Original Article

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A Randomized Controlled Trial of a Mindfulness-Based Relapse-Prevention Program with Problem-Solving Skills for Male Substance Users

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Abstract:

Objective: This Randomized Controlled Trial (RCT) aimed to examine the effectiveness of a mindfulness-based relapse-prevention program with problem-solving solution skills (MPSS) for male substance users on stress, deliberate self-harm, and drug-abstinence intention.

Material and Methods: Thirty-six male substance users aged 18–59 were recruited from a rehabilitation institute in Thailand and randomly assigned to the intervention and control groups equally. The MPSS was based on a mindfulness program with added problem-solving skills. Implementation included 8 sessions over a four-week period at the setting site, and a follow-up and an assessment were delivered via a mobile phone. Data were collected 3 times: at pre-intervention (week 0, T1), post-intervention (week 4, T2), and follow-up (week 6, T3). A three-month assessment followed in order to determine any addiction relapse. The Thai Perceived Stress Scale-10, the Revised Deliberate Self-Harm Inventory, and the Drug Abstinence Intention Questionnaire were used to assess the main outcomes. The reliability values were 0.82, 0.81, and 0.86, respectively. A two-way repeated measures ANOVA was used to determine the outcome differences between the groups and times.

Results: After completion of the intervention, participants in the intervention group had significantly higher drug-abstinence intentions and lower deliberate self-harm both at T2 and T3. They had lower stress at T3 than the control group. The intervention group underwent no emotional, mental or physical relapse 3 months after the program's completion. The control group had about a 60% relapse rate.

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Conclusion: These findings indicate that an MPSS is effective in lowering stress and deliberate self-harm, and increasing drug-abstinence intention without emotional, mental or physical relapse in male substance users.

Keywords: deliberate self-harm, drug-abstinence intention, male substance users, mindfulness, stress

Introduction

Substance use disorder (SUD) is the excessive use of legal or illicit drugs in a way that adversely affects the self or others and is marked by impaired control, social problems, risky behaviors, and physical/psychological dependence[1]. The public health burden of SUD is substantial, posing different demands on the healthcare systems, depending on the types and categories of psychoactive substances, such as cannabis, opioids, amphetamines, sedatives, cocaine, and hallucinogens[2]. SUDs are prevalent in the United States, with 10.8% of adults having had a problem with drug use[3]. In Thailand, studies reported a 5.6% prevalence of SUDs[4] and a 31.1% prevalence of moderate or high risk of alcohol or tobacco use among men attending district hospitals in the central[5], and a 33.0% prevalence of moderate to high-risk substance use in primary care in the south[6]. Men tend to have a higher prevalence of SUD than women[2,5,7].

Several intrinsic factors may be associated with SUD, such as negative thoughts, beliefs, knowledge, attitudes, values and life skills, or stress-prone personalities. These intrinsic factors produce stress that eventually leads to SUD and deliberate self-harm (DSH)[8,9]. Stress is considered an emotional state and a sense of being under pressure, resulting in different physical manifestations. Although individuals generally adapt to stressful situations, people with inappropriate stress-management skills may incorporate problematic substance use and physical self-harm in order to divert depressive feelings or psychological pressure[8,9].

One approach to confronting negative intrinsic factors leading to stress and SUD is a psychotherapeutic treatment program that combines mindfulness-based stress reduction (MBSR)[10] with problem-solving solution therapy[11,12]. The treatment includes mindfulness and meditation activities, such as body-scan meditation, breathing-awareness meditation, mindful yoga, and mindfulness while walking, standing, and eating. The treatment outcome consists of achieving an awareness that sensory perceptions, thoughts, and feelings merely happen and end. Mindfulness-based psychotherapy accepts the premise that intrusive thoughts emerge in the mind and can be adjusted by establishing new behaviors, thus creating a healthier world perception for participants[10].

According to Kabat-Zinn's approach to mindfulness[10], adding problem-solving skills grounded in Problem-Solving Therapy[11,12] and reviewing the related literature, mindfulness is defined as paying attention in a particular way, with purpose, focused on the present moment, and non-judgmentally. The key elements include: 1) Present-Moment Awareness, for example, when eating, you notice the taste, texture, and sensation of each bite rather than eating while distracted. 2) Non-Judgmental Observation: if stress arises, you notice it without trying to push it away or criticizing yourself for feeling stressed. 3) Intentional Attention refers to consciously choosing where to place your attention, rather than letting it wander on autopilot. You might deliberately focus on your breathing, physical sensations, or the sounds around you[11,12].

Conversely, problem-solving skills grounded in Problem-Solving Therapy, developed by Nezu, Nezu, and Gerber[11], is a cognitive-behavioral intervention that teaches

individuals practical skills in order to effectively manage life's challenges and reduce psychological distress. The key elements include problem orientation (adopting a positive, constructive attitude toward problems), problem definitions and formulations, generation of alternatives, decision making, and solution implementation and verification. Although they have different principles, these 2 theories complement each other perfectly. We used mindfulness to establish new behaviors, reduce deliberate self-harm, enhance drug abstinence intention, and problem-solving skills for reducing accumulated stress[11,12].

A previous study indicated that the mindfulness program developed from the MBSR showed promise for reducing DSH and improving the intentions of participants to abstain from drug use[13]. However, the program was ineffective in decreasing the stress levels of participants. One recommendation was to incorporate problem-solving skills based on problem-solving solution therapy[11]. It was anticipated that adding problem-solving skills to the mindfulness program would reduce the accumulated stress on unresolved problems that cause stress to persist[12]. Problem-solving skills refer to cognitive–behavioral skills that improve an individual's ability to cope with stressful life experiences.

