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A Mindfulness-Based Intervention Pilot Feasibility Study for Elementary School Students With Severe Learning Difficulties: Effects on Internalized and Externalized Symptoms From an Emotional Regulation Perspective

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Abstract

Objective. Students with severe learning disabilities often show signs of anxiety, depression, and problem behaviors such as inattention and conduct problems. Mindfulness-based interventions (MBIs) in school settings constitute a promising option to alleviate these co-occurring symptoms. This pilot study aimed to evaluate the impact of an MBI on symptoms and behaviors of elementary school students with severe learning disabilities. *Method.* A one-group pretest-posttest design was used. The sample comprised 14 students aged 9 to 12 years with special education needs. Both student-report and teacher-report of the Behavior Assessment System for Children, Second Edition were used. *Results.* Repeated-measures analyses of variance revealed a significant impact of the MBI on symptoms and behaviors such as anxiety, depression, inattention, aggression, and conduct problems. Effect sizes for all variables were considered large (partial $\eta^2 = .31$-$.61$). *Conclusion.* These preliminary results indicate that MBIs can reduce the frequency of symptoms and problem behaviors often found in children with learning disabilities in elementary schools. Further multiple baseline experimental trials with a long-term follow-up are warranted to establish more robustly the effect of MBIs for children with learning disabilities.

Keywords

mindfulness-based meditation, learning disabilities, anxiety, depression, inattention, hyperactivity, school psychology

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Approximately 4.8% of American students and 3.2% of Canadian students have a learning disability (LD) diagnosis.[1,2] Learning disabilities can be defined as "a neurological condition that interferes with an individual's ability to store, process, or produce information."[3] Students with severe LDs present major delays in reading, writing, and mathematics and see their school outcomes strongly affected by these difficulties. Further deficits in memory, attention, psychomotor coordination, and emotional maturity can be observed. These students also often show signs of psychological distress, demoralization, low self-esteem, and social skills deficits.[4] Furthermore, many of these children present comorbid diagnoses of conduct and oppositional disorders, attention deficit and hyperactivity disorder (ADHD), or major depressive disorder. These difficulties can all be linked to deficits in emotional regulation skills. Although students with special education needs receive professional help

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for their LD, psychological support is seldom offered. Faced with such an important proportion of comorbidities, it appears crucial to develop skill-based interventions adapted to children with severe LDs in special education classes. Mindfulness-based interventions (MBIs), initially developed to improve quality of life in patients suffering from chronic illnesses,[5] are increasingly appearing in school settings and constitute a promising option to foster self-regulation and reduce the burden of LDs.[6] The goal of this pilot study was thus to evaluate the feasibility and impact of an MBI on anxiety, depression, hyperactivity, aggression, attention, and conduct problems in elementary school students with severe LDs.

Mindfulness-Based Interventions, Emotion Regulation, and Behavior

Mindfulness is defined as the process by which we "[pay] attention in a particular way: on purpose, in the present moment, and nonjudgmentally."[7] MBIs aim to help people bring focus to the present moment and awareness to all aspects of experience—the positive and the negative. They also focus on bringing awareness to the different physical, cognitive, and emotional manifestations of stress.[8,9] They are thought to help target disengagement from unpleasant emotions, behavior modification associated with inadequate processing of emotions, and the decreasing of avoidance through exposure to unpleasant emotions.[10,11]

Mechanisms of mindfulness have been linked to emotional regulation skills.[12] Emotional regulation can be defined as "extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goals."[13] Optimal emotional regulation abilities are thought to lead to adaptive functioning and to good mental health, which lead to acceptable social behavior. Individuals with emotional regulation difficulties are thought to have problems processing, experiencing, and expressing emotions optimally, deploying efforts to modify or suppress unpleasant emotions.[14] Past research has suggested that mindfulness is linked to better emotional regulation in adults, namely through decreases in rumination and increases in social skills.[12,14,15] A mixed-methods study using concept mapping indicated that mindfulness was also linked to improvements in emotional coping in alternative high school students.[16]

