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[原著]

Effectiveness and evaluation of a program to improve the resilience of high school students using mindfulness breathing: Focusing on resilience, mood, and rumination

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Summary

High school students are prone to various types of stress due to physical and mental changes associated with biological maturation, changes in parent–child and peer relationships, and choices about future directions. This study used mindfulness to promote resilience to stress. Mindfulness exercises include mindfulness breathing, walking, and eating. The most common mindfulness breathing exercises were used in this study. As learning mindfulness generally requires a long-term commitment, maintaining the motivation to continue the practice is challenging. So we report the results of a 4-week low-intensity mindfulness program designed and implemented specifically to improve resilience. The participants were six high school seniors. The program comprised an initial viewing of a 10-minute video on mindfulness knowledge and breathing methods, followed by practice of mindfulness breathing while re-watching the portion of the instructional video on mindfulness breathing (5 minutes per session) during the intervention period. A self-administered questionnaire survey was completed before and after the intervention and one month after the intervention ended to assess effectiveness. The questionnaire assessed the participants' resilience, mood, and rumination. Results demonstrated that for "total resilience," "breakthrough power," and "overcoming power," the main effect Bayes factor (BF) values were valid. "Mood" also had a valid BF value for the main effect. However, for "rumination," the BF value for the main effect did not reach the validity level. This program may be useful for improving high school students' resilience, reducing their unpleasant mood, and supporting their healthy growth.

Keywords: resilience, mindfulness, rumination mood, educational material development

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Introduction

The rapid increase in mental illness and mental health problems among adolescents has become a serious concern in recent years (Patalay and Gage 2019), and prevention of such problems is considered an important issue in the fields of health education and adolescent psychiatry.

High school students are likely to experience various stressful situations. Stress factors include physical and mental changes associated with biological maturation, changes in parent–child and peer relationships, and the need to make decisions about future directions (Blos 1962; Ministry of Health, Labour and Welfare 2019). High school students also tend to experience increased aggression because of conflicts related to controlling sexual impulses and emotions (DiClemente et al. 2009). Compared to elementary and junior high school students, high school students have been reported to experience increased unpleasant emotions and stress reactions (Ozawa 2010; Yamaguchi, Yamaguchi, and Harai 2009); they are also less adept at coping with emotional conflicts than adults. Their inability to handle fluctuating emotions leads to a tendency to let unpleasant emotions guide their behavior or to choose inappropriate coping strategies, such as self-harm. Intense anger triggers violence against oneself (Ishida, Imura, and Watanabe 2017), and rumination has been found to heighten anger (Borders, Earleywine, and Jajodia 2010).

Rumination has been defined as engaging in behaviors and thoughts that passively focus your attention on your symptoms of distress and on all the possible causes and consequences of these symptoms (Nolen-Hoeksema and Harrell 2002). In brief, rumination is the process of continual and repeated thinking that tends to result from stress and mental distress.

The result is a vicious cycle that not only exacerbates stress and worsens mental health (Eguchi and Kunikata 2021) but also causes further distress through negative meaning-making around the experience. Thus, the ability to successfully cope with rumination is beneficial for the healthy development of students.

In addition, resilience—defined as the ability to recover from stress— has been understood from two main perspectives: first, as a process or state, and second, as an individual trait or ability that guides adaptation (Aldao, Mennin, and McLaughlin 2013). Resilience can be learned and developed (Grotberg, 2003). In particular, problem-solving orientation, self-understanding, and understanding of other people's psychology have been identified as factors conducive to developing resilience (Hirano 2010). Previous studies have demonstrated that resilience increases with age in Japanese adults (Ueno, Hirano, and Oshio 2018). Thus, we can contribute to the healthy development of students by effectively supporting its learning in educational settings. In recent years, mindfulness has gained attention as a way to improve resilience (Joyce et al. 2018). Mindfulness is defined as "intentional, present moment, non-judgmental attention" (Kabat-Zinn 2003). Furthermore, it has been demonstrated that mindfulness not only improves resilience, but also reduces rumination, depression, and anxiety (Ramel et al. 2004).

In other words, increased mindfulness is expected to (1) increase resilience, (2) reduce rumination as an ineffective

coping mechanism for unpleasant events, and (3) reduce unpleasant emotions such as anxiety and depression. This, in turn, reduces the distressing emotions that students experience. In other words, developing adaptive coping behaviors (mindfulness knowledge and skills) for stress may improve resilience and ease the negative thoughts experienced in stressful situations, contributing to a more fulfilling school life and a richer outlook toward life.

