RESEARCH ARTICLE

School-based mindfulness intervention for depressive symptoms in adolescence: For whom is it most effective?

Aino Saarinen[1] 🔵 | Mirka Hintsanen[2] | Tero Vahlberg[3] | Nelli Hankonen[4] | Salla-Maarit Volanen[5,6]

[1]Department of Psychology and Logopedics, University of Helsinki, Helsinki, Finland

[2]Division of Psychology, Faculty of Education, University of Oulu, Oulu, Finland

[3]Department of Biostatistics, Faculty of Medicine, University of Turku, Turku, Finland

[4]Faculty of Social Sciences, Social Psychology, University of Helsinki, Helsinki, Finland

[5]Folkhälsan Research Center, Helsinki, Finland

[6]Clinicum, Department of Public Health, University of Helsinki, Helsinki, Finland

Correspondence
Aino Saarinen, Department of Psychology and Logopedics, Faculty of Medicine, University of Helsinki, Haartmaninkatu 3, P.O. Box 21, 00014 Helsinki, Finland.
Email: aino.i.saarinen@helsinki.fi

Abstract

Introduction: There is accumulating evidence for the effectiveness of mindfulness-based interventions in alleviating depressive symptoms. A crucial question is, however, whether mindfulness interventions are more effective for some individuals than others, depending on individual characteristics before a mindfulness intervention. We exploratorily investigated whether the effectiveness of school-based mindfulness intervention against depressive symptoms is modified by executive functions, rumination, and emotion regulation among adolescents.

Methods: The longitudinal data included adolescents with at least mild depressive symptoms at the baseline ($n = 369$, at the 6th–8th grade, 68.4% female) who were randomized into a 9-week school-based mindfulness intervention group, into an active control group receiving relaxation program, or into an inactive control group. Adolescents' executive functions, rumination, and emotion regulation (i.e., acceptance, catastrophizing, and positive reappraisal) were assessed at the baseline; and depressive symptoms at three time points (at the baseline and at 9-week and 6-month follow-ups).

Results and Conclusions: In adolescents with at least mild depressive symptoms at the baseline, high catastrophizing, high acceptance, and low executive functions were found to increase the effectiveness of mindfulness-based intervention against depressive symptoms. There seemed to be some sex differences. Thus, when aiming to alleviate depressive symptoms, mindfulness-based intervention may possibly be more effective for adolescents with high catastrophizing, high acceptance, and low executive functioning (than for adolescents with the opposite dispositions). However, as this study was exploratory by nature and corrections for multiple testing were not used, the findings must be regarded as preliminary and need confirmation in further studies.

KEYWORDS
depression, emotion regulation, executive functions, longitudinal, mindfulness, rumination

1 | INTRODUCTION

During the 2010s, the rate of depressive symptoms has been drastically increasing among adolescents, which seems to be partly explained by an increased use of social media (Twenge et al., 2018). The prevalence of major depressive episodes is approximately 11% (Mojtabai et al., 2016). Additionally, there is evidence that depressive symptoms are particularly state-dependent in early adolescence, that is, depressive symptoms may emerge and disappear within comparatively short periods of time (Holsen et al., 2000; Larson et al., 2002; Tram & Cole, 2006). In this way, adolescents are particularly susceptible to

affective fluctuation. Further, adolescents with subclinical depression have a lower quality of life and a heightened risk for developing a major depressive disorder (Bertha & Balázs, 2013; Saluja et al., 2004). Accordingly, it has been emphasized that subclinical depression is a largely unrecognized health problem among adolescents and, thus, constitutes an important target for school-based interventions (Bertha & Balázs, 2013; Saluja et al., 2004).

From the 2010s onwards, growing interest has been directed to mindfulness-based interventions, that is, whether mindfulness training could help to protect against the emergence of depressive symptoms in adolescence. Among adults, meta-analyses have concluded that mindfulness training is an effective treatment for depression (Khoury et al., 2013; Spijkerman et al., 2016). Mindfulness-based interventions are found to effectively alleviate depressive symptoms in a variety of adult populations: for example, in a nonclinical population-based sample (Querstret et al., 2018), college students (Falsafi, 2016), primary care clinicians (Fortney et al., 2013), subjects with binge eating symptoms (Smith et al., 2006), subjects with fibromyalgia (Sephton et al., 2007), subjects with substance use disorders (Witkiewitz & Bowen, 2010), subjects with posttraumatic stress disorder (Colgan et al., 2016), and subjects with depressive disorder (Winnebeck et al., 2017).

Among adolescents, however, evidence has been rather inconclusive. While some randomized intervention studies have indicated that mindfulness training effectively reduces depressive symptoms in adolescents (Raes et al., 2014; Schonert-Reichl et al., 2015; E. M. Sibinga et al., 2016), other studies have resulted in null findings (Johnson et al., 2016; Lam, 2016; Mendelson et al., 2010; E. M. S. Sibinga et al., 2013). Accordingly, a recent meta-analysis did not find evidence for the effectiveness of mindfulness-based school interventions when aiming to reduce depression in adolescents (Caldwell et al., 2019). Importantly, the meta-analysis also found moderate heterogeneity in the effectiveness of mindfulness interventions between different samples (Caldwell et al., 2019). It has been emphasized that individual differences may affect the effectiveness of mindfulness training in school-based interventions (Carsley et al., 2018; Horowitz & Garber, 2006). Thus, some subpopulations of adolescents may benefit from mindfulness-based interventions more than others. Identifying those subpopulations could enhance possibilities for providing interventions the adolescents with highest likelihood to benefit from mindfulness-based interventions.

To date, it has been found that effectiveness of mindfulness interventions is modified by the baseline level of depression, gender, and practical implementation of mindfulness training. Specifically, students with lower (vs. higher) baseline levels of depression may on average benefit more from mindfulness training (Raes et al., 2014). Further, females (vs. males) may benefit more from mindfulness training including elements of enhancing self-compassion (Kang et al., 2018). In addition, the quality of mindfulness activities and the training of an intervention leader are shown to have an impact on the effectiveness of mindfulness training (Carsley et al., 2018).

It has remained unclear, however, whether dispositional traits could influence the receptivity and effectiveness of mindfulness training among adolescents. Previous theoretical frameworks have suggested that three features may be essentially related to the effectiveness of mindfulness training: executive functions (e.g., attention regulation), emotion regulation strategies (e.g., reappraisal, suppression), and frequency of negative emotions (e.g., rumination) (Cheung & Ng, 2019; Hölzel et al., 2011).

Regarding emotional regulation, conceptual frameworks have suggested that better emotion regulation skills may provide better possibilities to react nonjudgmentally to affective reactions and repetitive thoughts (Hölzel et al., 2011) that, in turn, is required in successful mindfulness meditation (Leary & Tate, 2007). A longitudinal study from middle childhood to middle age demonstrated that the repertoire of emotion regulation strategies is at smallest level in middle adolescence (Zimmermann & Iwanski, 2014). Challenges in emotion regulation, in turn, are strongly associated with depression in adolescence (Silk et al., 2003). Related to this, there is evidence that affective control, that is, a crucial component of emotion regulation especially in adolescence (Schweizer et al., 2020), may reduce the effectiveness of mindfulness interventions (Sass et al., 2013).

With regard to executive functions, it has been postulated that mindfulness may have more favorable health effects among those with better abilities on attention orientation and regulation: for example, if one is able to focus attention on breathing or bodily feelings for a long period of time (Hölzel et al., 2011). Appropriate attention regulation is suggested to enhance one's capacity to benefit from mindfulness (Hölzel et al., 2011). In adolescence, there may be individual differences in executive functions. Specifically, studies in cognitive psychology and neuroscience have demonstrated that executive functions are the skills that develop most slowly over age and may not likely reach a full maturation level before early adulthood (Lenroot & Giedd, 2006; Romer et al., 2017). Lower level of executive functions, in turn, is related to an increased risk for depression (Han et al., 2016). Further, mindfulness interventions are shown to affect the brain regions related to executive functions (e.g., the prefrontal cortex and anterior cingulate cortex) (Lifshitz et al., 2019; Twenge et al., 2012). Accordingly, one study suggested that low executive functions could possibly reduce effectiveness of mindfulness intervention (Fung et al., 2019).

Regarding rumination, it has been suggested that rumination and mindfulness are partly opposite characteristics for each other: mindfulness training aims to orient one's attention to the present moment, whereas rumination includes repetitive (and typically judgmental) processing of the past distress (Parmentier et al., 2019). It is known that rumination typically begins at the age of 12 years (Jose & Brown, 2008) and constitutes a substantial risk factor for depression (Rood et al., 2009). Further, there is preliminary evidence that children who ruminate frequently (vs. less frequently) are differently affected by

mindfulness-based interventions: for example, low rumination may predict a greater decline in aggression during intervention (van de Weijer-Bergsma et al., 2014).

