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Digital Interventions for Reducing Loneliness and Depression in Korean College Students: A Mixed-Methods Evaluation

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Digital Interventions for Reducing Loneliness and Depression in Korean College Students: A Mixed-Methods Evaluation

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Abstract

Background: The COVID-19 pandemic has exacerbated the prevalence of loneliness and depression among college students. Digital interventions, such as Woebot and Happify, have shown promise in alleviating these symptoms.

Objective: This study aims to investigate the effectiveness and acceptability of Woebot and Happify in reducing loneliness and depression among college students after the COVID-19 pandemic.

Methods: A mixed-methods approach was employed over four months. Sixty-three participants aged 18-27 from Sungkyunkwan University in Seoul, South Korea, were initially recruited, with inclusion criteria of elevated loneliness (UCLA Loneliness Scale score ? 34-40) and depression (PHQ-9 score ? 6). Attrition resulted in a final sample of 27 participants. Participants were randomly assigned to Woebot (n=22), Happify (n=21), or a control group using Bondee, a metaverse social network messenger app (n=10). Quantitative measures (UCLA Loneliness Scale, PHQ-9) and qualitative assessments (user feedback, focused interviews) were used.

Results: Modest decreases in loneliness and depression post-intervention were observed, although not statistically significant (likely due to small sample size). Welch's ANOVA found no significant differences between intervention groups (UCLA Loneliness: P=.5917; PHQ-9: P=.5058). Qualitative data indicated user satisfaction, with suggestions for improved app effectiveness and personalization.

Conclusions: Despite limitations, the study suggests the potential of well-designed digital interventions in alleviating college students' loneliness and depression. Findings underscore the importance of accessible digital tools, mental health literacy education, and comprehensive support systems. Further research with larger samples is needed.

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BK designed the study, collected and analyzed the data, and drafted the manuscript. MH provided feedback and critically reviewed the manuscript.

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Background: The COVID-19 pandemic has exacerbated the prevalence of loneliness and depression among college students. Digital interventions, such as Woebot and Happify, have shown promise in alleviating these symptoms.

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Methods: A mixed-methods approach was employed over four months. Sixty-three participants aged 18-27 from Sungkyunkwan University in Seoul, South Korea, were initially recruited, with an inclusion criterion of UCLA Loneliness Scale score ≥ 34. The final sample consisted of 27 participants due to attrition. Participants were randomly assigned to Woebot (n=15), Happify (n=9), or a control group using Bondee, a metaverse social network messenger app (n=3). Quantitative measures (UCLA Loneliness Scale, PHQ-9) and qualitative assessments (user feedback, focused interviews) were used.

Results: Although group mean decreases in loneliness and depression were observed post-intervention, the differences between the control and intervention groups were not statistically significant (UCLA Loneliness: p=0.674; PHQ-9: p=0.353). Qualitative data indicated user satisfaction, with suggestions for improved app effectiveness and personalization.

Conclusions: Despite limitations, the study highlights the potential of well-designed digital interventions in alleviating college students' loneliness and depression. The findings contribute to the growing body of research on accessible digital mental health tools and underscore the importance of comprehensive support systems. Further research with larger and more diverse samples is needed to better understand the effectiveness and optimization of such interventions.

Keywords: Loneliness; Depression; Digital interventions; College students; Mental health; Mixed-methods evaluation; Woebot; Happify

Introduction

The rising rates of depression and anxiety among college students worldwide, further compounded by the effects of the COVID-19 pandemic, emphasize the critical need for effective interventions to address these mental health challenges. In South Korea, the proportion of people in their 20s and 30s at risk of depression increased sixfold to 22.8% in 2021 compared to 2018 [1]. Similarly, in the United States, anxiety and depression symptoms among college students rose by 75% from 2019 to 2021 [2]. However, this trend is not solely attributable to the pandemic; college students' mental health has been consistently declining over the past decade [3].

Depression, a potentially fatal illness, is a leading cause of suicide, claiming approximately 800,000 lives worldwide each year [4]. South Korea's suicide rate surpasses the OECD average, with a notable increase in suicide rates among patients with depression [5, 6]. The seriousness of depression is underscored by its high mortality rate, complex etiology involving genetic, environmental, and psychological factors, and the persistent stigma surrounding mental health [4-6].

Loneliness, a significant risk factor for depression, is particularly prevalent among college students [13-15]. The college years are a period of heightened emotional vulnerability, with students being particularly susceptible to depression and loneliness [9,10]. Loneliness can lead to social withdrawal, sleep disturbances, and exacerbate depressive symptoms [11,13]. Hawkley and Cacioppo demonstrated that loneliness can indeed lead to depression, particularly in young adults. Their research suggests that even when controlling for factors such as stress and social support, loneliness remains a predictor of depression in college students [11]. The correlation between loneliness and depression is partially attributed to changes in neurotransmitters that regulate mood, such as serotonin and dopamine [12]. Additionally, loneliness can trigger negative coping behaviors like alcohol and drug use, further exacerbating feelings of depression [13].

Cacioppo et al. and Matthews et al. emphasized the importance of addressing loneliness and depression in young adults for their overall well-being and development [7,14]. Untreated depression in this age group can lead to academic difficulties, interpersonal relationship issues, and increased risk of self-harm or suicide. Timely intervention is essential to prevent progression to more severe or chronic depression. Various intervention methods suggest that addressing loneliness and depression in young adults can be effectively alleviated. Key to these interventions is social support through meaningful connections formed through family, friends, school, or community activities [15]. The college student period is crucial in career development stages and is characterized by increased independence, intimacy, and dynamic exploration of life goals [9,16]. However, college students often face challenges such as stress in adapting to new environments, anxiety about academic and career paths, and difficulties in relationships, all of which can negatively impact their psychological and emotional well-being [9,10]. Despite these challenges, the college years also provide unprecedented opportunities for intellectual growth and development [17,18].

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Digital mental health interventions have shown promise in overcoming the limitations of traditional mental health services [19]. Grounded in theories such as Self-Determination Theory (SDT) and Cognitive-Behavioral Therapy (CBT), digital interventions have demonstrated effectiveness in reducing symptoms of depression and anxiety [19,20]. SDT emphasizes the importance of autonomy, competence, and relatedness in engaging individuals and initiating sustained changes [21], while CBT posits that depression arises from negative thoughts and beliefs, which can be modified through cognitive restructuring and behavioral activation [23]. The anonymity and accessibility of digital interventions make them particularly appealing to digital-native college students [24].

This study explores the feasibility and acceptability of two digital therapy applications, Woebot and Happify, among college students experiencing loneliness. Inspired by the research of Lim et al. [25] on +Connect, this study contributes a larger sample size and extended intervention period for a comprehensive evaluation. Additionally, the research by Boucher et al. [22] and Fitzpatrick et al. [26] provided a foundation for selecting these specific digital interventions. The primary aim is to determine whether these digital interventions can meaningfully reduce feelings of loneliness and depression among college students in South Korea. The study also investigates the role of participants' beliefs and behaviors in the effectiveness of the interventions. The hypotheses are:

H1: Participants using Woebot and Happify will show a greater reduction in loneliness and depression scores compared to the control group using the Bondee app.

H2: Participants who expect this intervention experiment to reduce loneliness and depression will experience greater reductions in these symptoms (perceived benefits of action).

H3: Participants who believe that even digital applications can alleviate loneliness and depression will experience greater reductions in these symptoms (perceived barriers to action).

H4: Participants with low help-seeking behavior will experience greater reductions in loneliness and depression after using the digital interventions (help-seeking behavior).

Additionally, qualitative feedback will provide insights into the user experience, perceived effectiveness, and areas for improvement for these digital interventions.

Methods

Experimental Design

This study aims to explore the feasibility and acceptability of digital interventions in reducing loneliness and depression among university students. The study was conducted from March to June 2023, over a four-month period, with participants from Sungkyunkwan University's Colleges of Natural Sciences and Humanities and Social Sciences in Seoul, South Korea. The study utilized a mixed-methods approach, incorporating both quantitative and qualitative data collection and analysis. The clinical trial was registered with the Clinical Research Information Service (CRIS), a WHO ICTRP-linked registry (www.cris.nih.go.kr), under the registration number KCT0009449.

Intervention

Given the importance of selecting effective digital interventions for addressing loneliness and

depression among college students, Woebot and Happify were chosen for their demonstrated efficacy in prior research. Participants were provided with an instruction manual (see Multimedia Appendix 2) to guide them through the use of the assigned intervention app. Woebot, a chatbot based on CBT principles, has shown effectiveness in reducing symptoms of depression and anxiety among young adults, as evidenced by studies such as the randomized controlled trial by Kathleen Kara Fitzpatrick et al. [26]. Additionally, Happify has demonstrated promise in alleviating loneliness, particularly during challenging periods such as the COVID-19 pandemic, as reported by Eliane M Boucher et al. [22].

Moreover, both Woebot and Happify are readily accessible for download in Korea, providing convenient and accessible platforms for individuals seeking to improve their mental well-being. These chatbots were also selected based on the performance results of mental health chatbots that have been verified for effectiveness and satisfaction in clinical experimental studies. Building on the promising findings of a recent study by Li, Wong, and Yap [33], regarding their top-tier performance in engagement (Woebot 4.10 ± 0.14, Happify 4.60 ± 0.00), functionality (Woebot 4.65 ± 0.21, Happify 4.25 ± 0.00), and overall quality (Woebot 4.31 ± 0.09, Happify 4.15 ± 0.02) on a 5-point scale, Woebot and Happify were selected for the interventions. The features of Woebot and Happify are shown in Table 1, including the experiment instructions.

Given the lack of Korean language versions of Woebot and Happify, all interactions with the apps were conducted in English. This decision was made to ensure uniformity across all intervention groups, despite the potential challenge it posed to participants with lower English proficiency. No special cultural adaptations for Korean users were implemented, although compensation was provided in the form of a choice between equivalent value coffee coupons or cash, with all participants opting for the cash incentive.