The cause of stress is the stimuli that enter the process of brain perception. In addition to the stimuli that pass through various sensory organs, the thoughts processed by self-consciousness can also trigger stress[14,15]. Using MBSR, individuals can learn to manage whatever internal stress they may experience. The ability to problem-solve and manage stressful life events has been reported to be a predictor of drug-abstinence intention and relapse prevention[14]. Although a previous study showed the potential of an MBSR program in reducing DSH and enhancing drug user intention to abstain from the intake of drugs, it did not demonstrate effectiveness in decreasing stress[13]. The present study combines problem-solving skills with an MBSR program to address unresolved issues contributing to persistent stress.

DSH refers to an intentional action of causing physical injury to oneself. Persistence in repetitive DSH is simply a form of parasuicide[9,16]. DSH behavior is associated with substance-use or drug misuse and an increased risk of developing major depression or suicidality, especially suicidal ideation[17]. Mindfulness is relevant to DSH, especially in those who may or may not attempt suicide, and plays a role in a person's capacity to control impulses when experiencing negative emotions[18]. Few studies have focused on the effectiveness of mindfulness-based relapse-prevention programs with problem-solving solution skills (MPSS) among male substance users who engage in DSH.

Drug-abstinence intention refers to the practice of self-enforced restraint from addiction by abstaining from or avoiding behaviors leading to the use of addictive substances. A study reported that predicting relapse to substance use over a 12-month period was directly related to abstinence self-efficacy[19]. Barriers to strengthening drug-abstinence intention included the pre-release intention to resume using, resumption of using as a symbolic act of freedom, a perception that using provides stress relief to their difficult lives, and the use of drugs to cope with cravings for illicit substances that are commonly experienced upon release[19]. From reviewing the related literature, factors that contributed to drug-abstinence intention included cravings awareness, reducing ruminations, non-reactivity training, and body awareness in mindfulness components[10–12]. Moreover, psychological support, social integration, and practical skill building also had an effect on drug-abstinence intention[10–12].

Addiction relapse refers to the resumption of a person's use of substances after a period of sobriety, abstinence, or reduced use[20]. It occurs when a person returns to consuming or using substances. Addiction

relapse can be caused by stress, social triggers or physical withdrawal symptoms. Relapse is not a failure but, rather, a person's opportunity to learn from the experience, as well as a healthcare professional's opportunity to adjust the treatment plan accordingly. Seeking help from a healthcare professional or a support group can be crucial in managing a person's relapse and achieving long-term recovery[20]. Therefore, combining MPSS could be a two-pronged, but also unified, programmatic approach to reduce stress, DSH and improve a person's intention to abstain from drug use, as well as preventing addiction relapse.

Moreover, when comparing the MPSS to existing programs or routine care, we found that routine care often focuses primarily on symptom reduction and vocational skills. While existing programs such as CBT focus more on changing thought patterns directly, the MPSS emphasizes practical thinking, emotional-behavioral processing, and problem-solving[11,12]. Therefore, participants in the intervention group received the MPSS program, and participants in the control group received routine care.

This study aimed to examine the effectiveness of an MPSS on stress, DSH, and drug-abstinence intentions among male substance abusers, as well as assessing addiction relapse. We hypothesized that participants in the intervention group would have lower stress and DSH, and higher drug-abstinence intentions than participants in the control group at post-intervention and follow-up. In addition, addiction relapse in the intervention-group participants would be lower than in the control-group participants.

Material and Methods

Design

A randomized control trial was conducted. Data were compiled from February to July, 2023. The study was registered with the Thai Clinical-Trials Registry (TCTR20230404001).

Participants and setting

The participants were males with SUD in the rehabilitation stage who were being treated at a drug rehabilitation center in central Thailand. The center provides inpatient compulsory therapy for substance users. The inclusion criteria were aged 18–59 years, a score ≥25 on the Montreal Cognitive Assessment (MoCA)[21] and <36 on the Brief Psychiatric Rating Scale (BPRS)[22] to screen for cognitive problems and psychosis, respectively, absence of a severe mental health disorder, and ability to read and communicate in the Thai language. As based on a previous study[23], the sample size was calculated with the G*power program (version 3.1)[24] using a power=0.80, a significance level=0.05, and an effect size=0.61. When calculated thusly, the minimum sample size was 30 participants. With a 20% anticipated attrition rate, 36 participants were recruited and randomly assigned equally to the intervention and the control groups.

Sampling and randomization

Firstly, the Principal Investigator (PI) provided information sheets about the study's aims and procedures during a short morning meeting, and then screened individuals using the Montreal Cognitive Assessment (MoCA) and Brief Psychiatric Rating Scale (BPRS) to determine their eligibility for participation in the research. A research assistant (RA) who had experience in research was asked to allocate participants and perform the evaluation but did not participate in the MPSS nor discuss groupings with the research team and participants either before or after the intervention. Therefore, only the PI conducted the MPSS.