Taken together, differences in the level of executive functions, emotion regulation, and rumination could help explain the differential effectiveness of mindfulness interventions among adolescents. To date, however, the topic has been rather underexamined with very limited evidence. The current exploratory study used data from a randomized controlled trial (RCT) where the adolescents were randomized into a 9-week school-based mindfulness intervention group, into an active control group (i.e., relaxation program without mindfulness-related elements), or into an inactive control group (school curriculum as usual without any intervention). Students' depressive symptoms were assessed at the three time points: at the baseline, at the 9-week follow-up (at the end of the intervention), and at the 6-month follow-up. A previous study on this data set showed that mindfulness intervention did not have a main effect on depressive symptoms in the full sample, but predicted lower depressive symptoms in some subsamples (such as girls at the 7th grade) when compared to the active control group (Volanen et al., 2020). That study, however, investigated only the modifying effects of age, gender, and continuing mindfulness practice at home on the effectiveness of mindfulness intervention, but not possible modifying effects of psychological characteristics. The current study further investigated whether the effectiveness of school-based mindfulness intervention on depressive symptoms is modified by three individual characteristics: executive functions, rumination, and emotion regulation (i.e., acceptance, catastrophizing, or positive reappraisal). We focused on adolescents who had at least mild depressive symptoms at the beginning of the intervention. We did not set hypotheses as the present study was exploratory by nature.

2 | METHODS

2.1 | Participants

The study used data from a cluster RCT with three study arms (retrospective registration: ISRCTN18642659). The main results of the study have been reported previously (Volanen et al., 2020). The study design is illustrated in Figure 1. There were altogether 247 eligible schools (from 14 municipalities from the Southern Finland) that were invited to participate in the
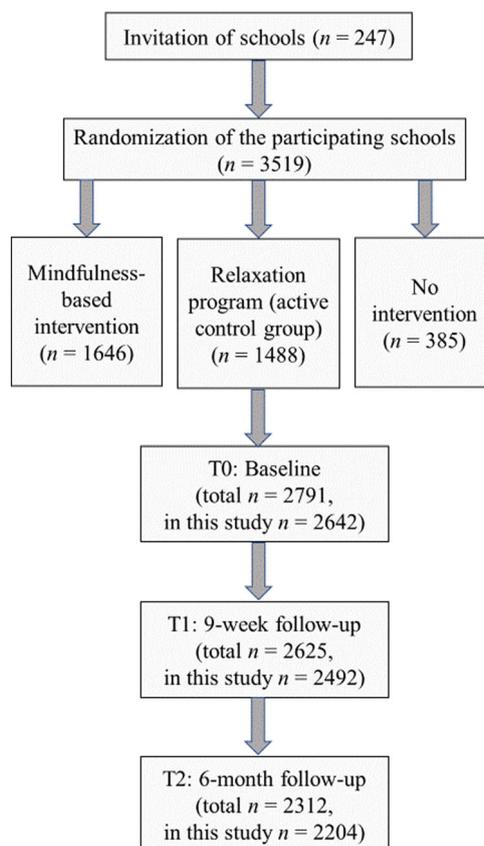
FIGURE 1 Study design. In this study, we included adolescents with RBDI values available in at least one measurement point (i.e., at T0, T9, or T26)

study. From the invited schools, 56 (24%) participated in the study. The participants were Finns and aged between 12 and 15 years (6th, 7th, or 8th grade in the comprehensive school).

To control for socioeconomic factors, the schools were classified into three groups on the basis of school location and an average apartment price per square meter (Volanen et al., 2016). Thereafter, eligible schools in each socioeconomic group were randomly allocated into a mindfulness-based intervention (n = 94 classes), into an active control group who participated in a relaxation program (n = 85 classes), or into an inactive control group who followed the school curriculum without any interventions (n = 31 classes). To blind each participant's intervention group, the participants were informed that they will participate in a 9-week program called "Skills for Wellbeing."

All the groups participated in a baseline measurement (T0) and two follow-up measurements at the end of the intervention (9 weeks after the baseline) (T9), and 6 months postintervention (26 weeks after the baseline) (T26). A more detailed description of the study design is available elsewhere (Volanen et al., 2016).

In this study, the main analyses were conducted among all the adolescents with at least mild depressive symptoms at baseline (n = 369). As additional analyses, the analyses were rerun in the full sample (n = 2937).

2.2 | Mindfulness-based intervention

The mindfulness-based intervention consisted of a 9-week mindfulness-program .b (Stop and Breathe/Be) (Huppert & Johnson, 2010). The aim of the intervention was to promote emotional awareness, sustained attention, and attentional and emotional regulation. The .b-program included a 45-min group session every week during school hours and short home practices (the participants were recommended to practice 5–6 times per week, approximately 3–15 min at a time). The .b intervention practices were conducted by trained and certified mindfulness facilitators who had years of established mindfulness meditation practice.

2.3 | Active control group: Relaxation program

Active control group participated in a 9-week standardized relaxation program called "Relax." The frequency and duration of the practices were similar to those of the mindfulness intervention group: a 45-min group session every week and short home practices (the participants were recommended to practice 5–6 times per week). The control program included practices related to, for example, stress management, sleeping quality, screen time, and experiential relaxation practices. The relaxation practices were conducted by either certified school teachers or experienced leaders of well-being practices among adolescents. The relaxation practices were aimed not to include any mindfulness-related elements. For more details, see Volanen et al. (2016).

2.4 | Measures

Depressive symptoms were evaluated with a modified version of the Beck Depression Inventory (RBDI) (Beck et al., 1988). A more detailed description of the modification is provided elsewhere (Raitasalo, 2007). The questionnaire included altogether 13 items that measured different depressive symptoms and were responded with a 4-point scale (0–3) according to the severity of the symptoms. Due to ethical reasons, the item concerning suicidal ideation was removed. This did not affect the psychometric properties of the scale (Kosunen et al., 2003). We calculated the sum of the items for each participant who had responded to at least eight items. The responses were scaled so that higher values of RBDI referred to higher depressive symptoms. The internal reliability of the RBDI has been found to be very good (Cronbach's α = 0.86) (Volanen et al., 2016), and the RBDI has been used among adolescents in Finland also previously (Kaltiala-Heino et al., 1999).

Executive functions were measured with the Executive Functioning scale of the Viivi questionnaire (Korkman et al., 2004) filled by the adolescents' parents. The questionnaire included altogether 25 items (e.g., "The child is often inattentive or makes mistakes due to carelessness"; "The child has difficulties to follow given guidelines and to complete tasks"). The items were responded with a 3-point scale (1 = does not apply; 2 = applies sometimes or to some extent; 3 = definitely applies). The items measured four subdomains of executive functions: attention and concentration (9 items); hyperactivity and impulsivity (9 items); passivity or hypoactivity (4 items); and organizing ability (3 items). We calculated the mean score of the items for all the participants whose parents had responded to at least 70% of the items. The items were scaled so that higher values referred to higher executive functions. A more detailed description of the questionnaire can be found elsewhere (Korkman et al., 2004). The validity of the questionnaire has been found to be good previously (Bohlin & Janols, 2004). In this study, the Cronbach's α coefficient of executive functions was 0.92 (at the baseline measurement).

Rumination was evaluated with the Rumination and Reflection Scale (Trapnell & Campbell, 1999) filled by the adolescents. The scale included 12 items (e.g., "I am worried about many issues"; "I'm often unhappy, sad, or tearful") that were responded with a 5-point scale (1 = strongly disagree; 5 = strongly agree). The mean score of the items was calculated for all the participants who had responded to at least 10 items. The items were scaled so that higher values referred to higher rumination. The scale has been used also previously (Borders et al., 2010). In this study, the Cronbach's α coefficient of rumination was 0.88 (at the baseline).

Emotion regulation was assessed with The Cognitive Emotion Regulation Questionnaire (CERQ) (Jermann et al., 2006) filled by the adolescent. The CERQ included a statement ("Sometimes it happens nice things and sometimes tough things in life. When encountering tough things, how often do you have this kind of thoughts?") that was followed by 16 items measuring four different styles of stress regulation (each scale includes 4 items): (1) *Acceptance* (e.g., "I think that I have to accept that this happened"; "I think that I must learn to live with it"); (2) *Catastrophizing* (e.g., "I often think that what I have experienced is the worst that can happen to a person"; "I often think that what I have experienced is much worse than what others have experienced"), and (3) *Positive reappraisal* (e.g., "I think I can learn something from the situation"; "I think that the situation also has its positive sides"), (4) *Rumination*. The subscale of rumination was excluded because we also had a separate and more comprehensive scale of rumination. The items were responded with a 5-point scale (from "never or very rarely" to "always or almost always"). The sum of the items was calculated for all the participants who had responded to at least three subscale items. Previously, internal reliability, predictive validity, and structural validity are found to be good (Garnefski & Kraaij, 2007). In this study, baseline Cronbach's α coefficients were 0.78 for acceptance, 0.80 for catastrophizing and 0.79 for positive reappraisal.

