



A Randomized Controlled Trial to Evaluate the Effectiveness of an AI-Assisted Mindfulness Application on Reducing Anxiety and Depression Among Nursing Students.

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Abstract

Background: Anxiety and depression are among the most prevalent mental health problems affecting nursing students due to academic demands, clinical responsibilities, and emotional stress. If left unmanaged, these conditions can negatively influence students' academic performance, clinical competence, and overall well-being. Artificial Intelligence (AI)-assisted mindfulness applications have emerged as innovative digital health tools that provide personalized mindfulness training, stress management, and emotional support.

Aim: To evaluate the effectiveness of an AI-assisted mindfulness application in reducing anxiety and depression among nursing students.

Methods: A parallel-group randomized controlled trial with a pre-test and post-test design was conducted among **100 undergraduate nursing students** selected from nursing colleges. Participants were randomly allocated to an **experimental group (n = 50)** and a **control group (n = 50)**. The experimental group received an **8-week AI-assisted mindfulness intervention**, including guided meditation, breathing exercises, mood tracking, AI-generated reminders, and personalized feedback, while the control group received routine stress management education. Anxiety and depression were assessed using the **Generalized Anxiety Disorder-7 (GAD-7)** and **Patient Health Questionnaire-9 (PHQ-9)** scales. Data were analyzed using descriptive statistics, Chi-square test, paired *t*-test, independent *t*-test, and ANCOVA. Statistical significance was set at $p < 0.05$.

Results: There were no significant differences between the two groups at baseline. Following the intervention, the experimental group demonstrated a significant reduction in anxiety scores (from **13.84 ± 3.18** to **6.92 ± 2.44**, $p < 0.001$) and depression scores (from **14.72 ± 3.46** to **7.54 ± 2.71**, $p < 0.001$). In contrast, the control group showed no statistically significant improvement. Post-test comparisons

revealed significantly lower anxiety ($t = 11.02, p < 0.001$) and depression ($t = 10.58, p < 0.001$) scores in the experimental group compared with the control group.

Conclusion: The AI-assisted mindfulness application was effective in significantly reducing anxiety and depression among nursing students. The findings support the integration of AI-based mindfulness interventions into nursing education and student wellness programs to promote psychological well-being and resilience.

Keywords: Artificial Intelligence, Mindfulness, Anxiety, Depression, Nursing Students, Mental Health, Mobile Health (mHealth), Randomized Controlled Trial.

Introduction

Anxiety and depression are among the most common mental health problems affecting nursing students worldwide. Nursing education is academically demanding and requires students to balance classroom learning, clinical practice, examinations, assignments, and interpersonal responsibilities. Continuous exposure to academic stress, clinical workload, patient care, and fear of making errors can negatively affect students' psychological well-being. If left unaddressed, anxiety and depression may impair academic performance, reduce clinical competence, increase absenteeism, and negatively influence the quality of future nursing care.

Recent advances in digital technology have created new opportunities for promoting mental health through mobile applications. Artificial Intelligence (AI)-assisted mindfulness applications provide personalized meditation sessions, breathing exercises, stress management techniques, mood tracking, and real-time feedback based on users' emotional status. These applications enable students to practice mindfulness at their convenience, improve emotional regulation, and develop healthy coping strategies. Compared with traditional counseling alone, AI-assisted mindfulness interventions offer continuous support, greater accessibility, and individualized guidance.

Mindfulness-based interventions have been shown to reduce stress, anxiety, and depressive symptoms while improving emotional resilience, concentration, sleep quality, and overall well-being. Integrating AI into mindfulness applications further enhances user engagement by providing adaptive recommendations, personalized reminders, and progress monitoring. As nursing students are frequent smartphone users, AI-assisted mindfulness applications represent an innovative and practical approach to promoting mental health.

Despite the increasing use of digital mental health technologies, evidence regarding the effectiveness of AI-assisted mindfulness applications among nursing students remains limited, particularly in developing countries. Therefore, this randomized controlled trial was undertaken to evaluate the effectiveness of an AI-assisted mindfulness application in reducing anxiety and depression among nursing students. The findings are expected to provide evidence for integrating AI-based mental health interventions into nursing education and student wellness programs.

