



# Practice matters: The role of mindfulness skills in emotion dysregulation in borderline personality disorder

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## ABSTRACT

Mindfulness skills training constitute a core element of dialectical behavior therapy (DBT) that has been proposed as a key component to improve emotion dysregulation (ED) in borderline personality disorder (BPD). However, the relationship between the time spent practicing mindfulness skills at home and changes in ED is not well-understood. This study aimed to determine whether daily mindfulness practice meaningfully improves ED, and, if so, the minimum dose needed to do so. A total of 75 BPD outpatients participated in a 10-week DBT mindfulness skill training program. We systematically tracked the participants' mindfulness practice and their ED levels throughout the sessions. A total of 499 observations were recorded. We used multilevel modeling with a time-lagged approach to investigate the association between weekly practice and ED over time. Greater mindfulness practice predicted improvements in ED in the following week. A bidirectional relationship was also found; a higher level of ED impaired subsequent mindfulness practice. When accounting for the previous week's ED level, participants who practiced  $\geq 3$  days and  $> 30$  min per week experienced a statistically significant decrease in ED compared to those who did not engage in regular practice. These results highlight the key role of mindfulness practice as a behavioral component to improve emotion regulation in individuals with BPD. These findings suggest that therapists should inform patients about the minimum dose of mindfulness practice needed to improve emotion regulation in order to adjust expectations and improve treatment outcomes.

## 1. Introduction

Borderline personality disorder (BPD) is a highly complex, severe mental illness characterized by shifting intense emotions, unstable identity, and disturbed interpersonal relationships (American Psychiatric Association DSM-5 Task Force, 2013; Bohus et al., 2021). Individuals with BPD commonly experience intense and overwhelming emotions, which leads them to use maladaptive strategies such as self-injury to obtain immediate relief from those emotions (Linehan, 1993; Santangelo et al., 2017). Given the connection between overwhelming emotions and dysfunctional behavior, one of the key targets of psychological treatment for BPD is emotion dysregulation (ED).

Dialectical behavior therapy (DBT) has emerged as an empirically-based treatment for BPD (for a meta-analysis see: Storebø et al., 2020). DBT is a multifaceted therapeutic intervention consisting of

individual therapy sessions and group skills training (Linehan, 1993, 2014). Skills training, which teaches participants how to regulate emotions, is considered a key component of DBT (Chapman, 2019). Therefore, research has focused on exploring the processes by which DBT leads to improved emotion regulation in BPD (Gratz et al., 2016). In this regard, greater acquisition and use of DBT behavioral skills (e.g., assessed by weekly skills tasks) has consistently been found to contribute for clinical outcomes in BPD (Barnicot et al., 2016; Edwards et al., 2021; Rudge et al., 2020) and specifically for improvements in ED (Neacsiu et al., 2014; Southward et al., 2023). Interestingly, within DBT skills, mindfulness skills are the most used by participants (Lindenboim et al., 2007; Stepp et al., 2008) and the specific use of mindfulness skills appears to be one of the main components at the basis of ED improvements in BPD (Mehlum, 2021; Wyatt et al., 2023).

Mindfulness skills are considered a core component of DBT for the

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treatment of BPD, and mindfulness training is actively used to improve emotion regulation (Linehan, 2014). Several studies have evaluated the effectiveness of mindfulness skills training compared to other DBT modules (e.g., interpersonal effectiveness) in improving BPD symptoms (Carmona i Farrés et al., 2019; Elices et al., 2016; Soler et al., 2016). Interestingly, mindfulness skills alone mediate the impact of DBT skills training on psychiatric symptoms and associated risk behaviors (Krantz et al., 2018; Zeifman et al., 2019). Specifically, Schmidt et al. (2021) found that DBT mindfulness skills increase emotion regulation capacity, which in turn reduces BPD symptoms. However, it remains to be clarified how the link between the mindfulness practice and improvements in ED occurs.