2.5 | Statistical analyses

Statistical analyses were performed with the SAS System for Windows 9.4 (SAS Institute Inc.). The main analyses were conducted in the subsample of the participants with at least mild depressive symptoms (RBDI $\geq$ 5, $n = 369$) at the baseline. Additionally, the analyses were conducted separately among girls and boys because there is evidence for gender differences in the effectiveness of mindfulness interventions in this sample (Lassander et al., 2021) and also in other samples (de Vibe et al., 2013; Kang et al., 2018). It has also been pointed out that more research is needed on gender differences in the context of mindfulness-based interventions (Bluth et al., 2017).

The modifying effects of individual characteristics (executive functions, rumination, acceptance, catastrophizing, and positive reappraisal) on the effectiveness of intervention on the 9-week and 26-week change in depressive symptoms were analyzed with linear mixed models (to account for the clustered nature of the data). All the participants with RBDI data available in at least one measurement point were included in the analyses. Maximum-likelihood estimation was used to obtain unbiased and efficient parameter estimates for data with missing values. Models included random intercept to account for the classroom-level variance and time as a repeated factor (using unstructured covariance structure). Models included the main effects of gender, grade, group, time, modifier, and the two-way interaction effects of Modifier × Group, Modifier × Time, Group × Time, and the three-way interaction effect of Modifier × Group × Time. The modifying effects of the factors (executive functions, rumination, acceptance, catastrophizing, positive reappraisal) were tested with Modifier × Group × Time intervention effect.

First, the analyses were conducted for boys and girls simultaneously (adjusted for age and sex). Next, the analyses were rerun separately among girls and among boys (adjusted for age).

Bonferroni adjustment was used in pairwise comparisons between intervention and control groups. Two-sided statistical tests with a significance level of 0.05 were used. No adjustments for multiple testing were done because this study was exploratory by nature and corrections for multiple testing are shown to increase likelihood of type II errors (i.e., truly important associations might be regarded as nonsignificant) (Perneger, 1998).

As additional analyses, we reran the analyses in the full sample to examine the associations also among those participants with no depressive symptoms at the baseline ($n = 2937$).

3 | RESULTS

The descriptive statistics of the study variables are presented in Table 1. There were altogether 368 adolescents (30.7% were boys, 29.9% were at the 6th grade, 14.4% at the 7th grade, and 56.0% at the 8th grade). The inactive control group was comparatively small ($n = 46$), especially with regard to boys ($n = 9$). There were more adolescents in the intervention group ($n = 166$) and active control group ($n = 157$).

The results of the main analyses are presented in Tables 1–3. The tables show the effect of each modifying factor (executive functions, rumination, acceptance, catastrophizing, and positive reappraisal) on the change in depressive

TABLE 1 The descriptive statistics of the study variables

	Intervention group (n = 166)		Active control group (n = 157)		Inactive control group (n = 46)	
	Frequency (%)	Mean (SD)	Frequency (%)	Mean (SD)	Frequency (%)	Mean (SD)
Gender						
Boys	57 (34.3)		47 (29.9)		9 (19.6)	
Girls	109 (65.7)		110 (70.1)		37 (80.4)	
School grade						
6th grade	53 (31.9)		45 (28.7)		12 (26.1)	
7th grade	21 (12.7)		14 (8.9)		18 (39.1)	
8th grade	92 (55.4)		98 (62.4)		16 (34.8)	
RBDI						
Baseline		9.91 (5.88)		9.53 (5.31)		10.72 (5.63)
9-week follow-up		7.00 (6.65)		7.05 (6.17)		7.80 (7.56)
26-week follow-up		6.05 (6.69)		6.50 (7.10)		7.61 (7.14)

symptoms after 9 weeks and 26 weeks within the inactive control group, within the active control, and within the intervention group, and the modifying effect of each factor on the effectiveness of intervention (intervention vs inactive control, intervention vs. active control).

3.1 | Among all students with at least mild depressive symptoms (RBDI ≥ 5) at baseline

Table 2 presents the results among participants with at least mild depressive symptoms (RBDI ≥ 5) at the baseline. Age and sex were controlled for in the analyses. A significant difference was found in the effect of acceptance on the change in depressive symptoms after 9 weeks and after 26 weeks between the intervention group and the active control group (relaxation program group) ($p = 0.023$ without correction for multiple testing) but not between the intervention group and the inactive control group (teaching as usual). This indicated that, in students with at least mild depressive symptoms, high acceptance slightly increased the effectiveness of mindfulness-based intervention compared to relaxation program (but not compared to inactive control group) on depressive symptoms after 9 weeks and after 26 weeks. High acceptance was associated with decrease in depressive symptoms after 9 weeks in the intervention group ($p < 0.0001$), while this association was not significant in the active control group.

3.2 | Among girls with at least mild depressive symptoms (RBDI ≥ 5) at baseline

Table 3 presents the results among girls with at least mild depressive symptoms (RBDI ≥ 5) at the baseline. The analyses were adjusted for age. A difference was found in the effect of catastrophizing on the change in depressive symptoms after 9 weeks between the intervention group and the active control group (relaxation program group) ($p = 0.0334$ without correction for multiple testing) but not between the intervention group and the inactive control group (teaching as usual). This indicated that, in girls with at least mild depressive symptoms, high catastrophizing slightly increased the effectiveness of mindfulness-based intervention compared to relaxation program (but not when compared to the inactive control group) on depressive symptoms after 9 weeks. High catastrophizing was associated with decrease in depressive symptoms after 9 weeks in the intervention group ($p = 0.0301$), while this association was not significant in the active control group.

3.3 | Among boys with at least mild depressive symptoms (RBDI ≥ 5) at baseline

Table 4 presents the results among boys with at least mild depressive symptoms (RBDI ≥ 5) at the baseline. The analyses were adjusted for age. A difference was found in the effect of executive functions on the change in depressive symptoms after 9 weeks between the intervention group and the active control group (relaxation program group) ($p = 0.0329$ without correction for multiple testing) but not between the intervention group and the inactive control group (teaching as usual).

TABLE 2 The modifying effects of students' psychological characteristics on the effectiveness of mindfulness intervention on depressive symptoms (among students with RBDI ≥ 5 at baseline)

Modifying variable	9-week change			26-week change		
	Estimate	95% CI	p	Estimate	95% CI	p
Executive functions[a]						
0	−0.271	(−1.103; 0.560)	0.5208	−0.562	(−1.640; 0.517)	0.3056
Cont	**−0.496**	**(−0.901; −0.091)**	**0.0167**	−0.324	(−0.808; 0.159)	0.1878
Int	0.072	(−0.303; 0.447)	0.7055	−0.201	(−0.644; 0.242)	0.3728
Int versus 0	0.343	(−0.701; 1.388)	0.9180	0.361	(−0.974; 1.696)	1.0000
Int versus Cont	0.568	(−0.064; 1.199)	0.0877	0.123	(−0.628; 0.874)	1.0000
Rumination[a]						
0	−0.009	(−0.292; 0.274)	0.9506	0.259	(−0.096; 0.614)	0.1518
Cont	0.095	(−0.047; 0.238)	0.1896	0.127	(−0.036; 0.290)	0.1272
Int	0.046	(−0.085; 0.177)	0.4916	0.023	(−0.143; 0.190)	0.7825
Int versus 0	0.055	(−0.302; 0.412)	1.0000	−0.236	(−0.685; 0.213)	0.4752
Int versus Cont	−0.049	(−0.271; 0.173)	1.0000	−0.103	('−0.370; 0.164)	0.7681
Acceptance[b]						
0	−0.099	(−0.803; 0.604)	0.7810	−0.109	(−0.942; 0.724)	0.7968
Cont	−0.114	(−0.441; 0.214)	0.4952	−0.03	(−0.391; 0.330)	0.8690
Int	**−0.687**	**(−0.987; −0.388)**	**<0.0001**	**−0.754**	**(−1.117; −0.390)**	**0.0001**
Int versus 0	−0.588	(−1.463; 0.287)	0.2625	−0.645	(−1.685; 0.396)	0.3277
Int versus Cont	**−0.573**	**(−1.082; −0.065)**	**0.0230**	**−0.723**	**(−1.310; −0.137)**	**0.0116**
Catastrophizing[b]						
0	−0.119	(−0.586; 0.348)	0.6160	−0.052	(−0.604; 0.501)	0.8544
Cont	−0.118	(−0.420; 0.185)	0.4455	0.066	(−0.284; 0.417)	0.7090
Int	−0.240	(−0.489; 0.009)	0.0591	−0.172	(−0.491; 0.146)	0.2877
Int versus 0	−0.121	(−0.726; 0.485)	1.0000	−0.121	(−0.851; 0.609)	1.0000
Int versus Cont	−0.122	(−0.571; 0.326)	1.0000	−0.239	(−0.781; 0.303)	0.6431
Positive reappraisal[b]						
0	−0.115	(−0.555; 0.325)	0.6066	0.063	(−0.455; 0.581)	0.8117
Cont	0.082	(−0.181; 0.345)	0.5390	0.201	(−0.091; 0.493)	0.1769
Int	0.101	(−0.153; 0.354)	0.4350	0.227	(−0.075; 0.529)	0.1397
Int versus 0	0.216	(−0.365; 0.797)	0.8064	0.164	(−0.522; 0.851)	1.0000
Int versus Cont	0.019	(−0.400; 0.437)	1.0000	0.026	(−0.455; 0.507)	1.0000

