

# AI-Chatbots as Digital Mental Health Interventions: Assessing their Effectiveness in Reducing Depression, Anxiety and Stress among University Students

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## **Abstract**

This study explored the effectiveness of AI-based mental health interventions – specifically Wysa and Serenity – in reducing psychological distress among Pakistani undergraduate students. Using a quasi-experimental pre-test-post-test design, 297 students exhibiting mild to moderate symptoms of depression, anxiety, and stress were selected from four public universities in Khyber Pakhtunkhwa. Participants were randomly assigned to either an experimental group, which engaged with AI chatbots over an eight-week period, or a control group that received no intervention. The chatbot sessions were autonomous, flexible, and ethically safeguarded, allowing students to interact privately with digital agents trained in evidence-based therapeutic techniques. Quantitative analyses revealed significant reductions in psychological distress within the experimental group, with large effect sizes ranging from  $d = 0.72$  to  $0.93$ , while the control group showed negligible change. Gender-specific findings indicated that female students benefited more across all domains of distress. Structural equation modeling further confirmed that chatbot engagement significantly predicted lower levels of depression, anxiety, and stress, with the strongest effect observed for stress ( $\beta = -.47$ ). These results underscore the potential of AI chatbots as scalable, low-cost, and culturally sensitive tools for mental health support in resource-constrained university settings. The findings contribute to the growing body of digital mental health literature by empirically validating chatbot efficacy in a collectivist cultural context. The study also highlights the importance of integrating AI-based interventions into campus mental health frameworks to overcome barriers related to stigma, accessibility, and limited professional resources.

**Keywords:** AI-Chatbots, Wysa, Serenity, Depression, Anxiety, Stress.

## **Introduction**

Pakistan faces a critical shortage of mental health professionals, with fewer than 500 practicing psychiatrists serving a population exceeding 240 million, Pakistan has less than 0.2 psychiatrists per 100,000 people—far below the World Health Organization’s recommended minimum of 1 per 100,000 (Pakistan Mental Health Coalition & British Asian Trust, 2025). This scarcity severely limits access to formal treatment, leaving many individuals undiagnosed and untreated, and contributing to widespread psychological distress. In the absence of professional care, people often rely on informal support systems such as family or traditional healers, which may not align with evidence-based practices. Cultural stigma further complicates this landscape, as mental health issues are frequently interpreted through sociocultural or religious lenses rather than clinical frameworks (Ahmad & Koncsol, 2022). Emerging adults, particularly university students, are especially vulnerable due to developmental transitions, academic pressures, financial stress, and societal expectations (Riaz et al., 2024). The collectivist nature of Pakistani society, while offering communal support, can also discourage emotional disclosure and reinforce suppression of personal struggles. Given these challenges, many individuals with mental illness have limited opportunities for treatment. Attitudes toward traditional versus modern interventions shape help-seeking behaviors, with some communities favoring non-clinical approaches. However, there is growing recognition of the need to integrate evidence-based solutions into mental health care. Recent technological advancements—especially in artificial intelligence—offer promising avenues to bridge this gap. AI-powered tools such as chatbots can provide continuous, stigma-free support, enhancing accessibility and engagement (Alhuwaydi, 2024; Imran & Haider, 2022). In the context of Pakistan’s digital transformation, exploring AI-based mental health interventions is both timely and necessary. As mental health concerns rise among university students, effective, scalable, and culturally sensitive support systems are urgently needed (Holm-Hadulla & Koutsoukou-Argraki, 2015). Psychological distress among undergraduate students—particularly depression, anxiety, and stress—is a growing concern for educators and policymakers. Mental health services remain underfunded and largely inaccessible in rural Pakistan (Dayani et al., 2024).

## **AI-Chatbots and Mental Health**

The integration of artificial intelligence (AI) into mental health care presents promising solutions for addressing psychological distress among undergraduate students, particularly in managing depression, anxiety, and stress. AI chatbots like Wysa and Serenity offer immediate, accessible support, allowing students to engage with mental health resources at their convenience—an essential feature in fast-paced academic environments (Farzan et al., 2024; Liñan, 2025). These tools are designed to deliver personalized, conversational interactions, enhancing their relevance across diverse cultural contexts, including Pakistan (Saleem et al., 2024; Bokhari & Myeong, 2023). Their anonymity and ease of use help reduce stigma, encouraging students to seek help without fear of judgment (Inkster et al., 2018). Functionally, AI chatbots provide therapeutic conversations using techniques from Cognitive Behavioral Therapy (CBT), guiding users through structured dialogues that promote emotional awareness and coping strategies (Nelson et al., 2025; Poudel et al., 2025). Compared