From a list of 69 rehabilitee records of potential participants, 51 met the inclusion criteria. A computer-generated program randomly selected 36 males. Of those, 4 declined to participate. The process was repeated until 36 men agreed to participate. Simple randomization was used

to allocate the 36 participants to either the intervention or control groups by the research assistant (RA). Participants were blinded to group allocation. The RA used a computer-generated program to randomly select 18 participants for each group. The RA performed the evaluation but did not participate in the MPSS nor discuss grouping with the research team and participants during the evaluation. The principal investigator (PI) and research colleagues were unaware of the participants' recruitment and group allocation by the RA. Thus, this study was conducted in a single-blind fashion with a two-arm trial. Figure 1 shows the Consort flow diagram of the study.

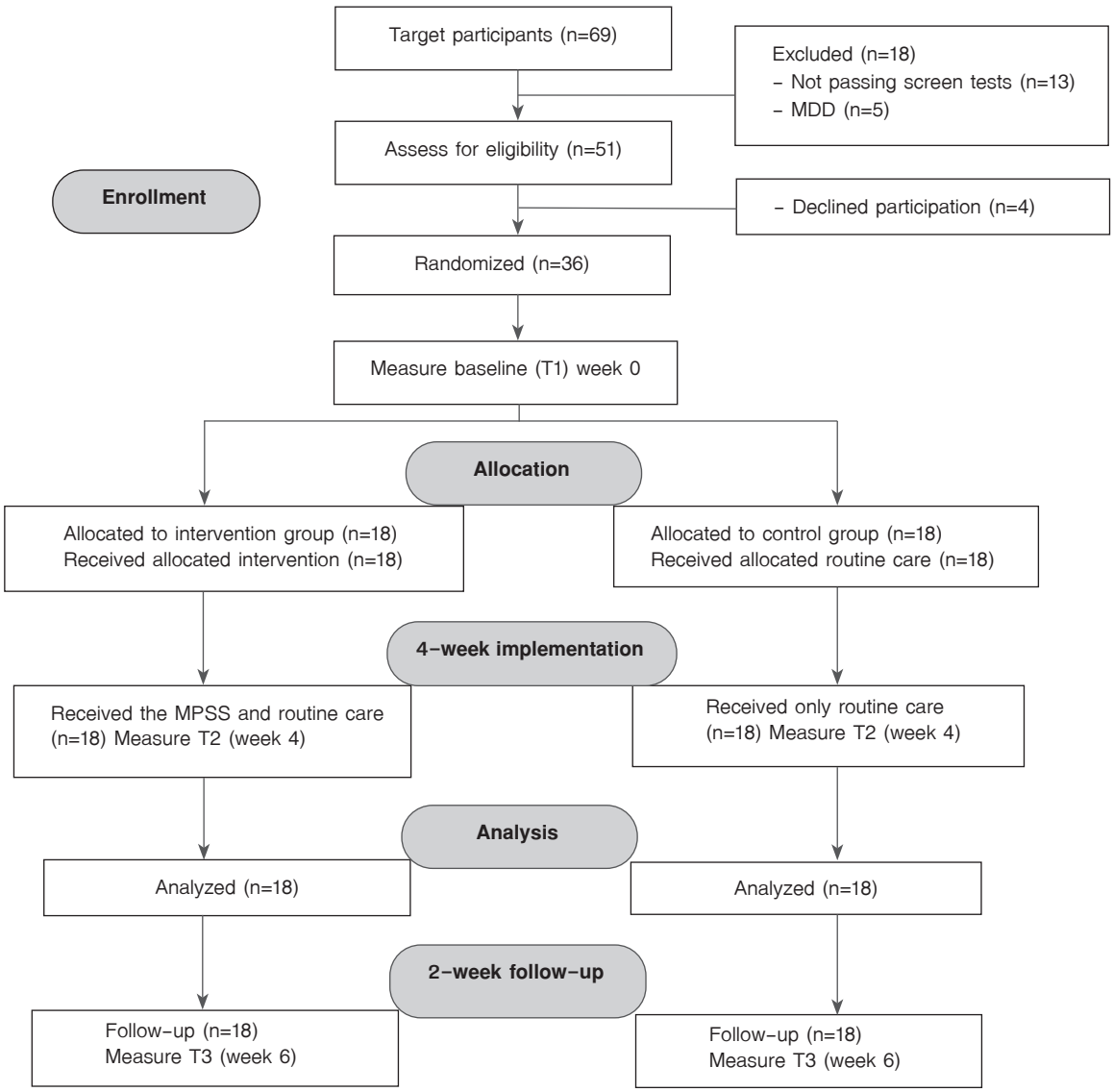

Figure 1 Consort flow diagram of the study

The intervention

The PI developed the MPSS based on the mindfulness program by Singtakaew et al.[13]. The authors recommended incorporating problem-solving skills into their intervention, which was based on the problem-solving therapy[11,12]. The PI had experience in psychiatric nursing care, and certified as a mindfulness-independent therapist. The PI screened potential participants using the MoCA and the BPRS. The MPSS was reviewed by 2 psychiatric nursing instructors and a psychiatrist. The validity value of IOC was 0.80, indicating strong agreement among the expert judges that the items in the assessment adequately represented the constructs they were intended to measure. The 18 participants completed 8 sessions over 4 weeks (twice per week on Saturdays and Sundays), each lasting approximately 90 minutes as follows:

Week 1: Sessions 1-2: The focus was on the practice of awareness, which is the ability to deepen one's own awareness of one's own identity while living in the present moment. These sessions consisted of 2 activities (self-awareness to manage distractions and awareness leading to a mindful life), plus problem-solving skills, which included managing and handling stressful events in daily life with 10 questions.