In the UK, mindfulness in schools has also been reported to be incorporated into primary and secondary education as an effective, cost-effective, accessible, and scalable way to promote adolescent mental health and wellbeing (University of Oxford 2023). Conversely, in Japan, initiatives to foster resilience in schools are scarce (Otani 2016). In particular, there are no initiatives targeting high school students. One reason for this is the current situation where the Japanese education system focuses on the acquisition of knowledge and skills necessary for university entrance examinations, and does not afford sufficient time for mindfulness. In general, mindfulness is an 8-week program, which requires 45–60 min of prolonged engagement each day. Many people stop mindfulness training, because they find it difficult to devote time and effort to the practice and to maintain the motivation to continue (Segal, Williams, and Teasdale 2007). We believe that there is a need for short-term mindfulness that can be adapted to Japanese educational settings. Therefore, in this study, we carefully selected the content of general mindfulness programs and developed a short-term mindfulness program to promote resilience (Resilience Focused Mindfulness Program, or RFM Program). The purpose of this study was to implement a RFM Program to promote resilience among high school students using mindfulness and evaluate the results of the program. In addition, the mindfulness educational materials developed for the program were evaluated.

Methods and Materials

Participants and recruitment procedures

Recruitment of research participants was conducted by distributing a letter of invitation regarding the research request to the principals of 18 high schools in the southern part of Prefecture A. After explaining the research premise orally and in writing to the entire grade level of one school that had given consent, students who wished to participate in the study were selected on a voluntary basis. In recruiting students (six girls in their third year of high school), we requested that those who were already practicing mindfulness on a daily basis do not participate in the study, as its purpose was also to evaluate the quality of the mindfulness materials. For those who wished to participate, a letter of explanation addressed to their parents was distributed by the researcher through the target school by mail, and consent from the parents was obtained. It should be noted that high schools are characterized by many students who have not attended school regularly or have stumbled in peer relationships.

Intervention design

The study employed a pre (T1)- and post (T2)-intervention comparative design. The duration of the intervention was four weeks. In addition, efficacy was measured four weeks after the end of the intervention (T3).

Intervention method

At the beginning of the intervention, all the participants provided informed

consent orally and in writing. Next, we conducted a pre-intervention effectiveness measurement (T1) and had the participants watch a 10-min video (a part of mindfulness educational materials consisting of psychoeducation and mindfulness breathing techniques; details are described below). After the first session that was conducted thrice a week, the participants gathered in the classroom outside of class time to engage in mindfulness breathing exercises in a group setting. During these exercises, participants watched video material (a part of mindfulness educational materials) on mindfulness breathing techniques for approximately 5-min and were asked to perform in accordance with these techniques. Eight video viewings of same mindfulness breathing exercises were conducted. Although mindfulness training generally includes homework, this was not required for the study because it aimed to evaluate the use of the teaching materials.

Overview of the RFM Program to improve resilience using mindfulness breathing

The RFM Program explains how repeatedly thinking unpleasant thoughts can increase depression and anxiety. Additionally, through mindfulness breathing exercises, learners are encouraged to become aware of how they feel at present, what they are thinking about, and what sensations they are feeling.

In previous studies, participants had difficulty sustaining 30–60 min of daily mindfulness practice (less than a quarter of participants were able to do so), and nearly half of the participants could not form a link between practice and effectiveness (Vettese et al. 2009). In other words, it cannot be said that the longer one works on mindfulness, the more beneficial it is. By contrast, there have been reports of the effectiveness of five minutes of mindfulness over seven days via the internet in reducing stress (Lam, Sterling, and Margines 2015), and of five minutes of mindfulness in adult palliative care patients with moderate to severe distress, showing immediate relief from suffering (Yik et al. 2021). Based on the above, five minutes of mindfulness breathing was employed in this study.

Mindfulness is based on gaining an understanding through knowledge and experience; the central element of mindfulness is the improvement of awareness. Therefore, the mindfulness educational materials were created to provide high school students with basic knowledge of mindfulness and facilitate their experience of mindfulness breathing by following a movie comprising psychoeducation (Table 1, 5 min) and mindfulness breathing (Appendix 1, 5 min). The mindfulness educational materials were created based on Kabat-Zinn's (2003) concept of mindfulness.