to traditional therapy, chatbots offer non-judgmental, anonymous support, lowering barriers for students hesitant to seek help (Tabassum et al., 2025). Their affordability and empathetic design make them especially valuable in underserved regions, promoting inclusive mental health care (Liṭan, 2025). AI chatbots like Wysa and Serenity offer promising solutions for managing depression and anxiety among undergraduate students, especially in culturally sensitive contexts like Pakistan. Despite their potential, challenges remain. Technical barriers such as limited internet access and digital literacy can restrict usage (Naamati-Schneider & Alt, 2024). Skepticism toward technology in mental health also affects acceptance among students and stakeholders (Boucher et al., 2021).

### **Wysa and Mental Health**

Wysa is an AI-powered mental health chatbot designed to provide scalable and accessible support, addressing the global shortage of mental health professionals (Hanna & Hanna, 2022; Casu et al., 2023). Its relevance is especially pronounced for undergraduate students facing academic, social, and personal pressures that contribute to anxiety and depression (Faheem et al., 2025; Liṭan, 2025). Wysa integrates Cognitive Behavioral Therapy (CBT) and other modalities to guide users through structured conversations that build emotional resilience (Thakkar et al., 2024; Cummins et al., 2015). A key strength of Wysa is its cultural sensitivity, which enhances its effectiveness in diverse populations (Ahmad & Koncsol, 2022). In Pakistan's collectivist society, where stigma often deters help-seeking, Wysa uses culturally relevant language and norms to foster engagement (Khan et al., 2024). This aligns with broader insights that AI can advance early detection and personalized treatment of mental health conditions (Zafar et al., 2024). Wysa's adaptability to users' cultural contexts improves usability and acceptance, especially where stigma inhibits open dialogue (Mensah, 2025; Marda, 2018). Engagement features such as anonymity, 24/7 availability, and feedback mechanisms allow students to access support comfortably (Manole et al., 2024). Anonymous interaction encourages candid emotional expression without fear of judgment (Inkster et al., 2018). Many users prefer chat-based support over traditional therapy, viewing Wysa as a safe and valid alternative (Zafar et al., 2024). Longitudinal studies are needed to assess its sustained impact (Ophir et al., 2025; Heinz et al., 2025).

### **Serenity and Mental Health**

Serenity is an AI-powered mental health chatbot designed to foster emotional intelligence and resilience among undergraduate students. It engages users in guided conversations that promote emotional regulation, empathy, and self-awareness through techniques rooted in Cognitive Behavioral Therapy (Sim & Choo, 2025; Helmy & Helmy, 2022; Hegde, 2025). This structured approach helps students reframe negative thought patterns and manage symptoms of depression and anxiety. Serenity's culturally sensitive design reflects Pakistani societal norms, using language and references that resonate with local values to enhance acceptability and engagement (Babu & Joseph, 2024; Zafar et al., 2024; Alotaibi & Sas, 2023; Majeed, 2024). Tailoring responses to cultural contexts is vital, especially in regions where stigma deters help-seeking (Tabassum et al., 2024; Khan et al., 2024). Serenity's 24/7 accessibility and anonymity reduce barriers to mental health support, encouraging students to initiate conversations without fear of judgment (Assayed, 2024;

AlMakinah et al., 2024; Shim et al., 2022; Psychology Today, 2024). Feedback mechanisms allow users to shape chatbot development, fostering a sense of ownership and improving satisfaction (Alharbi & Smith, 2018; Zafar et al., 2024). Emotional intelligence plays a key role in user engagement, and Serenity prompts reflection to strengthen emotional regulation (Pandey, 2024; Morgan & Cogan, 2025; Dehbozorgi et al., 2025). Privacy and ethical concerns are central to Serenity's deployment. Students must trust that their data is secure and interactions confidential (Ni & Jia, 2025; AlMakinah et al., 2024). Responsible AI development ensures that Serenity complements, not replaces, human clinicians (Zafar et al., 2024; Fitzpatrick et al., 2017; Miner et al., 2016; Gaffney et al., 2019). Accessibility challenges such as digital literacy and internet connectivity must be addressed through user-friendly design and educational initiatives (Casu et al., 2024; Vaidyam et al., 2019; Ebert et al., 2018; Pretorius et al., 2019).

