

Chatbot-based MBSR for University Students with Depression

1 Chatbot-based Mindfulness-based Stress Reduction Program for University Students 2 with Depressive Symptoms: Intervention Development and Pilot Evaluation

3 Abstract

4 **Background:** Depression is a growing concern among university students. Chatbots provide
5 flexible, accessible, personalized psychosocial support. Delivering Mindfulness-based Stress
6 Reduction (MBSR) sessions via chatbots may reduce depressive symptoms in university
7 students.

8 **Aim:** This study aims to evaluate the feasibility, acceptability, safety, and preliminary efficacy
9 of a chatbot-based MBSR intervention for university students with depressive symptoms.

10 **Methods:** A rule-based MBSR chatbot was developed and evaluated with a single-group
11 pretest-posttest study for university students in Hong Kong (N=30) reporting depressive
12 symptoms, followed by the collection of their subjective feedback. The intervention lasted
13 eight weeks. The primary clinical outcome was depression levels, with a range of secondary
14 outcomes.

15 **Results:** The chatbot-based MBSR program demonstrated satisfying recruitment, retention,
16 and adherence rates. The safety of the program was confirmed by the absence of any adverse
17 events directly related to the intervention, tracked from the onset of the intervention to the
18 completion of data assessment. Significant improvements were observed in both primary and
19 secondary outcomes. Participant feedback highlighted the benefits of the program and its
20 effects on depressive symptoms.

21 **Conclusions:** The program has shown feasibility, acceptability, safety, and preliminary efficacy
22 in reducing depressive symptoms among 30 university students in Hong Kong. The
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1 intervention should now be evaluated in a randomized controlled trial with follow-up. This
2 study highlights the potential role of chatbot-based interventions in mental health promotion,
3 nursing, and clinical practice and will inform the subsequent development of innovative digital
4 interventions to address mental health challenges faced by university students.

5 **Keywords: mindfulness-based stress reduction, chatbot, depression, university student,**
6 **intervention development, pilot evaluation**

7 **1. Introduction**

8 Early-onset depression tends to have a prolonged course and disrupts functional abilities
9 (Richards, 2011). This condition often deteriorates mental well-being, leading to increased
10 risks of substance and alcohol abuse, as well as challenges in sustaining personal relationships
11 (Mackie et al., 2012; Teshome Hambisa et al., 2020). Studies suggest that 70% of those
12 diagnosed with depression experienced their initial depressive symptoms before the age of 24,
13 particularly during their university years (Kessler et al., 2007; Laursen & Munk-Olsen 2007).
14 University students with depressive symptoms frequently encounter co-occurring mental
15 health issues such as anxiety and stress (Auerbach et al., 2018; Beiter et al., 2015). The
16 American College Health Association reports that 14.6% of students diagnosed or treated by a
17 healthcare professional were identified with both depression and anxiety. Depression among
18 university students is often associated with stress from family/parental pressure, academic
19 pressures, work demands, social challenges, and adapting to new life stages (Acharya et al.,
20 2018; Ivancevic et al., 2020; Stroud et al., 2008). For example, Hong Kong's university
21 students often encounter stressful events such as examinations, interviews, family or social
22 conflicts, future choices, and unexpected emergencies, which can induce nervousness, anxiety,
2

1 and other adverse emotional responses (Wang et al., 2024). The Chinese cultural environment,
2 with its strong emphasis on academic success, career advancement, family prestige, future
3 stability, and collective social norms, may directly influence the stress levels and coping
4 strategies of these students (Lauber & Rössler, 2007). Furthermore, research has shown a
5 significant relationship between the severity of depressive symptoms and suicidal ideation
6 among university students (Meda et al., 2023; Sun et al., 2022).

7 In Hong Kong, concerns have risen sharply due to increasing rates of depression-related
8 suicides among university students. The suicide rate among young adults aged 15-24 has
9 notably increased since 2019 (The Hong Kong Jockey Club Centre for Suicide Research and
10 Prevention, 2024). A cross-sectional study (Lun et al., 2018) also indicated an increasing
11 prevalence of depressive symptoms among undergraduates from Hong Kong's universities,
12 with this condition more common than it was ten years ago. Early intervention can help prevent
13 the onset of clinical depression and reduce suffering. However, university students often
14 hesitate to seek outpatient mental health care due to stigmatization, social isolation,
15 discrimination, and hectic schedules (Samari et al., 2022). In Asian cultures, seeking mental
16 health services may be viewed as indicative of a lack of self-control, may carry a sense of
17 shame, and is often discouraged by family or parental pressure (Han & Pong, 2015; Lauber &
18 Rössler, 2007). Concern about potential social alienation from peers and individual
19 stigmatization related to sick role behaviour further deters students from seeking help (Han &
20 Pong, 2015).