Week 2: Sessions 3-4: The focus was on the practice of acceptance, which means accepting what is happening in the present moment without judgment, resistance, or avoidance. This practice comprises two activities (knowledge of being free from thoughts and feelings, and awareness of one's own thoughts by maintaining a state of sound mindfulness), plus problem-solving skills, which include managing and handling stressful events in daily life with 10 questions.

Week 3: Sessions 5-6: Emphasis was placed on the practice of attention or control of the mind toward focusing on the present moment, while the transformative process fosters the understanding of one's own inner strength in making changes and self-healing. It has 2 activities (exploration of relationships and connections with a new heart and development of heart-to-heart communication), plus problem-solving skills, which include managing and handling stressful events in daily life with 10 questions.

Week 4: Sessions 7-8: Focus was on the practice of antecedents and contemplation of breathing. It is a body-mind connection, which can be applied in practice and as a daily routine on a regular basis. It consists of 2 activities (self-compassion and forgiving others, and going forward on life's path with determination), plus problem-solving skills, which include managing and handling stressful events in daily life with 10 questions.

We intervened with 10 questions related to problem-solving skills[11,12] on the worksheet for every session as follows: 1) Brief history and problems, 2) Problems that you want to discuss this time, 3) What is your negative perspective on problem solving? Why can't you solve the problem? 4) Explain your positive perspective on problem solving. 5) Can you change your negative perspective on problem solving to a positive perspective on successful or unsuccessful problem solving? Why? 6) What has been your problem-solving experience in the past? 7) After participating in mindfulness therapy activities, how do you think they can help solve your problems? 8) Proverbs/slogans or symbols/images that you use to encourage yourself, 9) What is your source of social support? and 10) What is your method of practicing meditation and mindfulness therapy in your daily life when you are stressed?

Research instruments

Screening measures:

MoCA

The MoCA[21] is used to assess different cognitive domains: Attention and concentration, executive functions,

memory, language, visual constructional skills, conceptual thinking, calculations, and orientation. The total possible score is 30; a normal score of ≥25 indicates eligibility to participate in the study.

BPRS

The BPRS[22] is an 18-item instrument. The examiner rates behavioral symptoms, such as anxiety, hostility, affect, guilt, and orientation on a 7-point Likert scale from absent to extremely severe. Total scores range from 18 to 126 points. Scores >36 indicate the presence of moderate-to-severe symptoms. Scores ≤36 indicated eligibility to participate in the study.

Outcome measures:

Stress

Stress was measured using the Thai Perceived Stress Scale-10 (TPSS-10)[25]. It has 2 subscales, perceived helplessness and lack of self-efficacy. Reflecting over the prior month, participants responded to 10 questions on a 5-point rating scale (0=never to 4=very often), with negatively worded items reverse-scored. Summed scores range from 0 to 40, with higher scores indicating a greater perceived level of stress. The Cronbach's alpha in this study was 0.82.

DSH

Developed by Singtakaew and Chaimongkol[9], the 10-item Revised Deliberate Self-Harm Inventory (DSHI-9r) was based on Lundh et al.[26]. Participants respond to the frequency in which they engage in 9 distinct DSH behaviors, such as cutting their wrists, arms, or bodies, sticking sharp objects into their skin or burning themselves, biting or punching themselves, or head banging. A 10th item elicits the frequency of self-harm behaviors that have resulted in hospitalization or a severe injury that required medical treatment. Total summed scores range from 0 to 60, with higher scores indicating an increased likelihood to engage in suicidal ideation. The Cronbach's alpha in this study was 0.81.

Drug-abstinence intention

Developed originally in Thai, the 13-item Drug Abstinence Intention Questionnaire[27] subdivides into 2 components: Intention not to participate in activities that lead to drug use, and determination not to use drugs. Participants responded to a 4-point rating scale (1=not at all true to 4=completely true). Summed scores range from 13 to 52, with higher scores indicating a higher likelihood of intentions to quit using drugs. The Cronbach's alpha in this study was 0.86.

Addiction relapse

At three-month post-intervention, participants in the intervention and control groups completed a relapse prevention checklist[28]. It has 13 questions with dichotomous responses (yes-no) and is divided into 3 components: Emotional, mental, and physical relapse. A panel of 2 psychiatric-nursing professors and a psychiatrist validated the relapse-prevention checklist regarding comparability and appropriateness. The validity value of IOC was 1.0. This indicates very strong agreement among expert judges.

Ethical considerations

The ethics committee of a university in Thailand approved the study (RBAC-EC-NUS-2-002/65). Permission to conduct the study was obtained from the rehabilitation center. The PI explained the goals and procedures of the study, research objectives, data collection procedures, and the risks and benefits to potential participants prior to data collection. Participants who volunteered signed informed-consent forms. Permissions to use all research instruments or translate from English into Thai were given by their respective developers/translators.

Upon discovering a relapse, we meticulously recorded all details of the incident, documenting the timing, severity, and contextual circumstances. Subsequently, the researchers facilitated the transfer of the affected participant to the appropriate officials within the responsible department for additional support. Throughout this process, we strictly adhered to the ethical guidelines in order to safeguard the participants' welfare and security.

Data collection

The Implementation: The PI implemented the MPSS for the intervention group and provided a booklet containing brief information about activities for each session and homework. At each session, participants responded to 10 questions related to problem-solving skills. They wrote their answers on worksheets, presented them orally to the group, and discussed them with the group during the implementation activity.