The mindfulness educational materials aim at improving awareness and acceptance through mindfulness breathing, understanding how to relate to uncomfortable thoughts caused by ruminations, and learning to practice ways of dealing with ruminations, such as noticing thoughts and viewing them objectively, without evaluation or judgment. Thus far, the implementation of mindfulness training has required instructors to be fully engaged and familiar with mindfulness, making it difficult to implement; the training materials involved in this program help address this issue by playing the instructional role for students directly. Furthermore, the program is likely to spread more widely because schools can

Table1 Details of the mindfulness educational materials

Type	Theme	Overview
Psychological education	Understanding through knowledge	1.What is mindfulness? 2.Effects of mindfulness 3.The state of mindfulness aims for: 1)The here and now 2)Awareness 3)No evaluation or judgment, no attempt to control 4.What is mindfulness breathing?
Mindfulness breathing	Understanding through experience	1.Breathing method and understanding through experience 1)Here and now 2)No evaluation, no judgment 3)No need to try to control it

easily set the timing of its implementation at their educational sites.

Evaluation of intervention effects

The primary outcome was resilience and secondary outcomes were mood and rumination. The effects of the intervention were assessed at three time points: before the intervention (T1), four weeks after the intervention began (T2), and four weeks after the intervention ended (T3), with the timing of the assessment based on previous research (Eguchi and Kunikata 2022). The participants completed the same self-administered questionnaire at all time points.

Demographic characteristics

Participants' gender, age, and current grade were obtained via the questionnaire.

Resilience

We used the resilience scale that was originally developed by Ishida, Imura, and Watanabe (2017). This scale comprises nine items, rated on a 5-point Likert scale, that assess three factors — *breakthrough power*, *overcoming power*, and *relationship-building skills*. Breakthrough power consists of three items that address the ability to analyze an unpleasant event and the ability to be flexible and solution-oriented. An example of one of these items is, "When I have encountered an unpleasant event, I gather information to solve the problem." Overcoming power consists of three items related to the ability to endure difficulties and overcome them with persistent effort. It includes items such as "I am able to persevere even when things are difficult." Relationship-building skills includes items such as "I have always been good at forming relationships with others." It consists of three items related to the ability to create desirable relationships independently, intentionally, and proactively. The higher the score, the higher the availability indicated by the item. The total resilience is the sum of all items.

Mood

The Japanese version of the K6 (Furukawa et al. 2008), which was originally developed by Kessler et al. (2002) in the US, was used to assess the participants' mood. It comprises six items regarding how the respondent has been feeling over the past week. The items, rated on a 5-point Likert scale, include "Do you feel hopeless?" and "Do you feel fidgety or restless?" Higher total scores indicate the possibility of more serious mental illness, with suggestions that scores of 9 or higher are equivalent

table2 Multiple comparisons of each scale score with the basic statistics using Bayesian estimation

item		T1		95%CI		T2		95%CI		T3		95%CI		BF	Multiple comparisons (two-tailed test)
		M	SD	2.50%	97.50%	M	SD	2.50%	97.50%	M	SD	2.50%	97.50%	(Main effect)	
resilience	total	31.2	5.74	-4.04	-0.58	35.3	6.31	-0.57	2.39	36.0	6.36	-0.12	3.03	8.443	T1 < T3 (BF= 5.414)
	Breakthrough Power	10.0	2.45	-2.37	-0.18	12.5	1.38	-0.38	1.53	12.7	1.21	-0.24	1.72	4.652	ns
	Overcoming Power	11.5	1.64	-1.34	-0.21	13.0	1.67	-0.10	0.88	13.0	1.79	-0.10	0.90	9.531	T1 < T2 (BF=4.589) T1 < T3 (BF=4.589)
	Relationship building skills	9.7	3.39	-0.67	0.13	10.0	3.74	-0.41	0.32	10.5	3.99	-0.10	0.72	0.996	
rumination		12.5	3.45	-0.33	2.69	9.8	3.25	-2.09	0.73	10.0	2.97	-1.91	0.89	0.881	
mood		11.7	3.14	0.25	2.28	8.7	2.73	-1.99	-0.08	9.7	2.34	-1.12	0.60	8.274	T1 > T2 (BF=8.958)

to mood and anxiety disorders and scores of 13 or higher indicate severe mental disorders (Furukawa et al. 2008).

Rumination

The Rumination Scale for Unpleasant Mood, which measures rumination that causes unpleasant moods, was created by the authors based on their conceptual analysis of rumination (Eguchi and Kunikata 2021). It consists of four items, rated on a 5-point Likert scale, such as "When I start thinking about unpleasant emotions (such as anxiety, depression, and anger), I keep thinking about them repeatedly even though I do not really want to think about them," and "My mind is occupied with unpleasant emotions (such as anxiety, depression, and anger) and it becomes difficult to think about other things." Higher scores on the scale indicate a stronger tendency toward rumination on unpleasant moods. Higher scores indicate stronger antipathy toward an unpleasant mood.

