhelmed by workload and inability to control and organize tasks. A To-Do list feature help declutter their brains and get more organized. This shows that although activities that directly help reduce stress and anxiety, such as meditation and relaxation, are important in this type of app, other activities that indirectly help manage stress and anxiety, such as To-Do lists, are equally important. Our results reveal two major ways an app can assist users in managing stress: by helping an already stressed or tense person manage the stress using activities such as meditation and relaxation. The second way is to include features that help manage stress sources, such as a To-Do list. Our findings show that it is important to have features that support both ways of managing stress in an app, as they work in different ways and seem to be complementary. However, it is also possible that some features may work better for certain people than others; hence, personalization may be

needed. For example, meditation may work best for some people, while gratitude or making a To-Do list works best for others.

The mood tracker feature, a customization option, and a hobby corner feature made participants feel more in control and on the right path toward self-discipline and love. Also, giving participants opportunities in the form of a diary or voice memo to express themselves made them feel that they were not restricted to just one feature and had options. This suggests that the self-monitoring Persuasive Strategy played a significant role in the effectiveness of the *iCare* app. One participant mentioned:

"***I felt so empowered*** *when I saw how many tasks I finished in a day. Also, being able to* ***change my appearance*** *for the social community makes the* ***app feel fresh***." [P14]

Our results show that the app was effective overall in promoting stress and anxiety management, and participants appreciated using it. This is in line with the qualitative comments from our participants. For example, participants in the interview said:

"*It was a great idea you came up with because I think this is the least discussed topic, especially in India. So,* ***this app is great*** *as it will help Indian working women. The* ***last two years have been a lot stressful***" [P2].
"*I'm* ***happy with the application,*** *and I'm glad that I agreed to be a part of this study because it helped me with many things, and I think I will continue using it*" [P10].

These comments support our findings that the app was successful in motivating the participants to manage stress and anxiety and have good mental health:

"*I found the* ***app wonderful****. It* ***helped me make myself accountable*** *and keep a check on my mental health*" [P20].

6.2 Changes Implemented to the App after the Phase 3 of the Study

Based on the participants' suggestions, we updated the *iCare* app, as this will help us in future studies. Table 6.1 shows the changes made to the features and suggestions/comments from the participants to support those changes.

Table 6. 1: Changes made to the features and comments to support those changes

Features	Changes	Comments
Diary	Added an edit button to the diary (Appendix Q).	*"There could be an editing option for the diary."* [P12]
Hobby corner	Added the option to pause the timer and added a create timer option (Appendix Q).	*"We should be able to pause the hobby corner timer and also create our timer."* [P14]
Hobby corner and Meditation music	Reflected the changes so that the timer and the music did not stop.	*"If the screen sleeps, the hobby corner timer shouldn't stop, or the meditation music shouldn't stop."* [P30]

6.3 Design Recommendations

Based on the results of this study, we found many different features that can be used to design mHealth apps for an underserved population to meet their requirements for mental health apps. Below, we offer a list of design recommendations for mental health apps that are likely to increase their effectiveness, usefulness, and ability to promote mental health.

- **Recommendation 1: Adding Reminders and To-Do List Strategies**

As in the case of working-class Indian women, they have a busy schedule, and having reminders can ease their burden of remembering the load of things based on their To-Do list. However, limiting the number of notifications and reminders is also important, as too many reminders can be distracting. Research shows that some users prefer frequent notifications because they need reminders to increase extended use, while others prefer fewer notifications because they can be a distraction [148]. Therefore, **mental health app designers should consider adding a reminder strategy** more frequently for users to take care of themselves based on the activities that are suitable for them. Thus, the app can allow users to set and customize their reminders according to user preferences.

Also, the app can assist participants in planning the activities in a way that leaves them some time for self-care and re-engaging in other leisurely activities they once enjoyed. It was on that note that a participant made this comment: "*I forget to have my own "me" time…these reminders which are affirming is great*" [P24]. We used a To-Do list to help users keep track of their tasks in the *iCare* app. A user reported that it was "fantastic to have something as a reminder" as they are very busy and can easily forget the tasks they need to do. It was helpful because it served as a tool to help them "decide the day before what I will be doing but when the day comes" so they do not forget. **The app can assist them by planning and helping users keep up with the many events in their busy lives**

and maintain a work-life balance.

- **Recommendation 2: Personalize the App by Suggesting New Strategies to Individual Users**

To personalize mental health apps, designers can suggest strategies using participants' profiles of what works for them. They can also recommend new strategies that have similarly worked for others and evaluate the effectiveness for that individual. If they are effective, include them in the list of effective procedures in the participant's profile. Concerning the strategies used in dealing with mental health issues, as mentioned in a study by Reen et al.[122], participants had different ways of handling stress, such as doing something to distract themselves from their current negative mood, so it is not wise to use a one-size-fits-all approach. For example, in the *iCare* app, we have added various features to lift participants' moods. Some may like to meditate while listening to music. "I think the sounds in the meditation music were very relaxing." In contrast, others may prefer the breathe feature "breathing exercises could work so well personally to calm me" or gratitude corner. Some might also want to share their feelings with the social community feature. Hence, **designers of mental health apps should consider how their audience deals with mental health issues, as this can help the users achieve the desired results.**

- **Recommendation 3: Ensure the User Interface is Simple and the Interactions are Straightforward**

Our results indicate that users appreciate having an app that is easy to use and understand. Existing studies show that mobile apps are often overly complex [158], and many find the interactions with the interface challenging [61,155]. Usability holds great importance concerning stress and anxiety management, as providing someone with an interface with complex navigation or a cluttered UI can increase their stress levels even more. If the interface is difficult to use, it could result in the abandonment of the app and, more importantly, add to their already stressful life. To verify that their app is usable, developers should **conduct a formal evaluation with the target audience**. Many users explained in the interview how easy it was to start using the interface because it was "easy to use." Based on these results, we suggest that the UI start with simple colours and an icon set so users can easily understand which features do what and add appropriate whitespaces (It is a white area surrounding a page's content and valuable features. White space's primary purpose is to create breathing room for your design by minimizing the quantity of text and functional items people view at once [207]) and trying to keep the home screen as decluttered as possible. This will likely improve

usability and increase adherence.

- **Recommendation 4: Make the App Reliable and Resourceful**

It is also crucial that the app only contains reliable information. These elements are critical for increasing user trust. In the *iCare* app, we added dedicated articles to the self-awareness feature where users could also click on the links to the actual resources. This made the participants believe that the provided information was legitimate and increased their trust in the app. Users prefer mHealth apps that are trustworthy [135], yet studies show that many apps fall short with respect to trustworthiness, appropriateness, personalization, and accessibility [152]. Our results also suggest that users prefer reliable resources which they can use and guide them when looking for information on improving their mental health. A user appreciated that the app's contents "helped in increasing self-awareness." **mHealth apps should offer reliable and resourceful resources, helping the user achieve their health goals.**

- **Recommendation 5: Encourage Users to Continue Using the App so they can Benefit from Learning to Manage their Stress**

A recent review of the perception of mHealth apps found that ease of use and usefulness of content are important factors to consider for sustaining user engagement [27]. Our results showed that users wanted to continue using it because it was useful in making them feel "happy" and "accountable" to themselves, ensuring that they are in good mental health, so they can cope with the stresses they experience in their day-to-day lives. One user said, "this app is a constant reminder that I need to take time for myself and helps me with stress management. I am going to continue using it" [P17]. Taken together, we recommend that mHealth apps should help users **recognize the importance of taking time to rejuvenate** and offer not only reminders but also **suggest relaxing activities that can alleviate stress**. For example, we added a hobby corner feature that will help users perform activities that relax them, or they can also use the breathe feature with nature sounds running in the background. This will likely keep users engaged as they find the app helpful and motivate continued usage.