## **Rationale**

In Pakistani universities, emotional silence is a culturally conditioned survival strategy. Students often suppress anxiety, depression, and stress to avoid being perceived as weak. Vulnerability risks social alienation, so many perform strength while suffering internally. Mental health remains a neglected public health domain, especially for young adults in higher education. Despite global progress, stigma and systemic neglect persist in Pakistan. With fewer than 400 psychiatrists for over 220 million people, access to care is critically limited (Ahmad, 2007). University students face long wait times and often rely on informal support systems like family or peers (Ahmad & Koncsol, 2022). These networks, while accessible, lack clinical expertise. The result is widespread emotional suffering with minimal professional intervention. Addressing this crisis demands culturally sensitive, scalable mental health solutions.

AI chatbots like Wysa offer innovative support for enhancing social self-efficacy among students facing stigma and limited access to traditional mental health care (Alsayed et al., 2024; Casu et al., 2024). Grounded in Cognitive Behavioral Therapy (CBT), Wysa facilitates emotional regulation, self-awareness, and coping strategies (Rawat, 2025; Mushtaq & Shivaramu, 2025). Its culturally sensitive design allows it to resonate with users in collectivist societies, fostering trust and engagement (Zafar et al., 2024; Ali & Viqar, 2024). With one in three university students experiencing psychological distress globally (Holm-Hadulla & Koutsoukou-Argraki, 2015), and Pakistan's mental health infrastructure severely under-resourced (Ahmad, 2007; Imran & Haider, 2022), Wysa emerges as a scalable solution. It uses CBT and other modalities to guide structured conversations that promote emotional resilience (Fitzpatrick et al., 2017; Nelson et al., 2025; Poudel et al., 2025). Its 24/7 availability and anonymous format help overcome barriers like stigma and scheduling constraints (Alsayed et al., 2024; Inkster et al., 2018).

Wysa's cultural attunement—through localized language and values—enhances relevance and user adherence (Batoool et al., 2024; Khan et al., 2024). Its natural language processing enables dynamic personalization, supporting emotional intelligence development such as empathy and self-regulation (Sim & Choo, 2025; Rawat, 2025; Mushtaq & Shivaramu, 2025). Empirical evidence supports Wysa's effectiveness in reducing anxiety, depression, and stress, though some studies report modest effects on depression (Alsayed et al., 2024; Klos et al., 2020). Still, its potential to complement traditional services is clear. Wysa fosters long-term coping

and emotional scaffolding, empowering students to manage distress proactively (Manole et al., 2024; Boucher et al., 2021). However, challenges such as digital literacy gaps and limited internet access persist, especially in rural areas (Naik et al., 2024; Chan, 2025). Ethical concerns around data privacy and skepticism toward AI require transparent communication and safeguards (Warrier et al., 2023; Saeidnia et al., 2024).

Serenity is an AI chatbot grounded in Cognitive Behavioral Therapy (CBT), guiding users through structured exercises that support emotional regulation and cognitive reframing (Helmy & Helmy, 2022; Hegde, 2025). These interventions are vital for students facing depression and anxiety, helping them disrupt negative thought patterns and build resilience. Serenity promotes emotional intelligence—self-awareness and empathy—as protective factors against psychological distress (Sim & Choo, 2025). Its culturally adaptive design incorporates local idioms and values, making interactions feel familiar and respectful (Alotaibi & Sas, 2023; Majeed, 2024). By framing support within culturally acceptable narratives like familial harmony or spiritual well-being, Serenity reduces resistance to help-seeking. Its scalability addresses the global shortage of mental health professionals without compromising empathy (Casu et al., 2023). User feedback mechanisms allow Serenity to refine responses and personalize support dynamically (Omarov et al., 2025). Ethical safeguards, including secure data handling and consent protocols, foster trust in socially sensitive environments (Zafar et al., 2024). Serenity adapts to demographic factors such as gender and socio-economic status, ensuring inclusivity (Kim, 2024; Faheem et al., 2025).

While research on AI chatbots in mental health is expanding (Inkster et al., 2018; Alsayed et al., 2024), much of it centers on symptom reduction in technologically advanced, high-income settings. There is limited culturally contextualized research on how students in low-resource, high-stigma environments like Pakistan perceive and emotionally engage with these tools (Ali & Viqar, 2024; Rehman & Sajjad, 2025). Psychological mechanisms such as emotional safety, perceived empathy, and cultural resonance remain underexplored (Klos et al., 2020; Spytka, 2025). Gendered experiences with chatbot interventions also lack sufficient attention, despite evidence of significant variation in help-seeking attitudes across genders in Pakistan (Hanna & Hanna, 2022; Majeed et al., 2022). This study holds theoretical and practical significance within Pakistan's higher education landscape, where mental health challenges are escalating but remain largely unaddressed. It contributes to the literature by evaluating AI chatbot interventions as culturally congruent, scalable alternatives to traditional therapy (Imran & Haider, 2022; Saleem et al., 2024). While AI tools have shown promise in Western contexts (Inkster et al., 2018; Farzan et al., 2024), their application in South Asia is still poorly understood. By assessing how chatbots can be adapted to meet the needs of underserved student populations, the research advances the discourse on digital mental health equity. The findings may inform university mental health policies, guiding the integration of low-cost, stigma-free AI tools into campus wellness programs. Emphasizing emotional engagement and cultural sensitivity, the study also supports psychoeducational efforts to reduce stigma and improve mental health literacy among students. This approach is vital for building inclusive, responsive support systems in Pakistani universities.

