Worldviews on Evidence-Based Nursing

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AI-Assisted Tailored Intervention for Nurse Burnout: A Three-Group Randomized Controlled Trial

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ABSTRACT

Background: High-stress environments, heavy workloads, and the emotional demands of patient care, which are common challenges faced by nurses, are factors that can lead to burnout. Shift work can make traditional burnout interventions costly and difficult to implement. Artificial intelligence (AI) could offer solutions that are less constrained by time, resources, and labor.

Aim: To investigate the effectiveness of an AI-assisted intervention in reducing nurse burnout.

Methods: A single-blind, three-group, randomized controlled trial of 120 nurses (40 per group) was conducted from June 2023 to July 2023. The AI-assisted tailored intervention included two 2-week programs, delivering one of four programs to the intervention group: mindfulness meditation, acceptance commitment therapy, storytelling and reflective writing, or laughter therapy. The experimental group received tailored programs based on demographic and work-related characteristics, job stress, stress response, coping strategy, and burnout dimensions (client-related, personal, and work-related). Control Group 1 self-selected their programs, while Control Group 2 was provided with online information on burnout reduction. Primary outcomes, client-related, personal, and work-related burnout, were measured at baseline, week 2, and week 4. Secondary outcomes, job stress, stress responses, and coping strategies, were assessed at baseline and week 4. Data were analyzed using ANOVA, repeated measures ANOVA, and the Scheffé test for post hoc analysis.

Results: The experimental group showed significant reductions in client-related burnout ($F = 7.725$, $p = 0.001$) and personal burnout ($F = 10.967$, $p < 0.0001$) compared to the other groups. Significant effects of time and time × group interactions were observed for client-related and personal burnout, with time effects noted for work-related burnout. Stress response reduction was highest in Control Group 1, followed by the experimental group and Control Group 2 ($F = 3.07$, $p = 0.017$).

Linking Evidence to Action: AI algorithms could provide tailored programs to mitigate nurse burnout, particularly in client-related and personal burnout. Reducing nurse burnout could contribute to the quality of care.

Trial Registration: This trial is registered with the Clinical Research Information Service (KCT0008546)

1 | Background and Significance

Globally, nurses frequently face high-stress environments and emotional labor, making them particularly vulnerable to burnout (Woo et al. 2020). The prevalence of burnout among nurses is approximately 30% worldwide and has gradually increased over the last decade (Ge et al. 2023). In Korea, 55.9% of frontline nurses reported experiencing burnout during the COVID-19 pandemic (Noh et al. 2022). Despite the growing demand for high-quality and quantity nurses due to evolving societal

circumstances and environmental shifts in the healthcare sector, poor working conditions and inadequate compensation have resulted in imbalanced nursing roles and responsibilities. For example, the patient-to-nurse ratio per shift in South Korea is 16.3 patients per nurse, which is more than twice that in the United States (5.2) and Switzerland (7.9), and nearly twice that in the United Kingdom (8.6) (National Assembly Research Service 2020). Existing policies, such as the differential nursing care fee system, are difficult to enforce and fail to address the increasing workload caused by higher patient acuity and shorter hospital stays (Kim 2023a, 2023b); therefore, the need for complementary intervention solutions is critical. Among nurses, unresolved burnout is an important issue as burnout not only affects individual nurses' well-being but also disrupts healthcare systems by reducing the quality of patient care and increasing turnover rates (Kim and Yang 2015).

Defined as a syndrome resulting from unmanaged chronic workplace stress (World Health Organization 2019), burnout is not a temporary condition but a complex phenomenon resulting from prolonged workplace stress. Burnout among nurses is often assessed in three dimensions, namely client-related, personal, and work-related burnout (Montgomery et al. 2021). Client-related burnout refers to the degree of burnout caused by unreasonable demands from patients and their caregivers (Kristensen et al. 2005). Personal burnout is the level of physical and psychological exhaustion resulting from physical and psychological stress (Kristensen et al. 2005). Work-related burnout refers to the degree of physical and psychological fatigue caused by an excessive workload and poor work environment (Kristensen et al. 2005).

Evidence suggests that burnout can be alleviated through psychological interventions, such as mindfulness meditation (Kabat-Zinn 2003), acceptance and commitment therapy (Barrett and Stewart 2021), reflective storytelling (Jun et al. 2022), and laughter therapy (Sís Çelik and Kılınç 2022). Mindfulness meditation is a widely used technique for addressing burnout and stress among nurses (Kabat-Zinn 2003; Salvado et al. 2021; Suleiman-Martos et al. 2020). Acceptance and commitment therapy, a recently developed form of cognitive behavioral therapy that combines acceptance and mindfulness with active engagement and behavioral change, has been used to alleviate burnout in various occupations (Barrett and Stewart 2021; Towey-Swift et al. 2023). Storytelling fosters psychological stability by sharing, listening to, and evaluating colleagues' experiences, developing meaningful connections, and expressing emotions (Jun et al. 2022). Storytelling and reflective writing improved self-awareness and self-compassion and decreased insomnia and loneliness among oncology nurses (Phillips et al. 2021). Laughter therapy alleviates psychological symptoms such as stress, anxiety, and depression (Sís Çelik and Kılınç 2022). While these interventions have demonstrated effectiveness in addressing the multifaceted dimensions of burnout, they are typically standardized, often lack flexibility, and fail to account for the diverse and multidimensional nature of burnout experiences among nurses.