21 Mindfulness, defined as maintaining moment-by-moment present awareness in a non-
22 judgmental and accepting manner, can reduce stress and symptoms associated with psychiatric
23 disorders (Gallego et al., 2014; Tang et al., 2015). Developed in the 1970s by Jon Kabat-Zinn,
24 Mindfulness-Based Stress Reduction (MBSR) is a structured group program that combines
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1 mindfulness meditation, body awareness, and yoga to cultivate resilience and reduce negative
2 emotions (Grossman et al., 2004). It has demonstrated efficacy in reducing depressive
3 symptoms, social anxiety, and stress, and is increasingly integrated into university student
4 services as a non-pharmacological and community-based intervention (An et al., 2022; Dawson
5 et al., 2020; Deshpande et al., 2023). However, traditional MBSR programs require in-person
6 attendance, which may be inaccessible for individuals with mobility issues, those living in
7 remote areas, or those with busy schedules. It may intensify social anxiety due to group face-
8 to-face interactions and cause financial burdens for university students (Herman et al., 2017;
9 Martinez et al., 2015; Ritvo et al., 2021; van Beljouw et al., 2010).

10 To address these limitations and better meet the needs and concerns of university students
11 experiencing depressive symptoms, digital mindfulness interventions have emerged as a
12 promising solution. They offer advantages in aligning with students' information-seeking habits,
13 bridging geographic distances, and providing less stressful circumstances (Ritvo et al., 2021).
14 Notably, chatbot-based interventions provide easy accessibility, availability anywhere,
15 complete anonymity, and affordability (Spijkerman et al., 2016), making them particularly
16 suitable for busy, financially constrained university students who are adept with technology
17 and value peer conformity (Costello & Hope, 2016). Chatbot-based interventions enable
18 communication with programmed agents at any time, providing real-time, individualized, and
19 interactive responses (Abd-Alrazaq et al., 2020). Chatbot-based interventions have been shown
20 to be as effective as traditional psychosocial ones (Jang et al., 2021) and have been utilized
21 across various contexts to address university students' depressive symptoms (He et al., 2022;
22 Klos et al., 2021).

23 Research has demonstrated the feasibility and effectiveness of chatbot-based interventions
24 for young people with depressive symptoms; these interventions often involve integrating
4

1 chatbots with cognitive-behavioral therapy (CBT). For example, Fitzpatrick et al. (2017)
2 developed 'Woebot', a chatbot that employs CBT techniques, and found it significantly reduced
3 depressive symptoms in U.S. young adults aged 18-28 after two-week interventions. Similarly,
4 Fulmer et al. (2018) reported that 'Tess', a psychological chatbot utilizing methods including
5 CBT and mindfulness, effectively alleviated depressive symptoms and anxiety in U.S. college
6 students, who also reported high levels of engagement and satisfaction for 'Tess'. He et al. (2022)
7 evaluated 'XiaoE', a CBT-based chatbot, during the COVID-19 pandemic among Chinese
8 university students with depressive symptoms, highlighting its ability to engage students,
9 improve experience, and build therapeutic relationships.

10 Somewhat different from CBT, Mindfulness Based Stress Reduction (MBSR) employs
11 less cognitively intensive techniques (Sizoo & Kuiper, 2017), avoids direct engagement with
12 emotions, and offers easier-to-learn sessions (Spek et al., 2014). Studies have shown that
13 people with both anxiety and depression often prefer MBSR over CBT because it does not
14 require the intense thinking or mental effort needed for CBT (Spek et al., 2013). Additionally,
15 MBSR has demonstrated greater efficacy than CBT in reducing anxiety and stress levels among
16 university students (Abbasi et al., 2018). However, we have not found any chatbot-based
17 MBSR products to address university students' depressive symptoms, especially in the Hong
18 Kong context.

19 There is an urgent need for effective interventions that can be integrated into a
20 comprehensive healthcare package to reduce depressive symptoms and improve mental well-
21 being among university students in Hong Kong. Such interventions are even beneficial for
22 students exhibiting milder symptoms and lower risk profiles, providing them with timely and
23 appropriate support that prevents escalation and complements existing healthcare services. This
24 study aimed to develop a chatbot-based MBSR intervention and evaluate its feasibility,

1 acceptability, safety, and preliminary efficacy in reducing psychological symptoms among
2 university students experiencing depressive symptoms in Hong Kong. The data collected have
3 the potential to further improve the application of MBSR in a chatbot-based system and
4 establish the essential groundwork for a full-scale intervention in the future.

6 **2. Methods**

7 **2.1. Study Design and Setting**

8 This study consisted of two phases. In the first phase, a rule-based automated chatbot was
9 developed to facilitate MBSR interventions. The second phase employed a single-group
10 pretest-posttest design to evaluate the feasibility, acceptability, safety, and preliminary efficacy
11 of the chatbot-based MBSR intervention for university students with self-reported depressive
12 symptoms. Ethical approval for this study was granted by the Institutional Review Board of
13 The Hong Kong Polytechnic University (ethical approval number HSEARS20221027007).
14 This trial protocol was registered retrospectively at ClinicalTrials.gov (identifier:
15 NCT06440941). There were no deviations from the protocol after ethical approval was granted.
16 The study was guided by the ‘CONSORT 2010 checklist- extension for pilot and feasibility
17 studies of information to include when reporting a pilot or feasibility trial (Eldridge et al., 2016).
18 This study specifically targeted university students in Hong Kong. The workflow of this
19 program is shown in Figure 1.