The problem-solving skills included managing and handling stressful events in daily life. Examples included: "Please give a brief history of your problems. How might you change a negative perspective on solving problems to a positive one? When stressed and you practice mindfulness meditation therapy in daily life, what aspects do you emphasize?" Participants also received homework activities to present the following week, such as recording (1) their practice of mindfulness and self-awareness to manage distraction and (2) practicing mindfulness and exploring relationships and meaningful communication. They wrote their responses on worksheets and discussed them with the group.

Routine care: At the rehabilitation center, staff nurses and social workers provided routine care that involved life-skills training, such as vocational-skills training, cooking skills, and growing vegetables. Brochures and other materials related to life skills were available in the activity room. Participants in the intervention and control groups received this routine care. In addition, the PI also provided printed information to the control group at week 6 (after measuring T3) about stress, DSH, drug-abstinence intention, etiology, signs and symptoms, self-management, and ways of preventing substance use relapse.

To prevent contamination between the experimental and control groups, we collected data at different time points. We implemented the intervention with the experimental group first. Only after the experimental group had completed the treatment and left the treatment center did we begin collecting data from the control group. To account for potential time-of-day effects, we scheduled all group activities during the same time period (afternoon) for both groups.

The outcome measures of stress, DSH, and drug-abstinence intention in the intervention and control groups were measured at pre-intervention (week 0, T1), immediately after completing the MPSS (post-intervention; week 4, T2), and 2 weeks after completing the MPSS (follow-up period, week 6, T3). The RA, who handled the evaluation process, maintained separation by not joining the MPSS or conversing about groupings with participants and research team members during evaluations. At three-month post-intervention, the PI assessed their addiction relapses by telephoning participants in both groups, asking them to answer questions using a relapse-prevention checklist.

All participants attended the program without any dropouts. We also had clear measures to encourage consistent participation in the activities, such as documenting attendance records for all the sessions and implementing strategies to promote attendance (reminders, incentives, flexible scheduling). As with homework, we recorded and tracked it at all times, with reminders from center staff to complete the homework before the activity day. Researchers checked all the homework and provided feedback on all the assignments.

Data analysis

Data were analyzed using the IBM®SPSS®version-26 statistical software[29], with a significance level set at p-value<0.05. Descriptive statistics were calculated to analyze participant characteristics and the pertinent variables. Two-way repeated measures ANOVAs were performed to determine the differences in mean scores for stress, DSH, and drug-abstinence intention between the intervention and control groups at T1, T2, and T3. Bonferroni-corrected *t*-tests were used to follow up on the significance of the interaction effects (Time x Group).

After data cleaning, we performed assumption testing for the multivariate and univariate analysis of variance, including outliers, normality, sphericity, homogeneity of variances and co-variances intercorrelation, multicollinearity, and independence. All assumptions were met.

There was no outlier with the findings from the inspection of the box plot and calculation of the Z-scores (all values were between -2.86 and 2.91). Normal distribution was tested using the Shapiro-Wilk test (p-value>0.05 in all groups), indicating that the data were normally distributed in all groups. Mauchly's test was used to test the assumption of sphericity. The total score of results showed no significant indication that the homogeneity of variance-covariance matrices was equal, and the sphericity assumptions were met. The test of homogeneity of variances for the between-subject comparison showed no significance (Levene's test: F(2,87)=2.34, p-value=0.103). This indicated that the variance of the dependent variables between the groups was equal. Then the homogeneity of variance assumption was met. Intercorrelation among the DVs (Bartlett's test of sphericity) was sufficiently correlated among the DVs in order to proceed with the analysis. The Pearson correlation coefficients between the DVs were all below 0.60, which means there was no multicollinearity. Finally, intraclass correlation (ICC) was significant (p-value>.001). Then, there was independence in the data.

Results

Demographic characteristics of the participants

The 18 participants in the intervention group ranged from 19 to 57 years old (*M*=32.6, *S.D.*=10.38). Two-thirds were single (66.7%) and half were freelance workers (50.0%). Five participants had completed 3 years of secondary education. Two-thirds of them earned an average monthly household income ranging from $272 to $544. Half (50.0%) began using substances at the age of 18 or older (*M*=17.4 years, *S.D.*=2.97; range 12–22 years); and about half credited their peers for beginning their use. The most frequently used substance was Yaba (72.2%), a mixture of methamphetamine and caffeine, and it was used daily. For over half the participants (55.6%), this program marked their first time for mandatory therapy.

The 18 participants in the control group ranged in age from 19 to 58 years old (*M*=33.4, *S.D.*=12.41). Most participants were single (77.8%) and freelance workers (61.1%). Five participants had completed 3 years of secondary education. The average monthly household income for two-thirds of the participants ranged from $272 to $544. Over half of them (55.6%) began using substances at the age of 18 or older (*M*=20.4 years, *S.D.*=7.83; range 12–42 years), and about half indicated that they had begun using because they wanted to try it. The most frequently-used substance was Yaba (55.6%). Less than half were using substances daily (44.4%). For half the participants (50.0%), this was their first time for mandatory therapy. No statistical differences in individual characteristics existed between the participants in the intervention and control groups. Since some of the collected and analyzed data are discrete and at levels below the interval scale, the p-values for mean data were calculated with the use of the Mann-Whitney U test. For percentages, the Chi-square test or Fisher's exact test was used.