Details of the scales are presented in Appendix 2 at the end of the paper.

Analysis

The study used a one-factor within-participant analysis of variance with Bayesian estimation to confirm the effects of the program. Bayesian estimation was used because it allows the use of distributions that fit the data even when those are not normally distributed, and it also allows stable analysis even with small sample sizes (Ozechowski 2014). Bayes factor (BF) values (More and Rouder 2021) were used to assess effects. The scaling of the prior distribution (Cauchy distribution) was set to rscale=0.5 (rscale=0.707 for multiple comparisons). The maximum number of Markov Chain Monte Carlo estimations was 10,000.

Research ethics

This study was approved by the Ethics

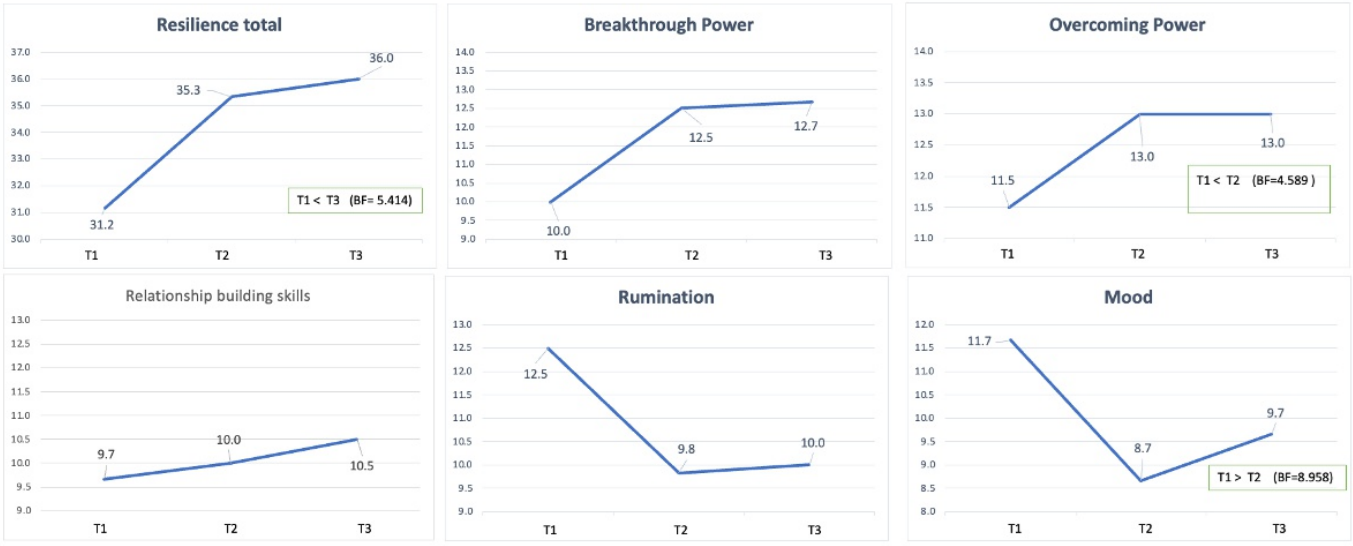

Figure 1 Changes in outcome scores
All positive BF scores are shown within the green rectangle.

Review Committee of [BLINDED FOR REVIEW]. In addition, this study was conducted after written and oral explanations were provided to all participants, their guardians, and the principal of the participants' high school, and consent for research cooperation was obtained from the participants or their guardians.

Results

The results of the basic statistics and BF analysis for the scores per level for each factor are shown in Table 2. The results of multiple comparisons for items for which the BF values of the analysis were effective is shown in Table 2. In addition, the results are illustrated in Figure 1.

The results of the BF analysis (validity level=3) demonstrated that the main evaluation item, "total resilience" (BF=8.443, error=0.58%), and the sub-items of resilience, "breakthrough power" (BF=4.652, error=0.41%) and "overcoming power" (BF=9.531, error=0.58%), were valid. However, the BF values for the main effect of "relationship-building skills," a subscale of resilience, did not reach the validity level (BF=0.996, error=0.51%).