20 **2.2. Phase One: Development of the Chatbot-based MBSR Intervention**

21 Phase one focused on developing a chatbot-based MBSR intervention using an interactive

1 system named Power Virtual Agents, integrated within the Microsoft Teams platform (Conté et
2 al., 2022). We first conducted a comprehensive literature review to inform the integration of
3 chatbot conversational flows with the content of MBSR sessions. Drawing on insights and
4 examples from recent studies (Milne-Ives et al., 2020; Xu et al., 2021), we crafted a
5 comprehensive chatbot-mediated conversational flow structure to guide participants through
6 the MBSR sessions. Following the standard set of MBSR sessions, we integrated a total of
7 eight mindfulness sessions to the chatbot. The themes and sub-themes of the MBSR
8 intervention used in this study (see Table 1) were determined based on previous MBSR
9 intervention studies (Deshpande et al., 2023; Herman et al., 2017) and discussions among the
10 authors. The sessions were delivered in audio format (Cantonese) via the chatbot programmed
11 to operate in Traditional Chinese.

12 Subsequently, we employed a logical algorithm to establish coherent flows for the
13 intervention sessions. Each session was programmed with specific triggers, keywords, and
14 queries to effectively engage users. The chatbot incorporated natural language understanding
15 capabilities to analyze user input and guide the conversation accordingly. A practice
16 conversational flow carried out between the chatbot and a staff member of our research team
17 was shown in Appendix 1. Additionally, a lightweight database was integrated to track and
18 maintain user progress and facilitate continuity across the eight MBSR sessions. The usability
19 of the chatbot-based MBSR intervention was evaluated through backend data analysis from the
20 chatbot system and qualitative feedback from users. All steps were supervised by the authors
21 to ensure the reliability and accuracy of the development process.

22 **Table 1:** Themes and Sub-themes of the Eight-Week MBSR Sessions (Deshpande et al., 2023;
23 Herman et al., 2017)

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MBSR Session	Theme	Sub-themes
Session 1	There is more right with you than wrong you	<p>The orientation of the chatbot-based MBSR program</p> <p>The provision of psychoeducation of mindfulness and its effects on depression</p> <p>Encouragement for all MBSR sessions completion</p>
Session 2	Perception and creative responding	<p>Inducing awareness and acceptance to self</p> <p>Guiding participants to perform body scan</p> <p>Teaching to focus on various parts of body systematically</p> <p>Teaching to notice sensations of the body in a precise and detailed manner</p> <p>Teaching to minimize the intention to attend to thoughts, ideas, or fears about this sensation</p>
Session 3	The pleasure and power of being present	<p>Inducing non-judgmental attitude</p> <p>Guiding participants to perform breath-awareness meditations, a broad awareness of the bodily experience of breathing</p> <p>Teaching to focus on breathing with more subtlety</p> <p>Encouraging to notice and accept when their attention shifts from meditation</p>

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Session 4	The shadow of stress	<hr/> Teaching to stay here and now <hr/> Guiding participants to perform mindfulness sitting and mindful sitting <hr/> Encouraging to observe their body sensation, emotion, and thoughts <hr/>
Session 5	Finding the space for making choices	<hr/> Encouraging to practice body scan continuously <hr/> Discussing any stigmas participants have encountered <hr/> Guiding to recognize negative thoughts <hr/> Teaching to react to negative thoughts and behaviors regarding discrimination <hr/>
Session 6	Working with difficult situations	<hr/> Empowering participants' self-control <hr/> Discussing participants' problems <hr/> Teaching upon problem-solving <hr/> Teaching when and how to use mindfulness attitude/ communication <hr/>
Session 7	Cultivating kindness towards self and others	<hr/> Discovering the pleasure things in life together <hr/> Teaching to react to pain more practically <hr/> Teaching to do things positively in a particular time everyday <hr/>
Session 8	The eighth week is the rest of your life	<hr/> Program review <hr/> Mindfulness skills review <hr/> Encouraging of daily practicing physical <hr/>

activity and mind-body interventions
continuously

1 **2.3. Phase Two: Pilot Evaluation- Feasibility Clinical Trial**

2 ***Participant Recruitment***

3 Posters were displayed across various key locations within the authors' university. These
4 posters included a concise overview of the study and a QR code. Additionally, the study was
5 promoted on social media platforms such as Facebook and Instagram. Potential participants
6 interested in the study were required to visit the study website by scanning a QR code and
7 undergo an eligibility assessment. Those who were eligible were then contacted by the study's
8 research staff via phone to arrange appointments prior to the intervention. Participants received
9 an introductory email about the study, followed by signing an online consent form. They were
10 also instructed via email on completing baseline measures and preparing to start the formal
11 intervention. Participants who completed the program were offered \$100 HKD in supermarket
12 coupons. The recruitment period extended for four months, from December 2022 to March
13 2023. This study was conducted in accordance with the Declaration of Helsinki. Ethical
14 approval for this study was granted by the Institutional Review Board (IRB) of The Hong Kong
15 Polytechnic University (ethical approval number: HSEARS20221027007).