Artificial intelligence (AI) has emerged as a potential tool to address these challenges. AI-assisted tailored programs could offer efficiency by automating the process of tailoring interventions and enhance user engagement through personalized recommendations (Kim et al. 2021; Gerich et al. 2022). While AI applications in health care have primarily focused on technological advancements, such as predictive modeling and voice recognition (Jung et al. 2020; Narang et al. 2021), few studies have explored their potential for addressing mental health challenges, such as burnout in clinical populations. The effectiveness of AI-assisted, personalized interventions for nurses experiencing burnout should be investigated.

This study leverages AI technology to evaluate the effectiveness of a tailored intervention that mitigates nurse burnout. Traditional standardized interventions that do not acknowledge the individual differences or multidimensional nature of burnout might have low participant compliance. The program's design addresses the limitations of traditional methods by offering flexibility and presenting a novel solution for tailored intervention with minimal resources. In doing so, this study advances the scholarship about AI applications in nursing intervention.

1.1 | Aims

This study aimed to evaluate the effectiveness of an AI-assisted, tailored intervention in reducing nurse burnout. Specifically, it compared the burnout reduction effects between the experimental group receiving the AI-assisted tailored burnout reduction program, Control Group 1, which self-selected a burnout reduction program, and Control Group 2, which received text-based burnout information via online blog.

2 | Methods

2.1 | Study Design

A single-blind, three-group, randomized controlled trial design was adopted, which included an experimental group, a structurally equivalent attention control group, and a pure control group (Melnyk et al. 2019). This study followed the Consolidated Standards of Reporting Trials guidelines for randomized clinical trials (Liu et al. 2020).

2.2 | Participants

The inclusion criterion was nurses who had been working independently in hospitals for at least 1 month during the time of data collection. New nurses who did not work independently or were in their preceptorship period might have different work experiences (Kim et al. 2020) that could influence burnout differently. The exclusion criteria were nurses who did not provide direct care to patients or had prior experience with cognitive behavioral therapy through a smartphone app to reduce burnout.

Participants were recruited between June 2 and 24, 2023, using convenience sampling. After randomization, the intervention and data collection lasted until July 27, 2023. Online flyers were posted in two large online communities for registered nurses in South Korea: one had 94,000 nurse license validated members and the other had 170,000 members who self-identified as nurses.

Among the 198 potential participants who were interested in the study, 63 were excluded (prior experience with cognitive behavioral therapy for burnout: $n = 61$; new nurses with < 1 month of work experience: $n = 2$), and five declined to participate (Figure 1). Finally, 120 nurses were included in the study and randomly assigned to three groups, with 40 participants each: the experimental group (burnout reduction program recommended by the AI algorithm), Control Group 1 (burnout program selected by the participant), and Control Group 2 (information on burnout reduction provided through online blogs).

2.3 | Sample Size Calculation

The sample size for this study was calculated using the G*power 3.1.9.7 program (Cohen 1988). Considering an effect size (Cohen's d) of 0.15 based on previous studies (Kawakami et al. 2023; Luangapichart et al. 2022), a significance level of 5%, and a power of 80%, a total sample size of 93 participants was required. Considering a 20%–25% dropout rate in online intervention programs (Schmidt et al. 2019) and surveys (Lozar Manfreda and Vehovar 2002), a dropout rate of 20% was expected in this study. Finally, the total number of participants was set at 120.

2.4 | Randomization

Randomization software was used to automatically assign participants to specific groups (randomizer.org, a service provided by the Social Psychology Network). The allocation ratio was 1:1:1, and all participants had an equal chance of being selected for each group. They were not informed about randomization until they were enrolled in the study. After randomization, participants in Control Group 1 were asked to select their preferred program from among the four options before starting the intervention. This approach was intended to minimize selection bias.

2.5 | Interventions

2.5.1 | Experimental Group

The intervention, which was developed by the authors of this study, was administered through a mobile application, Nurse Healing Space, which includes four burnout reduction programs: (1) mindfulness meditation, (2) acceptance and commitment therapy, (3) storytelling and reflective writing, and (4) laughter therapy (Table 1). The intervention lasted 4 weeks and comprised two 2-week programs, each with three 10–15-min sessions per week. The animated female characters in the videos guided the participants. For mindfulness meditation, participants followed the video instructions for body movement, respiration, and meditation. For acceptance and commitment therapy, participants practiced accepting and managing their emotions and thoughts following video instructions. For storytelling and reflective writing, participants watched a video about other nurses' stories then wrote about their own experiences. For laughter therapy, participants followed a video to perform dances and sing songs that induced laughing. The content of each program was developed in consultation with experts in each field.