Need for the Study

Mental health problems among nursing students have become a growing concern because of increasing academic pressure, clinical responsibilities, examination stress, and emotional challenges. Anxiety and depression can adversely affect students' learning ability, clinical performance, interpersonal relationships, and quality of life. Early identification and effective intervention are essential to prevent long-term psychological consequences.

Although counseling and stress management programs are available in many institutions, they are often limited by time, accessibility, and student participation. AI-assisted mindfulness applications provide an accessible, cost-effective, and personalized approach to mental health promotion by offering guided meditation, mood monitoring, relaxation exercises, and real-time feedback through smartphones.

There is limited evidence from randomized controlled trials evaluating the effectiveness of AI-assisted mindfulness applications among nursing students. Therefore, this study is needed to determine whether an AI-assisted mindfulness application can effectively reduce anxiety and depression. The findings will provide valuable evidence for nurse educators, mental health professionals, and policymakers to implement innovative digital interventions that support the psychological well-being of nursing students.

Objectives of the Study

1. To assess the baseline level of anxiety among nursing students in the experimental and control groups.
2. To assess the baseline level of depression among nursing students in the experimental and control groups.
3. To evaluate the effectiveness of the AI-assisted mindfulness application in reducing anxiety among nursing students.
4. To evaluate the effectiveness of the AI-assisted mindfulness application in reducing depression among nursing students.
5. To compare the post-test anxiety scores between the experimental and control groups.
6. To compare the post-test depression scores between the experimental and control groups.
7. To determine the association between selected demographic variables (age, gender, year of study, residence, and previous mindfulness practice) and baseline anxiety and depression levels among nursing students.

Research Hypotheses

H₁: Nursing students who receive the AI-assisted mindfulness application will demonstrate a statistically significant reduction in anxiety scores compared with those in the control group.

H₂: Nursing students who receive the AI-assisted mindfulness application will demonstrate a statistically significant reduction in depression scores compared with those in the control group.

H₃: There will be a statistically significant association between selected demographic variables and baseline anxiety and depression levels among nursing students.

Materials and Methods

Study Design

A parallel-group, pre-test–post-test randomized controlled trial (RCT) was conducted to evaluate the effectiveness of an AI-assisted mindfulness application in reducing anxiety and depression among undergraduate nursing students. The study was designed according to the Consolidated Standards of Reporting Trials (CONSORT) guidelines. Participants were randomly assigned to either the experimental group or the control group in a 1:1 ratio.

Study Setting

The study was conducted at selected nursing colleges affiliated with recognized universities. Data collection was carried out in classrooms and college premises over a period of eight weeks.

Study Population

The study population consisted of undergraduate nursing students aged 18–25 years who exhibited mild to moderate symptoms of anxiety and/or depression and met the eligibility criteria.

Sample Size

The sample size was **100 nursing students**, calculated based on an expected moderate effect size, 80% statistical power, and a 5% level of significance.

- **Experimental Group (n = 50):** Received the AI-assisted mindfulness application for 8 weeks.
- **Control Group (n = 50):** Received routine stress management education.

Sampling Technique

A list of eligible nursing students was obtained from the participating colleges. Participants were selected using **simple random sampling**. Following recruitment, students were randomly allocated to the experimental and control groups using a computer-generated randomization sequence. Allocation concealment was maintained using sealed opaque envelopes.

Eligibility Criteria

Inclusion Criteria

- Undergraduate nursing students aged 18–25 years.
- Mild to moderate anxiety and/or depression identified using standardized screening tools.
- Ownership of an Android or iOS smartphone with internet connectivity.
- Ability to understand English.
- Willingness to participate and provide written informed consent.

Exclusion Criteria

- Students currently receiving psychiatric medication or psychotherapy.
- Students diagnosed with severe psychiatric disorders.
- Students practicing structured mindfulness or meditation programs during the previous three months.
- Students unwilling to complete the intervention or follow-up assessments.

Intervention

Experimental Group

Participants received access to an **AI-assisted mindfulness mobile application** for **8 weeks**. The application incorporated artificial intelligence algorithms to personalize intervention based on participants' daily emotional responses and engagement patterns.