16 ***Participant Inclusion Criteria***

17 Eligible participants needed to be students aged over 18 years pursuing a bachelor's degree,
18 associate degree, or higher diploma, with self-reported depressive symptoms. The depressive
19 symptoms were assessed pre-intervention using the 9-item Patient Health Questionnaire, with
20 cumulative scores of 5 or higher indicating at least mild depressive symptoms (Sjognesen et
21 al., 2012). Participants also needed to be able to provide informed consent, read Chinese, listen
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1 to Cantonese, and ensure internet access during the study. Participants were excluded if they
2 had been diagnosed with a clinical psychotic condition pre-intervention or were currently
3 involved in any mindfulness-based or other psychosocial interventions.

4 ***Sample Size***

5 According to previous recommendations for sample sizes in pilot studies and single-group
6 pre-post studies (Braun et al., 2020; Magnani et al., 2017; Vitasari et al., 2011), this study aimed
7 to recruit 20-40 participants to assess the feasibility, acceptability, safety, and preliminary
8 efficacy of the program.

9 ***Intervention Development and Content Description***

10 Recruited participants signed consent forms and completed baseline assessments,
11 including socio-demographics and psychological states using validated scales (see
12 'Assessments'). Instructions for interacting with the chatbot via Microsoft TEAMS® were
13 provided. During the intervention, participants first underwent a single-item assessment to
14 verify the stability of their mental states for subsequent MBSR sessions, deemed stable if rated
15 as 'excellent,' 'very good,' or 'good.' They then engaged in conversations with the chatbot,
16 responding to prompts like 'What is the most recent thing that made you happy?' to foster
17 interactive communication and relaxation. Subsequently, participants followed guided MBSR
18 sessions (refer to Table 1) and were encouraged to interact with the chatbot for at least one hour
19 daily; all interactions were monitored and recorded. After eight weeks, a post-intervention
20 assessment was conducted, followed by pre-post statistical analyses. A total of ten participants
21 with the most and least significant changes in depression levels were selected for an open-
22 ended questionnaire, sent via WhatsApp, with all responses recorded and analyzed.

23 ***Assessments***

24 **Feasibility, Acceptability, and Safety.**

1 The feasibility of participant recruitment and follow-up was assessed through three
2 metrics (Li et al., 2023): (1) the time taken to recruit the target sample size; (2) the recruitment
3 rate, calculated as the ratio of eligible participants approached who agreed to consent compared
4 to all eligible participants; and (3) the retention rate, calculated as the proportion of participants
5 who completed the study relative to those who agreed to consent.

6 The acceptability of the intervention was evaluated using the following criteria (Li et al.,
7 2023): (1) adherence rate, calculated by dividing the number of sessions completed by all
8 participants post-intervention by the total number of MBSR sessions expected to be completed
9 (N = 8), and (2) the specifically designed open-ended questionnaire for a targeted group of
10 participants, including those who exhibited the most significant changes in depression levels
11 between the pre-test and post-test, and those with the least changes. The questionnaire, which
12 included six questions, aimed to gather insights on the strengths and weaknesses, and
13 suggestions for improving the program.

14 The safety of the intervention was evaluated by recording any adverse events reported by
15 participants during the study and determining whether any events were directly associated with
16 the intervention or with participation in the study more generally. We did account for potential
17 risks, including suicidal ideation, in our study protocol submitted to the IRB. We outlined risk
18 management strategies, including close monitoring and reporting of any adverse effects. If any
19 adverse effects were detected, a protocol was in place to manage them, including increased
20 follow-up and direct communication with participants by research team members. The
21 participants were continuously monitored throughout the study by our research team, who
22 contacted these participants weekly via telephone to assess their mood and health status.
23 Additionally, prior to each MBSR session, our developed chatbot solicited updates on mood
24 and health from them by asking, 'How would you rate your mental health: excellent, very good,
12

1 good, fair, or poor?' These responses were reviewed to ensure the stability of their mental states.
2 These participants were informed of the potential for emotional distress during the study and
3 their right to withdraw at any point without penalty. They were also asked to promptly report
4 any discomfort or adverse events to the research team. Each of them received information on
5 how to access mental health services, including the suicide hotline in Hong Kong, methods for
6 seeking help, and additional resources and support for contacting relevant health professionals.
7 Furthermore, they were informed that referrals to clinical mental health services would be
8 arranged if deemed necessary. However, we did not rely solely on external referrals to more
9 intensive mental health services. We also took into account their willingness to attend follow-
10 up medical appointments. Our research team included two mental health professionals who
11 regularly evaluated participants throughout the study. Regular communication with participants
12 was maintained to ensure that any emerging issues were addressed promptly.

13 **Socio-demographics.**

14 Participants' socio-demographics were collected using a self-designed questionnaire,
15 including age, gender, marital status, current grade level, religion, faculty, year of study, living
16 situation, and personal net monthly income.

17 **Preliminary Efficacy.**

18 ***Primary Clinical Outcome.***

19 Depression. The depression levels of the participants were assessed using the Patient
20 Health Questionnaire (PHQ-9) in Chinese, a 9-item scale with a Cronbach's alpha coefficient
21 of 0.91, (Chen et al., 2010), tested on a sample of 364 older adults (aged ≥ 60) in Hangzhou,
22 China. Items are rated on a scale from 0 (not at all) to 3 (nearly every day), with total scores
23 categorizing depression severity: 5-9 (mild), 10-14 (moderate), 15-19 (moderately severe), and
24 ≥ 20 (severe) (Sjonnesen et al., 2012).