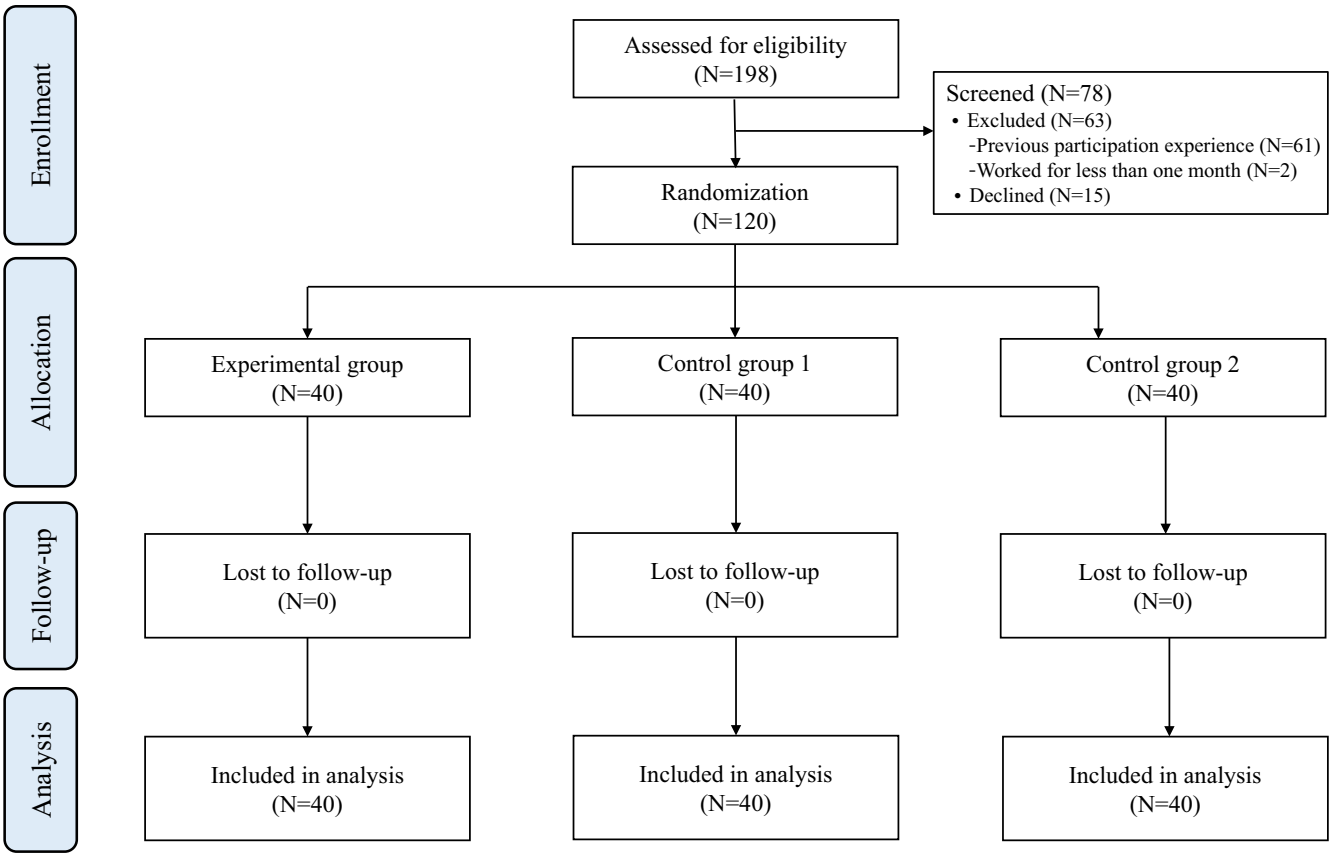

FIGURE 1 | Consolidated standards of reporting trials (CONSORT) diagram profile flow.

TABLE 1 | Program components of intervention.

Week #	Session #	Programs			
		Mindfulness meditation	**Acceptance and commitment therapy**	**Storytelling and reflective writing**	**Laughter therapy**
Week 1	1st session	Body-scan (upper body), self-compassion meditation	Hello my heart (introduction)	Work is piling up	Look like my mom, bee dance
	2nd session	Body-scan (lower body), yoga meditation	Thinking is just thinking (cognitive diffusion)	I am a person too	Don't make a wry face, bee dance
	3rd session	Sitting up straight meditation, relaxation meditation	This is the moment (being present in the moment)	There aren't enough hours in the day	When I go to LA, creative movement
Week 2	4th session	Body-scan (upper body), yoga meditation	Look back at me (self as context)	Am I an emotional outlet?	Look like my mom, open chest 1,2,3
	5th session	Body-scan (lower body), sitting up straight meditation	Worthy life (the best 3 moments of my life)	The working environment is too poor	Don't make a wry face, free movement
	6th session	Self-compassion meditation, relaxation meditation	Let's do it together (committed action and willingness)	There is a shortage of nurses	When I go to LA, creative movement

Figure 2 shows the operation of the application's AI algorithm in the intervention. We developed an AI algorithm that provides a tailored program based on participant similarity scores and burnout patterns. First, to calculate the similarity scores among participants, a total of 22 variables (5 categorical and 17 numerical) were used: demographic (age, gender, and marital status), work-related characteristics (job title, hospital size, clinical experience, department, overtime during the past month, shift type, and turnover intention), job stress (overload, role conflict as a professional, lack of expertise and skills, interpersonal problems, inappropriate treatment and compensation, and night shift), stress response (somatization, depression, and anger), coping strategies (social support seeking, problem-solving-focused coping, and avoidance-focused coping). For each variable, the biggest differences were weighted to be 1, so the maximum similarity score was 22. The AI algorithm finds the most similar participant who has the lowest similarity score with the new participant from the accumulated data.

Second, to find participants with similar burnout patterns, the AI algorithm compares the rank of the highest burnout dimensions, beginning with the participant with the lowest similarity score from the accumulated data. For example, if the new participant had the highest scores for personal burnout among burnout dimensions, the AI algorithm will search for the person with the highest scores for personal burnout among burnout dimensions, beginning with the person with the lowest calculated similarity scores from the accumulated data.