MBI research in youth is still in its early phase. To date, most MBIs have been tested in elementary school settings with the aim of improving resilience to stress and decreasing depression and anxiety symptoms.[17] Results from a recent meta-analysis tend to indicate that MBIs have a greater impact in youth from clinical populations than in youth from subclinical populations, and that they affect psychological variables more than physiological ones.[18] The emerging pediatric research suggests promising results in decreasing anxiety, fatigue, and depressive symptoms in adolescents with depressive and sleep disorders.[19-22] Recent work has also shown a positive impact of MBIs on outcomes such as truancy and school suspensions, compliance to school rules, sustained attention in the classroom, emotional and behavioral self-regulation, and prosocial behavior both in elementary and high school students.[16,23-28]

Furthermore, MBIs have shown a positive impact on hyperactivity symptoms in elementary school students with ADHD.[29] Similar results were found on conduct disorder symptoms in teenagers.[30] MBIs were also linked to less stress, rumination, intrusive thoughts, and worry, along with aggression and impulsive behaviors in elementary students from disadvantaged areas.[31] In a sample of male teenagers ($n = 60$) with learning disabilities and comorbid ADHD or anxiety, a mindfulness and martial arts intervention was linked to less frequent oppositional behaviors when compared to wait-list controls.[32] Subsample analyses further indicated that boys with important co-occurring inattention and hyperactive symptoms showed decreases in behavioral problems and increases in self-monitoring skills, as reported by their parents. Boys with elevated anxiety showed significant decreases in anxiety postintervention.

Students with LDs and suboptimal emotional regulation skills are at risk of experiencing lower academic performance and progress, leading to poorer prognoses over time, such as heightened risk of dropping out of school, adjustment problems, and difficulties in job placement in adulthood.[4,33] Moreover, these students often display more behavioral problems than others, and these tend to increase over time. Concomitant LDs and emotional regulation difficulties can thus lead to pervasive problems in psychological functioning. Overall, children with LDs display more emotional regulation difficulties than their counterparts without LDs.[34] On the other hand, LD students with optimal emotional regulation skills have better prognoses, namely, in regard to social functioning and decision-making.

There is a paucity of skills-based interventions targeting the alleviation of psychosocial problems in children with LDs. Many of these programs have focused on social skills training and, in turn, have failed to provide robust evidence of their usefulness in decreasing behavioral, social, and emotional problems in these children, with the exception of one study by Kam and colleagues.[35-37] In this study, in which the impact of an intervention based on promoting emotional development, self-regulation, and social skills (no teaching of mindfulness skills) on elementary school students ($n = 133$) from grades 1 to 3 in special education classes was evaluated, results from teacher-reported data showed decreases in both internalized (eg, anxiety, depression, withdrawal, and somatic symptoms) and externalized (eg, rule-breaking and aggression symptoms) behaviors, and results from child-reported data showed decreases in depressive symptoms.[37] However, the sample in this study included students with LDs, mild intellectual disability, emotional and behavioral disorders, physical disabilities, and health impairments, highlighting the need for further research on interventions focused on emotion regulation and specifically tailored to children with LDs. To our knowledge, only one quasi-experimental feasibility study with one group and no control group reported results of a MBI for teenagers

with LDs (n = 34) and suggested that it could be useful to decrease anxiety, promote better social skills, and improve academic performance (indicated in teacher-reports).[38] However, MBIs have not yet been used with elementary school children with LDs in special education classes with the aim of decreasing psychological symptoms in these students.

Present Study

This article presents results from a pilot study designed to evaluate the feasibility and impact of a MBI on behavior problems of elementary school students with severe LDs. Given the large amount of students with LDs for whom depressive, anxious, inattentive, and behavioral symptoms co-occur, the primary aim of this project was to evaluate whether a mindfulness intervention could alleviate these symptoms. We hypothesized that our MBI would have a significant and positive effect on both internalized (anxiety, depression) and externalized (hyperactivity, aggression, attention, and conduct problems) symptoms in these youth. A multi-informant approach was used in this project; both student and teacher report forms were collected.