## **Hypotheses**

H1: A significant proportion of undergraduate students report moderate to severe levels of psychological distress on standardized measures i.e, DASS-21.

H2: AI chatbot users scores low on depression, anxiety and stress on post-test as compared to pre-test.

H3: AI chatbot users scores significantly low on DASS as compared to non-users on post-test.

H4: Female undergraduate students who receive AI chatbot-based psychological interventions demonstrate significantly greater reductions in DASS-21 scores compared to male undergraduate students receiving the same intervention.

## **Method**

### **Research design**

This study employs a quasi-experimental pre-test-post-test design to assess the psychological impact of AI chatbot interventions on undergraduate students experiencing mild to moderate depression, anxiety, and stress. It involves two groups: an experimental group receiving structured sessions with Wysa and Serenity over eight weeks, and a control group with no intervention. Standardized measures of psychological distress was administered before and after the intervention.

### **Participants of the Study**

The study involved 380 undergraduate students from four public universities in Khyber Pakhtunkhwa, Pakistan, selected to ensure regional and disciplinary diversity. After screening with the DASS-21, 297 students with mild to moderate psychological distress were included, yielding a 78.2% diagnostic participation rate. Participants, aged 18 to 25, came from departments such as Social and Physical Sciences and voluntarily consented to the study after being briefed on its objectives and ethical safeguards. They were randomly assigned to either an experimental group, which engaged with AI mental health chatbots (Wysa and Serenity) over eight weeks, or a control group with no intervention. Ethical approval was secured from all participating institutions, and confidentiality was upheld throughout the research.

### **Inclusion Criteria**

Undergraduate students aged 18 to 25 years enrolled in aforementioned universities. Students who screen positive for mild to moderate psychological distress based on DASS-21 scores. Willingness to participate voluntarily and provide informed consent. Ability to read and understand English, the languages used by the AI chatbots. Access to a smartphone or internet-enabled device for engaging with chatbot interventions.

## **Exclusion Criteria**

Students with severe psychological distress or clinical diagnoses requiring immediate psychiatric intervention. Current engagement in formal psychotherapy or psychiatric treatment during the study period. Inability to commit to the full eight-week intervention period or complete pre- and post-assessments. Students with limited digital literacy that prevents meaningful interaction with the chatbot interface. Refusal to provide informed consent or concerns about data privacy and confidentiality.

## **Instruments**

### **Depression Anxiety and Stress Scale**

The DASS-21 is a brief, self-report tool developed by Lovibond and Lovibond (1995) to assess depression, anxiety, and stress. It is a shortened version of the original 42-item scale, designed for ease of use in clinical and research settings. The scale includes 21 items divided equally across three subscales: depression, anxiety, and stress. Each subscale captures distinct emotional symptoms such as hopelessness, autonomic arousal, and nervous tension. Based on a dimensional model, DASS-21 quantifies emotional distress rather than diagnosing clinical disorders. Items are rated on a 4-point Likert scale reflecting experiences over the past week. Scores are summed and multiplied by two to match the original DASS-42 scoring. The Urdu version has been validated for Pakistani populations, showing strong reliability (Aslam & Kamal, 2017). Cronbach's alpha values exceed .85, indicating excellent internal consistency. Confirmatory factor analyses support its structure and validity across diverse contexts (Henry & Crawford, 2005).

### **Wysa**

Wysa is an AI-powered mental health chatbot developed by Jo Aggarwal to provide scalable, anonymous, and culturally adaptable psychological support (Aggarwal, 2020). Launched in 2016, it addresses barriers like stigma and limited infrastructure by offering 24/7 text-based, judgment-free engagement. Wysa integrates CBT, DBT, mindfulness, and motivational interviewing, with over 200 self-help tools including journaling, mood tracking, and guided meditations (Casu et al., 2023). It also provides access to trained wellbeing coaches for deeper support. Grounded in digital mental health theory and affective computing, Wysa simulates emotionally intelligent dialogue to foster resilience and emotional regulation (Fitzpatrick et al., 2017). Empirical studies show its effectiveness in reducing depression, anxiety, and stress. Though not a clinical substitute, Wysa complements traditional care, especially in underserved and culturally diverse populations.