The intervention included:

- Personalized guided meditation sessions (10–20 minutes/day).
- Deep breathing and relaxation exercises.
- Mindfulness-based stress reduction techniques.
- Daily mood tracking and emotional self-monitoring.
- AI-generated motivational messages and reminders.
- Sleep relaxation exercises.
- Weekly progress reports with personalized recommendations.
- Stress management education modules.
- Goal setting and mindfulness practice tracking.

Participants were instructed to use the application daily throughout the intervention period.

Control Group

Participants in the control group received routine stress management education consisting of:

- Health education lectures.
- Printed educational materials on stress management.
- General lifestyle modification advice.
- Routine student counseling services available in the institution.

No AI-assisted intervention was provided to the control group during the study period.

Study Variables

Independent Variable

- AI-assisted mindfulness mobile application.

Dependent Variables

- Anxiety level.
- Depression level.

Demographic Variables

- Age.
- Gender.
- Year of study.
- Residence.
- Family type.
- Previous mindfulness practice.
- Daily smartphone usage.
- Average sleep duration.

Data Collection Instruments

Section A: Demographic Questionnaire

A structured questionnaire was developed to collect demographic information, including age, gender, academic year, residence, family type, smartphone usage, and previous mindfulness experience.

Section B: Generalized Anxiety Disorder-7 (GAD-7)

Anxiety was measured using the **Generalized Anxiety Disorder-7 (GAD-7)** scale, a validated seven-item instrument. Scores range from 0 to 21, with higher scores indicating greater anxiety severity.

Section C: Patient Health Questionnaire-9 (PHQ-9)

Depression was assessed using the **Patient Health Questionnaire-9 (PHQ-9)**, a validated nine-item questionnaire. Scores range from 0 to 27, with higher scores indicating more severe depressive symptoms.

Validity and Reliability

The study instruments were reviewed by experts in psychiatric nursing, psychology, and mental health research to establish content validity. A pilot study was conducted among 10 nursing students who were not included in the final sample. The instruments demonstrated satisfactory internal consistency, with Cronbach's alpha values greater than 0.80.

Data Collection Procedure

After obtaining ethical approval and permission from the participating nursing colleges, eligible students were invited to participate. Written informed consent was obtained before enrolment.

Baseline (pre-test) assessment of anxiety and depression was completed using the GAD-7 and PHQ-9 scales. Participants were then randomly assigned to either the experimental or control group.

The experimental group used the AI-assisted mindfulness application daily for eight consecutive weeks, while the control group received routine stress management education. Weekly follow-up reminders were provided to improve adherence. At the end of eight weeks, post-test assessments were conducted using the same standardized questionnaires.

Outcome Measures

Primary Outcome

- Reduction in anxiety scores measured using the GAD-7 scale.

Secondary Outcome

- Reduction in depression scores measured using the PHQ-9 scale.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee before commencing the study. Permission was obtained from the participating nursing colleges. Written informed consent was obtained from all participants before data collection.

Participation was entirely voluntary, and participants had the right to withdraw at any stage without penalty. Confidentiality and anonymity were maintained by assigning unique identification codes instead of participant names. All collected data were securely stored and used exclusively for research purposes.

Statistical Analysis

The collected data were entered into **IBM SPSS Statistics Version 26.0** for analysis.

Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize demographic characteristics and outcome variables.

Inferential statistics included:

- Chi-square test to assess associations between demographic variables and baseline anxiety and depression.
- Paired *t*-test to compare pre-test and post-test scores within each group.
- Independent *t*-test to compare post-test scores between the experimental and control groups.
- ANCOVA to adjust for baseline differences and evaluate the intervention effect.

A **95% confidence interval** was used throughout the analysis, and a **p-value < 0.05** was considered statistically significant.

Results

Participant Characteristics

A total of **100 undergraduate nursing students** participated in the study. Participants were randomly allocated into the **experimental group (n = 50)** and the **control group (n = 50)**. All participants completed the study, resulting in a **100% response rate**.