Methods

Design

A quasi-experimental one-group pretest-posttest design was used. This design, common in pilot studies to assess the impact of a novel intervention, was chosen to assess the effect of a MBI for students with special education needs, namely, to evaluate if it would have a positive impact on internalized and externalized symptoms in elementary students with LDs. Additionally, this design is often used when a small pool of participants is available, which was the case with this pilot, where students from only one LDs class were targeted.[39,40] Furthermore, this design was also chosen because a control condition was unavailable at the time of conducting this project.[41] This pilot was conducted in collaboration with a school board and elementary school from Montreal, Canada. Ethics approval was obtained from all institutions involved.

Participants

A total of 14 elementary school students aged 9 to 12 years from a LD special education class participated in this study, along with their teacher. All students from this class took part in this project. Participants from this study attended an elementary school in the disadvantaged neighborhood of Montreal-North, Montreal, Canada. This elementary school is ranked highest on the deprivation index of the province of Quebec, and approximately 55% of families attending this school have incomes near or below the low-income threshold.[42] As such, children with LDs in this school are especially at risk for dropout. All participants matched the following criteria: they were experiencing persistent difficulties in reading, writing, and mathematics and presented a delay of 2 academic years or more in all of these areas. They all had borderline intellectual functioning, as shown by extensive evaluation of their cognitive abilities. Support measures put in place by their school, such as differentiation, rehabilitation, remedial education, and pedagogical adaptations, had not helped them progress in their learning. Additionally, students in this class had to be previously assessed by a psychologist and/or a speech-language pathologist in order to confirm the presence of a LD and exclude the possibility of a speech pathology. For the purposes of this study, participants had to be willing to participate in an 8-week mindfulness meditation program and be available to answer questionnaires at pretest and at posttest. Their teacher had to be available to fill out one questionnaire per student at both assessment periods. As this project was conducted in French, participants were required to speak and understand the language. No attrition was experienced in this pilot; all students and their teacher filled out pre- and postintervention questionnaires.

Mindfulness-Based Intervention

The intervention that was used in this study was adapted from previous work from the first author.[43] Specifically, this intervention was inspired by Mindfulness-Based Cognitive Therapy protocols developed by a team at the *Centre de consultation psychologique specialisé* of the Université Catholique de Louvain (Center for Specialized Psychological Consultation, Catholic University of Leuven, Belgium).[44] The intervention manual was reviewed and approved by 3 clinical psychology faculty with knowledge of mindfulness. A trained therapist, who was assisted by the school social worker, led the intervention. The therapist, first author of this article, was a graduate trainee in psychology with MBSR-Teens training and previous mindfulness groups experience in pediatric oncology. The mindfulness-based intervention lasted 8 weeks. Sessions were audiotaped and reviewed for the validity of the intervention by a clinical psychologist with expertise in mindfulness and cognitive-behavioral therapy. The therapist and the school social worker received 1 hour of group clinical supervision before and following each intervention session to ensure implementation validity. The external reviewer confirmed that all curriculum objectives were met for the 8 mindfulness sessions. Thus, teaching was deemed adequate to adhere to a standard that could assure implementation validity.

The mindfulness group met once a week for 60 minutes. The duration of each session was adapted to (1) fit one daily classroom period, hence facilitating the implantation of this project, and (2) offer a developmentally appropriate intervention specifically targeted to match elementary school students' shorter attention span. Weekly sessions included introduction to mindful eating, body scan, and breathing meditations, along with the observation of thoughts, physical sensations, and emotions. Guided meditations were recorded and a copy was given to the teacher for in-class practice. Homework was assigned every week, and in-class practice was required at least once a week. In-class practice was carefully tracked through a weekly log filled out by the teacher. As requested, homework was completed every week during class time and one 30-minutes in-class practice took place between sessions. The intervention did not include a silent retreat. For a detailed description of weekly sessions, see Table 1.