As noted, while mindfulness training can be effective in DBT, the time spent practicing these skills at home is likely to impact treatment outcomes. Nevertheless, to our knowledge, only one study has evaluated the association between the amount of home practice of mindfulness skills and clinical outcomes in patients with BPD (Soler et al., 2012). In that study, daily practice correlated with improvement in general psychiatric symptoms and depression, but not with behavioral measures of inattention and impulsivity. In short, due to the lack of data, the extent to which mindfulness practice is an active component and serves as a specific process to improve ED remains unclear. In this regard, it is important to better understand the impact of practice time in order to potentiate the effectiveness of interventions designed to improve ED.

Spiritual traditions such as Buddhism emphasize the importance of regular meditation practice to alleviate suffering. In secular meditation, mindfulness practice has been described as being analogous to weight training, except that mindfulness targets the mind whereas weight training is aimed at building muscle (Kabat-Zinn, 1990). Based on the available data, this analogy seems to be accurate. Several studies have shown that the number of years of mindfulness practice, minutes per session, and days per week are all significantly associated with higher mindfulness scores (Davis & Hayes, 2011; Soler et al., 2014). However, few studies have measured and quantified the amount of mindfulness practice (i.e., practice time) needed to alleviate mental health problems (Creswell, 2017) and the results are mixed. For example, one study compared mindfulness-based cognitive therapy (MBCT) with and without meditation practice, finding no significant differences between the two conditions in preventing relapse in patients with depression (Williams et al., 2014). A meta-analysis (Vettese et al., 2009) performed to determine whether engagement in mindfulness practice was associated with clinical outcomes found a clinical benefit from mindfulness practice in only half of the 24 studies. Subsequently, Parsons et al. (2017) conducted a systematic review and meta-analysis of 47 studies that reported home practice time, finding that only 28 of those studies detected a significant (albeit small) association between the amount of home practice and treatment outcomes. Given these data, the extent to which the practice of mindfulness improves positive mental health outcomes remains unclear, particularly as a process of emotion regulation in clinical populations with high levels of ED, such as BPD. Nonetheless, it is important to note that the lack—or only small—significant association between practice and positive outcomes could be at least partially due to deficiencies in the methods used to date to track and assess home practice (Visted et al., 2015). In this regard, it is important to accurately quantify the time spent on home mindfulness practice in order to determine the true impact on emotion regulation, which would provide clinicians with valuable data about how much home practice is really needed. Similarly, quantifying the minimum effective dose would also benefit patients, who would then understand the amount of practice actually needed to improve their ED. In turn, this would adjust treatment expectations and increase motivation to regularly practice mindfulness.

According to the theoretical framework of DBT, core behavioral problems in BPD such as self-injury occur in response to a dysregulated emotional state (Linehan, 1993). Research findings support the importance of skills training to regulate emotions as a potential mechanism of change in DBT (Chapman, 2019), with mindfulness skills occupying a

central role in treatment (Linehan, 2014). However, studies carried out to explore the relationship between the amount of mindfulness practice and ED as an outcome variable are scarce. In fact, to our knowledge, no studies have been performed to examine this relationship using DBT mindfulness skills training in patients with BPD. Similarly, mindfulness practice may be mood-dependent, although research in this area is scant (see Elices et al., 2019), and thus the individual's degree of dysregulation could affect engagement in practice, which in turn would influence the extent of improvement in ED.

In this context, the aim of the present study was to determine whether mindfulness practice improves emotion regulation in BPD outpatients undergoing DBT mindfulness skills training. Specifically, we sought to determine whether the amount of mindfulness skill practice (days and minutes per week) plays a relevant role in improving emotion regulation. We also aimed to determine the minimum dose of mindfulness practice needed. This study was conducted under the following hypotheses: 1) participation in DBT-Mindfulness (DBT-MFN) training would decrease ED; 2) the temporal dynamics between weekly practice and ED would be bidirectional (i.e., ED would improve in those individuals who practiced mindfulness skills, and in turn, greater ED would affect commitment to practice); 3) participants who sustained their weekly practice of mindfulness skills would improve ED compared to participants who practice less, while controlling for the previous week's ED. We made no assumptions about the minimum dose needed because we have no prior history on the amount of practice relevant in DBT-MFN to obtain the expected results.