Table 1. Digital intervention: Woebot and Happify

	Woebot	Happify
Type of therapy	Cognitive behavioral therapy (CBT)	Cognitive behavioral therapy (CBT) and mindfulness
Delivery method	Chatbot	Chatbot, games, and activities
Cost	Free	Free and premium (paid)
Availability	Academic research	Commercialized
Other features	Weekly mood description	Mood tracking, social community, and rewards
Benefits	Can help improve mood, reduce stress, and improve cognitive function	Can help improve mood, reduce stress, and improve cognitive function
Previous representative research	Fitzpatrick et al. [26]	Boucher et al. [22]
Instructions	Step 1: Download the app from the app store or Google Play. Step 2: Create an account by entering your email address, password, date of birth, and nickname. Step 3: Open the app and use it for at least 15 minutes every day. You can choose from a variety of topics, including Focusing on positive, Relationship, Mindfulness & Meditation, and Managing emotions. You must also use the Gratitude Journal. Step 4: Capture and save the journal three times a week. This is necessary for record keeping and monthly participant rewards.	Step 1: Download the app from the app store or Google Play. Step 2: Create an account by entering your gender, age, race, occupation, family relationships, and current mental state. Step 3: Open the app and use it for at least 15 minutes every day. You can choose from a variety of activities in the Instant Play section, including Serenity Scene, Guided Meditation, and Negative Knockout. Thank mode is required for each activity. You can also use the Mindfulness & Meditation track (free). Step 4: Capture and save the activity tasks three times a week. This is necessary for record keeping and monthly participant rewards.

Participant Recruitment and Selection

The target sample size was based on previous studies of digital mental health interventions. Initially, 63 undergraduate and graduate students aged 18-27 were recruited through the university portal (see Multimedia Appendix 4 for the recruitment notice and survey questionnaires). Participants with very low loneliness scores (below 34) were excluded. While the recruitment notice mentioned that

participants should be confident in using English, as the Woebot and Happify applications do not have Korean versions, no applicants were excluded based on their English proficiency. To ensure fairness, all participants, including the control group using Bondee, were required to interact with the applications in English. Due to high attrition rates, the final sample consisted of 27 participants (Woebot: n=15, Happify: n=9, Bondee: n=3; see Table 4 for detailed participant information). To enhance retention, participants received a $30 incentive for completing the study and an additional $30 for completing the post-intervention assessment [27].

Randomization

Participants were assigned to one of the three groups (Woebot, Happify, or Bondee) using a stratified randomization method. The participants' names were blinded, and they were grouped to ensure similar distributions of age, gender, and loneliness scores across the groups. The decision to have fewer participants in the control group was made to ensure sufficient power in the intervention groups given the limited overall sample size and anticipated high attrition rates in the control group. This decision was made based on the judgment of the researchers to ensure the study's focus on the effectiveness of the interventions.

Assessment Tools and Data Collection

Quantitative Data: Collected using the UCLA Loneliness Scale (Korean version) and the PHQ-9 (Korean-translated version) before and after the intervention.
Primary Outcomes: Reduction in loneliness and depression scores.
Secondary Outcomes: User satisfaction and perceived benefits of the digital interventions. Quantitative data were collected using the UCLA Loneliness Scale (Korean version) and the PHQ-9 (Korean-translated version) before and after the intervention (see Multimedia Appendix 3 for the questionnaires).

Cronbach's alpha: In addition to examining the quantitative outcomes, Cronbach's alpha coefficients were calculated to assess the reliability of the measurement scales utilized in the study. The consistently high Cronbach's alpha coefficients for the UCLA Loneliness Index across all time points (ranging from 0.848 to 0.928) indicate strong internal consistency. This high internal consistency enhances the internal validity of the test and underscores the reliability of the loneliness scores obtained throughout the study. The robustness of the measurement instrument strengthens confidence in the interpretation of loneliness levels among participants, thereby bolstering the internal validity of our experiment.

The PHQ-9 coefficients were generally lower due to the shorter scale length (9 items). However, all PHQ-9 coefficients except for the baseline (0.680) were above the acceptable threshold of 0.6 for short scales [30].

Table 2. Cronbach's Alpha

Measurement Tool	Time Point	Cronbach's Alpha
UCLA Loneliness Index	Baseline	0.848
	1-Month Follow-up	0.893
	2-Month Follow-up	0.928
	Post-Intervention	0.904
PHQ-9	Baseline	0.680*
	1-Month Follow-up	0.702
	2-Month Follow-up	0.746
	Post-Intervention	0.769

Qualitative Data: Gathered through open-ended survey questions and five focus group interviews conducted via Zoom, each lasting approximately 90 minutes with 5-6 participants per group. Participants were given a preliminary orientation via KakaoTalk, a popular Korean social networking service, which included an introduction to the concept of focus group interviews, the methodology, and the anticipated questions. The interviews explored participants' experiences, coping mechanisms for loneliness, and app features. Participants were provided with an orientation document introducing the concept and methodology of focus group interviews, as well as a list of anticipated questions. However, due to time constraints, the actual interviews primarily focused on a subset of these questions, related to coping with loneliness and user experiences with the apps (see Multimedia Appendix 5 for details).

Interview Guide

- What features of the app did you find most helpful?
- What challenges did you encounter while using the app?
- How did the app impact your feelings of loneliness and depression?
- What improvements would you suggest for the app?

Data Analysis

Quantitative Analysis

- Descriptive Statistics: Mean, median, IQR, standard deviation [29].
- Group Comparisons: T-tests for normally distributed data and Mann-Whitney U tests for non-normally distributed data [32].
- Statistical Software: Data analysis was conducted using Python (numpy, scipy, and matplotlib) after extracting results from Google Surveys in CSV format.
- Significance Level: Alpha = 0.05.
- Confidence Interval: 95%.
- The data analysis code used in this study is available in Multimedia Appendix 6.

Qualitative Analysis

- Coding Approach: An inductive approach was used to identify themes from the data [28].
- Software: Zoom was used for real-time recording, Naver Clova was used for transcription, and Python-based text mining was used to extract key themes and related content.
- Process: Themes were identified and refined through iterative review of transcripts. The primary author conducted the coding, with periodic reviews by another researcher to ensure consistency.
- Validity and Reliability: Data validity and reliability were ensured through triangulation, member checking, and maintaining a detailed audit trail [30].
- Confidentiality: Data were deidentified to maintain participant confidentiality.

◆Homogeneity: Focus groups consisted of participants using the same app, primarily third-year university students.
◆Data Saturation: Achieved through repetitive themes identified across the focus groups.

Ethics Statement

This study was approved by the Institutional Review Board (IRB) of Sungkyunkwan University, Seoul, South Korea (IRB file number: SKKU 2023-02-043; approval date: February 27, 2023; see Multimedia Appendix 1 for the IRB approval letter). All participants provided informed consent prior to their involvement in the study (see Multimedia Appendix 7 for the informed consent form). Data were deidentified to ensure confidentiality.

CONSORT Reporting

This study followed the CONSORT reporting guidelines for randomized controlled trials. The CONSORT flow diagram, illustrating the flow of participants through the study, is presented in Figure 1 (included in the manuscript). The CONSORT-EHEALTH checklist (V1.6) [34] was also completed and is available as Multimedia Appendix 8 (included in the supplementary materials).

Results

Demographic and Clinical Variables of Participants at Baseline

Table 3 presents the demographic and clinical variables of participants at baseline. The table includes measures of central tendency and dispersion, such as mean, standard deviation, median, and interquartile range (IQR), for both the UCLA Loneliness Scale and PHQ-9 Depression Scale.

Table 3: Demographic and Clinical Variables of Participants at Baseline

Variable	Woebot (n=22)	Happify (n=21)	Control (Bondee) (n=10)
Scale, mean (SD)			
UCLA Loneliness	53.18(9.14) [52-61]	53.67 (11.05) [45-62]	53.50 (7.09) [48-59]
Depression (PHQ-9)	10.55 (5.89) [5-15]	9.14 (5.84) [5-12]	12.50 (7.47) [6-17]
Age, mean (SD)	23.5 (1.78) [22-25]	23 (2.14) [21-25]	22.9 (1.85) [21-24]
Gender, n (%)			
Female	14 (63.64%)	12 (57.14%)	5 (50%)
Male	8 (36.36%)	9 (42.86%)	5 (50%)
Majors, n (%)			
Humanities Social Science	11 (50%)	10 (47.62%)	4 (40%)
Natural Science & Engineering	11 (50%)	11 (52.38%)	6 (60%)

Note: The values in brackets represent the interquartile range (IQR).

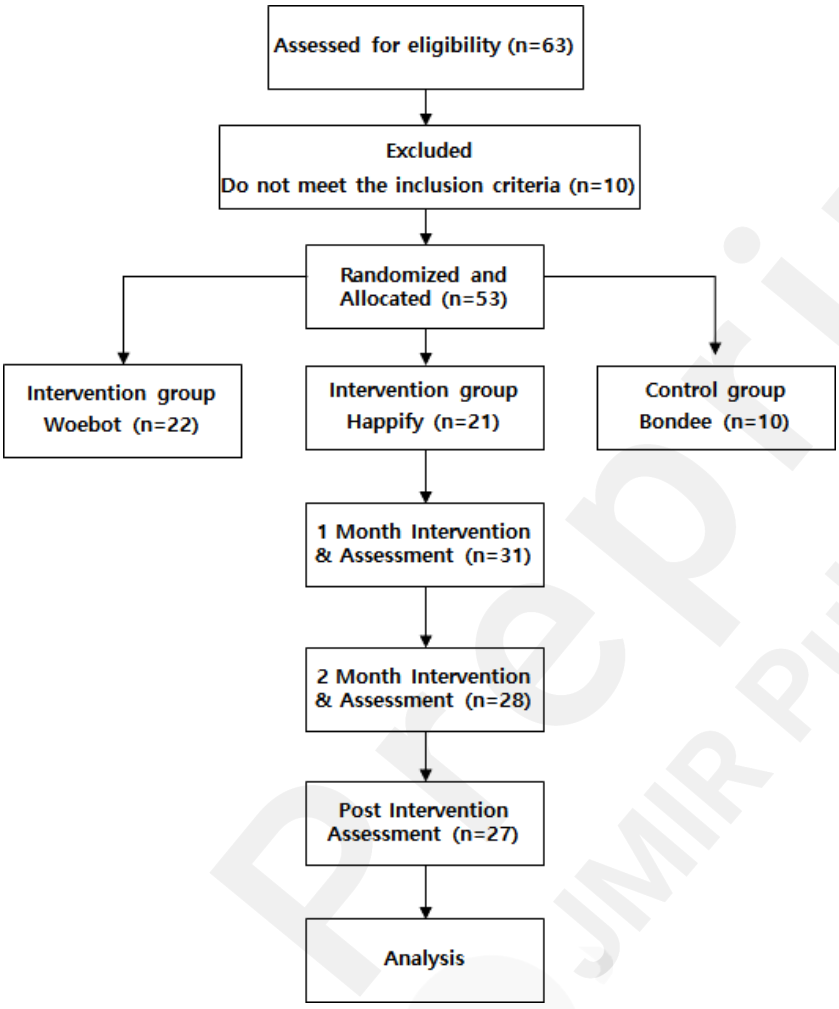
Among the initial 63 applicants, the average PHQ-9 score was 9.23, with 25 individuals (39.7%) classified as being at risk for depression (PHQ-9 ≥ 10). At the baseline survey, 23 out of 53 participants (43.4%) were categorized as being at risk for depression, which is considered a very high proportion according to the Ministry of Health and Welfare's criteria [1]. These findings highlight the urgent need for interventions to address the mental health crisis among college students.