Note: The estimates in the row "Int versus Cont" refer to the difference in the effect of each modifying factor on the change in depressive symptoms between the intervention group and the active control group. That is, if estimate is positive, it means that a high value in the modifying variable predicted a stronger increase in depressive symptoms at the follow-up point in intervention group (vs. control group). Instead, if estimate is negative, it means that having a high value in the modifying variable predicted a greater decrease in depressive symptoms at the follow-up point in intervention group (vs. control group). The estimates in the row "Int versus 0" refer to the difference in the effect of each modifying factor on depressive symptoms between the intervention group and the inactive control group.

Abbreviations: 0, inactive control group; Cont, active control group (relaxation group); Int, mindfulness intervention group.

[a]Estimates for 0.1-unit increase in the modifying variable.

[b]Estimates for 1-unit increase in the modifying variable.

TABLE 3 The modifying effects of girls' psychological characteristics on the effectiveness of mindfulness intervention on depressive symptoms (among girls with RBDI ≥ 5 at baseline)

Modifying variable	9-week change				26-week change		
	Estimate	95% CI	p		Estimate	95% CI	p
Executive functions[a]							
0	−0.243	(−1.060; 0.573)	0.5573		−0.703	(−1.837; 0.431)	0.2228
Cont	−0.179	(−0.697; 0.340)	0.4975		−0.321	(−0.878; 0.237)	0.2574
Int	−0.154	(−0.578; 0.269)	0.4722		−0.459	(−0.969; 0.050)	0.0769
Int versus 0	0.089	(−0.965; 1.143)	1.0000		0.244	(−1.181; 1.669)	1.0000
Int versus Cont	0.024	(−0.743; 0.791)	1.0000		−0.139	(−1.004; 0.726)	1.0000
Rumination[a]							
0	−0.012	(−0.283; 0.259)	0.9297		0.261	(−0.101; 0.624)	0.1571
Cont	0.116	(−0.052; 0.284)	0.1737		0.064	(−0.132; 0.260)	0.5214
Int	−0.139	(−0.311; 0.034)	0.1153		0.092	(−0.133; 0.317)	0.4211
Int versus 0	−0.126	(−0.495; 0.242)	0.8778		−0.169	(−0.658; 0.320)	0.8707
Int versus Cont	−0.255	(−0.530; 0.021)	0.0764		0.028	(−0.314; 0.370)	1.0000
Acceptance[b]							
0	−0.109	(−0.853; 0.635)	0.7738		−0.383	(−1.328; 0.562)	0.4252
Cont	−0.106	(−0.468; 0.256)	0.5642		0.122	(−0.283; 0.526)	0.5528
Int	−0.507	(−0.860; −0.153)	0.0052		−0.319	(−0.780; 0.143)	0.1752
Int versus 0	−0.398	(−1.341; 0.545)	0.6841		0.064	(−1.140; 1.269)	1.0000
Int versus Cont	−0.401	(−0.980; 0.179)	0.2403		−0.440	(−1.143; 0.263)	0.3171
Catastrophizing[b]							
0	−0.187	(−0.663; 0.288)	0.4381		−0.114	(−0.710; 0.482)	0.7070
Cont	0.246	(−0.115; 0.607)	0.1809		0.327	(−0.099; 0.752)	0.1315
Int	**−0.319**	**(−0.608; −0.031)**	**0.0301**		−0.143	(−0.536; 0.251)	0.4755
Int versus 0	−0.132	(−0.769; 0.505)	1.0000		−0.029	(−0.847; 0.789)	1.0000
Int versus Cont	**−0.565**	**(−1.094; −0.036)**	**0.0334**		−0.469	(−1.133; 0.194)	0.2236
Positive reappraisal[b]							
0	−0.217	(−0.653; 0.218)	0.3266		0.065	(−0.477; 0.607)	0.8139
Cont	−0.095	(−0.388; 0.197)	0.5226		0.112	(−0.210; 0.434)	0.4951
Int	−0.003	(−0.297; 0.292)	0.9860		0.354	(−0.018; 0.726)	0.0621
Int versus 0	0.215	(−0.388; 0.817)	0.8440		0.289	(−0.464; 1.042)	0.7734
Int versus Cont	0.092	(−0.383; 0.568)	1.0000		0.242	(−0.321; 0.806)	0.6651

Note: The estimates in the row "Int versus Cont" refer to the difference in the effect of each modifying factor on the change in depressive symptoms between the intervention group and the active control group. That is, if estimate is positive, it means that a high value in the modifying variable predicted a stronger increase in depressive symptoms at the follow-up point in intervention group (vs. control group). Instead, if estimate is negative, it means that having a high value in the modifying variable predicted a greater decrease in depressive symptoms at the follow-up point in intervention group (vs. control group). The estimates in the row "Int versus 0" refer to the difference in the effect of each modifying factor on depressive symptoms between the intervention group and the inactive control group.

Abbreviations: 0, inactive control group; Cont, active control group (relaxation group); Int, mindfulness intervention group.

[a]Estimates for 0.1-unit increase in the modifying variable.

[b]Estimates for 1-unit increase in the modifying variable

TABLE 4 The modifying effects of boys' psychological characteristics on the effectiveness of mindfulness intervention on depressive symptoms (among boys with RBDI ≥ 5 at baseline)

Modifying variable	9-week change			26-week change		
	Estimate	95% CI	p	Estimate	95% CI	p
Executive functions[a]						
0	−0.100	(−2.781; 2.581)	0.9409	−0.283	(−3.179; 2.613)	0.8458
Cont	−0.654	(−1.417; 0.109)	0.0912	0.005	(−0.937; 0.948)	0.9910
Int	0.737	(−0.092; 1.565)	0.0805	0.350	(−0.568; 1.267)	0.4493
Int versus 0	0.836	(−2.389; 4.062)	1.0000	0.633	(−2.858; 4.123)	1.0000
Int versus Cont	**1.391**	**(0.096; 2.686)**	**0.0329**	0.344	(−1.167; 1.855)	1.0000
Rumination[a]						
0	−0.046	(−1.080; 0.988)	0.9301	0.265	(−0.812; 1.341)	0.6262
Cont	−0.100	(−0.372; 0.171)	0.4652	0.101	(−0.196; 0.399)	0.5004
Int	0.237	(−0.006; 0.480)	0.0562	−0.153	(−0.450; 0.144)	0.3081
Int versus 0	0.283	(−0.937; 1.502)	1.0000	−0.418	(−1.699; 0.863)	0.9176
Int versus Cont	0.337	(−0.081; 0.755)	0.1387	−0.255	(−0.737; 0.227)	0.4641
Acceptance[b]						
0	0.192	(−1.812; 2.197)	0.8493	0.756	(−1.206; 2.718)	0.4458
Cont	−0.346	(−1.015; 0.323)	0.3076	−0.661	(−1.362; 0.039)	0.0639
Int	**−0.975**	**(−1.512; −0.439)**	**0.0005**	**−1.410**	**(−1.965; −0.856)**	**<0.0001**
Int versus 0	−1.168	(−3.548; 1.212)	0.5335	−2.167	(−4.506; 0.172)	0.0750
Int versus Cont	−0.629	(−1.613; 0.354)	0.2968	−0.749	(−1.774; 0.276)	0.1983
Catastrophizing[b]						
0	0.027	(−1.147; 1.201)	0.9635	0.125	(−1.122; 1.371)	0.8431
Cont	**−0.540**	**(−1.066; −0.014)**	**0.0445**	−0.213	(−0.811; 0.385)	0.4809
Int	−0.175	(−0.632; 0.282)	0.4493	−0.233	(−0.770; 0.305)	0.3922
Int versus 0	−0.202	(−1.646; 1.242)	1.0000	−0.357	(−1.914; 1.199)	1.0000
Int versus Cont	0.365	(−0.434; 1.164)	0.6015	−0.020	(−0.941; 0.902)	1.0000
Positive reappraisal[b]						
0	0.328	(−0.963; 1.619)	0.6153	0.073	(−1.307; 1.452)	0.9169
Cont	0.298	(−0.221; 0.817)	0.2565	0.339	(−0.273; 0.952)	0.2740
Int	0.266	(−0.199; 0.730)	0.2586	0.078	(−0.444; 0.599)	0.7684
Int versus 0	−0.062	(−1.636; 1.512)	1.0000	0.005	(−1.687; 1.697)	1.0000
Int versus Cont	−0.033	(−0.832; 0.767)	1.0000	−0.262	(−1.185; 0.661)	1.0000

Note: The estimates in the row "Int versus Cont" refer to the difference in the effect of each modifying factor on the change in depressive symptoms between the intervention group and the active control group. That is, if estimate is positive, it means that a high value in the modifying variable predicted a stronger increase in depressive symptoms at the follow-up point in intervention group (vs. control group). Instead, if estimate is negative, it means that having a high value in the modifying variable predicted a greater decrease in depressive symptoms at the follow-up point in intervention group (vs. control group). The estimates in the row "Int versus 0" refer to the difference in the effect of each modifying factor on depressive symptoms between the intervention group and the inactive control group.