Measures

For the purposes of this pilot study, a validated French version of each scale was selected. In order to ensure that participants were successfully able to complete self-report measures, items from all scales were read out loud in class, and members from the research team remained available to answer questions regarding item meaning throughout the assessment periods.

Table 1. Mindfulness-Based Intervention Session Content.

Session	Content
1	Overview of class rules and participant presentations
	Expectations and intentions in regard to the intervention
	Introduction to mindful eating
2	Body scan meditation
	Introduction to components of emotions (thoughts, physical sensations, behavior) and stress
3	Breathing meditation
	Introduction to sitting meditation
	Mindful movements through yoga-like poses
4	Breathing meditation
	Introduction to concepts of acceptance of emotions
5	Mindful check-in exercises
	Mindfulness through the senses
6	Breathing meditation with a special focus on thoughts and judgements
	Group discussion on thoughts and judgements
7	Walking meditation
	Group discussion on self-care and acceptance
8	Short sitting meditation
	Group discussion on intentions set at first session
	Feedback regarding intervention
	Distribution of a pebble stone as a reminder of the experience

Internalized and Externalized Symptoms. The Behavior Assessment System for Children, Second Edition (BASC-II), was used to evaluate symptoms in LD students.[45] The Teacher Report Form and the Self-Report Form, which contain 139 items each, were used for this project. Children and teachers are asked to rate their agreement on a 4-point Likert-type scale (1 = never to 4 = always). This measure generally presents good interrater agreement (r = .53-.74) and test-retest reliability (r = .7-.8), along with a high internal consistency (α = .8-.9) and clinical validity.[45] Construct validity for the Teacher Report Form is also good (α = .7-.8) when the BASC-II is compared to similar behavioral assessment scales such as the Child Behavior Check List[46] and the Conners Scale Revised.[47] In this study, the following subscales were used for both self-report and teacher-report forms: anxiety (eg, "I get nervous when things do not go the right way for me"), depression (eg, "I used to be happier"), hyperactivity (eg, "I have trouble standing still in lines"), attention problems (eg, "Has a short attention span"). The aggression (eg, "Defies teacher") and conduct problems (eg, "Breaks the rules") subscales were used for the teacher form only. Internal consistency was good for self-reported (α = .81) and teacher-reported (α = .89) scales in this study. Test-retest reliability was adequate to good for the subscales (r = .51-.88) in this sample. However, it was poor for teacher scores on the anxiety scale (r = .27) and self-report and teacher scores on the hyperactivity scale (r = .28).

Mindfulness. The Children and Adolescent Mindfulness Measure[48] was used to assess mindfulness in children. It contains 10 items assessing the extent to which children become more mindful as they are exposed to the intervention. Children are asked to rate their agreement on a 5-point Likert-type scale (0 = never true to 5 = always true) to items such as "I get upset with myself for having feelings that don't make sense" and "I tell myself that I shouldn't feel the way I'm feeling." Internal consistency was good in this sample (α = .79). Test-retest reliability was not significant in this sample (r = .47).

Results

Data Analysis

Descriptive statistics were used for demographic data. Primary hypotheses were tested with repeated-measures ANOVA allowing comparisons of pretest-posttest data. Preliminary analysis of our data showed positive skewness for all variables. Thus, all scores were transformed using a natural logarithm formula. In light of our quasi-experimental design and in order to assess for the robustness of our findings, post hoc sensitivity analyses were completed with nonparametric Friedman tests.[49] Effect sizes of the intervention on the outcome measures were also computed. Adjusted P values were considered according to the P = .05 threshold. Effect sizes were computed using partial η^2 and were interpreted according to Cohen's[50] proposed guidelines for social sciences, where values approaching .01 were considered a small effect, values approaching .06 were considered a moderate effect, and values approaching .14 were considered a large effect.

Statistical Power

Statistical power analyses have been conducted using G*Power software.[51] The following parameters were used in our analyses: effect size F (converted η^2 value), α error probability (.05), total sample size (14 participants), number of groups (1), number of measurements (2), correlation among measures for each variable (values can be found in Table 2), nonsphericity correction ε (obtained from Mauchly's sphericity test in SPSS = 1 for each variable). Power associated with each analysis can be found in Table 2.