Additionally, participants with a UCLA Loneliness Index score of 65 or higher, indicating severe loneliness, and those with a PHQ-9 score of 20 or higher, indicating severe depression, were advised to seek further counseling.

Participant Flow

Figure 1 illustrates the CONSORT flow diagram of participants through the study. Of the initial 63 respondents, 10 were excluded due to loneliness scores below 34. The remaining 53 participants were randomly assigned to the intervention groups (Woebot: n=22; Happify: n=21) and the control group (Bondee: n=10). Due to attrition, the final sample consisted of 27 participants (Woebot: n=15; Happify: n=9; Bondee: n=3).

Figure 1: CONSORT Flow Diagram of Participants' Flow



Quantitative Findings

Intervention Effects and Trends

The quantitative data analysis results, presented in Figure 2 and Table 4, show a decrease in loneliness and depression after the intervention. However, these effects did not reach statistical significance, likely due to the small sample size. The control group (Bondee) saw a significant decrease in user numbers (baseline: n=10; post: n=3), complicating comparisons. Consequently, Hypothesis 1 was not verified.

To address the unbalanced sample sizes (Bondee: n=3; Woebot: n=15; Happify: n=9), Welch's ANOVA was used, as it is robust to violations of equal variances. However, the overall small sample size limits the power to detect significant effects, and the quantitative results should be interpreted

with caution.

Figure 2: UCLA Loneliness and PHQ-9 Trend Charts

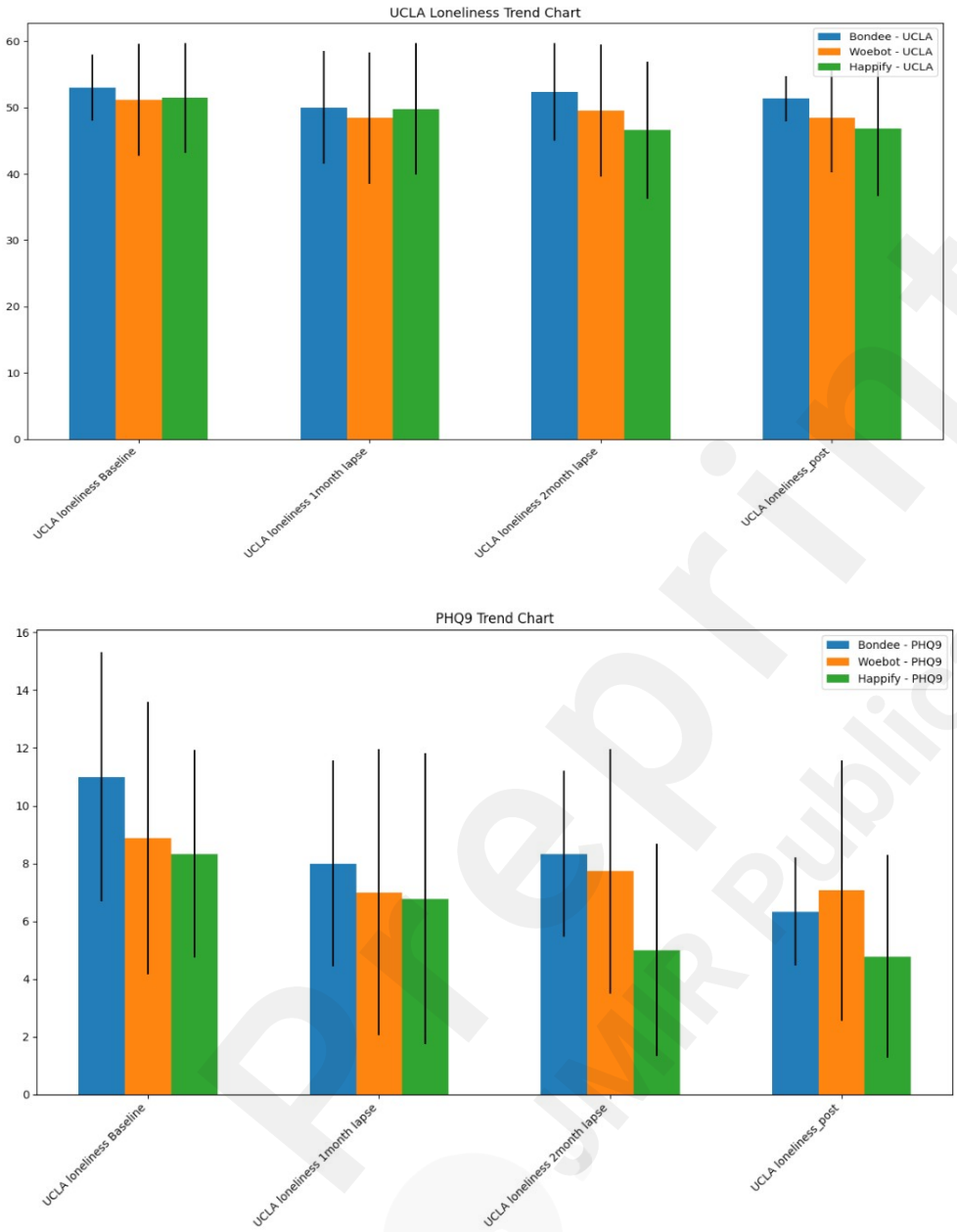


Table 4: Descriptive Statistics and Group Comparisons for UCLA Loneliness and PHQ-9 Scores

Variable	Time Point	Woebot (n=15) Mean (SD)	Happify (n=9) Mean (SD)	Control (Bondee) (n=3) Mean (SD)	Group Comparison Test	p-value
UCLA Loneliness	Baseline	51.13 (8.73)	51.44 (8.76)	53 (6.08)	T-test	0.934
	1 Month	48.40 (10.27)	49.78 (10.51)	50(10.39)	Mann-Whitney U	0.676
	2 Months	49.53 (10.26)	46.56 (10.72)	52.33 (8.96)	T-test	0.508
	Post-Intervention	48.47 (10.26)	46.78 (10.92)	51.33 (4.16)	T-test	0.674
PHQ-9 Depression	Baseline	8.87 (4.88)	8.33 (3.81)	11 (5.29)	T-test	0.782
	1 Month	7 (5.13)	6.78 (5.33)	8 (4.36)	Mann-Whitney U	0.833
	2 Months	7.73 (4.38)	5 (3.91)	8.33 (3.51)	T-test	0.138
	Post-Intervention	7.07 (4.67)	4.78 (3.73)	6.33 (3.21)	Mann-Whitney U	0.353

Note: p-values indicate the significance level of group comparisons. Alpha level set at 0.05. T-test was used for normally distributed data with equal variances. Mann-Whitney U test was used when data did not meet normal distribution criteria. For detailed data analysis procedures, please refer to the PHQ9 & Loneliness trend Analysis code provided in Multimedia Appendix 6.

Description of Results

UCLA Loneliness Scale

◆**Bondee (control group)**: The mean UCLA Loneliness score remained relatively stable, from 53 (SD=6.08) at baseline to 51.33 (SD=4.16) post-intervention. The group comparison test (T-test) did not show a statistically significant difference among the three groups at baseline (p=0.934) or post-intervention (p=0.674).
◆**Woebot**: The mean UCLA Loneliness score decreased from 51.13 (SD=8.73) at baseline to 48.47 (SD=10.26) post-intervention.
◆**Happify**: The mean UCLA Loneliness score decreased from 51.44 (SD=8.76) at baseline to 46.78 (SD=10.92) post-intervention.

PHQ-9 Depression Scale

◆**Bondee (control group)**: The mean PHQ-9 Depression score decreased from 11 (SD=5.29) at baseline to 6.33 (SD=3.21) post-intervention. The group comparison test (T-test) did not show a statistically significant difference among the three groups at baseline (p=0.782), and the Mann-Whitney U test did not show a significant difference between the control and intervention groups post-intervention (p=0.353).
◆**Woebot:** The mean PHQ-9 Depression score decreased from 8.87 (SD=4.88) at baseline to 7.07 (SD=4.67) post-intervention.
◆**Happify**: The mean PHQ-9 Depression score decreased from 8.33 (SD=3.81) at baseline to 4.78 (SD=3.73) post-intervention.

Overall, although the intervention groups (Woebot and Happify) showed decreases in both UCLA Loneliness and PHQ-9 Depression scores from baseline to post-intervention, the group comparison tests did not reveal statistically significant differences among the groups at either baseline or post-intervention for both measures.

Hypothesis Testing

As hypothesized in the Introduction, we investigated the effectiveness of the digital interventions and the role of participants' beliefs and behaviors in their outcomes.

H1: Intervention Effect

The quantitative results showed decreases in both UCLA Loneliness and PHQ-9 Depression scores from baseline to post-intervention in the intervention groups (Woebot and Happify). However, the group comparison tests (T-test for normally distributed data and Mann-Whitney U test for non-normally distributed data) did not reveal statistically significant differences between the control and intervention groups post-intervention (UCLA Loneliness: p=0.674; PHQ-9 Depression: p=0.353). Therefore, H1 was not supported.

H2: Perceived Benefits of Action
The positive group, which expected this intervention experiment to reduce loneliness and depression, showed higher reduction rates in scores compared to the negative group. However, Mann-Whitney U tests did not reveal statistically significant differences between the groups (UCLA Loneliness: p=0.926; PHQ-9: p=0.476). Therefore, H2 was not supported.