## 2. Method

### 2.1. Participants

Participants were recruited from the Department of Psychiatry Unit of a General Hospital. This outpatient program provides specialized care to individuals with BPD as a part of Public National Mental Health Service of Spain. A total of 95 outpatients with BPD were enrolled in a standard DBT skills training program. For the purposes of the study, the intervention consisted of a 10-week DBT mindfulness skill training program.

All participants were evaluated by a psychiatrist and a clinical psychologist from the psychiatry unit, both with extensive experience in the treatment of BPD. The clinical diagnosis was based on two semi-structured interviews, the Structured Clinical Interview for DSM IV axis I Disorders (SCID I; First et al., 1997) and the Revised Diagnostic Interview for Borderlines (DIB-R; Barrachina et al., n.d.).

The inclusion criteria were: 1) diagnostic confirmation of BPD; 2) age between 18 and 55 years; 3) absence of any of the following comorbid conditions: schizophrenia, drug-induced psychosis, organic brain syndrome, substance dependence, bipolar disorder, intellectual disability; 4) not receiving any other type of psychotherapy at the time of study enrollment. Patients were allowed to continue taking their usual medications prior to study enrollment. However, they were not allowed to change the type or dose of drugs during the 10-week study period. None of the participants had previously participated in group DBT skills training.

### 2.2. Procedure

Participants were enrolled in 10-week mindfulness-based DBT skills training program. Each session was 2.5 h. A total of seven groups (12–15 participants/group) participated in this program between February 2020 and October 2022. All groups were led by the same team (two clinical psychologists with training and experience in DBT and mindfulness meditation). Written informed consent was obtained from all participants prior to study inclusion. The study was approved by the Clinical Research Ethics Committee of the Hospital de la Santa Creu i Sant Pau and was conducted in accordance with the criteria of the

## Declaration of Helsinki.

**DBT-MFN training:** The intervention was based on the DBT skills training protocol (Linehan, 1993, 2014). The 10-week program consisted of one week of orientation and goal setting, followed by six weeks of mindfulness skills training, and finally three weeks of acceptance skills (from the distress tolerance module). This type of mindfulness training for BPD was proposed by Linehan as an alternative to standard DBT skills training (Linehan, 2014, p. 120) and its efficacy has been demonstrated in several clinical trials (Carmona i Farrés et al., 2019; Elices et al., 2016). The following mindfulness and acceptance skills were taught: 1) Wise Mind; 2) "What" Skills (i.e., observing, describing, participating); 3) "How" Skills (i.e., non-judgment, single-mindedness, and being effective); 4) Radical Acceptance; 5) Mind Turning and Willingness; 6) Half-smile and willing hands; and 7) Mindfulness of current thoughts (for details, see Supplementary material, Table S1).

The mindfulness skills taught during the sessions included both formal (i.e., meditation) and informal (i.e., being mindful of any thoughts or feelings, noticing not to be judging) mindfulness practices. In each session, a new skill was introduced and practiced through role-playing and discussion. At the conclusion of each session, participants were then provided with meditation audios (approximately 10 min in duration) and accompanying worksheets to practice the skills learned at home. The meditation audios were recorded by the lead therapist. Mindfulness practice at home included both formal (i.e., "stone flake in the lake" meditation for wise mind skill) and informal (i.e., completing a worksheet on the activities they did with wise mind during the week) exercises. At the next session, the homework was reviewed and each participant commented on his/her experience with the practice, including any difficulties. The therapist then reinforced the participants' progress and suggested effective ways to improve their practice.

## 2.3. Measures

Several repeated measures were performed weekly during the 10-week program. Only the first session (introduction/orientation) was not assessed, as it did not include mindfulness practice tasks. Prior to each new session, participants completed the short version of the Difficulties in Emotion Regulation Scale (DERS-18) and recorded the time spent practicing the assigned tasks (days and minutes per week), relative to the past week.

**Emotion Dysregulation.** The DERS-18 (Victor & Klonsky, 2016) was used to assess how participants managed difficult emotional experiences each week. We used the 18-item Spanish-language version of this self-report scale. The total score was used as an overall measure of emotion dysregulation. Items on this scale are rated from 1 (almost never) to 5 (almost always). The scale has high internal reliability (Cronbach's  $\alpha = 0.91$ ; Victor & Klonsky, 2016). In the current study, the scale was assessed during the first session, showing good internal reliability (Cronbach's  $\alpha = 0.87$ ).