### **Serenity**

Serenity is an AI-powered mental health chatbot designed to provide personalized emotional support, mindfulness guidance, and psycho-educational resources (Sannapureddy, 2023). It uses advanced NLP

frameworks like Hugging Face embeddings and Lang Chain to deliver empathetic, context-aware conversations. The app offers features such as emotional check-ins, CBT-based coping tools, PHQ-9 assessments, and calendar-based mood visualization (One Mind PsyberGuide, n.d.). Users can set goals like managing anxiety or building resilience, and Serenity tailors its responses accordingly. Grounded in CBT, MBSR, and positive psychology, it aligns with global digital mental health standards. Its architecture includes semantic filtering and privacy safeguards to ensure safe, relevant interactions. Early reviews highlight its effectiveness in managing anxiety, depression, and sleep concerns.

## **Procedure**

### **Phase I:**

#### **Step 1: Recruitment and Screening**

Participants were recruited from four public sector universities in Khyber Pakhtunkhwa—University of Peshawar, University of Haripur, University of Swabi, and Abdul Wali Khan University Mardan—via departmental announcements, student support centers, and digital outreach platforms. Ethical approval was obtained from the respective institutional review boards prior to data collection. A total of 380 undergraduate students aged 18–25 expressed interest and received detailed information sheets outlining the study’s objectives, confidentiality protocols, and voluntary nature of participation. Written informed consent was secured. All interested students completed the Depression Anxiety Stress Scales – 21 (DASS-21), with scores multiplied by two to align with the full DASS format. Based on severity thresholds, 297 students scoring within the mild to moderate range on at least one subscale were selected for further participation, representing a population suitable for non-clinical, technology-mediated mental health support.

#### **Step 2: Pre-Test Assessment**

Eligible participants completed the DASS-21 to establish baseline levels of depression, anxiety, and stress. Demographic data—including age, gender, academic discipline, and smartphone access—were also collected to contextualize findings and ensure equitable representation across the sample.

#### **Step 3: Group Allocation**

Using stratified randomization based on university and gender, participants were assigned to either the experimental or control group. The experimental group received access to AI-based mental health chatbots—Wysa and Serenity—while the control group continued with their routine academic activities without any intervention. This allocation ensured balanced representation across institutions and demographic categories.

## Phase II:

### Step 1: Intervention Implementation

Over an eight-week period, participants in the experimental group engaged with Wysa and Serenity, two AI-based mental health applications. Wysa provided cognitive behavioral therapy (CBT) exercises, mood tracking, and mindfulness tools, while Serenity offered adaptive emotional support and guided meditations. The intervention was designed to be flexible, private, and culturally appropriate, allowing students to interact with the chatbots autonomously within their home environments. Features such as journaling, breathing exercises, emotional check-ins, and self-reflection prompts were available for self-paced engagement. Technical support and onboarding guidance were provided, along with periodic reminders to encourage consistent use, though participation remained voluntary.

### Step 2: Post-Test Assessment

After the intervention period, all participants – both experimental and control – were re-administered the DASS-21 to assess changes in psychological distress. Additionally, the experimental group completed qualitative feedback forms to capture user experiences, emotional responses, and perceptions of cultural relevance regarding the chatbot interactions. All data were anonymized and coded for statistical analysis.

### Data Analysis

Quantitative data were analyzed using SPSS. Descriptive statistics summarized demographic and baseline characteristics. Inferential analyses included paired sample t-tests to evaluate within-group changes in psychological distress, and independent sample t-tests to compare post-test scores between experimental and control groups. Structural Equation Modeling (SEM) was employed to examine path coefficients and assess the impact of chatbot usage on mental health outcomes.

## Results

Table 1

Pre-Intervention Severity Levels of Depression, Anxiety, and Stress (Full Sample, N = 380)

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Severity Level	Depression	%	Anxiety	%	Stress	
Normal	70	18.4%	72	18.9%	71	8.7%
Mild	152	40.0%	150	39.5%	151	9.7%
Moderate	145	38.2%	147	38.7%	146	8.4%

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Severity Level	Depression	%	Anxiety	%	Stress	
Severe	13	3.4%	11	2.9%	12	.2%
Extremely Severe	0	0.0%	0	0.0%	0	.0%

*Note.* Severity levels are based on DASS-21 scoring thresholds (Lovibond & Lovibond, 1995). Scores were multiplied by 2 for full-scale equivalence. Only participants scoring in the mild to moderate range (n = 297) were retained for the intervention phase.