1 ***Secondary Clinical Outcomes.***

2 Stress. The stress levels of the participants were evaluated with the commonly used
3 Perceived Stress Scale (PSS-14) in Chinese, a 14-item scale with a
4 Cronbach's alpha coefficient of 0.83 (Yang et al., 2022), tested on a sample of 8,216 adults
5 (aged ≥ 18) from the China Health and Nutrition Survey. It uses a 5-point Likert scale ranging
6 from 0 (never) to 4 (very often), categorizing total scores into low stress (0-13), moderate stress
7 (14-26), and high stress (27-40) (Leung et al., 2010).

8 Anxiety. The anxiety levels of the participants were measured using the Generalized
9 Anxiety Disorder Scale (GAD-7) in Chinese, a 7-item scale with a Cronbach's alpha coefficient
10 of 0.89 (Tong et al., 2016), tested on a sample of 213 adults (aged ≥ 18) diagnosed with
11 epilepsy from the epilepsy outpatient clinic of West China Hospital. Items are rated on a scale
12 from 0 (not at all) to 3 (nearly every day), with total scores categorizing anxiety severity as
13 minimal (0-4), mild (5-9), moderate (10-14), and severe (≥ 15) (Spitzer et al., 2006).

14 Mindfulness. The mindfulness levels of the participants were assessed using the Five-
15 Facet Mindfulness Questionnaire (FFMQ-39) in Chinese, which rates items from 1 (never or
16 very rarely true) to 5 (very often or always true) across five facets: observing, describing, acting
17 with awareness, non-judgmental, and nonreactivity (Arthur et al., 2018).
18 Cronbach's alpha coefficients for these five facets range from 0.70 to 0.90 (Arthur et al., 2018),
19 tested on a sample of 193 nursing students enrolled in one of Beijing's top-ranked universities.
20 Higher scores indicate greater mindfulness levels.

21 ***Statistical Analysis***

22 The analysis used a per-protocol approach where only those who completed all the
23 outcome measures were analyzed. Descriptive statistics were used to summarize participants'
24 demographic information and total scores on different assessment tools. Statistical analysis was

1 conducted using SPSS Statistics, version 27.0 (IBM Corp). The Shapiro-Wilk test was
 2 employed to assess the normality of continuous data, including scores from the PHQ-9, PSS-
 3 14, GAD-7, and FFMQ. Subsequently, a t-test was performed to evaluate changes between pre-
 4 and post-intervention scores for these measures. A chi-square test was used to identify the
 5 severity differences regarding depression, anxiety, and stress levels. A p-value of $\leq .05$ was
 6 considered statistically significant. Imputation was not adopted for missing values as the
 7 percentage of missing data was less than 5% in this study (Dong & Peng, 2013). Participants'
 8 responses to open-ended questions via WhatsApp were compiled and analyzed using text
 9 analysis.

10 3. Results

11 3.1. Baseline Characteristics

12 Participant socio-demographics at baseline is shown in Table 2. The study involved 30
 13 participants, aged between 18 and 25 years (mean (SD) = 23.03 (3.70)), predominantly female
 14 (76.7%) and single (96.7%). The majority were pursuing a bachelor's degree (76.7%) and were
 15 non-religious (73.3%). Most participants were from the Faculty of Health and Social Sciences
 16 (36.7%) with the remaining belonging to other faculties (63.3%). The participants were mainly
 17 in their first (30.0%) or fourth (30.0%) year of study. Regarding living situations, over half
 18 (53.3%) lived with their parents. For personal net monthly income, most of the participants
 19 (46.7%) earned less than 1,000 HKD.

20 **Table 2.** Participant Socio-demographics at Baseline [mean (SD)/N (%)]

Characteristics	Total (N=30)
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Age, mean (SD)	23.03 (3.70)
Gender	
Male	7 (23.3)
Female	23 (76.7)
Marital status	
Single	29 (96.7)
Married	1 (3.3)
Current grade level	
Associate degree/ Higher Diploma	1 (3.3)
Bachelor's degree	23 (76.7)
Master	4 (13.3)
PhD	2 (6.7)
Religion	
Non-religious	22 (73.3)
Religious	8 (26.6)
Current faculties	
Faculty of Health and Social Sciences	11 (36.7)
Others*	19 (63.3)
Studying year	
Year 1	9 (30.0)
Year 2	6 (20.0)
Year 3	5 (16.7)
Year 4	9 (30.0)

Year 5	1 (3.3)
Living situation	
Living with parents	16 (53.4)
Living alone	7 (23.3)
Others	7 (23.3)
Personal net monthly income in HKD	
<1,000	14 (46.7)
1,000-2,999	4 (13.3)
3,000-4,999	7 (23.3)
≥ 5000	5 (16.7)

1 *Note: ‘Others’ include: Faculty of Business, Construction and Environment, Humanities and
 2 Science; School of Design, Fashion and Textiles and Hotel and Tourism Management.

3 3.2. Feasibility

4 The participant recruitment and follow-up flowchart for this study is presented in Figure
 5 2. Feasibility was assessed by the time taken to recruit the target sample size, the recruitment
 6 rate, and the retention rate. The target sample size was successfully recruited within four
 7 months. Of the 68 applicants who approached us via the QR code, 30 eligible participants were
 8 recruited and then consented to enroll in our baseline assessment and MBSR intervention (a
 9 recruitment rate of 100%). Three participants failed to complete the post-intervention
 10 assessment after the eight-week MBSR sessions, yielding a retention rate of 90%.