Finally, the AI algorithm recommends a 2-week program (Program 1) that was effective for the previous participant with the lowest similarity score and similar burnout pattern. After completing Program 1, the participant's burnout level is reassessed. When the burnout dimension with the highest scores is reduced by 50 points, the AI algorithm recognizes it as valid data and integrates it into the algorithm; if not, it is recognized as invalid data and is not integrated. As data accumulates, the AI continuously learns and updates the artificial neural network. Based on the reassessed burnout dimension scores after Program 1, the AI algorithm recommends a second 2-week program (Program 2) for the participant using the same algorithm. After completing Program 2, the variables were reassessed. Again, the AI algorithm updates its artificial neural network when it recognizes the valid data. The development, operation, optimization, and intervention contents of the AI algorithm are detailed in another study (Cho et al. 2024).

Participants in the experimental group completed a pre-test (107 items: demographic and work-related characteristics and study variables), Program 1 for 2 weeks, post-test 1 (19 items: burnout), Program 2 for 2 weeks, and post-test 2 (97 items: study variables).

2.5.2 | Control Groups 1 and 2

Control group 1 participants chose their preferred program among the four programs provided to the experimental group.

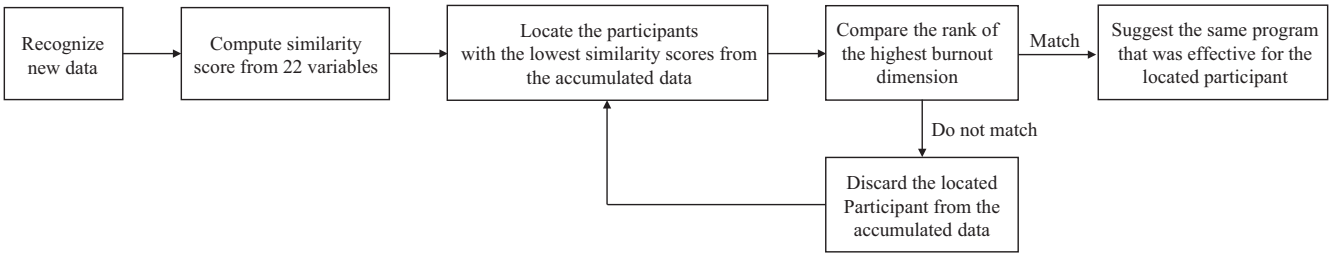

FIGURE 2 | AI algorithm process to provide the tailored program in Nurse Health Space.

The selected 2-week program was delivered via a URL link and conducted twice during the four-week intervention period. Participants in Control Group 2 were provided with guidance materials on the four programs through an online blog. Participants in both control groups were given the option to use Nurse Healing Space after completing the study.

2.6 | Measurement

2.6.1 | Demographic and Work-Related Characteristics

Demographic characteristics included participants' age, sex, and marital status. Work-related characteristics included participants' job titles, hospital sizes, clinical experience, departments, overtime during the past month, shift types, and turnover intention. Turnover intention was assessed using a rating scale ranging from 0 (no intention) to 10 (maximum intention).

2.6.2 | Primary Outcome

2.6.2.1 | **Burnout.** The Copenhagen Burnout Inventory (Kristensen et al. 2005) was used to measure three dimensions of burnout: (1) client-related, (2) personal, and (3) work-related burnout. It includes 19 items rated on a 5-point Likert scale, where 1 point corresponds to 0% and 5 points correspond to 100%. The instrument has demonstrated validity and reliability in nurses (Clinton and Shehadeh 2021) and has been validated in the Korean population (Jeon et al. 2019). Cronbach's α value in the present study was 0.94.

2.6.3 | Secondary Outcome

2.6.3.1 | **Job Stress.** Job stress was assessed using an instrument developed for Korean nurses (Gu and Kim 1985) that contains 23 items rated on a 5-point Likert scale. The total score ranges from 23 to 115, with higher scores indicating higher job stress. The instrument has been tested for reliability and validity (Kim et al. 2015) and is recognized as a tool for assessing job stress among Korean nurses (Cha and Baek 2023). Cronbach's α value in the present study was 0.88.

2.6.3.2 | **Stress Response.** Stress response was measured using the Stress Response Inventory-Modified Form (Koh et al. 2000), which has been verified for reliability and validity in a diverse and broad sample (Choi et al. 2006). It contains 22 items rated on a 5-point Likert scale. The total score ranges from 0 to 88, with a higher score indicating a higher stress response. The instrument has been validated in Korean workers, and strong correlations with established stress scales support its convergent validity (Choi et al. 2006). Cronbach's α value of the scale was 0.93 in the present study.

2.6.3.3 | **Coping Strategy.** Coping strategies were assessed using the Korean translation of the Coping Strategy Indicator (Amirkhan 1999) which has been translated and validated in Korean (Shin and Kim 2002). It includes 33 items rated on a 3-point Likert scale. The total score ranges from 33 to 99, with higher scores indicating a higher correspondence between stress and coping strategies. The instrument has been validated with Korean nurses and has demonstrated both reliability and validity as a tool for assessing coping strategies among nurses (Ju et al. 2023). Cronbach's α value of the scale was 0.83 in this study.