- **Recommendation 6: Help Users Reflect on Their Moods and Better Understand Themselves**

In the interviews, many users talked about how the *iCare* app was useful for reflecting on their moods and engaging in self-exploration, helping them to become more self-aware. Reflection is

important for self-improvement and developing a sense of urgency [73]. Not engaging in reflective and self-care practices can negatively impact our health, making it very difficult to manage our struggles when we need to deal with stressful situations [11]. In our study, users reported that using the *iCare* app eventually allowed them to explore more about themselves, and they stated that they "would love to use this app forever!" Another user said, "I could self-reflect and observe how I felt and what I felt. So, it did help me, and I can continue using this app as I think I now have a habit of mood tracking every day" [P4], showing that *iCare* was effective at building self-awareness. One more user described the experience as a "self-reflection journey" [P5], and it was like "Everyday interaction with someone you know" [P7], suggesting that the app is interactive, stimulating a sense of familiarity and companionship. As such, we recommend that mHealth apps **integrate exercises that help users reflect on their moods** and form **long-term habits** that help them gradually realize and become more aware of their feelings. We also recommend that mHealth apps be designed to **foster a sense of familiarity and companionship** by offering the user features that make the users expressive such as a diary feature or gratitude expressing feature.

- **Recommendation 7: Help Users to Rediscover Themselves**

Mental health apps should provide means for users to track positive things about their lives and reflect on them often to remind them how the good things are in their lives and how blessed they are. Especially helping reveal positive things they may have overlooked and undermine the negative things which people suffering from mental health tend to overrate and overfocus on [149]. As shown by the comment, "…I had not selected angry… I think of myself as a person who gets angry easily… It means that other things I think of myself might not be necessarily true" [P6].

7 CHAPTER 7 CONCLUSION

In this chapter, we summarize the thesis, highlight the limitations and contributions, and suggest potential directions for future work.

7.1 Limitations

The main limitation of this research is the use of a self-reporting tool where the participants filled out the Perceived Stress Scale and Generalized Anxiety Disorder Scale. Although we instructed the participants, in the consent form, to answer the questions sincerely and to make their answers a representation of an individual state of mind, it is a common belief that human perception is not always perfect, and bias would most likely be present. Although we cannot control the bias factor, we made sure that we collected baseline (pre-test) stress and anxiety measures. This baseline was further used to compare participants' actual change (post-test) in stress and anxiety.

Secondly, our app is focused on working-class Indian women; the findings may not generalize to other target audiences.

Thirdly, our participants might be people with a diagnosed condition that they did not share with us, which could have caused confounding factors about interventions being offered.

Finally, although the *iCare* app development language allows for cross-platform deployment, for this study, we limited it to Android users because in India, Android has over 85 percent market share [212], and it was easy to reach our target audience. A future app version can be deployed for Android and iPhone to cater to a broader group of audiences.

7.2 Study Summary

The findings from **Phase 1** of the study shed light on various factors contributing to mental health issues among our target audience and the strategies they used to deal with the problems. According to our findings, participants utilized multiple strategies to deal with their mental health difficulties, like staying alone, relaxing exercises, and ignoring the things that overwhelm them using techniques such as distraction. The themes that emerged were:

- *Events that Trigger Stress/Anxiety.*
- *Habits/Activities to Manage Stress/Anxiety.*
- *Social and Personal Factors that Play Major Roles in Mental Health.*

- *Participants' Views About Popular Existing Mental Health Apps - Headspace And Happify.*
- *Views on Features of the Apps.*
- *Motivation to Use the Mental Health App.*

In **Phase 2** of the study, based on the comments from the participants of **Phase 1,** we designed a prototype to be used by 40 working-class Indian women. We did this because it is a major step in our User-Centered Design approach, and we wanted to keep our target audience involved throughout the design and development process. We found the following nine themes:

- *Importance of Aesthetics.*
- *The Benefits of Being Anonymous.*
- *The Power of Customization.*
- *The Power of Personalization.*
- *Effectiveness of the App* for Stress and Anxiety Management.
- *The Usefulness of Feedback Provided by the App.*
- *User Interface.*
- *Finding a Safe Space.*
- *Suggestions.*

In **Phase 3** of the study, we took all the leading suggestions after asking the participants to use the prototype and interviewing them in Phase 2 and implemented them into our *iCare* app. After designing the app, we asked 30 working-class Indian women to use the app for two weeks, of which 22 participants agreed to an interview. We did this because it is a significant step in our User-Centered Design approach, and we wanted to keep our target audience involved throughout the design and development process of the *iCare* app. The third phase was a pre-and post-test study design of 30 participants. We effectively examined stress and anxiety levels before and after using the *iCare* app.

Further, we also investigated the user experience and the aesthetics of the *iCare* app, followed by the motivational appeal of the *iCare* app. Finally, we examined the perceived persuasiveness and

usefulness of the app. Phase 3 also had an optional one-on-one interview, and we found the following seven themes:

- *Effectiveness of the App for Stress and Anxiety Management.*
- *User Interface.*
- *Discovery About Oneself.*
- *Element of Surprise in the App.*
- *Using the App in the Long Run.*
- *Expectations and Suggestions.*
- *Overall Experience.*

The findings are summarized in Table 7.1.

Table7. 1: Study Summary

Tested Variables	**Outcome**
Issues, requirements and worries users have regarding mobile apps for mental health.	A better understanding of the viewpoints, preferences, opinions, requirements, and strategies that working-class Indian women use to deal with mental health concerns such as stress, depression, or anxiety.
Effectiveness of the *iCare* app in promoting positive changes toward stress and anxiety management	Highly effective. The results for the Wilcoxon signed-rank test, analysis of BMIS, and one-on-one interviews showed that the *iCare* app successfully promoted positive changes toward stress and anxiety management.
Motivational Appeal	Highly Effective across four dimensions (attention, relevance, confidence, and satisfaction)
User Experience and Aesthetics	Positive user experience and aesthetics for all the participants.
Perceived Persuasiveness and Perceived Usefulness	Highly Persuasive and Useful.

7.3 Future Work

In the future, we plan to run a more comprehensive study with a larger sample size for a longer duration. The duration of the study would be three months or more. There would be a minimum of three points of data collection about the stress and anxiety levels of the participants for this study. One time point at the beginning (baseline), one time point immediately at the end, and the third time point one month or more after the study. This would help keep track of participants' progress and the app's effectiveness in motivating stress and anxiety management. Also, to

increase the Ecological [130] and Internal validity [213], we can use the application log from the database and compare it with the qualitative data to validate the effect of the *iCare* app. In future, we plan to make experts such as psychiatrists an essential part of the study and explore the usage of other stress and anxiety measurement scales in a professional setting such as DSM- V [136].