Table 1 shows that the majority of students (N = 380) experienced mild to moderate levels of psychological distress before the intervention. Specifically, around 40% fell in the mild range and nearly 38% in the moderate range across depression, anxiety, and stress. Severe cases were minimal (under 4%), and none were classified as extremely severe. Only those within the mild to moderate range (n = 297) were included in the intervention phase, aligning with the study’s focus on non-clinical support.

**Table 2**

Psychometric properties of Subscales (N = 297)

SubScale	M	SD	Range	Cronbach’s $\alpha$
Depression (DASS-21)	15.82	4.67	10-20	.86
Anxiety (DASS-21)	13.94	4.21	8-14	.85
Stress (DASS-21)	18.76	5.03	15-25	.87

*Note.* All DASS-21 subscale scores were multiplied by 2 to align with full-scale equivalence. Cronbach’s alpha values reflect internal consistency reliability for each scale. Skewness and kurtosis values fall within acceptable ranges ( $\pm 1$ ), indicating approximate normality suitable for parametric analysis.

Table 2 shows that the DASS-21 subscales for depression, anxiety, and stress demonstrated strong internal consistency (Cronbach’s  $\alpha = .85-.87$ ) among the 297 participants. Mean scores fell within the mild to moderate range, and the data distribution was approximately normal, supporting the use of parametric statistical analyses.

**Table 3**

Pre-Test and Post-Test Scores for Experimental and Control Groups (N = 297)

<b>Outcome</b>	<b>Group</b>	Pre-Test M (SD)	Post-Test M (SD)	<i>T</i>	<i>df</i>	<i>p</i>	<b>Cohen's <i>d</i></b>
Depression	Experimental	14.85 (4.62)	10.32 (4.05)	-6.72	148	< .001	0.88
	Control	14.67 (4.55)	13.85 (4.72)	-1.21	147	.228	0.16
Anxiety	Experimental	13.42 (4.28)	9.74 (3.88)	-5.43	148	< .001	0.72
	Control	13.25 (4.10)	12.21 (4.18)	-1.56	147	.121	0.21
Stress	Experimental	15.92 (4.75)	10.98 (4.22)	-7.01	148	< .001	0.93
	Control	15.78 (4.68)	14.92 (4.67)	-1.33	147	.185	0.18

*Note.* M = mean; SD = standard deviation; df = degrees of freedom, All comparisons reflect within-group changes from pre-test to post-test. The experimental group received an AI chatbot intervention; the control group did not.

This table shows that the experimental group, which used AI chatbots, experienced significant reductions in depression, anxiety, and stress from pre-test to post-test ( $p < .001$ ), with large effect sizes (Cohen's  $d = 0.72-0.93$ ). In contrast, the control group showed no statistically significant changes across any outcome, and effect sizes were minimal. This suggests that the chatbot intervention was effective in reducing psychological distress among participants.

**Table 4**

*Pre-Test and Post-Test Scores by Gender for Depression, Anxiety, and Stress (N = 297)*

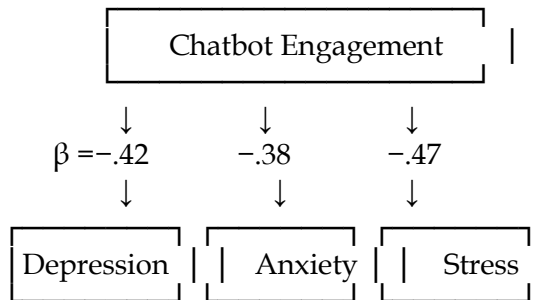
Outcome	Gender	Pre-Test M (SD)	Post-Test M (SD)	t	df	P	Cohen’s d
Depression	Male	14.62 (4.55)	12.43 (4.28)	-3.12	145	.00	0.52
	Female	14.88 (4.68)	10.21 (4.03)	-6.45	150	< .00	0.84
Anxiety	Male	13.25 (4.22)	11.34 (4.01)	-2.78	145	.00	0.46
	Female	13.39 (4.35)	9.62 (3.87)	-5.21	150	< .00	0.72
Stress	Male	15.78 (4.70)	13.42 (4.45)	-3.34	145	.00	0.55
	Female	15.96 (4.82)	11.02 (4.18)	-6.88	150	< .00	0.89

*Note.* M = mean; SD = standard deviation; df = degrees of freedom; Cohen’s d = effect size. Paired samples t-tests were conducted separately for male and female students. Greater mean differences and effect sizes indicate stronger intervention impact.