2.7 | Data Collection

Data were collected at baseline and at 2 and 4 weeks after baseline. The researcher sent reminders to participants who did not complete post-tests, even after the four-week study period had ended. Participants were required to complete each program to proceed to the next stage. Programs 1 and 2 were provided for 2 weeks each. However, the actual duration varied among participants; Program 1 ranged from 14 to 20 days (15.80 ± 1.30 days), whereas Program 2 ranged from 14 to 18 days (15.55 ± 1.0 days). Seven participants in Control Group 1 voluntarily contacted the researcher to express their satisfaction with the program.

2.8 | Ethical Approval

This study was reviewed and approved by the institutional review board of the principal investigator's institute (IRB No. ewha-202306-0001-01). Our AI algorithm was trained on data from 300 Korean volunteer nurses who were mainly female and in their 30's (Cho et al. 2024). Thus, the programs it suggested may not be equally effective in reducing burnout among underrepresented nurse groups. Additionally, the use of AI may reduce the autonomy of individual nurses by limiting their ability to select a program they deem most effective for their burnout. The potential ethical concerns surrounding the use of AI in personalized interventions were addressed by ensuring that the AI algorithm was designed to prioritize data privacy and confidentiality. Participants completed a pre-test with 107 items, which might have caused measurement burden. A referral list was provided to the participants in case they needed

TABLE 2 | Homogeneity of demographic and study variables among the three groups ($N = 120$).

Variables	Categories	Exp. ($n = 40$) n (%) or Mean ± SD	Cont.1 ($n = 40$) n (%) or Mean ± SD	Cont.2 ($n = 40$) n (%) or Mean ± SD	x^2 or F	p
Age (years)		31.55 ± 4.81	31.88 ± 4.95	32.05 ± 4.03	0.59	0.544
	< 30	14 (35.0)	12 (30.0)	11 (27.5)	1.85	0.395
	≥ 30	26 (65.0)	28 (70.0)	29 (72.5)		
Gender	Female	36 (90.0)	37 (92.5)	34 (85.0)	3.61	0.163
	Male	4 (10.0)	3 (7.5)	6 (15.0)		
Marital status	Single	31 (77.5)	25 (62.5)	28 (70.0)	0.84	0.653
	Married	9 (22.5)	15 (37.5)	12 (30.0)		
Job position	Staff nurse	35 (87.5)	32 (80.0)	34 (85.0)	1.42	0.490
	Charge/ Head nurse	5 (12.5)	8 (20.0)	6 (15.0)		
Hospital size (beds)	≤ 100	7 (17.5)	7 (17.5)	7 (17.5)	0.39	0.822
	101 ~ 500	22 (55.0)	23 (57.5)	20 (50.0)		
	≥ 500	11 (27.5)	10 (25.0)	13 (32.5)		
Clinical experience (years)		5.98 ± 4.00	5.66 ± 4.43	5.18 ± 3.03	1.73	0.181
	≤ 5	21 (52.5)	23 (57.5)	27 (67.5)	5.62	0.060
	> 5	19 (47.5)	17 (42.5)	13 (32.5)		
Working department	General ward	21 (52.5)	18 (45.0)	19 (47.5)	2.16	0.338
	ICU/ER	12 (30.0)	12 (30.0)	11 (27.5)		
	Others	7 (17.5)	10 (25.0)	10 (25.0)		
Overtime on average during the past month (h)	≤ 0.5	8 (20.0)	14 (35.0)	10 (25.0)	0.67	0.713
	≤ 1	14 (35.0)	12 (30.0)	11 (27.5)		
	≤ 1.5	10 (25.0)	9 (22.5)	13 (32.5)		
	> 2	8 (20.0)	5 (12.5)	6 (15.0)		
Type of shift	8-h shift	30 (75.0)	25 (62.5)	29 (72.5)	1.90	0.386
	12-h shift	3 (7.5)	4 (10.0)	4 (10.0)		
	Fixed	7 (17.5)	11 (27.5)	7 (17.5)		
Turnover intention		6.15 ± 1.75	6.10 ± 2.38	5.90 ± 1.82	0.62	0.541
Burnout	Total score	54.14 ± 10.93	49.51 ± 12.43	50.38 ± 12.68	0.96	0.617
	Client burnout	53.12 ± 11.66	46.98 ± 14.65	48.19 ± 15.95	3.83	0.146
	Personal burnout	55.90 ± 12.07	50.24 ± 13.30	51.18 ± 13.03	0.40	0.818
	Work-related burnout	53.51 ± 11.30	51.04 ± 12.39	51.58 ± 11.38	0.42	0.809
Job stress		3.53 ± 0.46	3.35 ± 0.46	3.49 ± 0.41	0.76	0.683
Stress response		1.96 ± 0.61	1.62 ± 0.71	1.87 ± 0.55	2.74	0.254
Coping strategy		2.17 ± 0.21	2.16 ± 0.26	2.14 ± 0.20	2.91	0.233

Note: Others = operating room, recovery room, delivery room, outpatient clinic, dialysis room, and administrative department.
Abbreviations: Cont.1, Control Group1; Cont.2, Control Group 2; ER, emergency room; Exp., experimental group; ICU, intensive care unit; SD, standard deviation.

TABLE 3 | Program distribution of experimental group and Control Group 1 ($N = 80$).