To help users to be able to customize the app, we plan to allow them to select which feature they want to see on their home screen, declutter it or give them the ability to customize. We believe that our design has the potential to not only help manage day-to-day stress and anxiety but also help users be even better, grow and reach even more goals. Health behaviours like sleep, PA, and diet are associated with mental health and well-being [159]. Thus, to enhance the functionality of the *iCare* app, features can include PA and diet tracking, and the system can recommend more personalized activities such as exercise routines and a healthy meal plan.

Although our study showed some interesting and significant findings, it also opened many research areas for other researchers in this domain. We measured motivation, which is a precursor to actual behaviour change. Future work could investigate if the increase in motivation translates to actual behaviour. We can achieve this through our plan of running the comprehensive study with a longer duration.

7.4 Conclusion

This thesis contributes to an important research field of Persuasive Technology and HCI4D within the HCI domain by developing a persuasive mHealth app for working-class Indian women. It demonstrates how persuasive apps can be designed to promote mental health. We conducted this study in three phases, and the results of a 14-day evaluation showed that the app effectively led to a reduction in stress and anxiety. Our findings also show that users found the app highly persuasive and useful in reducing stress and anxiety. Users had a positive user experience and motivational appeal, as demonstrated by their feedback comments in the qualitative data analysis and the statistically significant scores on the ARCS motivational model, Perceived Aesthetics Scale, Perceived Persuasiveness Scale, User Experience Questionnaire, and System Usability Scale. Most available apps target users in affluent nations; our study fills this gap by concentrating on underprivileged and low-resourced communities. Designers and developers can create mental health apps that are usable, useful, acceptable, and effectively used by the target audience to improve mental health and emotional well-being in the future by considering end users'

expectations and concerns.

7.5 Publications from this Thesis

So far, this research has led to **one publication and two submissions** (Appendix A)

Paper Title	Status	Conference
Improving Mental Health Among Working-Class Indian Women: Insight From An Interview Study	**Published**	LBW CHI'22: CHI Conference on Human Factors in Computing Systems
Insights from the Evaluation of An App for Improving Mental Health Among Working-Class Indian Women	**Submitted**	CHI 2023

7.5.1 Other publications during my Master's Degree

So far, I have **published three papers** (Appendix A).

Paper Title	Status	Conference
Saving Life and Keeping Privacy: A Study on Mobile Apps for Suicide Prevention and Privacy Policies	**Published**	PERSUASIVE 2022
The Journey: An AR Gamified Mobile Application for Promoting Physical Activity in Young Adults	**Published**	UMAP'22
Virtual, Augmented, and Mixed Reality as a Persuasive Tool for Physical Activity: A Systematic Review	**Published**	SeGAH 2022

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APPENDIX A. List of My Publications

Jaisheen Kour Reen and Rita Orji. 2022. Improving Mental Health Among Working-Class Indian Women: Insight From An Interview Study; In CHI EA '22: Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems. Pages 6

Jaisheen Kour Reen, Aniefiok Friday**,** and Rita Orji. 2022. Saving Life and Keeping Privacy: A Study on Mobile Apps for Suicide Prevention and Privacy Policies; In International Conference on Persuasive Technology. 17 pages.

Ifeanyi Odenigbo, **Jaisheen Kour Reen,** Chimamaka Eneze, Aniefiok Friday, and Rita Orji. 2022. Virtual, Augmented, and Mixed Reality as a Persuasive Tool for Physical Activity: A Systematic Review. In SeGAH 2022.

Ifeanyi Odenigbo, **Jaisheen Kour Reen,** Chimamaka Eneze, Aniefiok Friday, and Rita Orji. 2022. The Journey: An AR Gamified Mobile Application for Promoting Physical Activity in Young Adults. In UMAP'22

APPENDIX B. Permission to Use

In presenting this thesis in partial fulfilment of the requirements for master's in computer science degree from the Dalhousie University, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis work or, in their absence, by the Head of the Department or the Dean of the College in which my thesis work was done. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the Dalhousie University in any scholarly use which may be made of any material in my thesis.

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Head of the Faculty of Computer Science 6050 University Ave,
Dalhousie University,

Halifax, Nova Scotia, Canada B3H 1W5

APPENDIX C. Phase 1 interview questions

1. What are your views on the mental health issues in our Indian society? If a woman is going through any mental health issue, be it stress, depression, stress, anxiety, anything. How is super society treating it? Is it supportive or understanding or is its other way around?
2. Have you ever experienced any mental health issue for example stress or anxiety or depression or panic or new swing?
3. How did you overcome it?
4. Did you use any mobile application as a tool to support you at that point of time?
5. What are your views and Indian work culture? Is it healthy for us for the women of India?
6. What according to you is the role of salary in the mental health of Indian woman specifically who's working?
7. What are the activities in your day-to-day life that increase stress and anxiety in you?
8. Do you have any hobbies or any activities that you perform to distract yourself?
9. Do you think for many married Indian females the cause of stress can be that their husbands are not contributing equally in the household work?
10. Let's consider that the application is only designed for you only you have to use it, what features would you prefer to have?
11. What would motivate you to use this application that you just talked about?

APPENDIX D. Phase 2 interview questions

1. What did you think of the sign- up process?
2. What do you think about the chat bot feature?
3. What do you think of the homepage? Did you notice the 5-day streak?
4. What did you think of the meditation music feature? Would you use it? Did you find it calming?
5. What did you think of the breath feature? Would you use it?
6. What did you think of the mood tracker feature? Would you use it?
7. What did you think of the diary feature? Would you use it? How do you think it could help your mental health?
8. What do you think of the voice feature? Would you use it? How would it help with your mental health?
9. What did you think of the self-awareness feature? Would you use it?
10. What did you think of the To-Do list feature? Would you use it?
11. What did you think of the gratitude feature? Would you use it?
12. What did you think of the social community feature? Would you use it?
13. How do you feel about navigating the app? What did you like? What would you change?
14. Please provide your suggestions that can help to improve the app?

APPENDIX E. Phase 3 interview questions

1. What did you think about this app?

a) Describe your experience with the app

b) Was there anything you liked?

c) Was there anything you didn't like?

2. In the last two weeks how did you feel after using the app?

a) How did you feel while you were using the app?

b) After using the app for a period of 2 week, how did you feel?

3. How did the app affect you?

a) Did anything change for you while you were using the app?

b) Did you discover anything new about yourself while using the app?

4. Do you think you can trust the app? Why or why not?

5. Do you think you can continue using this app after this study? Why or why not?

6. How much time did you spend on this app?

a) Why?

b) What would make you use it for a longer period?

c) Do you think you would use it longer if you had more time?

7. Did this app help you in any way?

a) How did it help you?

b) What was useful about it?

c) Can you please provide an example of how it is useful?

d) What's most appealing about this app? Why?