Descriptive statistics of outcomes

Means and standard deviations of stress, DSH, and drug-abstinence intention for total scores at baseline (T1), post-intervention (T2), and follow-up (T3) for both the intervention and the control groups are presented in Table 1.

Table 1 Means and standard deviations of stress, deliberate self-harm and drug abstinence intention at three time periods

Outcomes	Time period	Intervention group (n=18)		Control group (n=18)	
		Mean	S.D.	Mean	S.D.
Stress (TPSS-10)					
Total scores	1	16.9	4.68	16.4	6.23
	2	13.9	5.66	15.6	3.76
	3	10.8	5.70	17.7	5.19
Deliberate self-harm					
Total scores	1	4.3	4.21	4.5	5.16
	2	1.9	3.18	4.9	5.13
	3	0.9	2.17	4.1	5.36
Drug abstinence intention					
Total scores	1	39.1	7.67	39.8	5.99
	2	44.9	5.18	40.2	5.70
	3	47.0	4.23	41.8	5.02

S.D.=standard deviation, TPSS-10=Thai Perceived Stress Scale-10

Primary-outcomes evaluation

Two-way repeated measures ANOVAs show that the interaction effects of stress scores (Table 2), DSH scores (Table 3), and drug-abstinence intention scores (Table 4) were statistically significant:

After finding significant interaction effects, testing the simple main effects of Bonferroni-corrected pairwise t-tests determined the differences of each outcome between the intervention and the control groups at each point in time. At baseline (T1), the 2 groups had no significant difference for any of the outcomes. For the stress, the results showed significant differences between the 2 groups at T3 ($F(1,34)=14.140$, p-value<0.05 and $\eta 2p=0.294$), but not at T2. The significant differences between the intervention and the control groups in the mean scores of DSH and drug-abstinence intention were found at both T2 ($F(1,34)=4.445$, p-value<0.05, $\eta 2p=0.116$, and ($F(1,34)=6.605$, p-value<0.05, $\eta 2p=0.163$, respectively) and T3 ($F(1,34)=5.598$, p-value<0.05, $\eta 2p=0.141$, and ($F(1,34)=11.383$, p-value<0.05, $\eta 2p=0.251$, respectively). These results indicate that the participants who received the MPSS had lower stress and DSH, and higher drug-abstinence intention than those who did not (see figures 2, 3, and 4).

Table 2 Two-way repeated measures ANOVA on total scores of stress

Source of variation	SS	*df*	MS	*F*	p-value	Partial eta squared (η_p^2)
Between subjects						
Group	194.676	1	194.676	4.380	<0.01	0.114
Error	1511.204	34	44.447			
Within subjects						
Time	116.241	2	58.120	3.001	0.050	0.081
Time x Group	252.352	2	126.176	6.516	0.003	0.161
Error time	1316.741	68	19.364			

SS=sum of squares, MS=mean square, df=degrees of freedom, F=F-statistic

Table 3 Two-way repeated measures ANOVA on total score of deliberate self-harm

Source of variation	SS	*df*	MS	*F*	p-value	Partial eta squared (η_p^2)
Between subjects						
Group	124.593	1	124.593	2.507	<0.001	0.069
Error	1689.815	34	49.700			
Within subjects						
Time	64.296	2	42.571	8.695	0.002	0.204
Time x Group	50.296	2	33.301	6.802	0.005	0.167
Error time	251.407	68	4.896			

SS=sum of squares, MS=mean square, df=degrees of freedom, F=F-statistic

Table 4 Two-way repeated measures ANOVA on total score of drug abstinence intention

Source of variation	SS	*df*	MS	*F*	p-value	Partial eta squared (η_p^2)
Between subjects						
Group	255.148	1	255.148	3.382	<0.001	0.090
Error	2565.037	34	75.442			
Within subjects						
Time	449.852	2	321.159	19.463	<0.001	0.364
Time x Group	190.296	2	135.857	8.233	0.003	0.195
Error time	785.852	68	16.501			