	Mindfulness meditation, *n* (%)	Acceptance and commitment therapy, *n* (%)	Storytelling and reflective writing, *n* (%)	Laughter therapy, *n* (%)
Exp.				
Program 1	5 (12.5)	6 (15.0)	7 (17.5)	22 (55.0)
Program 2	14 (35.0)	14 (35.0)	4 (10.0)	8 (20.0)
Total	19 (23.8)	20 (25.0)	11 (13.8)	30 (37.5)
Cont. 1				
P 1, P 2	7 (17.5)	9 (22.5)	5 (12.5)	19 (47.5)

Abbreviations: Cont.1, Control Group1; Exp., experimental group.

psychological support during or after their participation. An electronic informed consent form, which explained the research purpose, data collection, and participant's right to withdraw from the study at any time, was provided to each participant before the study commenced. The data collected were coded and anonymized.

2.9 | Statistical Analysis

Statistical analyses were conducted using SPSS Statistics version 23.0. Descriptive statistics were used to describe the participants' demographics and study variables. The χ^2-test and ANOVA were employed to test the homogeneity of the three groups. A repeated measure ANOVA was used to analyze the effect of the intervention on burnout by examining between-group differences over time. Before conducting repeated measures ANOVA, Mauchly's sphericity test, and Levene's test were conducted to ensure that the assumptions of sphericity and homoscedasticity were satisfied. The effects of the intervention on other variables were analyzed using a paired *t*-test, ANOVA, and the Scheffé test for post hoc analysis.

3 | Results

3.1 | Homogeneity of the Three Group

Table 2 shows the homogeneity of demographic characteristics and study variables among the three groups; no statistically significant differences were found among the three groups.

3.2 | Selected Programs for the Experimental Group and Control Group 1

Table 3 shows the programs assigned by the AI algorithm to the experimental group and the choice of programs available to Control Group 1. In the experimental group, laughter therapy (37.5%) was the most frequently assigned program, followed by acceptance and commitment therapy (25.0%), mindfulness meditation (23.8%), and storytelling and reflective writing (13.8%). For Control Group 1, which self-selected its preferred programs, laughter therapy was the most frequently selected program (47.5%), followed by acceptance and commitment therapy (22.5%), mindfulness meditation (17.5%), and storytelling and reflective writing (12.5%).

3.3 | Effect of the Intervention on Burnout

Table 4 and Figure 3 present the results of the repeated measures ANOVA for burnout. The experimental group demonstrated a significant reduction in client-related and personal burnout scores compared to the other two groups. Over the 4-week intervention period, significant effects were observed for client-related burnout in terms of groups ($F = 7.725$, $p = 0.001$), time ($F = 16.773$, $p < 0.0001$), and interaction ($F = 5.638$, $p < 0.0001$). For personal burnout, significant effects were observed for groups ($F = 10.967$, $p < 0.0001$), time ($F = 18.743$, $p < 0.0001$), and interaction ($F = 6.875$, $p < 0.0001$). No significant differences were found in work-related burnout, though differences in time effects were statistically significant ($F = 12.685$, $p < 0.0001$).

3.4 | Effect of the Intervention on Job Stress, Stress Response, and Coping Strategies

Table 5 shows the differences in job stress, stress responses, and coping strategies among the three groups. All groups exhibited a significant reduction in job stress scores after the four-week intervention (experimental group: $t = 3.02$, $p = 0.003$; Control Group 1: $t = 2.70$, $p = 0.008$; Control Group 2: $t = 2.53$, $p = 0.013$). However, no statistically significant differences were observed among the groups in terms of the degree of differences. The experimental group and Control Group 1 showed significant reductions in stress response scores (experimental group: $t = 2.04$, $p = 0.044$; Control Group 1: $t = 2.79$, $p = 0.006$), whereas Control Group 2 did not. The degree of differences in stress response scores varied significantly among the groups ($F = 3.07$, $p = 0.017$), with Control Group 1 showing the greatest reduction, followed by the experimental group and Control Group 2.

4 | Discussion

This study tested the effects of Nurse Healing Space, an AI-assisted, tailored intervention, on alleviating burnout among

TABLE 4 | Difference of burnout between the three groups (N = 120).

Study variables	Group	Pre-test	Post-test 1	Post-test 2	Differences	Source	F	p
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD			
Client-related burnout	Exp. (n = 40)	62.6 ± 18.3	54.8 ± 16.1	42.0 ± 15.1	20.6 ± 23.2	Group effects	7.725	0.001
	Cont.1 (n = 40)	52.3 ± 19.8	43.9 ± 18.4	44.8 ± 17.2	7.5 ± 20.2	Time effects	16.773	< 0.0001
	Cont.2 (n = 40)	49.7 ± 22.0	47.6 ± 15.3	47.3 ± 19.3	2.4 ± 20.7	Interaction effects	5.638	< 0.0001
Personal burnout	Exp. (n = 40)	67.5 ± 17.6	55.5 ± 18.6	44.7 ± 14.6	22.8 ± 21.7	Group effects	10.967	< 0.0001
	Cont.1 (n = 40)	55.8 ± 19.5	46.7 ± 16.1	48.2 ± 17.0	7.6 ± 20.8	Time effects	18.743	< 0.0001
	Cont.2 (n = 40)	52.3 ± 16.4	50.2 ± 14.4	51.0 ± 18.7	1.3 ± 21.0	Interaction effects	6.875	< 0.0001
Work-related burnout	Exp. (n = 40)	60.4 ± 17.7	53.2 ± 13.2	46.9 ± 14.8	13.5 ± 22.0	Group effects	2.631	0.076
	Cont.1 (n = 40)	55.6 ± 15.5	48.8 ± 13.9	48.8 ± 17.1	6.8 ± 18.7	Time effects	12.685	< 0.0001
	Cont.2 (n = 40)	53.3 ± 15.4	51.2 ± 14.9	50.3 ± 15.8	3.0 ± 21.5	Interaction effects	2.119	0.092

Note: Differences = pre-test score-post − test2 score.
Abbreviations: Cont.1, Control Group1; Cont.2, Control Group2; Exp., experimental group; SD, standard deviation.