Table 1. Distribution of Participants by Group

Group	Frequency (n)	Percentage (%)
Experimental	50	50.0
Control	50	50.0
Total	100	100.0

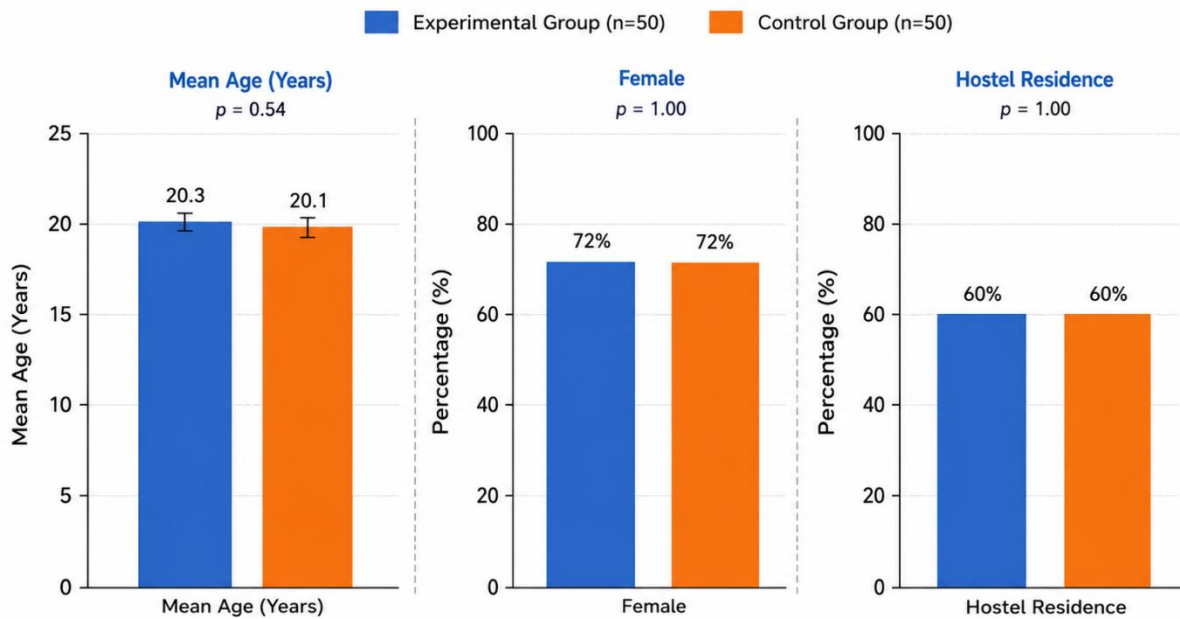
Baseline Demographic Characteristics

The mean age of participants was **20.2 ± 1.4 years**. Most participants were **female (72%)**, studying in the **3rd year B.Sc. Nursing (38%)**, and residing in hostels (60%). There were **no statistically significant differences** in demographic characteristics between the two groups ($p > 0.05$), indicating baseline comparability.

Table 2. Baseline Characteristics of Participants

Variable	Experimental (n=50)	Control (n=50)	p-value
Mean Age (Years)	20.3 ± 1.3	20.1 ± 1.5	0.54
Female	36 (72%)	36 (72%)	1.00
Hostel Residence	30 (60%)	30 (60%)	1.00