Abbreviations: 0, inactive control group; Cont, active control group (relaxation group); Int, mindfulness intervention group.

[a]Estimates for 0.1-unit increase in the modifying variable.

[b]Estimates for 1-unit increase in the modifying variable.

This indicated that, in boys with at least mild depressive symptoms, low executive functions slightly increased the effectiveness of mindfulness-based intervention compared to relaxation program (but not when compared to the inactive control group) on depressive symptoms after 9 weeks. The results, however, must be treated with caution since the group size of boys in the inactive control group was small ($n = 9$).

3.4 | Supplementary analyses: Including also students with none or very mild depressive symptoms at baseline

As supplementary analysis, we reran the analyses among students with any rate of depressive symptoms (including also students with none or very mild depressive symptoms at baseline) ($n = 2937$).

Supporting Information Material shows the results among all students (Table S1), among girls (Table S2), and among boys (Table S3) with any rate of depressive symptoms at baseline. Among all students or among girls, no significant differences were found in the effect of the modifying factors on depressive symptoms either between the intervention group and the active control group (i.e., relaxation program group) or between the intervention group and the inactive control group (teaching as usual). That is, in the full sample or among girls, none of the factors under investigation (executive functions, rumination, acceptance, catastrophizing, positive reappraisal) modified the effectiveness of mindfulness-based intervention on depressive symptoms.

Among boys, a significant difference was found in the effect of acceptance on the change in depressive symptoms after 9 weeks between the intervention group and the active control group (relaxation program group) ($p = 0.0141$ without correction for multiple testing) but not between the intervention group and the inactive control group (teaching as usual). This indicated that high acceptance increased the effectiveness of mindfulness-based intervention (vs. relaxation program) on depressive symptoms after 9 weeks among boys. High acceptance was associated with decrease in depressive symptoms after 9 weeks in the intervention group ($p = 0.0017$), while this association was not significant in the active control group.

4 | DISCUSSION

This exploratory study identified three characteristics that may possibly increase the effectiveness of mindfulness intervention when aiming to reduce depressive symptoms in adolescents with at least mild depressive symptoms at baseline. This study was exploratory by nature, however, and the findings should be regarded as preliminary and need confirmation in further studies. First, we found that high acceptance may increase the effectiveness of mindfulness-based intervention (vs. relaxation program) on depressive symptoms after 9 weeks and after 26 weeks. Second, among boys, low executive functions may increase the effectiveness of mindfulness-based intervention (vs. relaxation program) on depressive symptoms after 9 weeks. Third, among girls, high catastrophizing may be associated with the effectiveness of mindfulness-based intervention (vs. relaxation program) on depressive symptoms after 9 weeks. Overall, the results provide preliminary evidence that the effectiveness of mindfulness intervention may be modified by individual differences in executive functions, rumination, acceptance, and catastrophizing. Nevertheless, as this study was exploratory and we did not use correction for multiple testing because it could have increased risk for type II error (Perneger, 1998), the findings should be treated with caution and more research is needed to draw any firm conclusions.

By definition, high acceptance refers to regulating emotions by accepting an on-going or previous situation and learning to live with it (i.e., consumes no effort to changing, suppressing, or controlling one's affective states) (Kohl et al., 2012). To date, there is evidence that the effectiveness of mindfulness interventions may be partially explained by alterations in acceptance levels (Cheung & Ng, 2019; Lindsay & Creswell, 2019). Our study, in turn, tentatively suggested that adolescents with high acceptance at baseline benefited more from the mindfulness than control intervention, in terms of reduced depressive symptoms. This was the most robust finding of our study since acceptance modified the effectiveness of mindfulness intervention at both 9-week and 6-month follow-ups. Interestingly, there is evidence that the effectiveness of compassion-related interventions is modified by one's attitudes toward compassion (Kirby et al., 2019). Similarly, it may be that high acceptance facilitates one's involvement in mindfulness-related practices that, in turn, enhances the effectiveness of mindfulness intervention.

Executive functioning may potentially be a trait that differentially modifies the effectiveness of mindfulness intervention among adults versus adolescents. Specifically, among adults, impulsivity is related to a decreased tendency to act with awareness during a mindfulness intervention (Maltais et al., 2020). This study among adolescents, in turn, found that boys with low executive functions at baseline (i.e., inattentiveness, carelessness, tendency to make mistakes, difficulties to follow guidelines and complete tasks) may reduce their depressive symptoms after the mindfulness-based intervention less than those in the relaxation intervention. It is necessary to consider, however, that this finding must be regarded as preliminary and needs confirmation in further studies. In other studies, mindfulness-based interventions are reported to effectively

reduce impulsivity among adolescents (Franco et al., 2016) but not among adults (Korponay et al., 2019). The stronger relationship between mindfulness training and executive functioning in adolescents may be partly explained by the maturation level of prefrontal brain regions: the frontal lobes have not reached their highest level of maturation yet in adolescence (Lenroot & Giedd, 2006), and mindfulness training is shown to enhance the functioning of the prefrontal regions (Ives-Deliperi et al., 2011; Lutz et al., 2014).

Our results suggested that the effectiveness of the mindfulness intervention may possibly be higher in girls with high (vs. low) tendency to catastrophizing (e.g., beliefs that one's experiences are the worst that can happen in life). This is in accordance with a previous study showing that mindfulness intervention alleviates mental distress more effectively in students with high (vs. low) neuroticism (de Vibe et al., 2015). It is possible that individuals with high neuroticism or a strong tendency to catastrophizing may experience strong affective states easily and frequently. This, in turn, is related to directing attention to emotions and having clearer conceptions of affective states (Thompson et al., 2009) that are typically in the focus of mindfulness interventions. However, as our sample was comparatively small and we did not use corrections for multiple testing, further studies are needed on this topic.

Contrary to our expectations, high rumination at baseline may not modify the effectiveness of the mindfulness intervention. This result may have several explanations. First, depressive symptoms include an individually varying and heterogeneous set of affective symptoms, somatic distortions, and difficulties in the level of functioning in every-day life. Previous studies suggest that rumination may differentially modify the effectiveness of mindfulness intervention against various symptoms (such as anger or aggression) (van de Weijer-Bergsma et al., 2014). In adolescence, depressive symptoms commonly include irritability or anger (APA, 2013) but, in this study, we did not examine different sets of depressive symptoms separately. Second, as rumination typically begins at 12 years of age but there is also individual variation (Jose & Brown, 2008), some of the youngest participants in our sample (aged 12 years) may have slightly under-reported their dispositional tendency to rumination. Finally, since rumination is typical for depressive symptoms, there may be some overlap between the rumination and depression questionnaires.

Regarding study limitations, this study was based on a school-based intervention for school-aged children and adolescents (aged between 12 and 15 years) who had mostly mild and nonclinical depressive symptoms. Hence, the results cannot be directly generalized other age groups or populations with clinical depressive disorders. Second, as this study was exploratory by nature and our sample was comparatively small, we did not use correction for multiple testing. This was done to reduce likelihood for type II error (i.e., dismissing truly important findings). Hence, the results must be regarded as preliminary and more research is needed in larger samples to test the robustness of the associations. Third, the inactive control group was comparatively small ($n = 46$), especially with regard to boys ($n = 9$). Hence, the results concerning boys in the inactive control group must be regarded as preliminary, and more research is needed in larger samples.

Additionally, in our data, executive functioning, rumination, and emotion regulation were assessed only at the baseline. Those traits, however, may change during mindfulness interventions to some degree (Chi et al., 2018). For example, there may be developmental changes in executive functioning, evoked by, for example, environmental factors (Friedman et al., 2016). Furthermore, emotion regulation strategies are found to change over teenage years, including a decrease in adaptive regulation strategies between the ages of 11–15 years (Cracco et al., 2017; Zimmermann & Iwanski, 2014). Hence, studies with repeated measurements of these characteristics are needed.