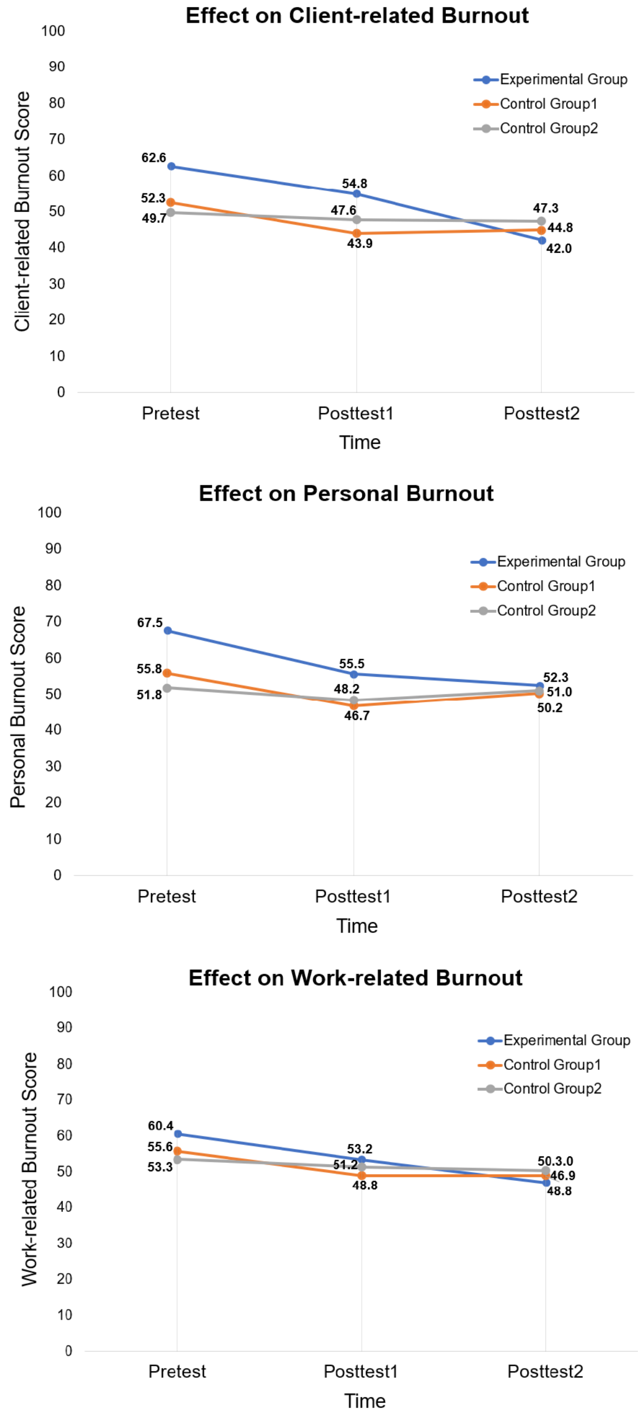

FIGURE 3 | Trends over time for burnout scores from repeated measures ANOVA.

nurses. Although there is evidence that tailored programs reduce nurses' burnout (Geuens et al. 2022; Lu et al. 2023), to our knowledge, no study has applied AI to provide tailored programs. One study that used AI in cognitive behavioral therapy to alleviate workers' depression, guided the program in a group format (Kawakami et al. 2021), which did not account for individual characteristics.

Among the burnout dimensions, client-related and personal burnout significantly decreased in the experimental group. These dimensions are primarily influenced by an individual's

TABLE 5 | Difference of job stress, stress response and coping strategy among three groups ($N = 120$).

Study variables	Group	Pre-test	Post-test2	Within groups	Differences	Between groups	
		Mean ± SD	Mean ± SD	*t* (*p*)	Mean ± SD	*F* (*p*)	Scheffé test
Job stress	Exp. ($n = 40$)	3.73 ± 0.56	3.33 ± 0.63	3.02 (0.003)	0.40 ± 0.75	1.31 (0.267)	
	Cont.1 ($n = 40$)	3.56 ± 0.57	3.14 ± 0.50	2.70 (0.008)	0.42 ± 0.56		
	Cont.2 ($n = 40$)	3.62 ± 0.41	3.36 ± 0.52	2.53 (0.013)	0.26 ± 0.45		
Stress response	Exp.[a] ($n = 40$)	2.14 ± 0.83	1.78 ± 0.74	2.04 (0.044)	0.35 ± 0.99	3.07 (0.017)	b > a > c
	Cont.1[b] ($n = 40$)	1.86 ± 0.85	1.38 ± 0.70	2.79 (0.006)	0.49 ± 0.63		
	Cont.2[c] ($n = 40$)	1.92 ± 0.53	1.83 ± 0.69	0.65 (0.521)	0.09 ± 0.57		
Coping strategy	Exp. ($n = 40$)	2.13 ± 0.27	2.20 ± 0.24	−1.20 (0.233)	−0.07 ± 0.32	0.94 (0.442)	
	Cont.1 ($n = 40$)	2.19 ± 0.28	2.14 ± 0.31	0.77 (0.443)	0.05 ± 0.28		
	Cont.2 ($n = 40$)	2.12 ± 0.24	2.16 ± 0.26	−0.71 (0.480)	−0.04 ± 0.30		