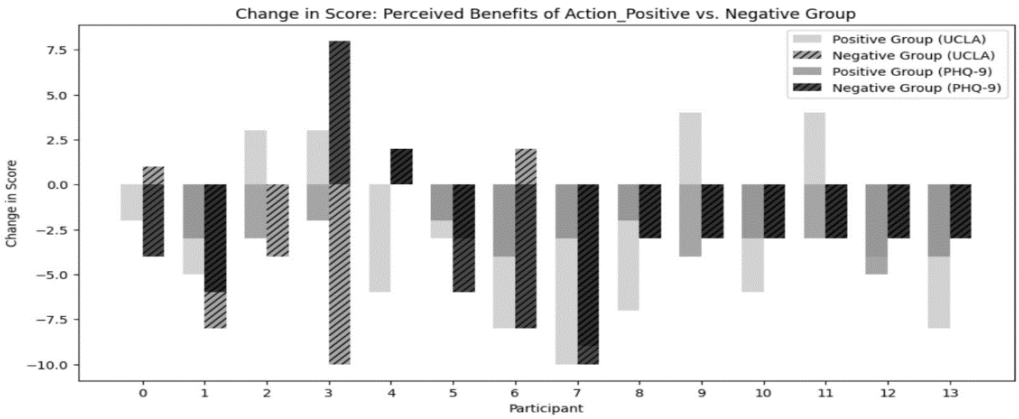
H3: Perceived Barriers to Action
For participants believing in the effectiveness of digital applications in general, the difference in UCLA Loneliness scores (p=0.595) and PHQ-9 scores (p=0.471) between the positive and negative groups was not statistically significant according to Mann-Whitney U tests. Therefore, H3 was not supported.

H4: Help-seeking Behavior
The results for self-help behavior attitudes showed non-significant differences between the groups (UCLA Loneliness: p=0.340; PHQ-9: p=0.623) based on Mann-Whitney U tests. Thus, H4 was not supported.

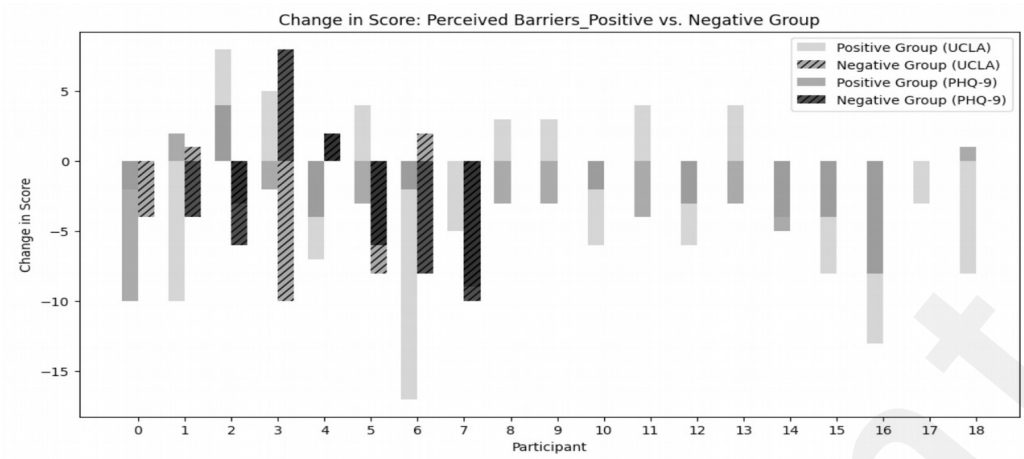
It is important to note that the small and unbalanced sample sizes across the study groups may have limited the statistical power and generalizability of the hypothesis tests. The notably smaller control group compared to the intervention groups, as well as the overall limited sample size, could have influenced the non-significant results. These limitations should be taken into account when interpreting the findings, and future studies with larger and more balanced samples are needed to further investigate these hypotheses and to obtain more conclusive results.

Figure 3 visually presents the comparisons between the positive and negative groups for each of the hypotheses (H2, H3, and H4). For H2 (Perceived Benefits of Action), H3 (Perceived Barriers to Action), and H4 (Help-seeking Behavior), the differences between the positive and negative groups were not statistically significant for either UCLA Loneliness or PHQ-9 Depression scores, as indicated by the p-values greater than 0.05.
Figure 3: Health Behavior Belief vs Loneliness and Depression

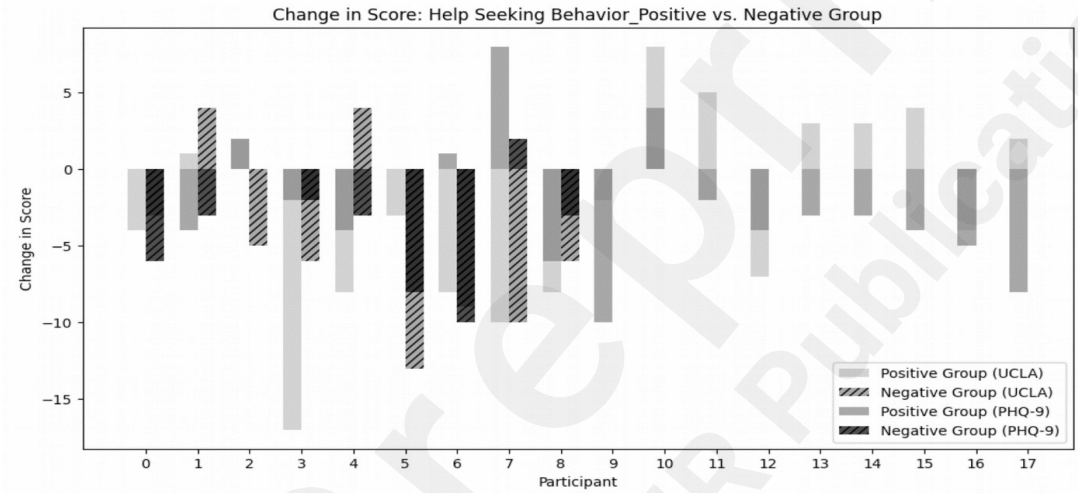
*Hypothesis2: Perceived benefits of action**
*(*The positive group is the group of people who answered 'I expected my loneliness and depression would decrease after the experiment)*



*Hypothesis3: Perceived barriers to action**
*(*The positive group is the group of people who answered 'even digital application can help people relieve loneliness)*



*Hypothesis4: Help-seeking behavior**
*(*The positive group is the group of people who answered 'it is difficult to control loneliness and depression on one's own will and efforts)*



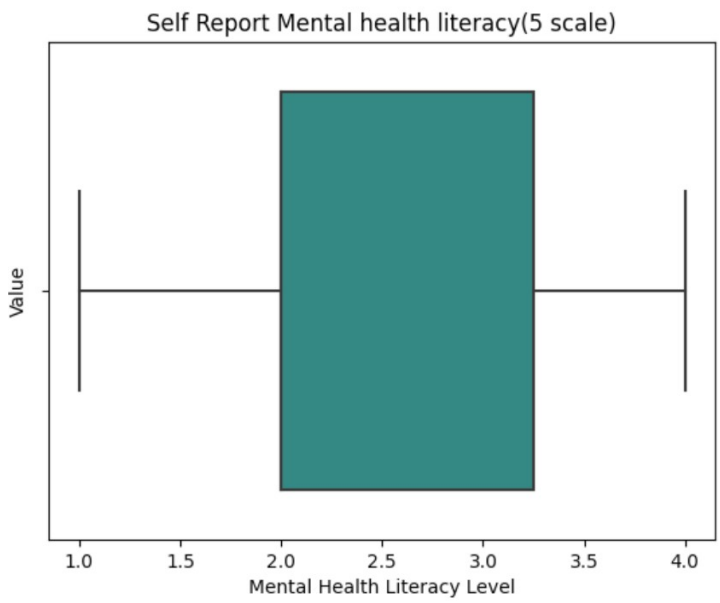
In summary, although the intervention groups showed reductions in loneliness and depression scores, the quantitative analyses did not provide statistically significant evidence to support the hypothesized intervention effect (H1) or the influence of participants' beliefs and behaviors on the outcomes (H2, H3, and H4). The non-significant results should be interpreted with caution due to the limitations imposed by the small sample size.

From the quantitative analysis, we added the self-reported mental health literacy levels and app satisfaction ratings. The results are as follows:

Self-Reported Cohort Mental Health Literacy

Participants rated their mental health literacy on a 5-point scale (1 = poor, 5 = abundant). The mean score was 2.57, indicating relatively low self-perceived mental health literacy (Figure 4).

Figure 4: Self-Reported Cohort Mental Health Literacy



App Satisfaction Rating

User satisfaction was moderate (Table 5). Most users were somewhat satisfied, with few reporting high satisfaction. Low retention rates suggest that even somewhat satisfied users may not have found the apps compelling enough for continued use.

Table 5: Satisfaction Ratings

Question	Very Satisfied		Somewhat Satisfied		Not satisfied	
	Woebot	Happify	Woebot	Happify	Woebot	Happify
Overall satisfaction	1	0	12	4	2	6
Easy to use	0	0	11	4	4	8
Novelty	0	0	5	2	10	7
Effectiveness	2	0	11	5	2	4
Intention to maintain	0	0	6	3	9	6

Not Satisfied = 1-3, Somewhat Satisfied = 4-7, Very Satisfied = 8-10)

Interpretation of Non-Significant Results

Despite non-significant quantitative results, qualitative insights highlight practical benefits and potential improvements for the interventions.

Qualitative Findings

The qualitative findings from the open-ended survey questions and focus group interviews provided valuable insights into participants' experiences with the digital interventions and their coping mechanisms for loneliness.

Favored App Features and Areas for Improvement

Participants highlighted favored features and areas for improvement in the digital interventions. Woebot users appreciated the app's responsiveness and tone, while Happify users valued features supporting meditation and gratitude practice. Suggestions for improvement included enhancing app effectiveness, personalization, and user interface.

Table 6: Participants' Favored Features

Category	Woebot (n)=17	Happify (n)=9
User Experience	Conversational feel, Daily Journal, Warm messages	Well-chosen name, Versatility
Contents	Gratitude journal, Psychological knowledge	Thank Activity, Guided Meditation
Features	Fast response, Varied content, Cute images	Thank Activity, Guided Meditation, Word game

Woebot and Happify users reported several limitations and areas for improvement during the first month of the intervention. One of the most significant drawbacks was that both applications only supported English, which could be a major barrier for non-English speaking users. This lack of language diversity highlights the need for mental health apps that cater to a wider range of users.

Table 7: Areas for Improvement

Category	Woebot (n)=17	Happify (n)=9
Language support	English only	English only
Content variety	Variety, but some repetition	The content seems a bit lacking
User experience	User input system / Infinite loop problem	Non-intuitive, Errors
Conversational features	Fixed responses	Repetitive questions
Overall feedback	Desire for more applicable contents	Not satisfactory, Pressure to subscribe

Another common issue was the repetitive and limited nature of the responses provided by the apps. Despite Woebot's diverse content, users noted that certain parts felt repetitive. Happify users also reported a lack of content variety. This suggests that even with advanced conversational agents, the interactions can still feel scripted and constrained by rule-based systems.