8. What's the hardest part about using this app? Why?

9. Was there anything surprising or unexpected about this app? Can you please provide an example?

10. Was there anything missing from this app that you expected? Why?

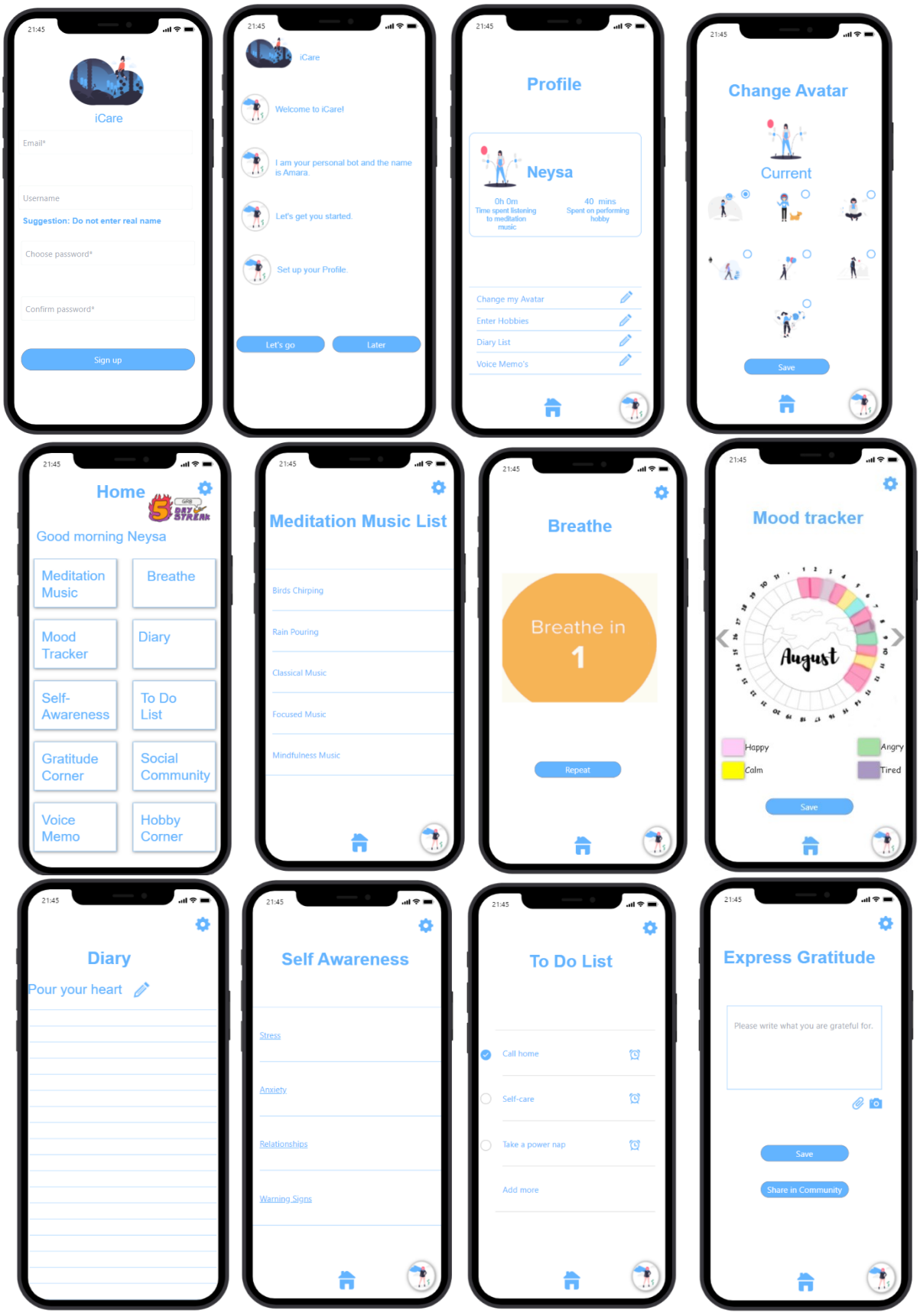
11. What could be done to improve this app?

12. Did you discuss about the app with anyone?

13. Do you think you would recommend this app to other females? Why or why not?

14. Finally, is there anything else you would like to tell me about your experience with the app I have not asked you?

APPENDIX F. Prototype




21:45
iCare
Post something...
Post
I had the most beautiful day. Thank you sisters for your suggestions.
3 comments
34
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Fusce convallis pellentesque metus id lacinia.
3 comments
34
21:45
Voice recorder
Redo
Save
21:45
My Hobby Corner
Start the hobby clock
Yeah!!! You did it !! You spent 40 mins at your hobby today!!
GO, GIRL!!!!
Do not forget to access your mood in the mood tracker now.
Mood tracker
Stop the hobby clock
21:45
Setting
Profile
Set Reminders
Change Username
Setup Fingerprint
Change App Theme
Emergency Contacts
Notifications
Privacy Policy
Logout
Delete Account

APPENDIX G. Ethics approval for all phases

DALHOUSIE UNIVERSITY
Research Services

Health Sciences Research Ethics Board
Letter of Approval

September 16, 2021

Jaisheen Kour Reen
Computer Science\Computer Science

Dear Jaisheen,

REB #: 2021-5750
Project Title: Designing a mobile application for Stress and Anxiety Management in Working-class Indian woman.

Effective Date: September 16, 2021
Expiry Date: September 16, 2022

The Health Sciences Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans*. This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Effective March 16, 2020: Notwithstanding this approval, any research conducted during the COVID-19 public health emergency must comply with federal and provincial public health advice as well as directives from Dalhousie University (and/or other facilities or jurisdictions where the research will occur) regarding preventing the spread of COVID-19.

Sincerely,

[redacted]

DALHOUSIE UNIVERSITY
Research Services

Health Sciences Research Ethics Board
Amendment Approval

December 10, 2021

Jaisheen Kour Reen
Computer Science\Computer Science

Dear Jaisheen,

REB #: 2021-5750
Project Title: Designing a mobile application for Stress and Anxiety Management in Working-class Indian woman.

The Health Sciences Research Ethics Board has reviewed your amendment request and has approved this amendment request effective today, December 10, 2021.

Effective March 16, 2020: Notwithstanding this approval, any research conducted during the COVID-19 public health emergency must comply with federal and provincial public health advice as well as directives from Dalhousie University (and/or other facilities or jurisdictions where the research will occur) regarding preventing the spread of COVID-19.

Sincerely,

[redacted]
Dr. Lori Weeks, Chair

DALHOUSIE UNIVERSITY
Research Services

Health Sciences Research Ethics Board
Letter of Approval

May 04, 2022

Jaisheen Kour Reen
Computer Science\Computer Science

Dear Jaisheen,

REB #: 2022-6072
Project Title: Evaluating the mobile application for Stress and Anxiety Management in Working-class Indian woman.