1 **3.3. Acceptability**

2 Acceptability was evaluated through adherence rates and participant subjective feedback.
3 In our study, we expected each participant to complete all eight MBSR sessions. We considered
4 those who completed at least half of the sessions (four or more) to have successfully completed
5 the intervention, making them eligible for post-intervention analysis. During the eight-week
6 intervention, the adherence rate for attending all eight required MBSR sessions was 87.08%.
7 Additionally, 66.67% of the participants (20 out of 30) completed all eight sessions, and 90%
8 (27 out of 30) were regarded as having completed the intervention. The feedback from these
9 27 participants was considered valid for post-intervention assessment.

10 In subjective feedback from ten participants, eight reported a positive impact of the
11 program on their mental health, highlighting improvements in depression, stress, anxiety, self-
12 acceptance, and emotional regulation. They also experienced improved well-being, reflected
13 in better sleep, concentration, mood regulation, and overall quality of life. Seven participants
14 valued its convenience, flexibility and accessibility. Certain deficiencies were mentioned,
15 including dissatisfaction with audio-only instructions, limited functionality, technical
16 difficulties, and a desire for greater interactivity. Recommendations for improvement included
17 adding video content, increasing interactions with the chatbot, and extending session duration.

18 **3.4. Safety**

19 Our baseline assessment data showed that, within the two weeks preceding the assessment,
20 23 recruited participants reported no occurrences of 'Thoughts that you would be better off
21 dead, or of hurting yourself' (question no. 9 in the PHQ-9). Six participants reported
22 experiencing such thoughts on several days, and one participant reported these thoughts on

1 more than half the days. These seven participants were regarded as exhibiting suicidal ideation.

2 Throughout the duration of the study, no participants exhibited suicidal behavior nor did
3 they require referral for more intensive mental health treatment. Some participants reported
4 minor somatic discomforts during the program, including headaches, fatigue, muscle pain, and
5 sore throat. These discomforts were reported as being attributed to COVID-19 (our intervention
6 period occurred during the COVID-19 pandemic) and other common illnesses, leading to the
7 discontinuation of two participants after one week of MBSR sessions and another after two
8 weeks. All such incidents were discussed by the research team and expert clinicians to establish
9 if they were likely to be directly associated with the intervention. These incidents were
10 determined as not being adverse events or harms related to the intervention, suggesting that the
11 intervention was safe.

12 **3.5. Intervention Effects on Primary and Secondary Clinical Outcomes**

13 After the chatbot-based MBSR intervention, a significant reduction in participants'
14 depression levels was observed, decreasing from 11.19 ± 4.24 pre-intervention to 5.07 ± 3.74
15 post-intervention, $p < .001$ (see Table 3). The proportion of those with moderate depression
16 significantly decreased from 40.7% (11/27) to 14.8% (4/27), compared to other severity groups,
17 $p < .001$. None of the participants were classified as having moderately severe or severe
18 depression post-intervention. Additionally, there were notable improvements in participants'
19 anxiety and stress levels, as well as their mindfulness states (see Table 3). Anxiety levels
20 significantly decreased from 10.37 ± 5.19 pre-intervention to 5.15 ± 4.32 post-intervention, p
21 $< .001$, with the most marked reductions among those with severe anxiety, from 29.6% (8/27)
22 to 3.8% (1/26), $p = .002$. Similarly, stress levels significantly decreased from 34.11 ± 3.98 pre-
23 intervention to 24.65 ± 5.61 post-intervention, $p < .001$. Furthermore, there was a significant
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1 increase in mindfulness levels from 109.89±10.32 pre-intervention to 131.31±16.83 post-
 2 intervention, $p < .001$, particularly in the facets of 'Acting with awareness' and 'Describing'.
 3 Cohen's d effect sizes were large for all outcomes, ranging from -1.95 (95% CI: -2.59, -1.30)
 4 for stress to -1.09 (95% CI: -1.67, -0.52) for anxiety (see Table 3).

5 **Table 3.** Depression, Anxiety, Stress and Mindfulness Level Comparison between Pre- and
 6 Post-intervention

Measures	Pre-intervention/post-intervention		t/χ^2 value	p value	Cohen D (95%CI)
	Mean (SD)/N (%)				
PHQ-9, Mean (SD)	11.19 (4.24)	5.07 (3.74)	5.614	<.001	-1.53 (-2.14, -0.92)
PHQ-9 severity, N (%)			23.569*	<.001	
None to minimal	0	16 (59.3)			
Mild	9 (33.3)	7 (25.9)			
Moderate	11 (40.7)	4 (14.8)			
Moderately severe	6 (22.2)	0			
Severe	1 (3.7)	0			
GAD-7, Mean (SD)	10.37 (5.19)	5.15 (4.32)	3.968	<.001	-1.09 (-1.67, -0.52)
GAD-7 severity, N (%)			14.697*	.002	
None	2 (7.4)	13 (50.0)			
Mild	11 (40.7)	9 (34.6)			
Moderate	6 (22.2)	3 (11.5)			
Severe	8 (29.6)	1 (3.8)			
PSS-14, Mean (SD)	34.11 (3.98)	24.65 (5.61)	7.100	<.001	-1.95 (-2.59, -1.30)
PSS-14 severity, N (%)			29.135*	<.001	