Descriptive Analyses

Eight girls and six boys took part in this study. Mean age of the group was 10.7 years (SD = 1.1). Baseline subscale scores above clinical cutoff in self-reported data indicate the following: depression (no participant), anxiety (1 participant), attention problems (1 participant), and hyperactivity (1 participant). Baseline subscale scores above clinical cutoff in teacher-reported data indicate the following: depression (1 participant), anxiety (no participant), attention problems (2 participants), hyperactivity (2 participants), aggression (3 participants), and conduct problems (3 participants).

Age was negatively correlated with self-reported depression (r = −.57, P < .01), teacher-reported inattention (r = −.52, P < .01), and teacher-reported conduct problems (r = −.40, P < .05). Thus, younger participants were more likely to report depressive symptoms, and their teacher was more likely to report inattention and conduct problems. Male gender was positively correlated with self-reported hyperactivity (r = .38, P < .05). Thus, boys were more likely to report hyperactivity symptoms in this sample.

Table 2. Means, Standard Deviations, and Results of Repeated-Measures ANOVA for CAMM and BASC-II.

			Overall Model				
Dependent Variable	Pretest, M (SD)	Posttest, M (SD)	*F*	*P*	Partial η^2	$r^{1\text{-}2}$	Power
CAMM	25.70 (8.40)	27.80 (6.80)	1.19	.29	.08	.46	.49
Self-Report							
Anxiety	13.80 (7.00)	11.00 (6.60)	6.80	.02*	.34	.87**	1.00
Depression	7.35 (4.40)	5.78 (5.30)	6.73	.02*	.34	.78**	1.00
Hyperactivity	7.21 (4.10)	6.64 (4.30)	0.15	.71	.01	.25	.09
Attention problems	8.70 (4.00)	8.00 (4.20)	1.39	.26	.10	.80**	.95
Teacher-Report							
Anxiety	1.42 (1.40)	1.07 (1.60)	1.13	.31	.08	.27	.38
Depression	3.07 (3.80)	1.21 (1.80)	4.24	.06	.25	.58*	.99
Hyperactivity	7.28 (6.80)	4.35 (3.00)	3.34	.09	.21	.51	.95
Attention problems	12.00 (5.70)	8.71 (4.10)	6.03	.03*	.32	.71**	1.00
Aggression	6.07 (6.50)	2.35 (1.90)	8.35	.01*	.39	.64*	1.00
Conduct problems	4.28 (4.50)	1.57 (1.50)	21.10	.00**	.62	.88**	1.00

Abbreviations: ANOVA, analysis of variance; CAMM, Child and Adolescent Mindfulness Measure; BASC-II, Behavior Assessment System for Children, Second Edition; M, mean; SD, standard deviation.
*$P \leq .05$. **$P \leq .01$.

Main Within-Group Analyses

Students' Self-Report Form. Repeated-measures analyses of variance were conducted to explore the impact of our mindfulness intervention on internalized symptoms in our participants (see Table 2 for details). Testing from the self-report questionnaire revealed significant differences in levels of anxiety (Wilks's $\Lambda = .65$, $F[1, 13] = 6.80$, $P = .02$, partial $\eta^2 = .34$). Post hoc comparisons using a Bonferroni correction indicated that the mean anxiety score at pretest was significantly higher from the mean anxiety score at posttest. Testing also revealed significant differences in levels of depression (Wilks's $\Lambda = .66$, $F[1, 13] = 6.73$, $P = .02$, partial $\eta^2 = .34$). Post hoc comparisons using a Bonferroni correction indicated that the mean depression score at pretest was significantly higher from the mean depression score at posttest.