Effective Date: May 04, 2022
Expiry Date: May 04, 2023

The Health Sciences Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans*. This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,

[redacted]
Dr. Lori Weeks, Chair

APPENDIX H. PSS and GAD scale (Pre-test)

PSS (Pre-test):

In the last month, how often have you been upset because of something that happened unexpectedly? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last month, how often have you felt that you were unable to control the important things in your life? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last month, how often have you felt nervous and stressed? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last month, how often have you felt confident about your ability to handle your personal problems? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last month, how often have you felt that things were going your way? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last month, how often have you found that you could not cope with all the things that you had to do? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last month, how often have you been able to control irritations in your life? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last month, how often have you felt that you were on top of things? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last month, how often have you been angered because of things that happened that were outside of your control? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

GAD (same for pre- and post-test):

Feeling nervous, anxious or on edge *

- Not at all
- Several Days
- More than half the days
- Nearly every day
- NA

Not being able to stop or control worrying *

- Not at all
- Several Days
- More than half the days
- Nearly every day
- NA

Worrying too much about different things *

- Not at all
- Several Days
- More than half the days
- Nearly every day
- NA

Trouble relaxing *

- Not at all
- Several Days
- More than half the days
- Nearly every day
- NA

Being so restless that is hard to sit still. *

- Not at all
- Several Days
- More than half the days
- Nearly every day
- NA

Becoming easily annoyed or irritable *

- Not at all
- Several Days
- More than half the days
- Nearly every day
- NA

Feeling afraid as if something awful might happen *

- Not at all
- Several Days
- More than half the days
- Nearly every day
- NA

PSS (Post-test):

In the last two weeks, how often have you been upset because of something that happened unexpectedly? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last two weeks, how often have you felt that you were unable to control the important things in your life? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last two weeks, how often have you felt nervous and stressed? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last two weeks, how often have you felt confident about your ability to handle your personal problems? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last two weeks, how often have you felt that things were going your way? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last two weeks, how often have you found that you could not cope with all the things that you had to do? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last two weeks, how often have you been able to control irritations in your life? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last two weeks, how often have you felt that you were on top of things? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last two weeks, how often have you been angered because of things that happened that were outside of your control? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

In the last two weeks, how often have you felt difficulties were piling up so high that you could not overcome them? *

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often
- NA

APPENDIX I. BMIS

I feel... *

	definitely do no...	do not feel	NA	slightly feel	definitely feel
Lively	○	○	○	○	○
Happy	○	○	○	○	○
Sad	○	○	○	○	○
Tired	○	○	○	○	○
Caring	○	○	○	○	○
Content	○	○	○	○	○
Gloomy (feelin...	○	○	○	○	○
Jittery (nervous)	○	○	○	○	○
Drowsy (half a...	○	○	○	○	○
Grouchy (irrita...	○	○	○	○	○
Peppy (lively)	○	○	○	○	○
Nervous	○	○	○	○	○
Calm	○	○	○	○	○
Loving	○	○	○	○	○
Fed up	○	○	○	○	○
Active	○	○	○	○	○

APPENDIX J. Post-test questionnaire

System Usability Scale:

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
I think that I would like to use this app frequently	○	○	○	○	○
I found the app unnecessarily complex.	○	○	○	○	○
I thought the app was easy to use	○	○	○	○	○
I think that I would need the support of a technical person to be able to use this app.	○	○	○	○	○
I found the various functions in the app were well integrated	○	○	○	○	○
I thought there was too much inconsistency in this app.	○	○	○	○	○
I imagine that most women would learn to use this app very quickly.	○	○	○	○	○
I found the app very awkward to use.	○	○	○	○	○
I felt very confident using the app.	○	○	○	○	○
I needed to learn a lot of things before I could get going with this app.	○	○	○	○	○

ARCS Scale:

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
The app would capture and hold my attention.	○	○	○	○	○
The app has contents that stimulates my curiosity.	○	○	○	○	○
The content of the app is relevant to me.	○	○	○	○	○
I can relate to the content of this app.	○	○	○	○	○
The content of the app makes sense to me.	○	○	○	○	○
The content of the app is useful to me.	○	○	○	○	○
It is easy to understand and use the app.	○	○	○	○	○
The app would help me manage my stress and anxiety.	○	○	○	○	○
The app would help me to build confidence in my abilityhealthy mental health.	○	○	○	○	○
I would really enjoy using the app.	○	○	○	○	○
It would be a pleasure to use an app like this.	○	○	○	○	○
The app would help me accomplish a healthy mind set.	○	○	○	○	○

Perceived Aesthetics and Usefulness Scale:

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
The app is visual.	○	○	○	○	○
The app is clean.	○	○	○	○	○
The app is pleasant.	○	○	○	○	○
The app is fascinating.	○	○	○	○	○
The app is sophisticated.	○	○	○	○	○
The app is creative.	○	○	○	○	○

Please rate your level of agreement or disagreement with each of the following statements *

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
The app will help me improve my mental health.	○	○	○	○	○
The app will help me accomplish my mental health goals easily.	○	○	○	○	○
The app will be useful in my day to day life.	○	○	○	○	○
The app will make it easier to reach my mental health goals.	○	○	○	○	○

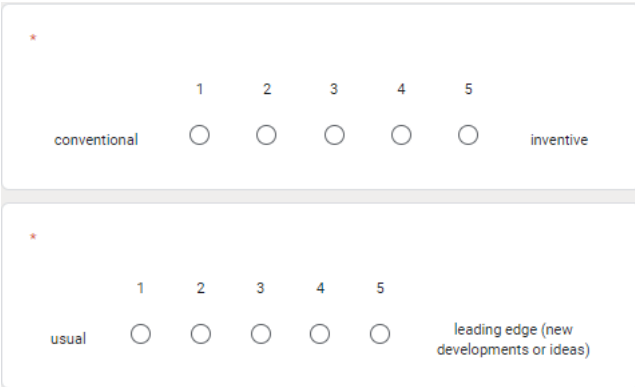
Perceived Persuasiveness Scale:

Please rate your level of agreement or disagreement with each of the following statements *

	Strongly disagree	Disagree	Neither	Agree	Strongly Agree
The app would influence me.	○	○	○	○	○
The app would be convincing.	○	○	○	○	○
The app would be personally relevant for me.	○	○	○	○	○
The app would make me reconsider my mental health habits.	○	○	○	○	○

User-Experience Questionnaire:

	1	2	3	4	5	
obstructive	○	○	○	○	○	supportive
*						
complicated	○	○	○	○	○	easy
*						
inefficient	○	○	○	○	○	efficient
*						
confusing	○	○	○	○	○	clear
*						
boring	○	○	○	○	○	exciting
*						
not interesting	○	○	○	○	○	interesting