Comparison of Baseline Characteristics Between Groups



Values are Mean ± SD for Age and n (%) for Categorical Variables

Comparison of Anxiety Scores

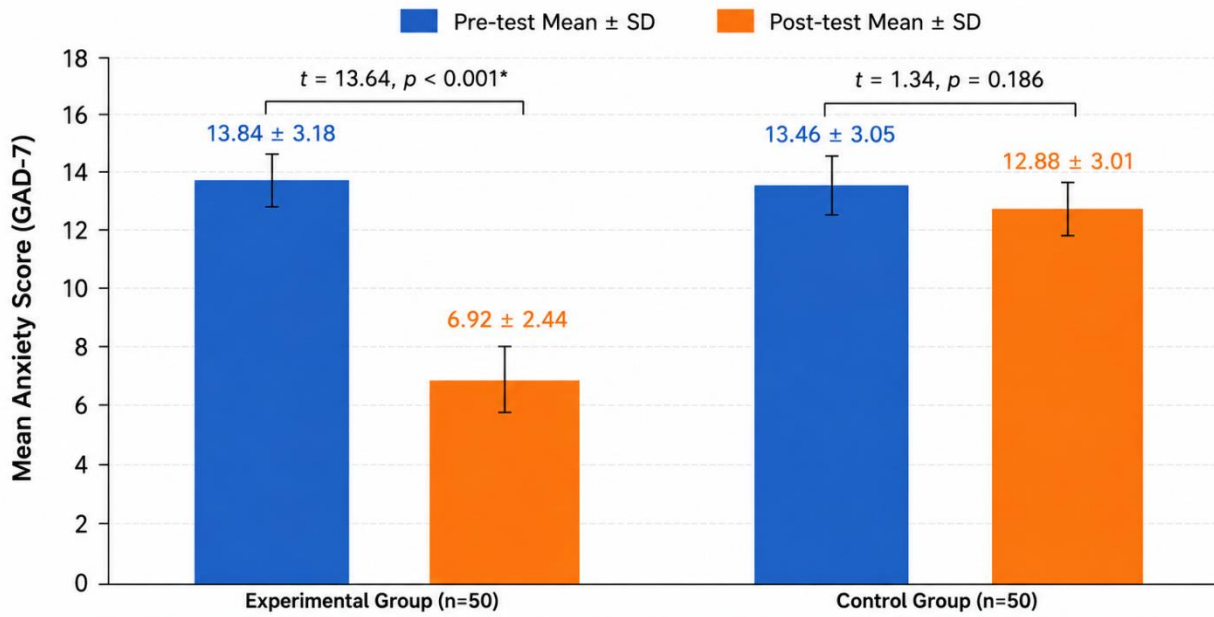
There was no significant difference in pre-test anxiety scores between the experimental and control groups ($p > 0.05$). Following the 8-week AI-assisted mindfulness intervention, the experimental group demonstrated a significant reduction in anxiety scores compared with the control group.

Table 3. Comparison of Anxiety Scores

Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Difference	t-value	p-value
Experimental	13.84 ± 3.18	6.92 ± 2.44	6.92	13.64	<0.001*
Control	13.46 ± 3.05	12.88 ± 3.01	0.58	1.34	0.186

*Significant at $p < 0.05$

Comparison of Pre-test and Post-test Anxiety Scores Between Groups



Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Difference	t-value	p-value
Experimental	13.84 ± 3.18	6.92 ± 2.44	6.92	13.64	<0.001*
Control	13.46 ± 3.05	12.88 ± 3.01	0.58	1.34	0.186

* Significant at p < 0.05

Comparison of Depression Scores

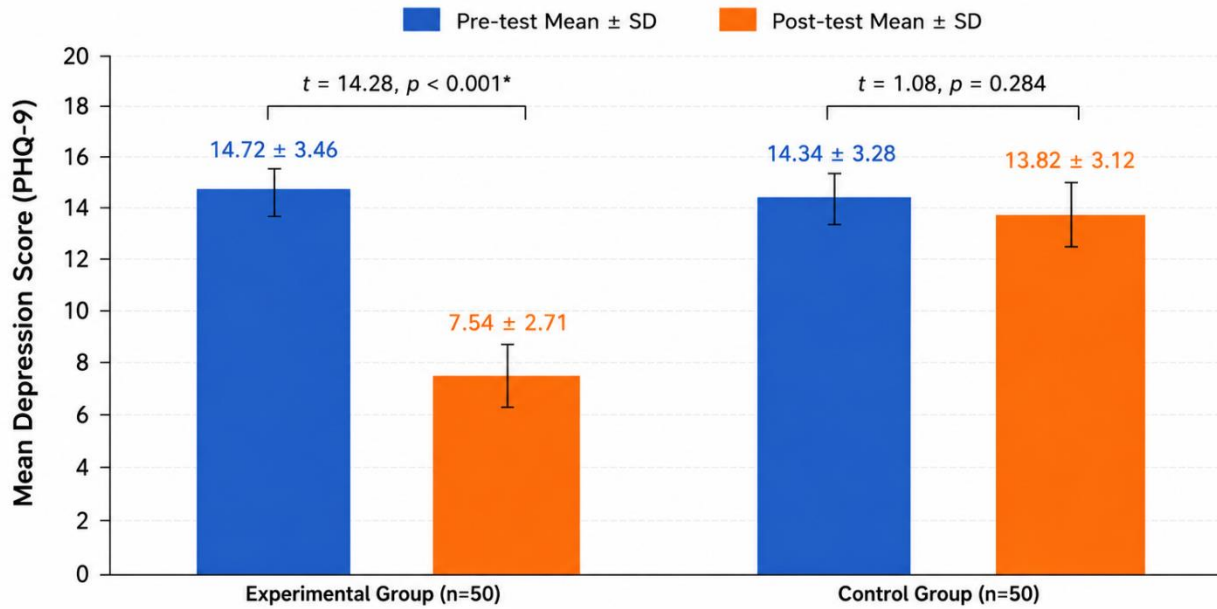
The post-test depression scores showed a significant reduction in the experimental group compared with the control group.