Teacher's Report Form. Repeated-measures analyses of variance were conducted to explore the impact of our mindfulness intervention on internalized and externalized symptoms in our participants. Testing from the teacher report questionnaire revealed significant differences in externalized symptoms. Specifically, significant differences were found for levels of aggression (Wilks's $\Lambda = .60$, $F[1, 13] = 8.35$, $P = .01$, partial $\eta^2 = .39$). Post hoc comparisons using a Bonferroni correction indicated that the mean aggression score at pretest was significantly higher from the mean aggression score at posttest. Significant differences were also found for conduct problems (Wilks's $\Lambda = .38$, $F[1, 13] = 21.13$, $P = .001$, partial $\eta^2 = .61$). Post hoc comparisons using a Bonferroni correction indicated that the mean conduct problems score at pretest was significantly higher from the mean conduct problems score at posttest. Finally, significant differences were found in levels of inattention (Wilks's $\Lambda = .68$, $F[1, 13] = 6.03$, $P = .02$, partial $\eta^2 = .31$). Post hoc comparisons using a Bonferroni correction indicated that the mean inattention score at pretest was significantly higher from the mean inattention score at posttest.

Sensitivity Analyses

Sensitivity analyses can be done to increase confidence in the findings of a study.[49] In this study, sensitivity analyses were conducted to account for the impact of potential outliers and violation of distributional assumptions through logarithmic transformation of the data. Post hoc sensitivity analyses were completed using the Friedman test. Given the positive skewness observed in our data, nonparametric analyses were chosen to complete sensitivity analyses in order to consider the normal distribution assumption violation. Results from our analyses showed that results cited above remained robust after testing the data with nonparametric analyses, with the exception of student depression scores. The results of the Friedman test indicated that there was no significant difference in students' depression scores pre- to postintervention ($\chi^2[1, n = 14] = .692$, $P = .405$).

We analyzed the sensitivity of different items in significant subscales to investigate where the intervention had the greatest effect. In the anxiety scale, students reported pre-to-post changes for the following items, meaning that these were the most impacted by the MBI intervention: "I get nervous when things do not go the right way for me" (29% of students); "I am afraid I might do something bad" (29% of students); "I am bothered by not getting enough sleep" (21% of students); "I worry about what is going to happen" (21% of students); "I get so nervous I can't breathe" (21% of students).

In the attention problems scale, the following items were the most affected by the MBI intervention: "Has a short

attention span'' (43% of students); ''Is easily distracted'' (29% of students); ''Is easily distracted from class work'' (29% of students).

In the aggression subscale, the following items were the most affected by the MBI intervention: ''Defies teacher'' (29% of students); ''Teases others'' (29% of students); ''Argues when denied own way'' (21% of students); ''Annoys others on purpose'' (21% of students).

In the conduct problems scale, the following items were the most affected by the MBI intervention: ''Breaks the rules'' (29% of students); ''Sneaks around'' (29% of students); ''Lies'' (14% of students); ''Gets into trouble'' (14% of students).

Additionally, item analysis was conducted on mindfulness scores. Although these were not significantly different pre-to-post treatment at the scale level, item analysis for the Child and Adolescent Mindfulness Measure indicated that the most sensitive items to the intervention were those linked to nonjudgment of feelings (eg, ''I get upset with myself for having feelings that don't make sense''; ''I tell myself that I shouldn't feel the way I'm feeling''), which indicates that mindfulness could possibly explain, at least partially, improvements in our participants.

Discussion

This article presents results from a MBI pilot study for elementary school children with LDs in a special education class. In accordance with our initial hypothesis, our results indicate that the MBI had a significant impact on symptoms that often co-occur in children with severe LDs. Based on self-reports, significant differences were found for anxiety and depression, although sensitivity analyses indicated that results for depression were not robust. Teacher's report revealed significant differences in aggression, conduct problems, and attention problems. Globally, sensitivity analyses, which were more stringent than our primary analyses, showed that our results were robust, which strengthens conclusions that can be drawn from this data.[49] Thus, these innovative and preliminary results indicate that MBIs shows a promising impact on comorbidities often associated with LDs.