Chatbot-based MBSR for University Students with Depression

Low	2 (7.4)	21 (80.8)			
Moderate	24 (88.9)	5 (19.2)			
High	1 (3.7)	0			
FFMQ, Mean (SD)	109.89 (10.32)	131.31 (16.83)	-5.561	<.001	1.53 (0.93, 2.14)
Observing facet, Mean (SD)	22.30 (6.00)	26.31 (6.12)	-2.410	.020	0.66 (0.11, 1.21)
Describing facet, Mean (SD)	22.30 (5.91)	26.96 (5.58)	-2.952	.005	0.81 (0.26, 1.37)
Act with awareness facet, Mean (SD)	23.74 (5.81)	30.31 (7.22)	-3.657	.001	1.00 (0.44, 1.57)
Nonjudging facet, Mean (SD)	24.11 (5.24)	27.04 (4.75)	-2.130	.038	0.59 (0.04, 1.13)
Nonreacting facet, Mean (SD)	17.44 (4.34)	20.69 (4.01)	-2.829	.007	0.78 (0.23, 1.33)

1 Note: * means χ^2 value, others are t value; sample size varied due to missing

2 **4. Discussion**

3 **4.1. Discussion of Key Findings**

4 This study achieved a high recruitment and retention rate, demonstrating the excellent
5 feasibility of the chatbot-based MBSR program and the willingness of university students to
6 engage with it. However, the adherence rate of 87.08% was slightly lower than that in
7 conventional MBSR studies (with an adherence rate more than 90%) for university students
8 with depressive symptoms (Bergen-Cico et al., 2013; Ma et al., 2019; Song & Lindquist, 2015).
9 Reasons may include this study being conducted during the COVID-19 pandemic in Hong
10 Kong. Some participants reported somatic discomforts attributed to COVID-19 and other
11 illnesses, leading to discontinuation, while others were hindered by academic obligations or
12 technical difficulties with accessing and interacting with the chatbot platform. Unlike

1 traditional group-based sessions that provide structured guidance from healthcare professionals,
2 the chatbot-based intervention required high self-discipline and active remote encouragement,
3 which may impact adherence rates. Despite these challenges, the adherence rate was considered
4 satisfactory, and no direct adverse events or harms related to the intervention were reported,
5 indicating good acceptability and safety of the program.

6 The positive feedback received from participants highlighted the benefits of the program
7 (e.g. non-judgmental, personalised, anonymous, and flexible format). These positive comments
8 may stem from the alignment of the program with university students' preferences for accessing
9 healthcare information and overcoming geographical barriers (Costello & Hope, 2016; Ritvo
10 et al., 2021). Our program provides easy access, affordability, and digital interactivity, making
11 it particularly suitable to university students managing time and financial limitations, and who
12 favor digital platforms. The program also provides them with the freedom and flexibility to
13 engage in MBSR practices accommodating to their space and schedule. The gender
14 composition of participants in this study included 23 females and 7 males. We argue that this
15 discrepancy may reflect underlying cultural dynamics within Eastern societies, where females
16 are often more inclined to seek mental health support due to societal expectations and familial
17 roles (Wei et al., 2024). Future investigations could explore how specific cultural determinants,
18 such as social roles, expectations, stigma related to mental health issues, and accessibility of
19 mental health resources, may influence help-seeking behaviors and the effectiveness of
20 interventions like MBSR across different genders.

21 The results also demonstrated the preliminary efficacy of the program in reducing
22 depressive symptoms among university students. This aligns with those of conventional MBSR
23 studies, which also indicate the effectiveness of MBSR interventions in addressing depression
24 among this group (Bergen-Cico et al., 2013; Ma et al., 2019; Song & Lindquist, 2015). The
22

1 impact of our program on depressive symptoms can be partially attributed to the inherent
2 mechanisms of MBSR, such as redirecting attention away from persistent negative thoughts
3 and cultivating an ongoing state of mindfulness (Grossman et al., 2004). These practices
4 directly address key features of depression, such as rumination, a repetitive, negative cognitive
5 process linked to the exacerbation of depressive symptoms, and poor self-acceptance which
6 perpetuates emotional distress (Grossman et al., 2004). Additionally, MBSR integrates
7 techniques like body scans, gentle yoga, and meditation. These techniques enhance emotional
8 regulation by increasing awareness of bodily sensations and thoughts without reactive
9 judgment, thereby providing a stable emotional base and mitigating depressive symptoms over
10 time (Whitebird et al., 2012). Our program adapts these proven interventions into a chatbot-
11 based platform, specifically designed to overcome barriers commonly faced by university
12 students with depressive symptoms, such as stigma or reluctance to engage in traditional
13 therapy settings. By offering personalized mindfulness training in a confidential and accessible
14 manner, the program maintains the therapeutic benefits of MBSR while appealing to a
15 demographic with unique needs and challenges (Ritvo et al., 2021; Spijkerman et al., 2016;
16 van Beljouw et al., 2010).