Table 4 presents gender-based comparisons of pre- and post-test scores for depression, anxiety, and stress among 297 participants. Both male and female students showed statistically significant reductions across all three outcomes following the intervention ( $p < .001$ ). However, the effect sizes (Cohen’s d) were notably larger for female students—ranging from 0.72 to 0.89—compared to males (0.46 to 0.55), indicating that the intervention had a stronger psychological impact on female participants. Overall, the results suggest that while the AI-based mental health intervention was effective for both genders, it was particularly impactful for female students.

**Figure 1**

*Structural Equation Model of Chatbot Usage Predicting Mental Health Outcomes (N = 297)*



**Table 5**

*Model Summary*

Path	B	SE	95% CI		p
			LL	UL	
Chatbot → Depression	-.42	.07	-.55	-.29	< .001
Chatbot → Anxiety	-.38	.06	-.50	-.26	< .001
Chatbot → Stress	-.47	.08	-.62	-.32	< .001

*Note.* All paths are statistically significant. Standardized coefficients reflect moderate to strong inverse relationships between chatbot engagement and mental health symptoms.

Table 5 presents the results of a structural equation model assessing the impact of chatbot engagement on mental health outcomes. All path coefficients are statistically significant ( $p < .001$ ), indicating that increased interaction with AI-based chatbots is associated with reductions in depression ( $\beta = -.42$ ), anxiety ( $\beta = -.38$ ), and stress ( $\beta = -.47$ ). The standardized beta values reflect moderate to strong inverse relationships, and the confidence intervals (95% CI) confirm the robustness of these effects. Overall, the model supports the effectiveness of chatbot interventions in alleviating psychological distress.

**Discussion**

This study addresses the growing psychological distress among Pakistani university students, exacerbated by cultural stigma, limited mental health resources, and academic pressures. It implemented an AI chatbot intervention to provide psycho-educational support and emotional guidance in a scalable, culturally sensitive format. The primary focus was on assessing changes in depression, anxiety, and stress using the DASS-21 scale. The intervention demonstrated promising potential for non-clinical mental health support in resource-constrained academic settings. All measures showed strong internal consistency, supporting the reliability of the findings. The study contributes to the development of accessible digital mental health solutions tailored to local needs.

In a country where mental health support is often inaccessible and stigmatized, this study offers compelling evidence that AI chatbots can serve as effective, scalable tools for emotional relief among university students. The intervention led to statistically significant reductions in depression, anxiety, and stress among participants in the experimental group, while the control group showed minimal change. Depression scores dropped from 14.85 to 10.32 ( $t = -6.72$ ,  $p < .001$ ,  $d = 0.88$ ), indicating a strong therapeutic effect. Fitzpatrick et al. (2017) similarly found that Woebot reduced depressive symptoms in young adults, while Fulmer et al. (2023) reported sustained

PHQ-9 improvements with Tess. Rawat (2025) observed large reductions in depression ( $d = 0.75$ ) using culturally adapted chatbots. Anxiety scores declined from 13.42 to 9.74 ( $t = -5.43$ ,  $p < .001$ ,  $d = 0.72$ ), suggesting reduced anticipatory worry and arousal. Anand and Srivastava (2025) found similar results with Wysa among Indian students, and Chen et al. (2025) showed chatbots outperforming nurse hotlines in reducing GAD-7 scores. Oghenekaro and Okoro (2024) reported improved anxiety and emotional intelligence among Nigerian students using chatbot tools. Stress scores showed the most pronounced change, decreasing from 15.92 to 10.98 ( $t = -7.01$ ,  $p < .001$ ,  $d = 0.93$ ), reflecting enhanced coping and emotional regulation. Carlos and Dela Peña (2025) found dramatic stress reductions ( $d = 2.43$ ) among Filipino undergraduates, with improved sleep and clarity. Schillings et al. (2023) demonstrated that ELME, a mindfulness chatbot, improved stress and attentional control, while Anand and Srivastava (2025) noted resilience gains in their Wysa study. Collectively, these findings affirm the therapeutic potential of AI chatbots and support their integration into culturally sensitive mental health strategies for university populations in resource-constrained settings.