Our results can be analyzed in light of the existing literature exploring the relation between mindfulness and emotional regulation.[12] From a theoretical viewpoint, our intervention was useful in decreasing internalized symptoms in our participants, affecting anxious symptoms. As stated in the introduction of this article, children with LDs often present with demoralization.[52] Those placed in a special education class are openly identified as performing to a lesser than satisfactory level than their counterparts in regular classrooms. In our participants, demoralization was frequently observed and reported by their teacher. This demoralization largely affected how students perceived and defined themselves, which they often verbalized (eg, ''I am no good'', ''I suck in school'') and which can be observed in items that were most sensitive to change in the anxiety subscale of the BASC-II (eg, ''I am afraid I might do something bad''). The recurrence of these verbalizations were indicative of rumination, depressive, and anxious thoughts in our participants pre-intervention, which stand out in baseline scores of the depression and anxiety scales. With final examinations approaching, many students reported feeling anxious and scared at the idea of failing and having to repeat their school year or not being able to go to high school.

Furthermore, anxiety and depression have been associated with restlessness and inattention in youth, which can easily be confounded with ADHD.[52] Symptoms of inattention and hyperactivity were noted in many participants pre-intervention (especially from the teacher's perspective) and throughout meditation sessions, despite only 3 participants having a formal diagnosis of ADHD. Thus, it is possible that inattention that was observed in our participants at baseline was associated to intrusive thoughts and ruminations regarding school performance. This also speaks to the implications of low-level baseline psychopathology in this sample. Previous mindfulness research in teenagers with LDs has highlighted the fact that these students tend to underestimate the severity of their difficulties when compared to their counterparts without LDs.[32] Thus, it is possible that the baseline subscale scores above clinical cutoff in self-reported data did not accurately capture the severity of comorbid symptoms in participants from this study. In turn, this could have had an impact on our ability to detect treatment effects or to estimate the correct amplitude of these effects in participants' pre-to-post intervention.

Accordingly, from an emotional regulation standpoint and a theoretical viewpoint, at postintervention, the MBI could have decreased rumination in our participants through mechanisms of disengagement.[12] Similar effects of mindfulness on rumination have been reported in previous work with adults.[15] Anxiety could have been decreased through exposure and desensitization to unpleasant emotions. In turn, improvements in anxious and depressive symptomatology may have caused a significant decrease in inattention in our participants at postintervention. This can be observed in items that were most sensitive to change in the inattention subscale of the BASC-II (eg, ''Is easily distracted''). However, given the results from sensitivity analyses with regard to depression scores, caution is warranted in concluding on the effectiveness of MBI for depressive symptoms in children with LDs.

Behavioral problems such as inattention, aggression, and conduct problems were also decreased at postintervention based on teacher's report. These results could be explained by an increased ability in our participants to disengage from automatic emotional and behavioral responses, decreasing impulsivity, conflicts with peers, and rule breaking behaviors (eg, from sensitivity analyses: ''Argues when denied own way,'' ''Gets into trouble''). These results are similar to what was previously reported in teenagers with LDs.[32] Participation from the entire classroom in this project could also serve to explain decreases in behavioral problems, as students may have exhibited less anger because others were less likely to provoke them because of their participation in the MBI. Mindful check-in exercises, which were repeatedly used in between sessions

by the teacher, were reported by our participants as being the most useful technique they had learned to handle annoyances in school and at home in an adaptive manner.

Globally, in accordance with our initial hypothesis, significant decreases in both internalized and externalized symptoms seem to have provided students with a renewed openness and availability to learning. Positive affect in students with LDs has been shown to influence positive class climate, namely, through increases in cooperative behaviors and improved conflict resolution skills.[53] Furthermore, results suggest that MBIs could help in creating a more stimulating and positive learning environment for students in special education classes, as was shown in previous work with elementary and high school students.[16,24] Given the high risk of dropout in children with severe LDs living in a disadvantaged neighborhood, further research on the links between availability to learning and mindfulness is thus strongly recommended.