SS=sum of squares, MS=mean square, df=degrees of freedom, F=F-statistic

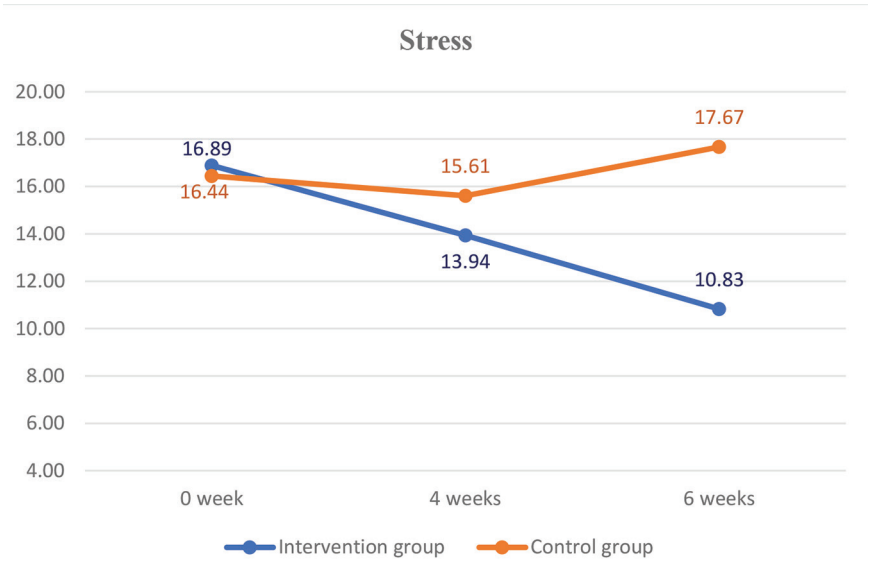

Figure 2 Comparison of mean stress scores of the 2 groups at each point in time

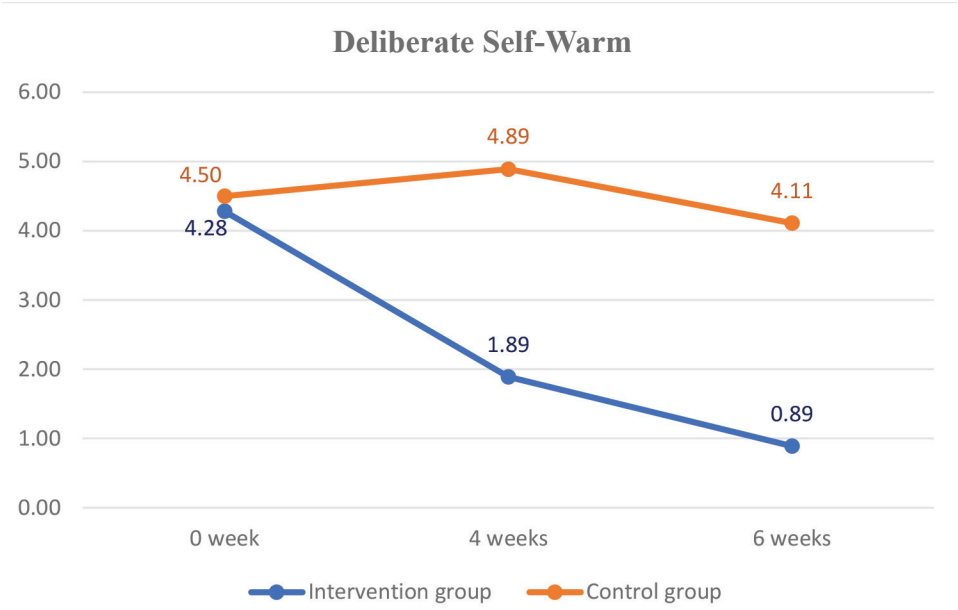

Figure 3 Comparison of mean scores of deliberate self-harm in the 2 groups at each point in time

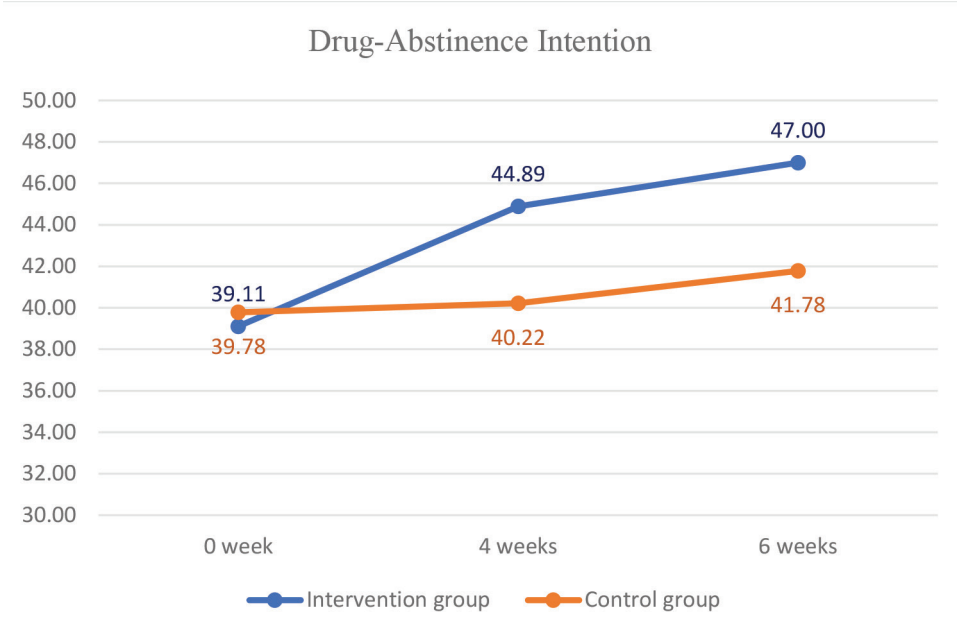

Figure 4 Comparison of mean scores of drug-abstinence intention in the 2 groups at each point in time

Addiction relapse assessment

Three months after completing the MPSS, all the participants in the intervention group responded "No" to each question on the relapse prevention checklist. They reported they could manage stressful events in their daily lives. They denied problems with sleeping or eating and stated that they never used addictive substances, even when in risky situations where drugs were present. They continued to use the mindfulness techniques of the MPSS in their daily lives.

For the control group, 4 participants indicated they had an emotional relapse and 7 had both an emotional, and a mental relapse. Seven participants in the control group could not manage the stressful events of their daily lives and glamorized, or romanticized their past use. They reported problems with sleeping, eating problems or mood swings. Four had tried to seek out opportunities for drug use, but without success, because they feared getting caught by the police. Thus, 11 out of 18 participants in the control group had emotional and/or mental relapses.