Woebot users encountered problems with the user input system, which sometimes led to infinite loops or errors in the conversation flow. This could be frustrating for users seeking smooth and intuitive interactions. Happify users also found the interface less intuitive than expected.

In terms of conversational abilities, both apps had limitations. Woebot's responses could feel fixed and repetitive, while Happify's questions were sometimes perceived as repetitive. These issues

underscore the challenges in creating truly dynamic and engaging conversational experiences.

The attrition rates were notably different between the two intervention groups. Woebot had a decrease from 22 participants to 15, whereas Happify saw a decrease from 21 participants to 9. This significant attrition in the Happify group suggests that user satisfaction may have played a role in retention rates. Participants' feedback indicated that issues such as non-intuitive design and pressure for premium subscriptions might have contributed to the higher dropout rate for Happify compared to Woebot.

Overall, users expressed a need for more relevant and applicable content in both apps. Woebot users desired content that was better tailored to their specific needs, while Happify users reported dissatisfaction with the overall experience and felt pressured to subscribe to premium services.

Table 8: App Enhancement Suggestions

Suggested Enhancement	Mentions
Connection system with mental health professionals	12
Reward system for activities performed	7
High-quality feedback for gratitude journals	5
Platform as home (button) and detail page function	4
Alarm system for activities to be performed	4
Personalized opt-in function based on individual needs	4
Various video content for users	3
Podcast on loneliness and depression	2
User content (UCC) and peer-to-peer networking	2

Table 8 summarizes the participants' suggestions for enhancing the apps, which include improving the chatbot's conversational abilities, providing more personalized content, offering a wider variety of interactive features, and enhancing the user interface. Participants also emphasized the importance of integrating these apps with professional mental health support systems.

These findings highlight the need for designing mental health apps that are linguistically inclusive, offer diverse and engaging content, provide intuitive user experiences, and deliver effective conversational interactions. Addressing these limitations could greatly enhance the effectiveness and user satisfaction of digital mental health interventions. Moreover, this feedback underscores the essential need to integrate digital platforms with both online and offline medical systems, ensuring that students have seamless access to professional support. As Lambert (31) highlighted, the therapeutic relationship is crucial for psychotherapy's effectiveness, and our study's participants similarly emphasized the importance of connecting with mental health professionals for effective digital applications.

Coping Mechanisms for Loneliness

During the focus group interviews, participants shared a diverse array of coping mechanisms for loneliness (Table 9). These strategies encompassed goal-setting, distraction, self-care, and social connection.

Table 9: How Do You Cope with Loneliness? What Do You Do?

	Coping Strategies
Goal-setting:	Participants emphasized redirecting their focus towards tangible achievements, such as studying for English proficiency certificates or scholarships. ***"I'm motivated to achieve things. I like to find a way out and do various things. After graduating from high school, I started reading books seriously, even though I avoided classic novels like Frankenstein because they were difficult.*** "
Distraction	Overcoming emotional entanglement, participants turned to diverse forms of distraction. ***"I used to get caught up in my emotions, but lately, I've been trying to get out of them. For example, I watch interesting TV shows. I listen to new songs, both upbeat and ballads. I find something to do to distract myself. I watch TV or YouTube. I find something I can immerse myself in. I watch games or dramas. I watched 'Iltascansdal.' I watch games or dramas."***
Self-care	Self-care strategies include going for walks, reading specific books, and consciously managing negative thoughts.***"Life is a journey, so it's important to be strong on your own. I've been working out at the gym recently."*** Participants emphasize regular exercise routines, waking up on time, and engaging in activities like writing during challenging times.
Social Connection	Interpersonal engagement emerged as a key coping mechanism, with participants highlighting the significance of talking to people, especially close friends, to alleviate loneliness. ***"I've tried various things, but talking to people is the only way to forget those feelings. I prefer to talk to close friends rather than new people. I miss being around people. I cope by talking to other people. I talk to other people and express my feelings."***

Participants emphasized redirecting focus towards tangible achievements and utilizing diverse forms of distraction to manage loneliness. Self-care activities and interpersonal engagement were highlighted as crucial aspects of coping with loneliness. These insights suggest that a multifaceted approach addressing individual coping strategies and broader social connections is essential.

Gratitude Journaling and Positive Experiences

Participants' responses to the gratitude journaling feature of the apps revealed instances of positive emotional transformation. Engaging in gratitude journaling enhanced self-compassion, fostered acceptance, and strengthened social bonds. The interactive nature of the chatbots and the sense of care conveyed through warm greeting messages were particularly appreciated by participants dealing with loneliness or isolation.

Figure 5: Students' Positive Experiment Experiences Word Clouds

state
meditation
avatars
daily
room
feeltime
response
writing
gratitude
conversation
moments
Journal
Convenience
Cute
space
various
diverse
happy
messages
emotions
day
positive
one
robot
knowledge
word
think
grateful
Moderate
Randomness
provided
Enjoyed
Reflecting
design
life
spend
reflect
Updating
Simplicity
Intimate
Decorate
Receiving
occasional
Psychological
atmosphere
despite
Expressing
diary
concrete
mindset
current
oneself
Quick
ways
connect
autonomy
Chatbot
solid
desired
express
methods
virtual
topics
settings
character
understandable
provision
thoughts
choices
decorating
spare
quizzes
descriptive
comfortable
Immersive
Mutual
nature
non
tone
explain
typing
feeling
objectively
finding
back
manage
moods
jarring
check
Natural
based
past
using
simple
system
entries
actual
delivery
varying
memes
input
summarize
language
default
preferences
program
personalizing
warm
chosen
discover
everyday
reactions
accessibility
welcoming
landscape
fresh
stop
activity
chat
name
overlooked
without
buttons
content
survey
well
receive
situation
receive
receive
receive

moments with the app. The word size represents the frequency of mentions, with "gratitude," "daily," "conversation," "meditation," "response," and "writing" being the most common. This indicates that participants frequently benefited from the app in daily gratitude practices, meditation, conversations, and writing. The word cloud quickly highlights these common themes and experiences.

Table 10: Specific Examples of Best Used Cases

Category	Subcategory	App	Positive Change	Specific Example
Gratitude Journal	Positive Emotion Enhancement	Woebot, Happify	Increased happiness, sense of accomplishment, Reduced negative emotions, Developed a positive mindset	*"When I wrote down what I was grateful for every day in Woebot, I was able to be grateful for even the small things."* *"Through Happify's Thank You, there were times during the week when I thought about the things I was grateful for and felt happy."*
	Self-Reflection	Woebot, Happify	Reflect on the day, Understand yourself, Explore positive values	*"When I used the journal to write down three things I was grateful for each day in Woebot, I was able to reflect on the day."* *"Writing a gratitude journal in Happify made me think about the things I was grateful for."*
	Daily Life Improvement	Woebot, Happify	Reduced stress, Increased mental stability, Improved sleep quality	*"When I felt really frustrated, writing a gratitude journal in Woebot helped me to feel neutral."* *"When I tried to submit a screenshot of my gratitude journal in Happify, I was surprised to see the old gratitude I had forgotten."*
Meditation and Deep Breathing	Concentration Improvement	Happify	Improved concentration, Reduced distractions, Efficient time management for goal achievement	*"On the way home on the subway, or in bed before going to sleep, I wrote thank activity, and I was able to look back on the day and feel relieved that I was able to get through the day safely, and that there were things to be grateful for, even if they were small."*
	Physical Health Improvement	Woebot	Reduced blood pressure and heart rate, Increased immunity, Relaxed muscles and relieved pain, Improved sleep quality and reduced fatigue	Brief Meditation before Sleep for Emotional Regulation
	Emotion Regulation	Woebot	Reduced anxiety, stress, and depression, Improved emotion recognition and regulation ability, Maintained peace of mind	*"There was a moment when I was able to regulate my emotions. "* *"One day, when someone I was in touch with said they were going to confess, I suddenly thought of the app and wrote that."*
Miscellaneous	Positive Emotions	Bondee	Emotional stability and healing effect	*"The experience of just floating sky photos when I'm tired"*

Table 10 presents the specific instances when participants found the apps most beneficial, categorized by the positive changes they experienced, such as emotion enhancement, gratitude journaling, daily life improvement, and physical health improvement. Participants reported increased happiness, reduced negative emotions, better sleep quality, enhanced concentration, and even physical health benefits like reduced blood pressure and fatigue through app usage.

These examples suggest that digital mental health interventions have the potential to positively impact various aspects of college students' well-being, even if these effects were not fully captured in the quantitative analysis. The qualitative data indicates that consistent use of these apps could lead to meaningful improvements in users' mental health and overall well-being.

Discussion

This study adds to the research on digital mental health interventions by evaluating Woebot and Happify in reducing loneliness and depression among college students. Compared to Fitzpatrick et al. [26], our study had a longer intervention period and a post-intervention follow-up for a more comprehensive evaluation. While Lim et al. [25] had a similar period, our study had a larger sample size and more extensive analyses. Unlike Boucher et al. [22], who focused on qualitative insights

during a shorter period, our mixed-methods approach over a longer duration provided a better understanding of the interventions' efficacy and user experiences. Our study uniquely compares Woebot and Happify, offering insights into their effectiveness and user preferences.

The quantitative data showed a moderate positive correlation between loneliness and depression ($r = 0.37$, $p < 0.001$), highlighting their complexity. This suggests that while related, loneliness and depression are distinct, and other factors may influence college students' mental health outcomes (see the PHQ9 & Loneliness trend Analysis code in Multimedia Appendix 6).

The moderate correlation between loneliness and depression highlights their intricate, bidirectional relationship. Loneliness can lead to depressive symptoms due to a lack of social connection, while depression can increase loneliness through social withdrawal. This suggests that interventions targeting either issue may positively affect the other. However, loneliness and depression are distinct constructs that require different approaches: social skills and connections for loneliness, and CBT and emotion regulation for depression.

Additionally, the moderate correlation suggests that other factors, such as stress, coping mechanisms, and resilience, also play a role in mental health outcomes. This underscores the need for comprehensive, multi-faceted interventions that address the diverse challenges faced by college students. Even within the small control group using Bondee, the slight decrease in loneliness and depression scores suggests that any form of structured interaction can have beneficial effects, emphasizing the importance of social engagement and connection.