Table 4. Comparison of Depression Scores

Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Difference	t-value	p-value
Experimental	14.72 ± 3.46	7.54 ± 2.71	7.18	14.28	<0.001*
Control	14.34 ± 3.28	13.82 ± 3.12	0.52	1.08	0.284

*Significant at p < 0.05

Comparison of Pre-test and Post-test Depression Scores Between Groups



Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Difference	t-value	p-value
Experimental	14.72 ± 3.46	7.54 ± 2.71	7.18	14.28	<0.001*
Control	14.34 ± 3.28	13.82 ± 3.12	0.52	1.08	0.284

* Significant at p < 0.05

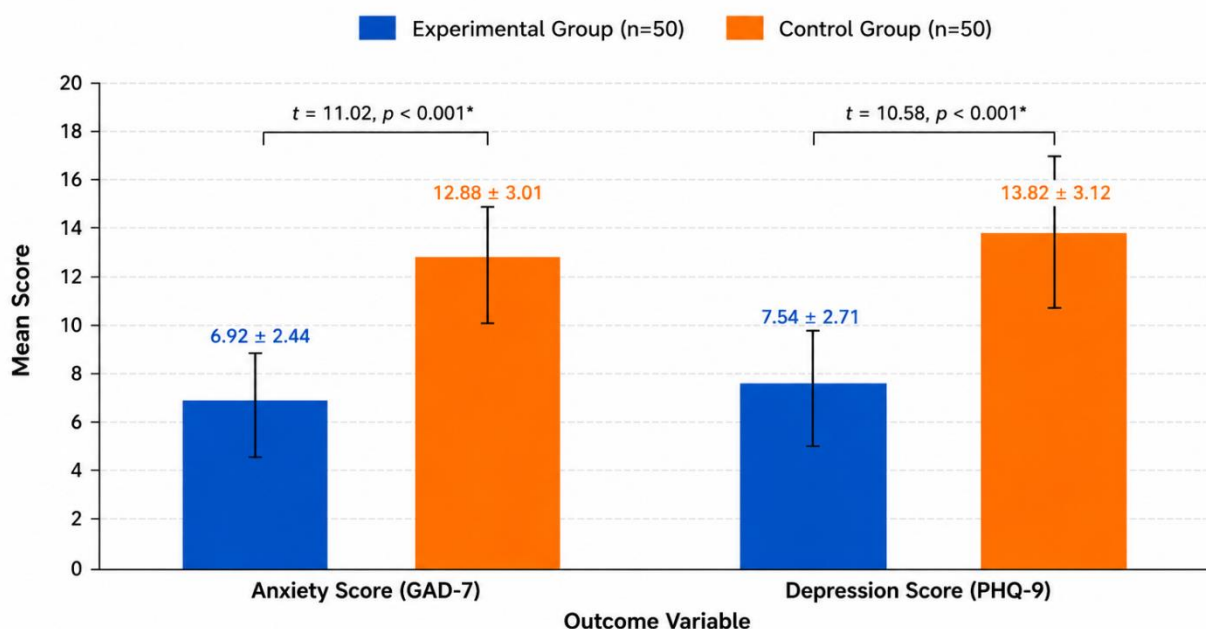
Comparison of Post-Test Scores Between Groups

The post-test anxiety and depression scores were significantly lower in the experimental group than in the control group.