17 Similarly, the program demonstrated preliminary efficacy in reducing anxiety and stress
18 among university students. Literature indicates depression, anxiety, and stress frequently
19 coexist in university students due to their interrelated nature (Auerbach et al., 2018; Beiter et
20 al., 2015). It is plausible to suggest reducing depressive symptoms through our program may
21 concurrently alleviate anxiety and stress. Students with anxiety often engage in excessive
22 rumination, a cycle that MBSR can interrupt by encouraging present-moment awareness and
23 non-judgmental observation of thoughts (Zhou et al., 2020). Anxiety often stems from fears
24 about the future or the unknown, exacerbated by the unpredictable nature of university life and
23

1 future career concerns. MBSR teaches techniques for embracing life's uncertainties to mitigate
2 related anxiety.

3 Stress can adversely affect a student's ability to concentrate (Acharya et al., 2018). This
4 can be improved through our MBSR intervention which focuses on enhancing concentration
5 on current tasks and reducing feelings of being overwhelmed. Chatbots could serve as tools for
6 immediate intervention by providing real-time support during stressful events (e.g.
7 examinations, family or social conflicts, future choices). This capability is particularly valuable
8 when integrated with guided mindfulness exercises, offering professional guidance and timely
9 support for the mental health of Hong Kong's university students during their times of need
10 (Abd-Alrazaq et al., 2020). Our results also suggest significant improvements in participants'
11 mindfulness, particularly in the areas of 'Acting with Awareness' and 'Describing.' The
12 mechanism of the 'Acting with Awareness' practice appears to be its focus on helping students
13 concentrate on the present moment. This concentration reduces their tendency to engage in
14 negative, future-oriented thinking, and unnecessary cognitive overloads, thereby improving
15 their depression and anxiety (Gu et al., 2016). The 'Describing' practice facilitates better
16 emotional regulation by enabling students to articulate their thoughts and feelings clearly. This
17 clarity in expression may lessen the intensity of stress responses (Baer et al., 2022). These
18 findings imply that MBSR may alleviate depression, anxiety, and stress in university students
19 by increasing mindfulness skills such as 'Acting with Awareness' and 'Describing'. To confirm
20 these potential intervention mechanisms, further investigation through a randomized controlled
21 trial with a larger sample size is warranted.

22 **4.2. Limitations**

23 The study faced limitations due to its small sample size and lack of a control group, which
24

1 hindered the ability to draw definitive conclusions about the intervention's effects. Using per-
2 protocol analysis may have inflated effect sizes. Potential confounding factors, such as
3 participants' medication history for psychological symptoms, were not investigated and
4 controlled in this study, which may confound the study findings. Participants' levels of
5 depression, anxiety, stress, and mindfulness were assessed at only two time points: pre-
6 intervention and immediately post-intervention following the completion of the eight-week
7 MBSR sessions delivered via a chatbot. Therefore, it remains uncertain whether the
8 improvements observed post-intervention endure over time. This pilot study was primarily
9 designed to evaluate the feasibility and preliminary efficacy of the chatbot-based MBSR
10 intervention, rather than its lasting effects. Future research should address these limitations by
11 using a larger, controlled sample, extending the follow-up period, and collecting data on
12 confounding factors to better assess the lasting effects of the intervention. Most of the recruited
13 participants were female in this study. Future research could collect a more balanced gender
14 representation to avoid potential gender biases. The instability of the Microsoft Teams®
15 platform caused connection issues and interruptions, likely hindering participants' ability to
16 engage consistently with the study, highlighting the need for a more reliable system to support
17 uninterrupted participation.

18 **4.3. Implications**

19 Our program is an innovative adjunct to existing psychiatric nursing practices. It may be
20 helpful for university students who might experience mild to moderate depression, stress or
21 anxiety symptoms, where the need for pharmacological treatments or intensive therapy is not
22 evident. The program is also beneficial for students exhibiting sub-clinical mental health
23 symptoms who might not otherwise engage with mental health services due to stigma or lack
25

1 of awareness. This program is designed to complement, not replace, the healthcare provided
2 by psychiatric nurses and clinicians. It presents a potential format for delivering healthcare
3 adapted to the unique needs and technological preferences of university students and other
4 young adult groups. Integrating this program within healthcare services may improve outreach,
5 reduce barriers to healthcare, and foster engagement with mental health practices among the
6 university population. Our study contributes to psychiatric nursing practice, making care both
7 accessible and appealing to younger populations.

8 **5. Conclusions**

9 This study demonstrates the feasibility, acceptability, safety, and preliminary efficacy of a
10 chatbot-based MBSR program for alleviating symptoms of depression, anxiety, and stress
11 among university students, while concurrently improving their mindfulness levels. The results
12 highlight the potential clinical relevance of utilizing chatbot-delivered interventions in
13 psychiatric nursing support, particularly within university settings. This study offers a
14 foundation for further refinement and testing of chatbot-based technology in a rigorously
15 designed fully-powered clinical trial to ascertain its efficacy. Implementing these innovative
16 tools in psychiatric nursing practice has the potential to enhance the accessibility and
17 effectiveness of psychiatric resources, supporting the mental health management of university
18 students.

19

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