Gender-based analysis revealed that both male and female students experienced statistically significant reductions in psychological distress following the AI chatbot intervention, with female participants showing notably greater improvements across depression, anxiety, and stress. For depression, males showed a moderate reduction ( $d = 0.52$ ), while females exhibited a larger effect ( $d = 0.84$ ), echoing Fitzpatrick et al. (2017) and Fulmer et al. (2023), who found stronger outcomes among female users of Woebot and Tess, respectively. Rawat (2025) similarly reported that Pakistani female students responded more positively to culturally adapted chatbot interventions. In anxiety reduction, males improved moderately ( $d = 0.46$ ), whereas females showed a more substantial decline ( $d = 0.72$ ), consistent with Anand and Srivastava (2025), Chen et al. (2025), and Oghenekaro and Okoro (2024), who all noted greater responsiveness among female students. Stress scores followed the same pattern, with males showing moderate improvement ( $d = 0.55$ ) and females demonstrating a large effect ( $d = 0.89$ ). Carlos and Dela Peña (2025) found similar gender differences in stress relief among Filipino undergraduates, while Schillings et al. (2023) and Vidic (2024) highlighted enhanced mindfulness and coping among female students. These findings suggest that although chatbot interventions are effective for both genders, female students may benefit more due to higher baseline distress, emotional receptivity, and deeper engagement with introspective content. The results underscore the importance of gender-sensitive approaches in designing and implementing digital mental health tools.

The Structural Equation Model (SEM) provided compelling evidence for the predictive efficacy of chatbot engagement in reducing psychological distress—specifically depression, anxiety, and stress—among Pakistani

university students. All three paths were statistically significant, with standardized beta coefficients ranging from  $-.38$  to  $-.47$ . The strongest inverse relationship was observed between chatbot engagement and stress ( $\beta = -.47, p < .001$ ), indicating that the intervention was particularly effective in alleviating tension and physiological arousal. This aligns with Carlos and Dela Peña (2025), who reported dramatic stress reductions among Filipino undergraduates using chatbots, and Schillings et al. (2023), who found that ELME improved attentional control and stress regulation. Anand and Srivastava (2025) also noted enhanced coping and resilience in their Wysa study. The path to depression was similarly significant ( $\beta = -.42, p < .001$ ), suggesting that frequent chatbot interaction helped disrupt maladaptive cognitive patterns and foster emotional regulation. Fitzpatrick et al. (2017) found that Woebot reduced depressive symptoms within two weeks, while Fulmer et al. (2023) observed sustained PHQ-9 improvements with Tess. Rawat (2025) demonstrated that culturally adapted chatbots yielded large reductions in depression among Pakistani students. For anxiety, the path coefficient was moderately strong ( $\beta = -.38, p < .001$ ), indicating reduced anticipatory worry and internal tension. Chen et al. (2025) showed chatbot support outperformed helplines in lowering GAD-7 scores, and Oghenekaro and Okoro (2024) reported improved anxiety outcomes and emotional intelligence among Nigerian students. Anand and Srivastava (2025) also found significant anxiety reductions with Wysa, emphasizing the value of immediate, stigma-free support. Collectively, these findings affirm the therapeutic potential of AI chatbots in culturally sensitive, resource-constrained academic settings.

## Conclusion

Current study establishes the effectiveness of AI chatbot interventions in reducing depression, anxiety, and stress among Pakistani university students. The findings highlight the value of scalable, culturally sensitive digital tools in addressing psychological distress in resource-limited academic settings. Statistically significant improvements were observed across all mental health domains, with stronger outcomes among female participants. Structural equation modeling confirmed robust inverse relationships between chatbot engagement and distress levels. These results align with global evidence supporting conversational AI for emotional support. The study contributes to digital mental health research and offers practical implications for campus-based interventions. It lays the groundwork for integrating AI tools into national mental health strategies.

## Limitations and Suggestions

Despite its promising findings, this study has several limitations. First, the sample was limited to students from four public universities in Khyber Pakhtunkhwa, which may restrict generalizability to other regions or private institutions. Second, the intervention relied on self-reported engagement with

chatbots, without objective usage metrics, which may introduce reporting bias. Third, the study excluded students with severe psychological distress, limiting insights into clinical populations. Fourth, the short duration of the intervention (eight weeks) may not capture long-term effects or sustained behavioral change. Fifth, cultural nuances in emotional expression and help-seeking behaviors were not deeply explored beyond gender-based analysis. Future research should expand to diverse academic settings across Pakistan, including rural and private institutions, and incorporate longitudinal designs to assess lasting impact. Integrating chatbot usage analytics could enhance understanding of engagement patterns. Studies involving clinical populations and mixed-method approaches—combining quantitative outcomes with in-depth qualitative interviews—would offer richer insights. Finally, co-designing chatbot features with local students could improve cultural relevance and emotional resonance, strengthening intervention efficacy.



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