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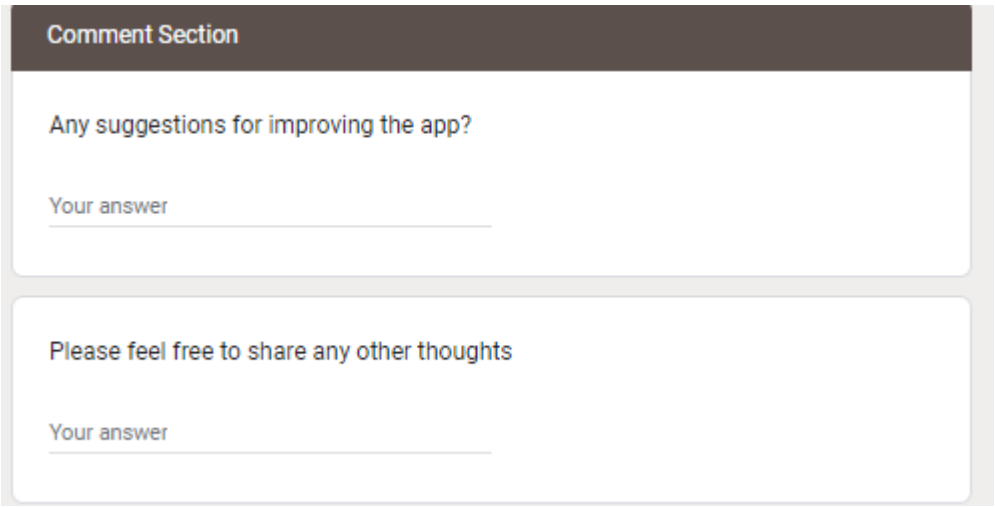


APPENDIX K. Recruitment notice for Phase 1 participants

Project Title: Designing a mobile application for Stress and Anxiety Management in Working-class Indian woman

Description:

We are looking for people who have self-diagnosed depression or anxiety or low mood or panic attack or stress that interferes with their ability to fully take part in functions and activities like learning, feeling, and expressing positive-negative (good or bad/ happy or sad) emotions. The study's goal is to create a mobile application to help working-class Indian females in India manage stress and anxiety. The research will contribute to the field of persuasive technology for stress and anxiety. Participants will participate in a focus group study (A focus group is a group interview involving a small number of demographically similar people or participants who have other common traits/experiences) in which they will discuss some questions about mental health issues as well as their needs and concerns about mental health and well-being applications. Please note if you are not comfortable in being a part of a focus group study, you can participate in a 1-on-1 interview with the lead researcher. Participants must be:

18 years and older.
Working females.
Must know Basic English.
Who have self-diagnosed depression or anxiety or low mood or panic attack or stress that interferes with their ability to fully take part in functions and activities like learning, feeling, and expressing positive-negative (good or bad/ happy or sad) emotions.

In the focus group session, you will meet with the researcher and other participants online over Microsoft teams. You will be provided with a joining link via email. In this session, the researcher will explain the study and get consent. The researcher will ask questions about mental health issues and participant's needs and concerns of designing an application for stress and anxiety management. You will be given two apps namely Happify and Headspace, you will be required to explore the features of these applications and share your valuable suggestions, ideas and concerns. You will also discuss it with other participants in the group. This should take about 40-60 mins. You will be entered in a draw to win a $50 amazon gift card. Please note that only one person randomly would be selected to win the $50 amazon gift card.

In the 1-on-1 interview you will meet with the researcher online over Microsoft teams. You will be provided with a joining link via email. In this session, the researcher will explain the study and get consent. The researcher will ask questions about mental health issues and participant's needs and concerns of designing an application for stress and anxiety management. You will be given two apps namely Happify and Headspace, you will be required to explore the features of these applications and share your valuable suggestions, ideas and concerns. You will also discuss it with other participants in the group. This should take about 40-60 mins. You will be entered in a draw to win a $50 amazon gift card. Please note that only one person randomly would be selected to win the $50 amazon gift card.

If you are interested in participating, please contact Jaisheen Kour Reen (js346515@dal.ca).

APPENDIX L. Recruitment for Phase 3 participants

Project Title: Evaluating the Mobile Application for Managing stress and anxiety in working-class Indian woman

Description:

We are looking for people who have self-examined depression or anxiety or low mood or panic attack or stress that prevents their ability to fully take part in functions and activities like learning, feeling, and expressing positive-negative (good or bad/ happy or sad) emotions. The study's goal is to evaluate a mobile application designed to help working-class Indian women in India manage stress and anxiety. The research will add to the field of persuasive technology for stress and anxiety. Participants will be asked to use the app for 1 week for at least 8-10 mins a day. The app is designed by the lead researcher for managing stress/anxiety among working-class Indian women. For my research I am using Google's Firestore as a database (which will be used to collect data from the mobile app such as your name) for the mobile application. This database is being used to support the application and the users. This database will hold users email id, pictures uploaded by the users, the voice recordings and the log data (which means we will be able to check if any feature crashes/stops in the app so that we can fix it; we will also be able to check which app feature is being used how many times by how many users, no identifiable data will be collected through the log), the reason behind all this is that if we don't make the data online that means adding it to the database then the user will lose her data as soon as she uses the app on some other phone or uninstalls the app. But if you delete the account the entire data will be deleted. The following app permissions will be required to run the app: Microphone (for voice recording feature); Camera (for posting pictures to social community or attaching to gratitude feature); Photo gallery (for attaching pictures from gallery to social community or gratitude feature). After using the app for 1 week you will be requested to fill two scales which will contain questions related to the ease of use of the app (which means how easy it was for you to use the app) and your experience with the app. Finally, you will be given an option to take part in a one-on-one interview with the lead researcher where you will be asked questions related to the app features and you can share your concerns and design suggestions. This one-on-one interview will be audio recorded after taking your consent. Please be noted that audio recording the session is important to further use your views in the improvement of the application.

Participants must be:

1. 18 years and older.
2. Working females.
3. Must own an Android phone or iPhone.
4. Must know Basic English.
5. Who have self-examined depression or anxiety or low mood or panic attack or stress that prevents their ability to fully take part in functions and activities like learning, feeling, and expressing positive-negative (good or bad/ happy or sad) emotions.

If you agree to use the app, you will get the consent form through the email and all further communication will be done through email. In the one-on-one interview you will meet with the researcher online over Microsoft teams. You will be provided with a joining link via email. In this session, the researcher will explain the study. The researcher will ask questions about your experience with the app and any changes you experienced in managing your stress/anxiety after using the app.

If you are interested in participating, please contact Jaisheen Kour Reen (js346515@dal.ca).

APPENDIX M. Consent form for Phase 3 participants

Project title: Evaluating the Mobile Application for Managing stress and anxiety in working-class Indian woman
Lead researcher: Jaisheen Kour Reen, a graduate student at Faculty of Computer Science, js346515@dal.ca
Contact person: Jaisheen Kour Reen, Faculty of Computer Science, js346515@dal.ca
Supervisor: Dr. Rita Orji, Faculty of Computer Science, rita.orji@cs.dal.ca

Introduction
We would like to invite you to participate in a research study being conducted by Jaisheen Kour Reen. You may leave the study at any time. This is a study, and participation is entirely voluntary(independent). The information provided below explains what is involved in the research, what you will be asked to do, and any benefits, risks, or inconvenience or discomfort that you might experience. Participating in the study may not benefit you, but it is possible that we will learn something that will benefit others. You should ask Jaisheen, the lead researcher, any questions you have about this study. Please feel free to ask as many questions as you want. If you have any further questions, please contact the lead researcher.