Interestingly, even the small Bondee control group saw slight decreases in loneliness and depression, suggesting structured interaction has benefits. This underscores the importance of social engagement and connection.

Several factors might explain why the interventions didn't yield significant effects. Firstly, the English-only apps may have reduced engagement, especially for those less proficient in English.

Additionally, the demanding academic schedule and competitive environment, coupled with daily stressors, may have exacerbated depression and loneliness, reducing intervention effectiveness. This underscores the need for holistic digital mental health interventions considering these factors.

Additional Considerations for the Korean Context

In South Korea, research on digital interventions for reducing loneliness and depression among college students is extremely rare. There are very few studies, and none involve structured intervention experiments. This highlights the importance of developing and validating Korean-language digital mental health interventions. Given the severe mental health crisis among Korean college students, immediate intervention is crucial.

Korean college students highly valued conversational elements, positive reinforcement, educational features, and reward mechanisms in digital interventions. This study serves as a critical pilot for the future development of Korean-language support features, as well as reward-based CBT chatbots integrating positive psychology and empathetic support. The outcomes of this research provide a foundational understanding that will guide the creation of more effective and culturally relevant digital mental health tools for Korean college students.

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Implications

The findings of this study have several important implications for future research and practice in the field of digital mental health interventions for college students:

1. **Personalized, user-centered design**: Future interventions should be tailored to the unique needs and preferences of college students to enhance engagement and effectiveness. For example, conducting in-depth user interviews to develop customized opt-in features and various personas can significantly improve the personalization of digital mental health tools. As mentioned by participants in Table 8, features such as alarm systems for activities and personalized opt-in functions based on individual needs were frequently suggested.

2. **Integration with professional and peer support**: Digital interventions should seamlessly connect with both online and offline mental health professionals. Additionally, peer support groups, such as the University of Michigan's Wolverine Support Network [35] and listener systems like 7 Cups [36], can be effective alternatives for providing emotional support and fostering a sense of community.

3. **Mental health literacy education**: Incorporating mental health literacy education into college curricula and developing holistic support systems is crucial for addressing the persistent challenges faced by students. Institutions should prioritize comprehensive approaches to mental health promotion.

4. **Longitudinal research**: Further research with larger, more diverse samples and extended follow-up periods is needed to validate the efficacy and long-term impact of digital interventions. This will help in understanding their sustained benefits and potential limitations.

5. **Development of LLM-based chatbots**: Enhancing chatbots with Korean language support, positive psychology, empathy, and reward mechanisms can potentially better meet the mental health needs of Korean college students, improving engagement and effectiveness. Future research should focus on developing and evaluating such chatbots tailored to the specific needs and preferences of Korean college students.

Limitations

The current study has several limitations that should be acknowledged. First, the small and unbalanced sample sizes across the study groups may have limited the statistical power and generalizability of the results. The notably smaller control group compared to the intervention groups could have influenced the non-significant findings. Additionally, due to the limited sample size and the need to ensure sufficient power in the intervention groups, an uneven distribution of depression scores was observed at baseline (p=0.782). Although the mean depression scores were within a similar range across the groups, this limitation should be considered when interpreting the results, as the groups may not be perfectly comparable in terms of initial depression severity. Future studies with larger and more balanced samples are needed to confirm the efficacy of digital interventions for college students.

Second, the reliance on self-report measures may have introduced response bias. Incorporating

objective measures and diagnostic assessments could enhance the validity of future studies. Third, the use of English-language interventions may have influenced engagement and satisfaction among participants with lower English proficiency. Future research should explore the development and evaluation of interventions in participants' native languages. Finally, the study's duration may have been insufficient to capture long-term effects. Longer follow-up periods are needed to assess the sustainability of treatment effects and identify potential barriers to long-term engagement with digital mental health tools.

Conclusions

This mixed-methods study provides valuable insights into the efficacy and user experiences of digital mental health interventions for college students. While the quantitative findings did not show significant effects, the qualitative data revealed the potential of well-designed digital interventions to positively impact various aspects of college students' mental health and well-being. Participants' experiences with gratitude journaling, meditation, and other app features suggest that consistent use of these tools could lead to meaningful improvements in emotional, cognitive, and physical health.

However, the study also underscores the importance of considering contextual factors and individual preferences when designing and implementing digital mental health interventions. Future research should focus on developing personalized, user-centered interventions that address the unique needs of college students and explore ways to integrate these tools with professional support systems. Moreover, a comprehensive approach to promoting mental health among college students is needed, which includes mental health education and the provision of holistic support systems. Further large-scale, longitudinal studies are necessary to confirm the efficacy and sustained impact of digital interventions on college students' mental health outcomes.

Acknowledgements

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Assignment number: HI22C2185

Conflicts of Interest

The author declares that there is no conflict of interest.

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Multimedia Appendices

The full Multimedia Appendices can be found in the attached file.

Supplementary Files

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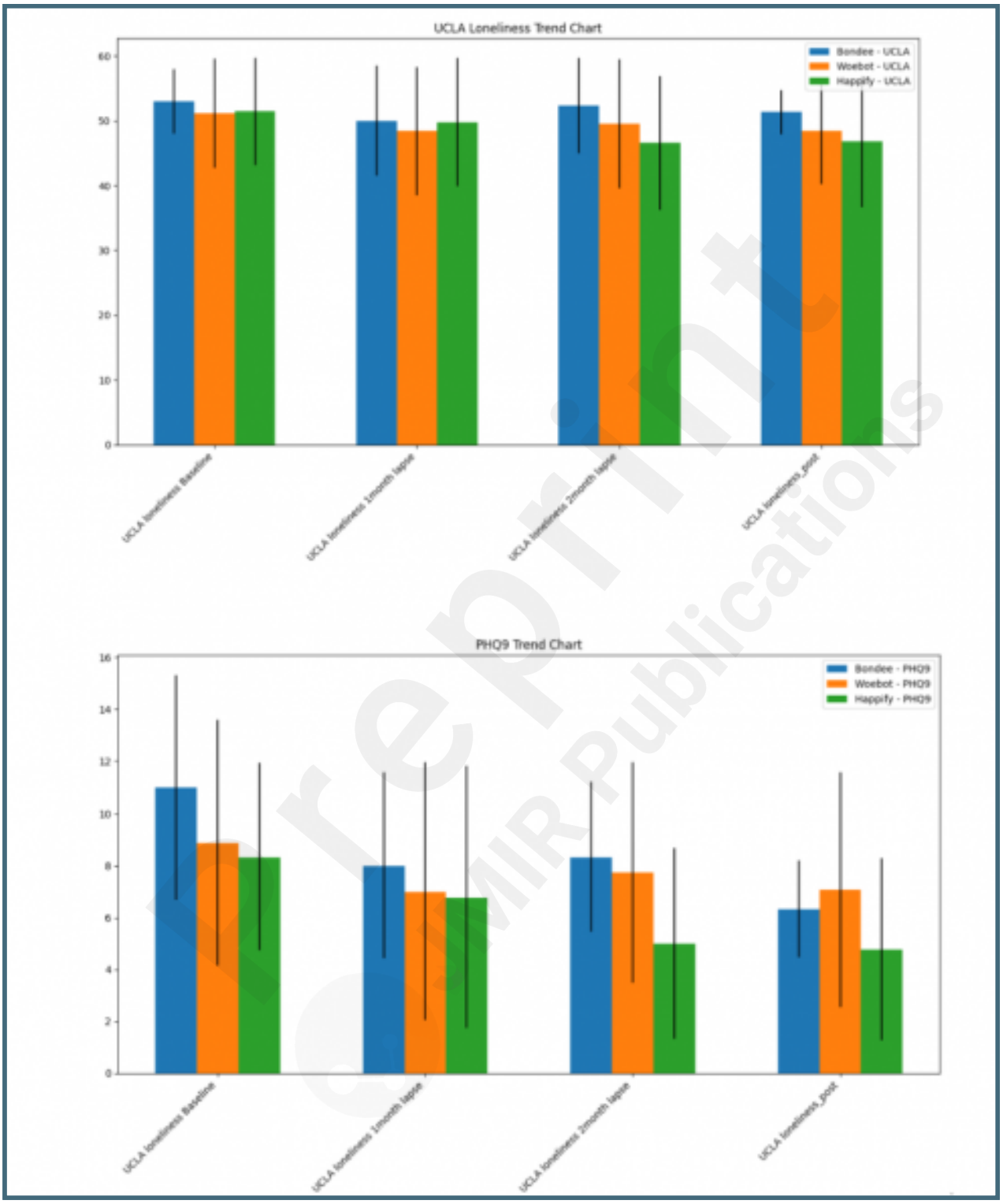
Untitled.


UCLA Loneliness Trend Chart
Bondee - UCLA
Woebot - UCLA
Happify - UCLA
0
10
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60
UCLA loneliness Baseline
UCLA loneliness 1month lapse
UCLA loneliness 2month lapse
UCLA loneliness_post
PHQ9 Trend Chart
Bondee - PHQ9
Woebot - PHQ9
Happify - PHQ9
0
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UCLA loneliness Baseline
UCLA loneliness 1month lapse
UCLA loneliness 2month lapse
UCLA loneliness_post