**Weekly Tasks.** At the start of each session participants were asked to indicate the time spent each week practicing the mindfulness skills exercises (formal and informal). They also indicated how much time it took them to complete the worksheets. We assessed two time-related continuous variables: 1) number of days practiced per week (range, 0–7) and 2) total weekly practice time in minutes. Then, the first variable, "practice days", was categorized into four levels, as follows: 0 = did not practice; 1 = 1–2 days of practice; 2 = 3–4 days of practice; 3 = 5–7 days of practice. The second variable, "practice time", was categorized into six levels, as follow: 0 = did not practice; 1 = 1–10 min; 2 = 11–20 min; 3 = 21–30 min; 4 = 31–50 min; 5 = more than 50 min.

## 2.4. Data analysis

Descriptive analyses of the participants' sociodemographic and clinical characteristics were performed. Then, we assessed continuous variables for normality and outliers. Most of the variables showed a

normal distribution. The practice time variable had a non-normal distribution and was square root transformed to achieve normality. Next, we determined whether any of the sociodemographic and clinical variables was associated with weekly mindfulness practice engagement (i.e., practice days and/or time). For these analyses, we performed a one-way ANOVA for continuous variables and the Bonferroni post hoc test for multiple comparisons. Pearson's Chi-square test ( $\chi^2$ ) was used to compare categorical variables. The post-hoc test was calculated using corrected standardized residuals. This method indicates which cells in the contingency table contribute significantly to the overall chi-square statistic (see Beasley & Schumacher, 1995). A paired simple *t*-test was calculated to assess pre-post treatment change in ED, based on DERS-18 scores. Cohen's *d* effect size was calculated by dividing the mean difference between pre- and post-training by the averaged standard deviation (Cumming, 2014).

We then conducted multilevel modeling (MLM) analyses with a restricted maximum likelihood (REML) estimation method and time-lagged approach to examine the relationship over time between the frequency of weekly mindfulness practice and ED. Continuous variables used in these analyzes (i.e., practice days, practice time, and DERS-18) were mean centered. First, we assessed the temporal dynamics between mindfulness practice and ED. In these analyses, mindfulness practice at session *x* (i.e., practice days and practice time per week, separately) predicted the level of ED at session *x*+1, ensuring there was no overlap between measures. We then explored the reverse temporal dynamics by assessing whether the level of ED (DERS-18 score) in session *x* predicted the level of engagement with mindfulness practice in session *x*+1. Second, we assessed whether different frequencies of mindfulness practice were associated with an improvement in ED, controlling for the ED level from the previous time segment (i.e., previous week). For these analyses, the variables practice days and practice time were categorized in order to identify the specific dose of practice related to improvements in ED (i.e., DERS-18). In these analyses, weekly practice was used to predict ED at session *x*, controlled for ED at session *x*-1. As such, there was no temporal overlap in segments assessed for ED. The weekly practice level (practice days and practice time) was considered as a fixed effect and the participants as random effects (random participants' intercept). MLM is recommended for the analysis of repeated measures data because this method is more robust than other methods in cases with missing data (e.g., participants who did not attend all sessions). On the MLM, regression coefficients were transformed into an effect size (*r*), which were classified as follows: small (0.1–0.3), medium (0.3–0.5), and large (>0.5) (Cohen, 1988). All models were tested with the lme4 package (Bates et al., 2015) using RStudio (CoreTeam, 2017). The IBM-SPSS statistical software program (v. 24) was used to perform the descriptive analyses.