Purpose and the Research Study
The study's goal is to evaluate a mobile application designed to help working-class Indian women manage stress and anxiety. If you agree to participate then you will receive the link to the app (for Android and iPhone). You will be requested to use the app for 1 week for at least 8-10 mins a day. For my research I am using Google's Firestore as a database (which will be used to collect data from the mobile app such as your name) for the mobile application. This database is being used to support the application and the users. This database will hold users email id, pictures uploaded by the users, the voice recordings and the log data (which means we will be able to check if any feature crashes/stops in the app so that we can fix it; we will also be able to check which app feature is being used how many times by how many users, no identifiable data will be collected via the log), the reason behind all this is that if we don't make the data online that means adding it to the database then the user will lose her data as soon as she uses the app on some other phone or uninstalls the app. But if you delete the account the entire data will be deleted. The following app permissions will be required to run the app: Microphone (for voice recording feature); Camera (for posting pictures to social community or attaching to gratitude feature); Photo gallery (for attaching pictures from gallery to social community or gratitude feature). After using the app for 1 week you will be requested to fill two scales which will contain questions related to the ease of use of the app (which means how easy it was for you to use the app) and your experience with the app. Finally, you will be given an option to take part in a one-on-one interview with the lead researcher where you will be asked questions related to the app features and you can share your concerns and design suggestions.
Please be noted that audio recording the session is important to further use your views in the improvement of the application.
Who Can Take Part in the Research Study:
To participate in this study, you must be 18 years and older working-class Indian female living in India, who has experienced now or in the past mental health issues based on self-diagnosis (i.e., depression or anxiety or low mood or panic attack or stress); you must own an Android phone or iPhone. Also, you must know Basic English.

Possible Benefits, Risks and Discomforts:

As mentioned above I will be using Google's Firestore as a database (which will be used to collect data from the mobile app such as your name) for the mobile application. This database will hold users email id, pictures uploaded by the users, the voice recordings and the log data. Your data will be protected as only the lead researcher has access to the database as it's created using her gmail dedicated only to this database. The gmail account has two step verification on, linked to the phone number of the lead researcher. The lead researcher is a student and has no intention to use this data for any other purposes other than this thesis project. I will ensure adequate security and non-disclosure of your data to third parties, including their identity. This app will not provide any discomfort to your mobile phone's performance.

You would be free to stop using the app at any time, but you should inform the lead researcher about that. If you successfully complete using the app for one week and then while filling the forms you want to stop, you may go ahead and not submit it but if you submit it and then do not want to go for the one-on-one interview then your form contribution cannot be discarded/deleted by the lead researcher.
You would be free to leave the one-on-one interview at any time and the lead researcher would be able to disregard your contribution.
There are no direct benefits for those who participate in this research project. An indirect benefit is the opportunity to contribute to research that may improve the lives of people suffering from mental illnesses.

Compensation:
No Compensation

How your information will be protected:

The researchers will use their Dalhousie University credentials for the Microsoft Teams meeting, which will ensure that the Teams meeting recordings are securely stored in Canada. During the live Teams meeting, audio and video content is routed through the United States, and therefore may be subject to monitoring without notice, under the provisions of the US Patriot Act while the meeting is in progress. After the meeting is complete, meeting recordings made by Dalhousie are stored in Canada and are inaccessible to US authorities.
All logged data will be transcribed and electronically recorded. Only the lead researcher and supervisor have access to the data stored on lead searchers password protected laptop. All data will be stored in a secure location on the lead researcher's laptop, which will be password protected. Only anonymized data will be analysed and accessed on a secure computer (encrypted drive and password protected) that only the lead researcher and the supervisor will have access to. The anonymity of textual data will be preserved by using pseudonyms in any journal or conference presentation.
For the one-on-one interview, only the researcher will know your data and it will be kept confidential.
If You Decide to Stop Participating:
You would be free to stop using the app at any time, but you should inform the lead researcher about that. If you successfully complete using the app for one week and then while filling the forms you want to stop, you may go ahead and not submit it but if you submit it and then do not want to go for the one-on-one interview then your form contribution cannot be discarded by the lead researcher.
You would be free to leave the one-on-one interview at any time and the lead researcher would be able to disregard/delete your contribution.
How to Obtain Results
Results for one-on-one interview will not be provided. Instead, when the entire study is ended as this is just Phase 2 of the study, the results will be published which will hold anonymous comments from

participants using participant ID as P1, P2. No individual results will be provided. You can check the below check box to receive the copy of the publication.

Questions

We are happy to talk with you about any questions or concerns you may have about your participation in this research study. Please contact Jaisheen Kour Reen (js346515@dal.ca) [or Rita Orji (at rita.orji@dal.ca)] at any time with questions, comments, or concerns about the research study If you have any ethical concerns about your participation in this research, you may also contact Research Ethics, Dalhousie University at (902) 494-1462, or email: ethics@dal.ca.

"I have read the explanation about this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent to take part in the study. However, I understand that my participation is voluntary and that I am free to withdraw from the study at any time."

Participant	Researcher
Name: _____	Name: _____
Signature: _____	Signature: _____
Date: _____	Date: _____

If you are interested in giving a one-on-on interview at the end. Please check below and provide your email address:

☐ "I would like to a part of one-on-one interview."

if this option is chosen, please include a contact email address: _____

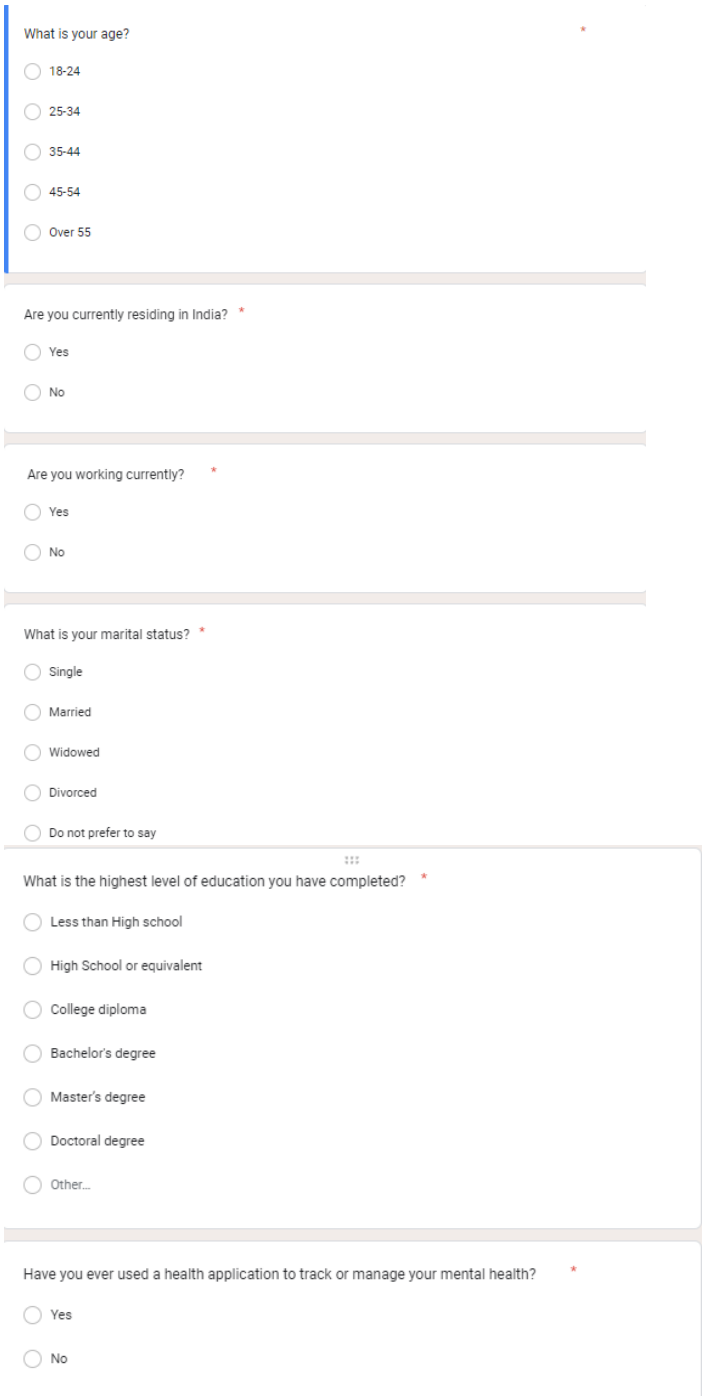
If you are interested in seeing the results of this study, please check below and provide your email address. We will contact you with publication details that describe the results.