Figures

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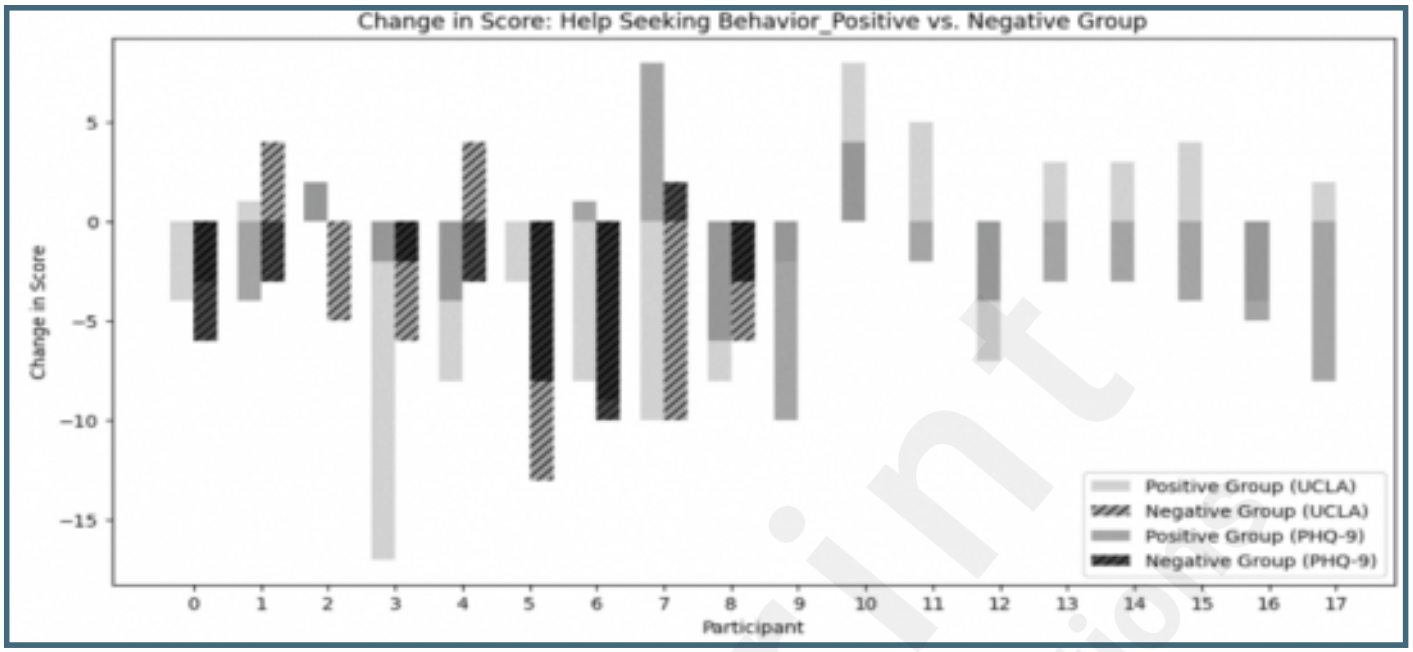
Health Behavior Belief vs Loneliness and Depression (Help-seeking Behavior).



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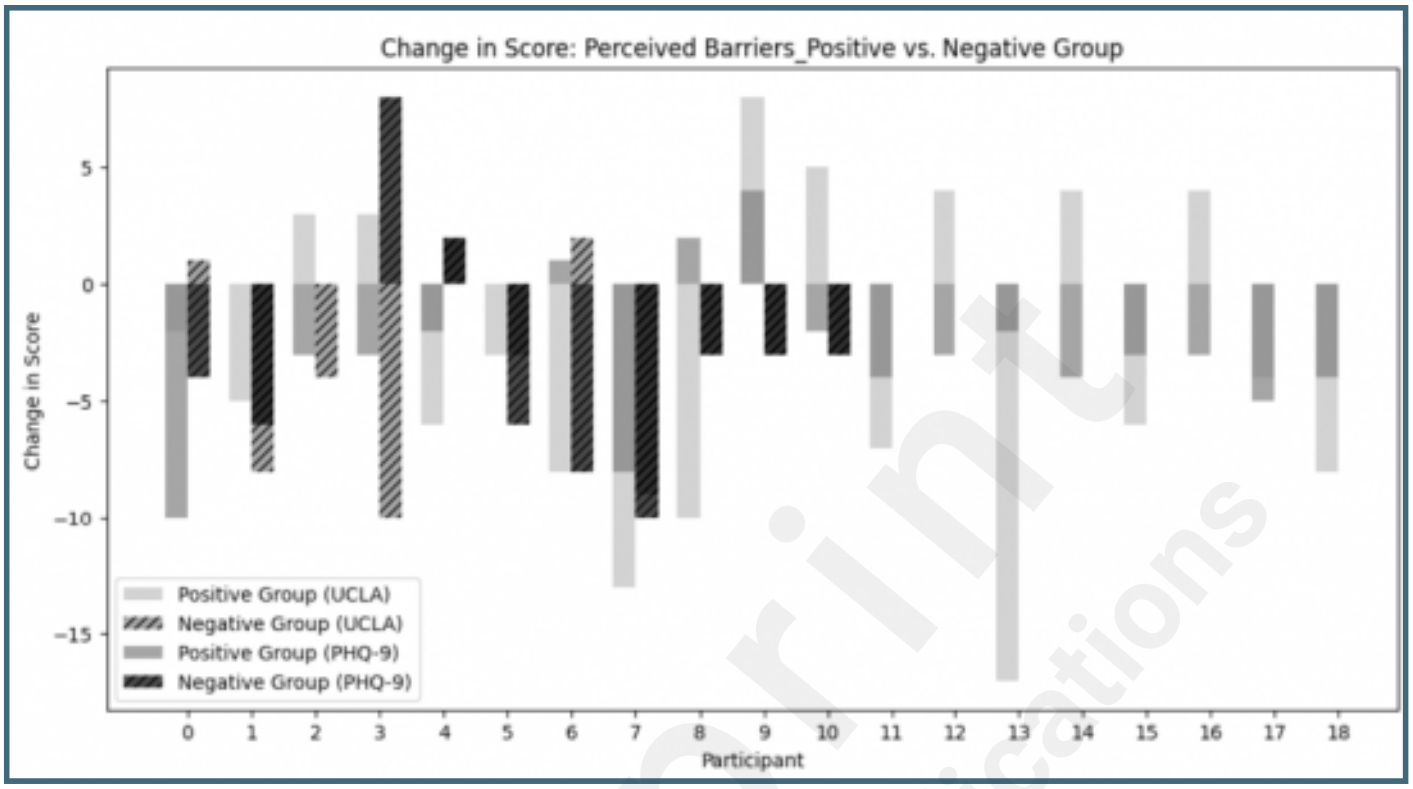
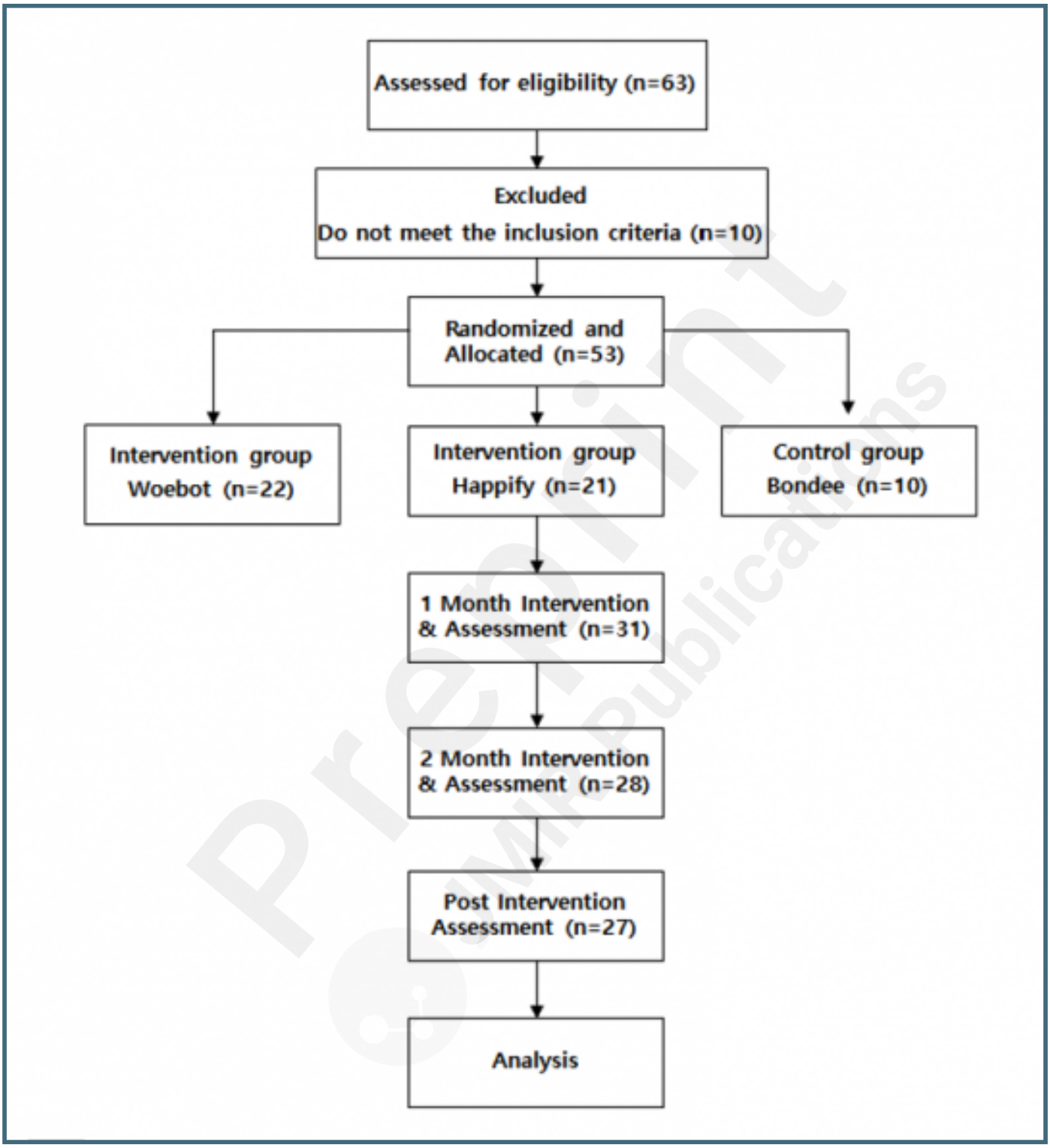
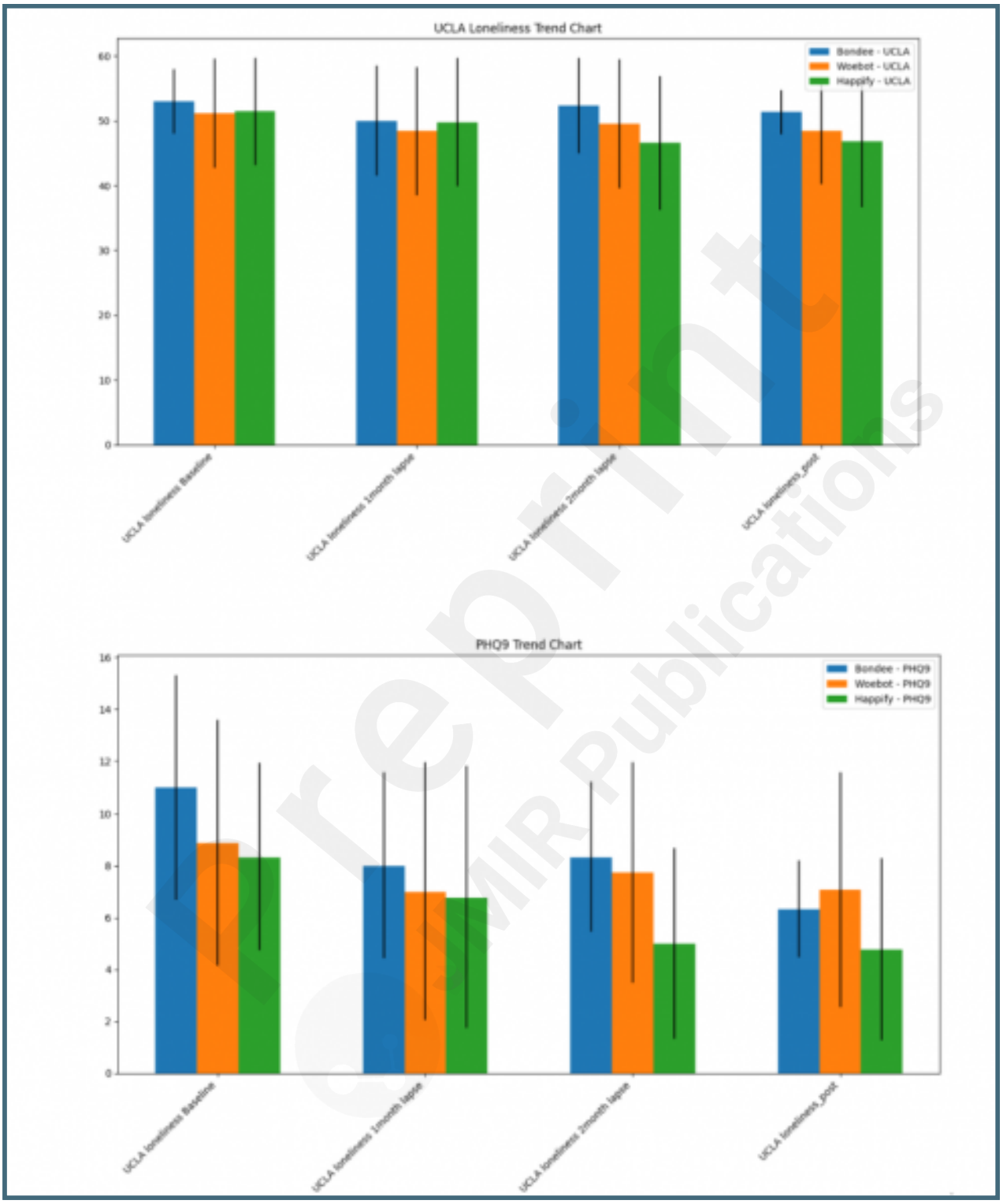
Health Behavior Belief vs Loneliness and Depression (Perceived Barriers to Action).