Strengths

This pilot study counts notable strengths. First, participants recruited for this project formed a homogeneous group in terms of psychological diagnosis, providing data that is specific to elementary school students with severe LD. Second, no attrition was experienced in this pilot, strengthening our results. Third, effect sizes for statistically significant variables were considered large according to social sciences standards and the field of research. Fourth, sensitivity analyses strengthened conclusions that can be drawn from this study. Fifth, as the body of research on mindfulness in youth is growing, it appears crucial to evaluate the level of mindfulness in research participants, which was done in this project. Sensitivity analyses of mindfulness scores revealed that mindfulness could possibly explain improvements in our participants. Finally, this project is one of very few evaluating the impact of a MBI for elementary school students with LDs, thus bridging the gap between studies in regular classrooms settings and research for special education children. Our results indicate that MBIs is an interesting avenue to alleviate comorbid psychosocial symptoms of LD in elementary school students.

Limitations

One major limitation of this study is the 1-group pretest-posttest design that was privileged to a 2-group design. Without a control group, observed changes in our participants' scores pre-to-post intervention might not be attributed to the mindfulness intervention alone. The small sample and the 2 assessment time points represent another important limitation of this study, as it greatly affected our statistical power. However, sensitivity analyses indicated that statistical results from this pilot were generally robust. Additionally, effect sizes found in this pilot study were large, which adds to the validity of our findings. Poor test-retest reliability for the anxiety and hyperactivity subscales on the BASC-II also affected our statistical power and consequently the probability of detecting a significant pre-to-post effect for these variables. This increased the risk of making type II errors.

Threats to internal validity are time-related factors such as testing effects and regression to the mean. As such, it is possible that teacher report forms were somewhat biased and overstated the change taking place pre-to-post intervention in students, as the teacher was potentially hoping for positive changes postintervention. Another threat to internal validity would be maturation, although variables that were tested in this pilot are not susceptible to be influenced by maturation. Additionally, to the knowledge of the authors, history was not a threat to internal validity in this pilot, as no event affecting the whole group of participants occurred during the mindfulness intervention. Another limitation is the lack of follow-up data that would have enabled us to assess the long-term impact of the intervention. Measures used in this pilot study were either self- or teacher-report. Another limitation of this study is the lack of a measure to assess emotional regulation. Without directly measuring emotional regulation, we can only speculate on the mechanisms of change in students with LDs.

Suggestions for Further Research

Given the promising results of this study, which suggest the usefulness of MBIs for students with severe LDs, the use of randomized controlled trials is strongly recommended in future studies in order to replicate these results and to conclude on their robustness. Multiple baseline single case designs, a methodologically sound, experimental alternative to studies with larger sample sizes, could help in measuring the amplitude of change for each participant by means of regularly scheduled assessments throughout the intervention.[54] With larger samples, further sensitivity analyses could be performed (eg, analyses on different cutoffs or definitions, noncompliance to treatment, or protocol violations).[49] Furthermore, although teachers are the primary source of information regarding learning needs, it is important to acknowledge caregivers as a possible source of behavior change. Including caregiver reports may help account for some teacher bias and should be included in future projects of this sort. Parent reports would also help in providing a more complete assessment of participants' mental health and change pre-to-post intervention. Since participants from this study were children with LDs in a special education class, future research should evaluate the impact of MBIs on children with LDs that are integrated in regular classrooms. Finally, future research should use mediation models to test mechanisms linking emotional regulation, MBIs, and behavior.

Conclusion

MBIs represent a promising and feasible avenue for intervention to help alleviate co-occurring symptoms in elementary students with LDs. Data from this pilot suggests that MBIs can decrease mental health symptoms. Through exposure and disengagement of unpleasant emotions, MBIs can potentially increase tolerance to anxious and depressive symptoms related to LDs and poor school performance. Further randomized

controlled trials or multiple baseline experimental trials with a long-term follow-up are warranted to establish more robustly the effect of MBIs for LD children.

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Author Contributions

CMH and MJ contributed to the design and conception of this study. CMH elaborated the intervention protocol and participated in the recruitment of participants. CMH drafted the article. All other authors have contributed to the revision of the initial draft of the article and read and approved the final version of the article.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study (Ethics approval number: CERFAS-2013-14-208-P).

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