For the secondary endpoints, the BF value for the main effect did not reach the validity level for "rumination" (BF=0.881, error=0.47%). In contrast, for "mood," the BF value for the main effect was valid (BF=8.274, error=0.54%). "Total resilience" (BF=5.414) at T1 (mean: 31.167) was significantly l differences at T3 (mean: 36).

The results before and after the intervention and one month later are as follows. Among the resilience sub-items, "breakthrough power" showed no significant differences. For "overcoming power" (BF=4.589), scores (mean: 11.5) were significantly different from those at T2 (mean: 13). There was also a significant difference between T1 (mean: 11.5) and T3 (mean: 13) scores for "overcoming power" (BF=4.589). Further, there was a significant difference between T1 (mean: 11.667) and T2 (mean: 8.667; BF=8.958) scores for

"mood."

Discussion

This study aimed to evaluate the effectiveness of the RFM Program. The results suggest that the students who participated in the study showed increased resilience and improved mood. The following is a discussion of the results and an evaluation of the RFM Program.

Implications for resilience

The total resilience score increased from pre- to post-intervention (T1<T3), and the score for the subscale "overcoming power" also increased from pre- to post-intervention (T1<T2). Furthermore, a main effect of time was observed for "breakthrough power."

The main reason for the participants' increased resilience might be that they became more aware of themselves through mindfulness knowledge and mindfulness breathing. Mindfulness can be understood as the act of becoming aware. In particular, the mindfulness breathing we used in the intervention included training to focus on not only the breath but also physical sensations and thoughts, and to observe what one perceived without evaluation or judgment. In other words, mindfulness breathing is training to understand the self as it is. This may have led to an improvement in "self-understanding," which is a factor in resilience. In particular, being able to objectively observe situations arising in the self may have reduced involvement in events and led to increased resilience and the ability to endure difficulties (overcoming power).

Many of the interventions that have been shown to be effective in improving resilience have been related to promoting self-understanding (Hara and Tsuzuki 2013; Robertson et al. 2015). In other words, a deeper awareness of the self may have led to the discovery of previously unnoticed potential resilience, which may, in turn, have facilitated the recognition of available resilience. These findings suggest that high school students benefit from RFM Program, even for a short period, through the promotion of awareness.

In addition, not only the direct effects of RFM Program but also the indirect effects of participation in the RFM Program may be considered. For example, in research on caring, care is considered the mainstay of human relationships, brought about by the interrelationship between the caregiver and the cared-for (Sato 2010). The American Psychological Association (APA; 2016) lists "relationships that engender love and trust, provide role models, encouragement, and reassurance, and help people become more resilient" as a factor in improving resilience. In other words, APA (2016) states that "relationships," or interactions with others, promote resilience. In other words, the interaction between the participant and implementer throughout the RFM Program may have influenced the development of the effect.

In contrast, the resilience subscale of "relationship-building skills" did not reach a validity level. The "relationship-building skills" section of the questionnaire in this study addresses the ability to build good relationships with others and includes items related to experiences such as "I am good at interacting with others on my own." The intervention period in this study was short and the students lived in a dormitory, which might have influenced the lack of opportunities to utilize relationship-building skills.

Implications for rumination

The results show that the intervention reduced ruminant scores, but not significantly. This suggests that students may have a better understanding of how to deal with their thoughts after watching the mindfulness educational materials, and that mindfulness breathing exercises may have increased their awareness of their thinking state. For example, the results show that at T1, many students answered "3: Neither agree nor disagree" to questions such as "My mind is occupied with unpleasant moods (e.g., anxiety, depression, anger) and I have difficulty thinking about other things" and "I have difficulty ignoring thoughts related to unpleasant moods (e.g., anxiety, depression, anger)." Students were more likely to answer "3: neither, nor does it apply" at T1 and T2. However, at T2 and T3, more students selected "2: Not very applicable" and "4: Somewhat applicable." In other words, the original purpose of mindfulness, which was to train students to become aware of their thoughts, rather than to train them to stop thinking, may have been achieved.

Implications for mood

Mood improved significantly more at T2 than at T1. The effects of mindfulness on anxiety and depression are unequivocal (Aust and Bradshaw 2017; Fjorback et al. 2011; Khoury et al. 2013). Standard mindfulness consists of an eight-week mindfulness program with daily homework (approximately 45 min; Kabat-Zinn 2003). However, even short periods of mindfulness have been shown to reduce anxiety and depression (Geschwind et al. 2011). Furthermore, five minutes of meditation (similar to mindfulness breathing exercises) has been reported to have immediate mood change and stress-improving effects (Ishikawa et al. 2020). Furthermore, participants' improved mood may be a result of mindfulness changing the way they relate to negative thoughts. An important effect of mindfulness is improved "acceptance," or the ability to accept oneself and the world around them as they are (Hayes, Follette, and Linehan 2004). This increased acceptance facilitates the facing and overcoming of problems and concerns. In other words, the impact of thoughts (rumination), such as interpreting events negatively or worrying about the future, may have been reduced, leading to improved mood.