## 3. Results

### 3.1. Sociodemographic and clinical characteristics of the sample

A total of 95 patients were enrolled in the 10-week DBT-MFN training program. Of these, 13 discontinued treatment before the first session (i.e., only attended the introduction/orientation session) and 7 completed <3 weekly assessments (i.e., only attended one or two mindfulness skills sessions and/or did not complete the weekly assessment). Participants with at least 3 weekly assessments were considered as criteria to run multilevel analyses with repeated measures over time (Santangelo et al., 2014) and model the within-person changes in ED over the course of DBT-MFN training. As a result, a total of 75 outpatients with a diagnosis of BPD were included in the analyses, resulting in a total of 499 observations (*M* = 4.95, *SD* = 2.60) across the nine sessions (note that the 1st session—orientation and goal setting—was not included in the multilevel analyses because mindfulness skills were not practiced in that session). We found no differences between participants who dropped out (or completed <3 assessments) and the rest of

the study participants in clinical and sociodemographic variables (all  $p$ -values  $< 0.11$ ). The sociodemographic characteristics of the sample are shown in Table 1.

There was no association between sociodemographic variables (age, sex, educational level, or employment status) and weekly practice of mindfulness skills (practice days and time in minutes) (all  $p$ -values  $> 0.09$ ). Similarly, we found no association between weekly practice and baseline DIB-R scores, prior suicide attempts, or history of non-suicide self-injury ( $p$ -value  $> 0.10$ ). The type of pharmacological treatment had no effect on the level of weekly practice (all  $p$ -values  $> 0.16$ ).

Overall, the participants practiced mindfulness skills for a median of 3 days ( $M = 2.80$ ,  $SD = 1.97$ , range = 0–7) and a mean of 27.90 min per week ( $SD = 27.81$ , range = 0–180). The total frequency of practice in DBT-MFN was also assessed. 16.2% of the time participants did not engage in practice at home during mindfulness training. In relation to practice days, in most cases (63.2%), the participants practiced mindfulness, 1–2 days or 3–4 days per week. Less commonly (20%), they practiced 5–7 days. In relation to practice time, slightly more than half (51.5%) of participants practiced  $< 30$  min/week, while 15.6% practiced between 31 and 50 min, and 16.8% practiced  $> 50$  min per week. Interestingly, the mean time spent practicing mindfulness skills increased over the course of training, both in days ( $b = 0.16$ ,  $SE = 0.02$ ,  $p < 0.001$ ) and minutes ( $b = 1.27$ ,  $SE = 0.38$ ,  $p < 0.01$ ). Only one participant did not practice mindfulness during the training period. All other participants practiced mindfulness at some point during the training period.

### 3.2. DBT-MFN training decreases the level of ED over time

Significant decreases in ED were observed from the pre-to post-training assessment, with a medium effect size ( $t = 18.06$ ,  $p < 0.001$ ,  $d = 0.79$ ;  $M_{pre} = 63.59$  (9.66),  $M_{post} = 54.59$  (12.98)).

In terms of session-by-session changes in ED over the 10-week course, we observed an improvement in ED levels over time ( $b = -0.78$ ,  $SE = 0.14$ ,  $p < 0.001$ ) (see Fig. 1). Specifically, mean levels of ED did not decrease significantly from sessions 2 to 4 versus baseline score (all  $p$ -values  $> 0.09$ ). However, from session 5 onward, the level of ED decreased significantly (session 5:  $b = -3.35$ ,  $p < 0.05$ ; session 6:  $b =$

**Table 1**  
Sociodemographic Characteristics of total sample.

	Total sample ( $N = 75$ )
Age, mean (SD)	27.55 (9.09) [range 18–53]
Sex, female, $n$ (%)	70 (93.3)
Educational level, $n$ (%)	
Secondary school	33 (44)
Any post-secondary school	23 (30.7)
College degree	16 (21.3)
Master degree	3 (4)
Employment Status, $n$ (%)	
Unemployed	17 (22.7)
Employed	25 (33.3)
Student	24 (32)
Sick leave	4 (5.3)
Disability pension	5 (6.7)
Experience in meditation practice, $n$ (%)	13 (17.3)
Clinical characteristics, mean (SD)	
DIB-R total score	7 (1.05)
Previous self-injury behavior, $n$ (%)	
Past suicide acts	32 (42.6)
Past non-suicide self-injury	53 (70.6)
Pharmacological treatment, $n$ (%)	
Antidepressant	56 (74.6)
Benzodiazepines	27 (36)
Antipsychotics	17 (22.6)
Mood stabilizers	15 (20)

Notes. SD, standard deviation. DIB-R = Revised Diagnostic Interview for Borderlines.