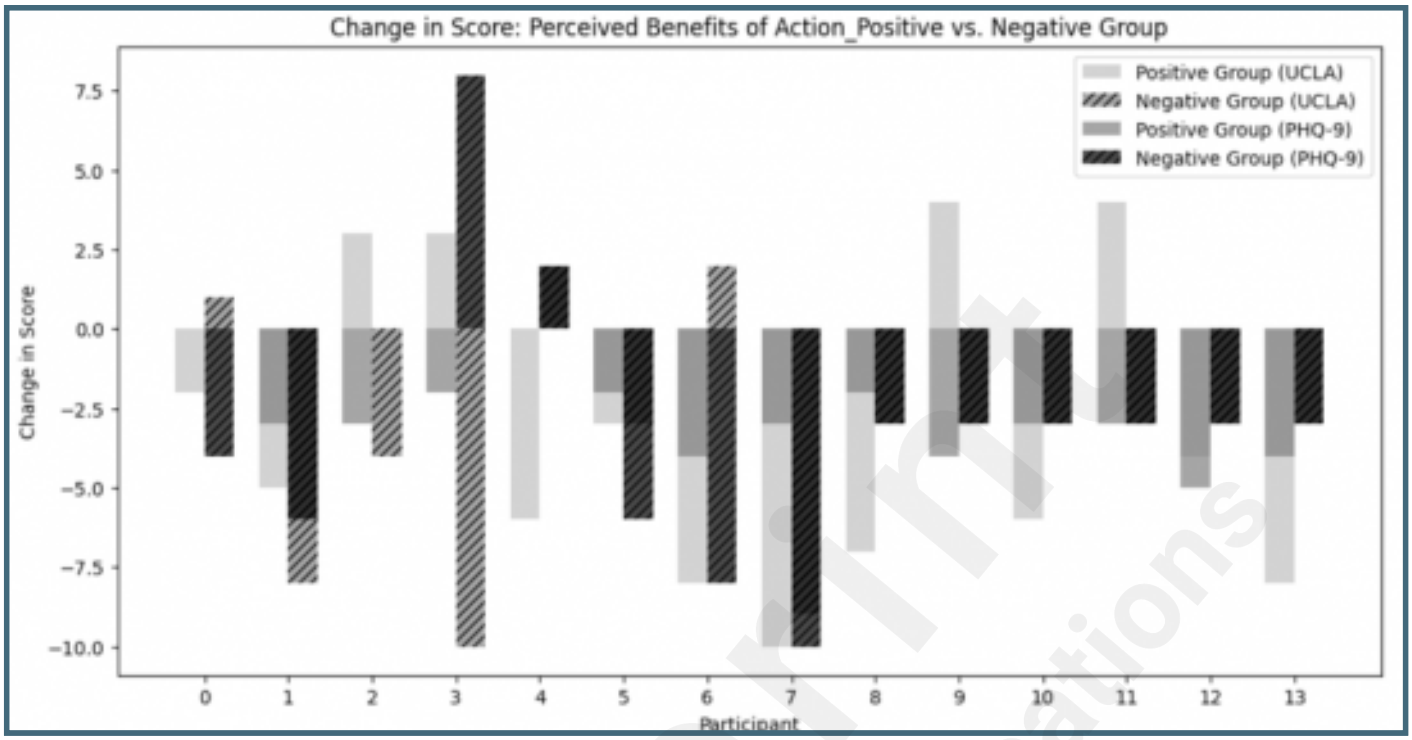
CONSORT Flow Diagram of Participants' Flow.



UCLA Loneliness and PHQ-9 Trend Charts.



Health behavior belief vs loneliness and depression (Perceived Benefits of Action).



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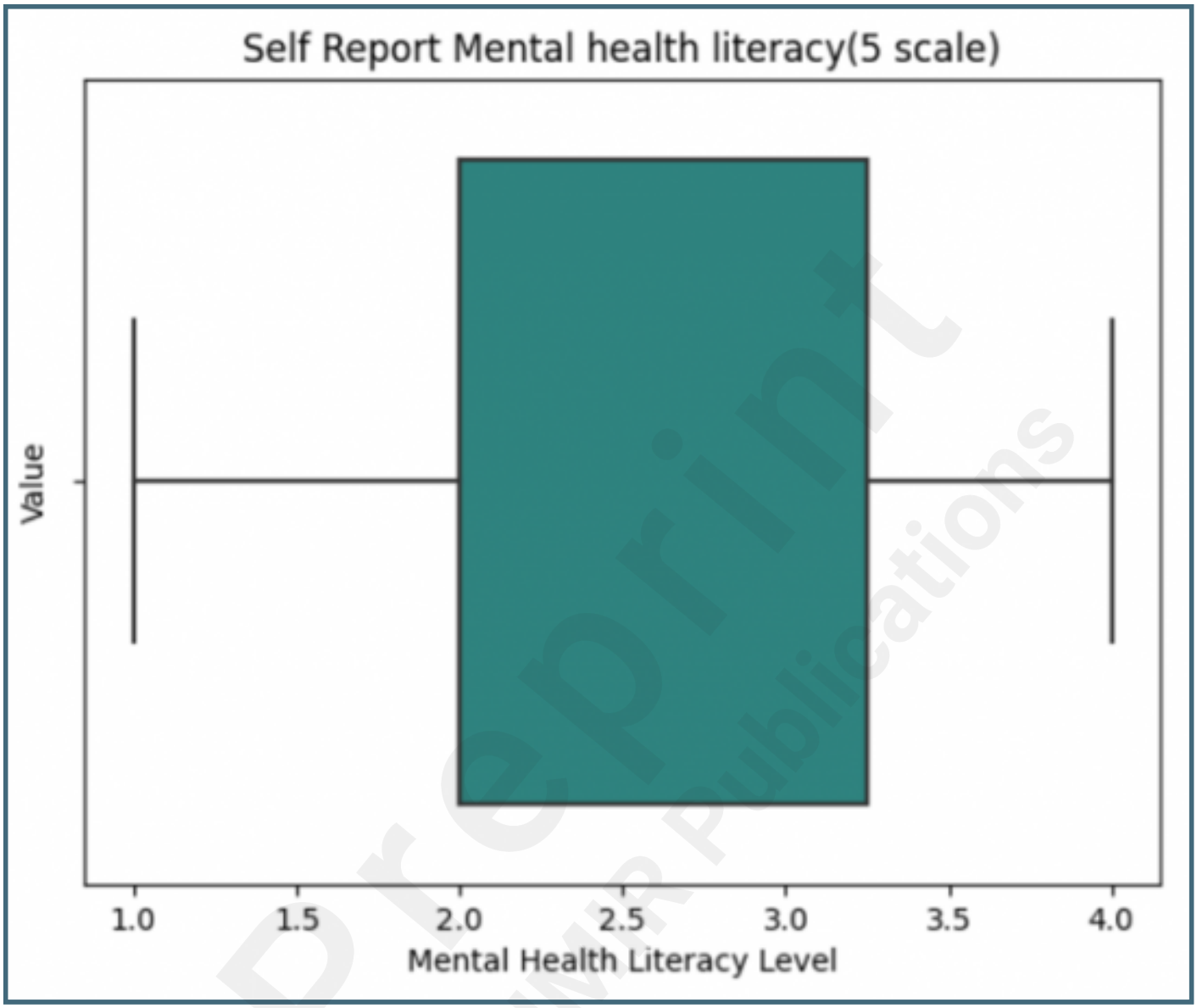
Self-Reported Cohort Mental Health Literacy.



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Students' Positive Experiment Experiences Word Clouds.

Multimedia Appendixes

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Untitled.
URL: http://asset.jmir.pub/assets/d27026b46848a7c14c4dec414a6b7256.pdf

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CONSORT (or other) checklists

CONSORT eHealth checklist.
URL: http://asset.jmir.pub/assets/3065bf6715acfc643c216ee897075d11.pdf

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