Finally, it is necessary to note that most of the effects of the mindfulness intervention on depressive symptoms were evident only after 9 weeks but not after 26 weeks. It has been common also previously that the effects of mindfulness-based interventions have not been evident on long-term outcomes after the intervention has ceased (Chi et al., 2018; Eisendrath et al., 2016). One reason for this may be a lack of statistical power at follow-ups, as has been suggested previously (Chi et al., 2018). Also, our sample was comparatively under-powered so that stronger moderation effects could likely be obtained in larger samples. Nevertheless, it is a crucial question whether the long-term effectiveness of mindfulness-based interventions could be somehow enhanced. Future studies could further investigate whether the training sessions should be slightly longer (in this study, the home sessions last for 3–15 min) or more strongly linked to a participants' daily routines (to ensure continuity of mindfulness training). Indeed, there is evidence that home practice is related to intervention outcomes (Parsons et al., 2017) and, in this intervention, the amount of continued home practice was suboptimal among most participants (Beattie et al., 2020). Importantly, the long-term effects of mindfulness training could also be enhanced by providing the intervention for specific subgroups of adolescents who would most benefit from the intervention.

CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

ETHICS STATEMENT

The study protocol has been approved in the ethical review board of the University of Helsinki (in humanities and social and behavioral sciences), Statement 1/2014. The study protocol has also been reviewed and approved in the educational departments of the respective school districts. A written informed consent is requested from all participants and their parents. The linkage of the survey data to national health registries will be carried out based on appropriate authority and participant consent. The participants were informed that the participation in the study is voluntary and that they may withdraw from the study at any time without giving a reason. Also the teachers received their letter of invitation where information regarding, for example, the questionnaires and difficult feelings that some questions may raise in some children was presented. The teachers were at the classrooms while participants filled in the questionnaires and during the intervention and control treatment sessions. Parents filled in their questionnaire at home, and brought it in a closed envelope to school from where researchers collect them as well as teachers' questionnaires.

DATA AVAILABILITY STATEMENT

Data is available from the authors on request.

ORCID

Aino Saarinen http://orcid.org/0000-0003-4495-8360

REFERENCES

APA. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). American Psychiatric Association.

Beattie, M. M., Konttinen, H. M., Volanen, S. M., Knittle, K. P., & Hankonen, N. E. (2020). Social cognitions and mental health as predictors of adolescents' mindfulness practice. *Mindfulness*, 11(5), 1204–1217. https://doi.org/10.1007/s12671-020-01331-8

Beck, A. T., Steer, R. A., & Carbin, M. G. (1988). Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clinical Psychology Review*, 8, 77–100.

Bertha, E. A., & Balázs, J. (2013). Subthreshold depression in adolescence: A systematic review. *European Child and Adolescent Psychiatry*, 22(10), 589–603. https://doi.org/10.1007/s00787-013-0411-0

Bluth, K., Roberson, P. N. E., & Girdler, S. S. (2017). Adolescent sex differences in response to a mindfulness intervention: A call for research. *Journal of Child and Family Studies*, 26(7), 1900–1914. https://doi.org/10.1007/s10826-017-0696-6

Bohlin, G., & Janols, L. O. (2004). Behavioural problems and psychiatric symptoms in 5-13 year-old Swedish children—A comparison of parent ratings on the FTF (Five to Fifteen) with the ratings on CBCL (Child Behavior Checklist). *European Child & Adolescent Psychiatry*, 13, 14–22. https://doi.org/10.1007/s00787-004-3003-1

Borders, A., Earleywine, M., & Jajodia, A. (2010). Could mindfulness decrease anger, hostility, and aggression by decreasing rumination? *Aggressive Behavior*, 36(1), 28–44. https://doi.org/10.1002/ab.20327

Caldwell, D. M., Davies, S. R., Hetrick, S. E., Palmer, J. C., Caro, P., López-López, J. A., Gunnell, D., Kidger, J., Thomas, J., French, C., Stockings, E., Campbell, R., & Welton, N. J. (2019). School-based interventions to prevent anxiety and depression in children and young people: A systematic review and network meta-analysis. *Lancet Psychiatry*, 6(12), 1011–1020. https://doi.org/10.1016/s2215-0366(19)30403-1

Carsley, D., Khoury, B., & Heath, N. L. (2018). Effectiveness of mindfulness interventions for mental health in schools: A comprehensive meta-analysis. *Mindfulness*, 9(3), 693–707. https://doi.org/10.1007/s12671-017-0839-2

Cheung, R. Y. M., & Ng, M. C. Y. (2019). Mindfulness and symptoms of depression and anxiety: The underlying roles of awareness, acceptance, impulse control, and emotion regulation. *Mindfulness*, 10(6), 1124–1135. https://doi.org/10.1007/s12671-018-1069-y

Chi, X. L., Bo, A., Liu, T. T., Zhang, P. C., & Chi, I. (2018). Effects of mindfulness-based stress reduction on depression in adolescents and young adults: A systematic review and meta-analysis. *Frontiers in Psychology*, 9, 1034. https://doi.org/10.3389/fpsyg.2018.01034

Colgan, D. D., Christopher, M., Michael, P., & Wahbeh, H. (2016). The body scan and mindful breathing among veterans with PTSD: Type of intervention moderates the relationship between changes in mindfulness and post-treatment depression. *Mindfulness*, 7(2), 372–383. https://doi.org/10.1007/s12671-015-0453-0

Cracco, E., Goossens, L., & Braet, C. (2017). Emotion regulation across childhood and adolescence: Evidence for a maladaptive shift in adolescence. *European Child & Adolescent Psychiatry*, 26(8), 909–921. https://doi.org/10.1007/s00787-017-0952-8

Eisendrath, S. J., Gillung, E., Delucchi, K. L., Segal, Z. V., Nelson, J. C., McInnes, L. A., Mathalon, D. H., & Feldman, M. D. (2016). A randomized controlled trial of mindfulness-based cognitive therapy for treatment-resistant depression. *Psychotherapy and Psychosomatics*, 85(2), 99–110. https://doi.org/10.1159/000442260

Falsafi, N. (2016). A randomized controlled trial of mindfulness versus yoga: Effects on depression and/or anxiety in college students. *Journal of the American Psychiatric Nurses Association*, 22(6), 483–497. https://doi.org/10.1177/1078390316663307

Fortney, L., Luchterhand, C., Zakletskaia, L., Zgierska, A., & Rakel, D. (2013). Abbreviated mindfulness intervention for job satisfaction, quality of life, and compassion in primary care clinicians: A pilot study. *Annals of Family Medicine*, 11(5), 412–420. https://doi.org/10.1370/afm.1511

Franco, C., Amutio, A., López-González, L., Oriol, X., & Martínez-Taboada, C. (2016). Effect of a mindfulness training program on the impulsivity and aggression levels of adolescents with behavioral problems in the classroom. *Frontiers in Psychology*, 7, 1385. https://doi.org/10.3389/fpsyg.2016.01385

Friedman, N. P., Miyake, A., Altamirano, L. J., Corley, R. P., Young, S. E., Rhea, S. A., & Hewitt, J. K. (2016). Stability and change in executive function abilities from late adolescence to early adulthood: A longitudinal twin study. *Developmental Psychology*, 52(2), 326–340. https://doi.org/10.1037/dev0000075

Fung, J., Kim, J. J., Jin, J., Chen, G., Bear, L., & Lau, A. S. (2019). A randomized trial evaluating school-based mindfulness intervention for ethnic minority youth: Exploring mediators and moderators of intervention effects. *Journal of Abnormal Child Psychology*, *47*(1), 1–19. https://doi.org/10.1007/s10802-018-0425-7

Garnefski, N., & Kraaij, V. (2007). The Cognitive Emotion Regulation Questionnaire–Psychometric features and prospective relationships with depression and anxiety in adults. *European Journal of Psychological Assessment*, *23*(3), 141–149. https://doi.org/10.1027/1015-5759.23.3.141

Han, G., Helm, J., Iucha, C., Zahn-Waxler, C., Hastings, P. D., & Klimes-Dougan, B. (2016). Are executive functioning deficits concurrently and predictively associated with depressive and anxiety symptoms in adolescents? *Journal of Clinical Child and Adolescent Psychology*, *45*(1), 44–58. https://doi.org/10.1080/15374416.2015.1041592

Holsen, I., Kraft, P., & Vitterso, J. (2000). Stability in depressed mood in adolescence: Results from a 6-year longitudinal panel study. *Journal of Youth and Adolescence*, *29*(1), 61–78. https://doi.org/10.1023/a:1005121121721

Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How does mindfulness meditation work? proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on Psychological Science: A Journal of the Association for Psychological Science*, *6*(6), 537–559. https://doi.org/10.1177/1745691611419671

Horowitz, J. L., & Garber, J. (2006). The prevention of depressive symptoms in children and adolescents: A meta-analytic review. *Journal of Consulting and Clinical Psychology*, *74*(3), 401–415. https://doi.org/10.1037/0022-006x.74.3.401

Huppert, F. A., & Johnson, D. M. (2010). A controlled trial of mindfulness training in schools: The importance of practice for an impact on well-being. *Journal of Positive Psychology*, *5*(4), 264–274. https://doi.org/10.1080/17439761003794148

Ives-Deliperi, V. L., Solms, M., & Meintjes, E. M. (2011). The neural substrates of mindfulness: An fMRI investigation. *Social Neuroscience*, *6*(3), 231–242. https://doi.org/10.1080/17470919.2010.513495

Jermann, F., der Linden, V., d'Acremont, M., Zermatten, M., & A. (2006). Cognitive Emotion Regulation Questionnaire (CERQ)—Confirmatory factor analysis and psychometric properties of the French translation. *European Journal of Psychological Assessment*, *22*(2), 126–131. https://doi.org/10.1027/1015-5759.22.2.126

Johnson, C., Burke, C., Brinkman, S., & Wade, T. (2016). Effectiveness of a school-based mindfulness program for transdiagnostic prevention in young adolescents. *Behaviour Research and Therapy*, *81*, 1–11. https://doi.org/10.1016/j.brat.2016.03.002

Jose, P. E., & Brown, I. (2008). When does the gender difference in rumination begin? Gender and age differences in the use of rumination by adolescents. *Journal of Youth and Adolescence*, *37*, 180–192.

Kaltiala-Heino, R., Rimpela, M., Rantanen, P., & Laippala, P. (1999). Finnish modification of the 13-item Beck Depression Inventory in screening an adolescent population for depressiveness and positive mood. *Nordic Journal of Psychiatry*, *53*(6), 451–457. https://doi.org/10.1080/080394899427700

Kang, Y., Rahrig, H., Eichel, K., Niles, H. F., Rocha, T., Lepp, N. E., Gold, J., & Britton, W. B. (2018). Gender differences in response to a school-based mindfulness training intervention for early adolescents. *Journal of School Psychology*, *68*, 163–176. https://doi.org/10.1016/j.jsp.2018.03.004

Khoury, B., Lecomte, T., Fortin, G., Masse, M., Therien, P., Bouchard, V., Chapleau, M. A., Paquin, K., & Hofmann, S. G. (2013). Mindfulness-based therapy: A comprehensive meta-analysis. *Clinical Psychology Review*, *33*(6), 763–771. https://doi.org/10.1016/j.cpr.2013.05.005

Kirby, J. N., Seppälä, E., Wilks, M., Cameron, C. D., Tellegen, C. L., Nguyen, D. T., & Doty, J. (2019). Positive and negative attitudes towards compassion predict compassionate outcomes. *Current Psychology*. https://doi.org/10.1007/s12144-019-00405-8

Kohl, A., Rief, W., & Glombiewski, J. A. (2012). How effective are acceptance strategies? A meta-analytic review of experimental results. *Journal of Behavior Therapy and Experimental Psychiatry*, *43*(4), 988–1001. https://doi.org/10.1016/j.jbtep.2012.03.004

Korkman, M., Kadesjö, B., Trillingsgaard, A., Janols, L. O., Michelsson, K., Strand, G., & Gillberg, C. (2004). *Viivi (5–15)-käsikirja. Kyselylomake vanhemmille 5–15-vuotiaiden kehityksestä ja käyttäytymisestä.*

Korponay, C., Dentico, D., Kral, T., Ly, M., Kruis, A., Davis, K., Goldman, R., Lutz, A., & Davidson, R. J. (2019). The effect of mindfulness meditation on impulsivity and its neurobiological correlates in healthy adults. *Scientific Reports*, *9*(1), 11963. https://doi.org/10.1038/s41598-019-47662-y

Kosunen, E., Kaltiala-Heino, R., Rimpelä, M., & Laippala, P. (2003). Risk-taking sexual behaviour and self-reported depression in middle adolescence—A school-based survey. *Child: Care, Health and Development*, *29*(5), 337–344. https://doi.org/10.1046/j.1365-2214.2003.00357.x

Lam, K. (2016). School-based cognitive mindfulness intervention for internalizing problems: Pilot study with Hong Kong elementary students. *Journal of Child and Family Studies*, *25*(11), 3293–3308. https://doi.org/10.1007/s10826-016-0483-9

Larson, R. W., Moneta, G., Richards, M. H., & Wilson, S. (2002). Continuity, stability, and change in daily emotional experience across adolescence. *Child Development*, *73*(4), 1151–1165. https://doi.org/10.1111/1467-8624.00464

Lassander, M., Hintsanen, M., Suominen, S., Mullola, S., Vahlberg, T., & Volanen, S. M. (2021). Effects of school-based mindfulness intervention on health-related quality of life: Moderating effect of gender, grade, and independent practice in cluster randomized controlled trial. *Quality of Life Research*, *30*, 3407–3419. https://doi.org/10.1007/s11136-021-02868-4

Leary, M. R., & Tate, E. B. (2007). The multi-faceted nature of mindfulness. *Psychological Inquiry*, *18*(4), 251–255. https://doi.org/10.1080/10478400701598355

Lenroot, R. K., & Giedd, J. N. (2006). Brain development in children and adolescents: Insights from anatomical magnetic resonance imaging. *Neuroscience and Biobehavioral Reviews*, *30*(6), 718–729. https://doi.org/10.1016/j.neubiorev.2006.06.001

Lifshitz, M., Sacchet, M. D., Huntenburg, J. M., Thiery, T., Fan, Y., Gärtner, M., Grimm, S., Winnebeck, E., Fissler, M., Schroeter, T. A., Margulies, D. S., & Barnhofer, T. (2019). Mindfulness-based therapy regulates brain connectivity in major depression. *Psychotherapy and Psychosomatics*, *88*(6), 375–377. https://doi.org/10.1159/000501170

Lindsay, E. K., & Creswell, J. D. (2019). Mindfulness, acceptance, and emotion regulation: Perspectives from Monitor and Acceptance Theory (MAT). *Current Opinion in Psychology*, *28*, 120–125. https://doi.org/10.1016/j.copsyc.2018.12.004

Lutz, J., Herwig, U., Opialla, S., Hittmeyer, A., Jäncke, L., Rufer, M., Grosse Holtforth, M., & Brühl, A. B. (2014). Mindfulness and emotion regulation—An fMRI study. *Social Cognitive and Affective Neuroscience*, *9*(6), 776–785. https://doi.org/10.1093/scan/nst043

Maltais, M., Bouchard, G., & Saint-Aubin, J. (2020). Predicting mindfulness facets: An examination of executive control, neuroticism, and impulsivity. *Canadian Journal of Behavioural Science-Revue Canadienne Des Sciences Du Comportement*, *52*(1), 1–7. https://doi.org/10.1037/cbs0000152

Mendelson, T., Greenberg, M. T., Dariotis, J. K., Gould, L. F., Rhoades, B. L., & Leaf, P. J. (2010). Feasibility and preliminary outcomes of a school-based mindfulness intervention for urban youth. *Journal of Abnormal Child Psychology*, *38*(7), 985–994. https://doi.org/10.1007/s10802-010-9418-x

Mojtabai, R., Olfson, M., & Han, B. (2016). National trends in the prevalence and treatment of depression in adolescents and young adults. *Pediatrics*, *138*(6). https://doi.org/10.1542/peds.2016-1878

Parmentier, F. B. R., Garcia-Toro, M., Garcia-Campayo, J., Yanez, A. M., Andres, P., & Gili, M. (2019). Mindfulness and symptoms of depression and anxiety in the general population: The mediating roles of worry, rumination, reappraisal and suppression. *Frontiers in Psychology*, 10, 10. https://doi.org/10.3389/fpsyg.2019.00506

Parsons, C. E., Crane, C., Parsons, L. J., Fjorback, L. O., & Kuyken, W. (2017). Home practice in mindfulness-based cognitive therapy and mindfulness-based stress reduction: A systematic review and meta-analysis of participants' mindfulness practice and its association with outcomes. *Behaviour Research and Therapy*, 95, 29–41. https://doi.org/10.1016/j.brat.2017.05.004

Perneger, T. V. (1998). What's wrong with Bonferroni adjustments. *BMJ*, 316(7139), 1236–1238. https://doi.org/10.1136/bmj.316.7139.1236

Querstret, D., Cropley, M., & Fife-Schaw, C. (2018). The effects of an online mindfulness intervention on perceived stress, depression and anxiety in a non-clinical sample: A randomised waitlist control trial. *Mindfulness*, 9(6), 1825–1836. https://doi.org/10.1007/s12671-018-0925-0

Raes, F., Griffith, J. W., Van der Gucht, K., & Williams, J. M. G. (2014). School-based prevention and reduction of depression in adolescents: A cluster-Randomized Controlled Trial of a Mindfulness Group Program. *Mindfulness*, 5(5), 477–486. https://doi.org/10.1007/s12671-013-0202-1

Raitasalo, R. (2007). *Mielialakysely. Suomen oloihin Beckin lyhyen depressiokyselyn pohjalta kehitetty masennusoireilun ja itsetunnon kysely.* Retrieved from Helsinki.