When a relapse was found, we documented the relapse events thoroughly, including timing, severity, and circumstances. Then, the participant would be transferred by the researchers to the relevant officers within that particular area for further assistance. Importantly, we followed ethical protocols in order to ensure participant safety and wellbeing.

Discussion

The findings revealed that the MPSS is effective in that it could reduce stress levels and DSH, as well as increase the intention to abstain from drugs for males with SUD. Thus, all hypotheses were fully supported. Our findings are consistent with the study of Korponay et al.[30], who reported that neither short- nor long-term mindfulness practices may effectively redress impulsive behavior derived from inhibitory motor control or planning-capacity deficits in healthy adults. Goldberg et al.[31] reviewed 24 randomized controlled trials that compared mindfulness-based interventions (MBIs) and no treatment. Although the evidence was uncertain regarding MBI's impact on craving intensity and serious adverse events, an analysis of treatment acceptability indicated that MBIs caused little to no increase in the outcomes. Therefore, mindfulness therapy alone may be insufficient, either in helping those who use substances to reduce stress and resort to DSH behaviors, or in improving their intention to refrain permanently from drug use.

Recent neurobiological investigations of the effect of mindfulness meditation on the brain have focused on self-regulation to control cravings and distressing emotions that cause changes in dopaminergic functioning[32]. Dopamine release is strongly associated with a decreased desire to return to substance use[33]. Mindfulness meditation activates the dorsolateral prefrontal cortex, cerebral cortex, anterior striatum, and precentral and postcentral gyri, which are involved with attention and autonomic nervous system functioning[34]. Components of problem-solving skills help curtail cravings and contribute to healthier outcomes, such as reductions in stress and DSH behaviors, intention to quit drug-use behavior, and improved quality of life[32,33]. Problem-solving skills promote taking concrete steps toward solutions, which reduces ruminations and the mental burden of unresolved issues, especially the accumulated stress. Furthermore, as people solve problems successfully, they build a toolkit of coping strategies they can apply to future stressors. Problem-solving skills reduce the ambiguity around stressful situations, and uncertainty is a major contributor to stress[11,12].

The MPSS emphasizes attention to the present moment. The program is practiced through experiential learning with instructions on problem-solving skills that affect a person's cognition and behavior, leading to drug-

abstinence intention[34]. An advantage of the MPSS is the method taught for intervening in the participants' daily activities. Noone and Hogan[35] emphasize the importance of substance users adhering to an intervention-based protocol.

Furthermore, the effectiveness of MPSS may be particularly pronounced in conditions where emotional reactivity complicates rational problem-solving, such as addiction recovery, chronic pain management, and mood disorders. By pairing mindfulness (which helps regulate emotional responses) with systematic problem-solving approaches, individuals can break the cycle where stress impairs cognitive function, leading to poor decisions that create more stress.

Moreover, the MPSS and routine care are different in 5 key domains: Integrative approach, self-regulation, present-moment awareness, non-judgmental stance, and sustainability. For the integrative approach, while routine care often addresses symptoms in isolation, MPSS combines mindfulness practices with structured problem-solving techniques, creating a holistic intervention that targets both immediate stressors and underlying cognitive patterns. Routine care typically relies on external guidance and interventions, whereas MPSS emphasizes developing internal self-regulation skills that patients can apply independently across various situations. Unlike routine care that may focus primarily on past events or future outcomes, MPSS cultivates present-moment awareness as a foundation for effective problem identification and solution generation. MPSS also encourages a non-judgmental approach to problems and emotions, which differs from some traditional approaches that may implicitly reinforce self-criticism when problems arise. In addition, sustainability: Routine care often provides temporary relief or requires ongoing professional involvement, while MPSS aims to equip individuals with durable skills they can continue to apply and refine independently while developing more sustainability[10-12].

Conclusion

The MPSS was effective in decreasing stress and DSH, improving drug-abstinence intention, and preventing relapse in male substance users. The cooperation of mindfulness with problem-solving skills in treatment, with support from health professionals, strengthened the success level in achieving the outcomes. Mental health nurses could utilize the MPSS to help males with SUD.

Limitations and recommendations

Although the researchers found that problem-solving skills reduced stress in the literature review, we could not add it as another intervention to be compared with MBSR, MBSR+ Problem-solving skills (PSS), PSS, and the control group due to resource constraints (budget, participant recruitment challenges, time limitations). The primary interest was in enhancing MBSR specifically, rather than comparing multiple interventions. Previous studies may have already established PSS effectiveness, and the researchers were specifically interested in the value-added of combining it with MBSR. Statistical power considerations might have limited the number of comparison groups that could be effectively analyzed. Moreover, the participants in this study originated from a single setting, thus limiting generalizability. Further investigations in a variety of settings are still needed. Additional outcomes, such as re-hospitalization and quality of life, should also be considered.

Authorship contribution

All authors involved in interpreting the results and writing this manuscript have successfully met the authorship criteria and agree with the content of the final version of this manuscript.

Data availability

Data are available upon reasonable request.

Ethics committee

Ethical Committee of the Institutional Review Board (IRB), Rattana Bundit University [IRB code: RBAC-EC-NUS-2-002/65]

Registration

Thai Clinical Trial Registration: TCTR20230404001

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Conflict of interest

Arunothai Singtakaew reports that financial support was provided by the NRCT. Nujjaree Chaimongkol declares no conflict of interest.

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