Table 5. Independent t-Test for Post-Test Scores

Outcome Variable	Experimental Mean ± SD	Control Mean ± SD	t-value	p-value
Anxiety Score	6.92 ± 2.44	12.88 ± 3.01	11.02	<0.001*
Depression Score	7.54 ± 2.71	13.82 ± 3.12	10.58	<0.001*

Comparison of Post-test Mean Scores Between Groups



Outcome Variable	Experimental Mean ± SD	Control Mean ± SD	t-value	p-value
Anxiety Score (GAD-7)	6.92 ± 2.44	12.88 ± 3.01	11.02	<0.001*
Depression Score (PHQ-9)	7.54 ± 2.71	13.82 ± 3.12	10.58	<0.001*

* Significant at $p < 0.05$

Association Between Demographic Variables and Baseline Anxiety

A statistically significant association was observed between **average daily sleep duration** and baseline anxiety levels ($\chi^2 = 7.86, p = 0.020$). No significant association was found with age, gender, or year of study.

Table 6. Association Between Selected Demographic Variables and Baseline Anxiety

Variable	χ^2 Value	p-value	Interpretation
Age	2.14	0.343	Not Significant
Gender	0.62	0.431	Not Significant
Year of Study	1.87	0.392	Not Significant
Sleep Duration	7.86	0.020*	Significant

Summary of Results

- Both groups were comparable at baseline ($p > 0.05$).
- The experimental group showed a **significant reduction in anxiety scores** following the AI-assisted mindfulness intervention ($p < 0.001$).
- The experimental group also demonstrated a **significant reduction in depression scores** compared with the control group ($p < 0.001$).
- Post-test anxiety and depression scores were significantly lower in the experimental group than in the control group.
- Sleep duration showed a significant association with baseline anxiety levels, whereas age, gender, and year of study were not significantly associated.

These findings indicate that the **AI-assisted mindfulness application was effective in reducing anxiety and depression among nursing students.**

Discussion

The present randomized controlled trial evaluated the effectiveness of an AI-assisted mindfulness application in reducing anxiety and depression among nursing students. The findings demonstrated that nursing students who used the AI-assisted mindfulness application showed a statistically significant reduction in anxiety and depression scores compared with those who received routine stress management education.

There was no significant difference in baseline characteristics between the experimental and control groups, indicating that both groups were comparable before the intervention. After the 8-week intervention, the experimental group showed a marked decrease in anxiety (GAD-7) and depression (PHQ-9) scores, whereas only minimal changes were observed in the control group. The personalized meditation sessions, breathing exercises, mood tracking, AI-generated reminders, and real-time feedback likely contributed to improved emotional regulation and psychological well-being.

These findings are consistent with previous studies reporting that mindfulness-based digital interventions effectively reduce stress, anxiety, and depression among university students. The incorporation of Artificial Intelligence enhanced participant engagement through personalized support and continuous monitoring, making the intervention more effective than routine health education alone. The results suggest that AI-assisted mindfulness applications can serve as a practical and innovative strategy for promoting mental health among nursing students.

Summary

This randomized controlled trial was conducted among **100 nursing students**, with **50 participants in the experimental group** and **50 participants in the control group**, to evaluate the effectiveness of an AI-assisted mindfulness application in reducing anxiety and depression.

The experimental group received an **8-week AI-assisted mindfulness intervention**, while the control group received routine stress management education. The study demonstrated a significant reduction in both anxiety and depression scores among nursing students who used the AI-assisted mindfulness application ($p < 0.001$). The intervention proved to be effective in improving the psychological well-being of nursing students and may be incorporated into nursing education and student wellness programs.

Conclusion

The AI-assisted mindfulness application was effective in significantly reducing anxiety and depression among nursing students. The intervention provided personalized mindfulness training and continuous psychological support, resulting in improved mental well-being compared with routine stress management education.

The findings support the integration of AI-assisted mindfulness applications into nursing colleges as an innovative, accessible, and cost-effective strategy to promote students' mental health. Future studies with

larger sample sizes, multiple institutions, and longer follow-up periods are recommended to confirm the long-term effectiveness of this intervention.

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