Romer, D., Reyna, V. F., & Satterthwaite, T. D. (2017). Beyond stereotypes of adolescent risk taking: Placing the adolescent brain in developmental context. *Developmental Cognitive Neuroscience*, 27, 19–34. https://doi.org/10.1016/j.dcn.2017.07.007

Rood, L., Roelofs, J., Bogels, S. M., Nolen-Hoeksema, S., & Schouten, E. (2009). The influence of emotion-focused rumination and distraction on depressive symptoms in non-clinical youth: A meta-analytic review. *Clinical Psychology Review*, 29(7), 607–616. https://doi.org/10.1016/j.cpr.2009.07.001

Saluja, G., Iachan, R., Scheidt, P. C., Overpeck, M. D., Sun, W. Y., & Giedd, J. N. (2004). Prevalence of and risk factors for depressive symptoms among young adolescents. *Archives of Pediatrics & Adolescent Medicine*, 158(8), 760–765. https://doi.org/10.1001/archpedi.158.8.760

Sass, S. M., Berenbaum, H., & Abrams, E. M. (2013). Discomfort with emotion moderates distress reduction in a brief mindfulness intervention. *International Journal of Behavioral Consultation and Therapy*, 7(4), 24–27.

Schonert-Reichl, K. A., Oberle, E., Lawlor, M. S., Abbott, D., Thomson, K., Oberlander, T. F., & Diamond, A. (2015). Enhancing cognitive and social-emotional development through a simple-to-administer mindfulness-based school program for elementary school children: A randomized controlled trial. *Developmental Psychology*, 51(1), 52–66. https://doi.org/10.1037/a0038454

Schweizer, S., Gotlib, I. H., & Blakemore, S. J. (2020). The role of affective control in emotion regulation during adolescence. *Emotion*, 20(1), 80–86. https://doi.org/10.1037/emo0000695

Sephton, S. E., Salmon, P., Weissbecker, I., Ulmer, C., Floyd, A., Hoover, K., & Studts, J. L. (2007). Mindfulness meditation alleviates depressive symptoms in women with fibromyalgia: Results of a randomized clinical trial. *Arthritis & Rheumatism-Arthritis Care & Research*, 57(1), 77–85. https://doi.org/10.1002/art.22478

Sibinga, E. M., Webb, L., Ghazarian, S. R., & Ellen, J. M. (2016). School-based mindfulness instruction: An RCT. *Pediatrics*, 137(1). https://doi.org/10.1542/peds.2015-2532

Sibinga, E. M. S., Perry-Parrish, C., Chung, S. E., Johnson, S. B., Smith, M., & Ellen, J. M. (2013). School-based mindfulness instruction for urban male youth: A small randomized controlled trial. *Preventive Medicine*, 57(6), 799–801. https://doi.org/10.1016/j.ypmed.2013.08.027

Silk, J. S., Steinberg, L., & Morris, A. S. (2003). Adolescents' emotion regulation in daily life: Links to depressive symptoms and problem behavior. *Child Development*, 74(6), 1869–1880. https://doi.org/10.1046/j.1467-8624.2003.00643.x

Smith, B. W., Shelley, B. M., Leahigh, L., & Vanleit, B. (2006). A preliminary study of the effects of a modified mindfulness intervention on binge eatin. *Complementary Health Practice Review*, 11, 133–143.

Spijkerman, M. P., Pots, W. T., & Bohlmeijer, E. T. (2016). Effectiveness of online mindfulness-based interventions in improving mental health: A review and meta-analysis of randomised controlled trials. *Clinical Psychology Review*, 45, 102–114. https://doi.org/10.1016/j.cpr.2016.03.009

Thompson, R. J., Dizén, M., & Berenbaum, H. (2009). The unique relations between emotional awareness and facets of affective instability. *Journal of Research in Personality*, 43(5), 875–879. https://doi.org/10.1016/j.jrp.2009.07.006

Tram, J. M., & Cole, D. A. (2006). A multimethod examination of the stability of depressive symptoms in childhood and adolescence. *Journal of Abnormal Psychology*, 115(4), 674–686. https://doi.org/10.1037/0021-843x.115.4.674

Trapnell, P. D., & Campbell, J. D. (1999). Private self-consciousness and the five-factor model of personality: Distinguishing rumination from reflection. *Journal of Personality and Social Psychology*, 76(2), 284–304. https://doi.org/10.1037/0022-3514.76.2.284

Twenge, J. M., Joiner, T. E., Rogers, M. L., & Martin, G. N. (2012). Cognitive-affective neural plasticity following active-controlled mindfulness intervention. *Journal of Neuroscience*, 32(44), 15601–15610. https://doi.org/10.1523/jneurosci.2957-12.2012

Twenge, J. M., Joiner, T. E., Rogers, M. L., & Martin, G. N. (2018). Increases in depressive symptoms, suicide-related outcomes, and suicide rates among US adolescents after 2010 and links to increased new media screen time. *Clinical Psychological Science*, 6, 3–17.

de Vibe, M., Solhaug, I., Tyssen, R., Friborg, O., Rosenvinge, J. H., Sørlie, T., & Bjørndal, A. (2013). Mindfulness training for stress management: A randomised controlled study of medical and psychology students. *BMC Medical Education*, 13, 107. https://doi.org/10.1186/1472-6920-13-107

de Vibe, M., Solhaug, I., Tyssen, R., Friborg, O., Rosenvinge, J. H., Sørlie, T., Halland, E., & Bjørndal, A. (2015). Does personality moderate the effects of mindfulness training for medical and psychology students? *Mindfulness*, 6(2), 281–289. https://doi.org/10.1007/s12671-013-0258-y

Volanen, S. M., Lassander, M., Hankonen, N., Santalahti, P., Hintsanen, M., Simonsen, N., Raevuori, A., Mullola, S., Vahlberg, T., But, A., & Ssuominen, S. (2020). Healthy learning mind-effectiveness of a mindfulness program on mental health compared to a relaxation program and teaching as usual in schools: A cluster-randomised controlled trial. *Journal of Affective Disorders*, 260, 660–669. https://doi.org/10.1016/j.jad.2019.08.087

Volanen, S. M., Lassander, M., Hankonen, N., Santalahti, P., Hintsanen, M., Simonsen, N., Raevuori, A., Mullola, S., Vahlberg, T., But, A., & Suominen, S. (2016). Healthy learning mind—A school-based mindfulness and relaxation program: A study protocol for a cluster randomized controlled trial. *BMC Psychology*, 4(1), 35. https://doi.org/10.1186/s40359-016-0142-3

van de Weijer-Bergsma, E., Langenberg, G., Brandsma, R., Oort, F. J., & Bogels, S. M. (2014). The effectiveness of a school-based mindfulness training as a program to prevent stress in elementary school children. *Mindfulness*, 5(3), 238–248. https://doi.org/10.1007/s12671-012-0171-9

Winnebeck, E., Fissler, M., Gärtner, M., Chadwick, P., & Barnhofer, T. (2017). Brief training in mindfulness meditation reduces symptoms in patients with a chronic or recurrent lifetime history of depression: A randomized controlled study. *Behaviour Research and Therapy*, 99, 124–130. https://doi.org/10.1016/j.brat.2017.10.005

Witkiewitz, K., & Bowen, S. (2010). Depression, craving, and substance use following a randomized trial of mindfulness-based relapse prevention. *Journal of Consulting and Clinical Psychology*, 78(3), 362–374. https://doi.org/10.1037/a0019172

Zimmermann, P., & Iwanski, A. (2014). Emotion regulation from early adolescence to emerging adulthood and middle adulthood Age differences, gender differences, and emotion-specific developmental variations. *International Journal of Behavioral Development*, *38*(2), 182–194. https://doi.org/10.1177/0165025413515405

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

How to cite this article: Saarinen, A., Hintsanen, M., Vahlberg, T., Hankonen, N., & Volanen, S.-M. (2022). School-based mindfulness intervention for depressive symptoms in adolescence: For whom is it most effective? *Journal of Adolescence*, 94, 118–132. https://doi.org/10.1002/jad.12011