Note: Differences = pre-test score-post − test2 score.
Abbreviations: Cont.1, Control Group1; Cont. 2, Control Group2; Exp., experimental group; SD, standard deviation.

awareness level (Kristensen et al. 2005), suggesting that burnout reduction programs may effectively address them. Clinical nurses experience high-stress levels due to complex interpersonal relationships with patients and their families, as well as exposure to verbal and physical violence (Kim et al. 2017). Acceptance and commitment therapy can help individuals reflect on, reconsider, and adjust their relationships with patients, potentially reducing client-related burnout (Prudenzi et al. 2022; Towey-Swift et al. 2023). Personal burnout can also be mitigated by altering these perceptions.

Change in an individual's burnout perception may accumulate over days or weeks rather than as immediate shifts in knowledge, skills, or attitudes (Ceravolo and Raines 2019). Work-related burnout scores were reduced in the experimental group over 4 weeks. However, only time effects were significant for work-related burnout when compared to the other two groups. This burnout may thus be an indicator of organizational problems in the workplace (Kristensen et al. 2005). Consistent with this finding, a prior study reported that mindfulness-based intervention was ineffective in reducing work-related burnout among nurses in acute care settings (Brouwer et al. 2023). Furthermore, while a burnout management program in another study was effective in lowering burnout among nurses with low workloads, it was less effective for those with high workloads (Hung et al. 2023). Nurses who frequently work overtime or have a heavy workload experience considerable physical and mental stress and, consequently, may not feel like doing anything after work (Bakker et al. 2020), making it unlikely for them to access the burnout program on their own. Additionally, work-related factors are associated with workload, which may be related to hospital policy regarding the nursing workforce and work environment improvements rather than a one-time intervention. Compared to Western countries, South Korea is grappling with a more severe nursing shortage, resulting in increased nursing workload (Kang and Shin 2020). For instance, the number of nurses in South Korea in 2021 was 4.6 per 1000 people, which is lower than the Organization for Economic Co-Operation and Development's (2022) average of 8.4 nurses per 1000 people. Our study highlights the significance of providing comprehensive strategies at the hospital level to reduce work-related burnout in nurses.

The job stress scores decreased in all three groups. Contrary to a previous study that demonstrated a reduction in job stress using mindfulness meditation (Green and Kinchen 2021), the reduction was not statistically significant in this study. The reduction in job stress scores following the burnout program may be understandable, considering that job stress often stems from workplace burnout (Marković et al. 2024). Stress responses decreased in the experimental group and Control Group 1 after the intervention. Interestingly, Control Group 1 participants, who selected their own program exhibited the highest reduction in stress response scores. This finding aligns with a recent meta-analysis which showed that allowing participants to choose their preferred treatment yields better clinical outcomes, possibly due to increased autonomy and motivation (Delevry and Le 2019). Future research should explore how individual preferences and baseline stress levels interact to influence the outcomes of such interventions. Additionally, understanding the specific mechanisms by which burnout-focused interventions reduce job stress could further inform tailored program development.

4.1 | Implications

Our study offers valuable insights for nurses, nursing administrators, and nursing scholars. We previously studied 300 nurses for AI algorithm optimization before testing the effectiveness of the intervention in the current study. Although this is just one study, the findings could be a reference for nurses who are optimizing AI algorithms to provide tailored psychological interventions. Nursing administrators could use our AI algorithm to provide an efficient nurse burnout program that saves resources and energy by providing a data-driven tailored intervention. Based on our results, nursing scholars can use AI algorithms that accumulate and update user similarity data through artificial neural networks to design a data-driven approach to developing tailored interventions.

4.2 | Study Limitations

This study has several limitations. First, as the effectiveness of the AI-based burnout reduction program was verified over only 4 weeks, its long-term effects could not be evaluated. We suggest doing so in follow-up studies. Second, outcome variables were measured at short intervals—two-and four-week intervals for burnout and other variables, respectively—which might have introduced measurement bias. Third, although the experimental group's program usage was monitored daily via a web-based batch management system, direct observation was not feasible. As the entire trial was conducted online, it was not possible to directly verify what the participants were actually engaging with. Fourth, as data were self-reported, there is a possibility of bias due to participants' subjective perceptions and fraudulent information. Finally, although the sample size was determined through a power calculation, the relatively small sample size of 40 participants per group presents a potential risk to external validity.

4.3 | Linking Evidence to Action

- AI-assisted tailored interventions effectively reduce client-related and personal burnout among nurses, highlighting the importance of individualized approaches in psychological health care.
- AI algorithms present a promising method for developing scalable, personalized interventions in nursing, potentially revolutionizing psychological health support in high-stress environments.
- Allowing participants to choose their preferred program may help improve stress response reduction, suggesting that personal choice plays a critical role in the success of interventions.

5 | Conclusion

This study evaluated the effect of an AI-assisted, tailored intervention on alleviating nurse burnout. To our knowledge, it is the first study to provide tailored programs using AI technology based on individual nurses' demographic and work-related characteristics, burnout related factors, and burnout dimensions.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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