Overall evaluation of the RFM Program and its contribution to science

The results of this study indicate that the RFM Program (a low-intensity mindfulness program focusing on improving resilience) would be helpful for students. In addition to the improvement in resilience, an improvement in mood was also suggested by the results, that is, not being overly influenced by negative thoughts and controlling emotional reactions. Improved resilience aids the mind's ability to adapt to difficult situations. In particular, there is concern about the increase in students needing help during adolescence, such as those with tendencies toward violence against self and others. Additionally, those with such tendencies in their first year of high school have an increased need for help as they move up through the grades (Ishida et al. 2018). In addition, such students lack the ability to seek help, and it is difficult for those around them to notice their disorder and help them (Matsumoto 2009). We believe that the early use of RFM Program in educational settings for groups of students will not only improve their resilience but also contribute to the early detection of students in need of

help, provide opportunities for support, and help students improve their mental ability to adapt to difficult situations. In addition, resilience continued to improve after the intervention in this study, but mood worsened again. In other words, it can be inferred that resilience can be improved once the RFM Program is attended, but continuation of the program is desirable for mood stability. Mindfulness educational materials may also be useful in that they are easy for students to access and use.

Safety of the RFM Program

This mindfulness program can be considered safe to students for the following reasons. First, it did not worsen mental health conditions such as anxiety and depression, according to participants' scores on the K6 scale. Second, participants did not report maladjustment or adverse events during the intervention, even though they may have been asked to reflect on their own psychological state and unpleasant past events through questionnaires. Generally, meditation and mindfulness practice techniques are considered to have fewer risks. However, people with mental illness or trauma are cautioned (Chan-ob and Boonyanaruthee 1999; Epstein and Lieff 1981; Sharma et al. 2016) that these techniques may produce some problems. Care may need to be taken when applying mindfulness techniques to people with mental illness or trauma.

Limitations

Limitations of this study include the lack of a control group, one location, limited sample size, and the fact that no mindfulness-related factors were measured. Therefore, changes in each measure could have been influenced by other factors outside the intervention. Therefore, the results have been carefully considered. Future studies should include additional sample sizes and comparisons with a control group.

Conclusion

The results of a 4-week intervention using 5-min mindfulness breathing exercises with the mindfulness educational materials developed for six high school seniors showed an increase in resilience and an improvement in mood. The results suggest that RFM Program may be useful for improving resilience and reducing unpleasant mood among high school students and may contribute to supporting their healthy development. It was also found that the RFM Program would be safe for these students. The next step will be to include more participants and update the program.

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マインドフルネス呼吸法を用いた高校生のレジリエンス向上に向けたプログラムの効果と評価 ーレジリエンス、気分、反すうに着目してー

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要旨

高校生は、さまざまなストレスが生じやすい時期である。本研究ではストレスに対する回復力（レジリエンス）を促す方法としてマインドフルネスに着目した。本研究では、レジリエンス向上に特化した 4 週間の低強度マインドフルネスプログラムを作成し実施した結果について報告する。

対象者は高校 3 年生 6 名であった。プログラムは、初回にマインドフルネスの知識と、マインドフルネス呼吸法の方法に関する約 10 分の動画を視聴し、介入期間にマインドフルネス呼吸法（1 回 5 分）の教示用動画を視聴しながらマインドフルネス呼吸法を練習するものである。効果の評価は、自記式質問紙調査方を用いて介入前後と、終了 1 ヶ月後に行った。評価項目は、レジリエンス、気分、反すうとした。

結果，“レジリエンス合計”（BF=8.443, error=0.58%）、レジリエンスの下位項目である“突破”（BF=4.652, error=0.41%）、“忍耐”（BF=9.531, error=0.58%）は、主効果の BF 値が有効であった。また、“気分”（BF=8.274, error=0.54%）も主効果の BF 値が有効であった。以上より、本プログラムを行うことは、高校生のレジリエンスの向上や不快気分の軽減に有用であり、高校生の健やかな成長を支援することに寄与しうる可能性が推察された。

キーワード:マインドフルネス、教材開発、反すう、レジリエンス、高校生