☐ "I would like to be notified by email when results are available via a publication."

if this option is chosen, please include a contact email address: _____

Thank you.

APPENDIX N. Demographic questionnaire for all phases



What is your age? *

- 18-24
- 25-34
- 35-44
- 45-54
- Over 55

Are you currently residing in India? *

- Yes
- No

Are you working currently? *

- Yes
- No

What is your marital status? *

- Single
- Married
- Widowed
- Divorced
- Do not prefer to say

What is the highest level of education you have completed? *

- Less than High school
- High School or equivalent
- College diploma
- Bachelor's degree
- Master's degree
- Doctoral degree
- Other...

Have you ever used a health application to track or manage your mental health? *

- Yes
- No

APPENDIX O. Recruitment notice for Phase 2 participants

Project Title: Designing a mobile application for Stress and Anxiety Management in Working-class Indian woman

Description:

We are looking for people who have self-diagnosed depression or anxiety or low mood or panic attack or stress that interferes with their ability to fully take part in functions and activities like learning, feeling, and expressing positive-negative (good or bad/ happy or sad) emotions. The study aims to evaluate the mock-up of a mobile application for managing stress and anxiety. The study will contribute to the research area of persuasive technology for stress and anxiety. Participants will participate in a 1-on-1 interview with the interviewer (that is me).

18 years and older.
Working females.
Must know Basic English.
Who have self-diagnosed depression or anxiety or low mood or panic attack or stress that interferes with their ability to fully take part in functions and activities like learning, feeling, and expressing positive-negative (good or bad/ happy or sad) emotions.

In the 1-on-1 interview you will meet with the researcher online over Microsoft teams. You will be provided with a joining link via email. In this session, the researcher will explain the study and get consent. The researcher will email you a video of how to use the mock- up of the app and also the link to the mock-up. In the interview questions will be asked regarding the different screens of the mock up and then your valuable suggestions will be taken. The interview will last for 30-35 mins

If you are interested in participating, please contact Jaisheen Kour Reen (js346515@dal.ca).

APPENDIX P. Internal reliability

PSS:

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.778	.771	10

GAD:

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.774	.783	7

System Usability Scale:

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.731	.753	10

UEQ:

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.818	.793	7

Perceived Usefulness:

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.936	.939	4

Perceived Aesthetics:

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.886	.892	6

ARCS:

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.920	.924	12

Perceived Persuasiveness:

Reliability Statistics

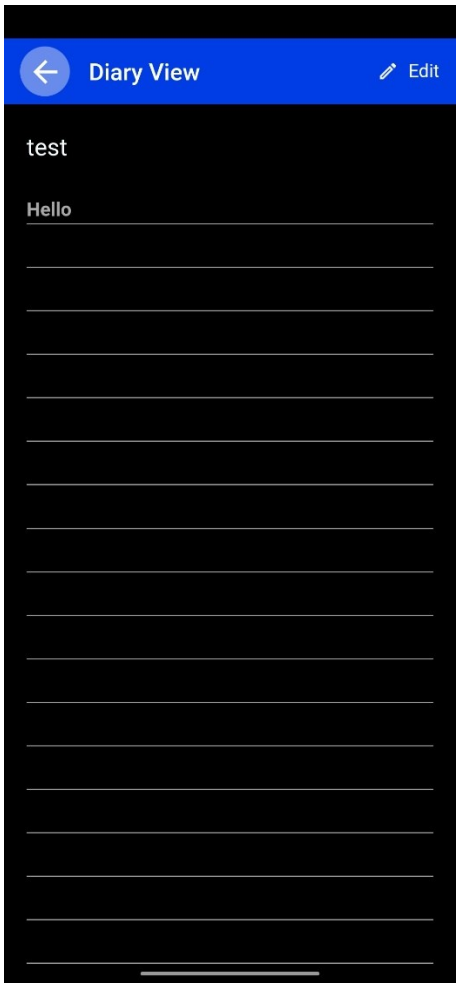
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.911	.912	4

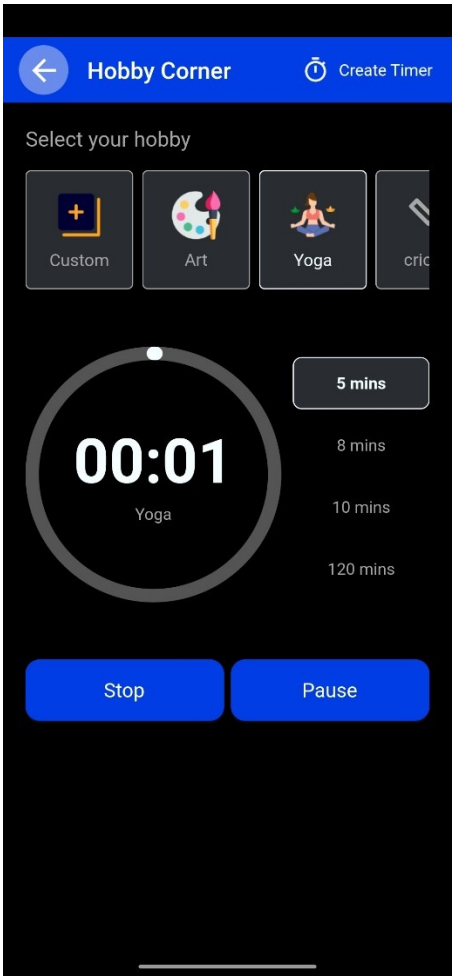
BMIS:

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.842	.833	16

APPENDIX Q. Changes to *iCare* App





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Submission ID:lbw5839

Author/Presenter(s): Jaisheen Kour Reen:Dalhousie University;Rita Orji:Dalhousie University

Type of material:poster paper

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