$-5.01$ ,  $p < 0.01$ ; session 7:  $b = -5.98$ ,  $p < 0.001$ ; session 8:  $b = -5.06$ ,  $p < 0.01$ ; session 9:  $b = -6.42$ ,  $p < 0.001$ ).

### 3.3. Temporal dynamics between mindfulness practice and ED

The temporal dynamics between mindfulness practice and ED were assessed using time lagged measures. Engagement with practice days at session  $x$  temporally predicted improvements in ED at session  $x+1$  ( $b = -0.86$ ,  $p < 0.001$ ,  $r = 0.17$ ). Next, we tested the inverse relationship. The temporal association between ED level at session  $x$  and practice days at session  $x+1$  was not statistically significant, although a trend towards significance was observed ( $b = -0.01$ ,  $p = 0.07$ ,  $r = 0.09$ ).

We found a bidirectional relationship between practice time and ED levels. Minutes of practice at session  $x$  predicted improvements in ED at session  $x+1$  ( $b = -0.51$ ,  $p < 0.01$ ,  $r = 0.14$ ). Conversely, the ED level at session  $x$  predicted lower practice engagement in terms of minutes at session  $x+1$  ( $b = -0.02$ ,  $p < 0.05$ ,  $r = 0.12$ ), indicating a bidirectional association between mindfulness practice and ED.

### 3.4. Association between weekly practice and ED, controlled by the previous week's ED level

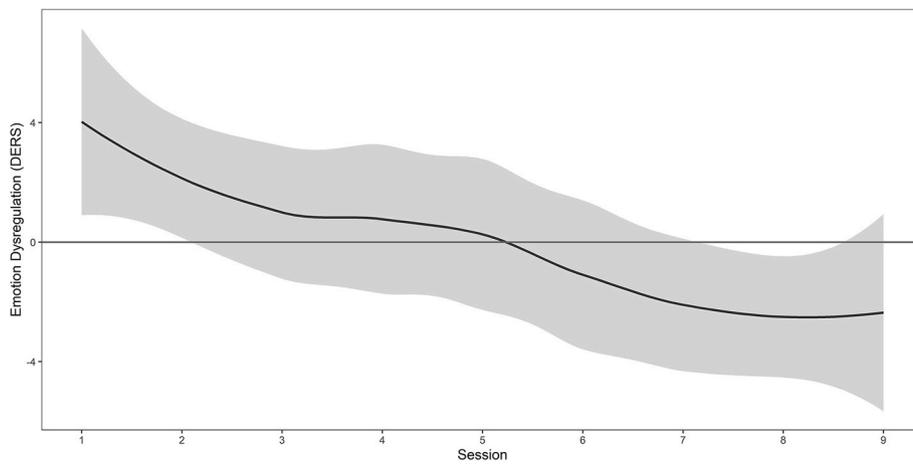
We assessed whether the amount of weekly practice (days and time) was associated with ED, controlling for the ED level measured the previous week. This assessment was performed using time-lagged analysis (i.e., whether weekly practice predicted improvements in ED at session  $x$ , controlled by ED at session  $x-1$ ). Practice frequencies of 3–4 days and 5–7 days per week were both associated with a significant reduction in ED compared to no practice (see Table 2 and Fig. 2). There was no significant difference between a practice frequency of 1–2 days versus no practice.

In terms of practice time (in minutes), 31–50 min and  $> 50$  min per week were both associated with a significant reduction in ED compared to no practice when controlling for the ED level assessed the previous week (Table 2 and Fig. 3). There were no differences between a practice frequency of  $< 30$  min per week versus no practice.

Finally, we explored session by session whether the frequency of mindfulness practice depended on participants' level of ED that week. We found that at the beginning of the training, those who reported no practice had a higher level of ED compared to those participants who practiced 5–7 days ( $F(3, 70) = 2.76$ ,  $p = 0.05$ ;  $M_{no\ practice} = 63.86$  vs.  $M_{5-7\ days} = 47.40$ ) and  $> 30$  min per week ( $F(5, 60) = 3.21$ ,  $p < 0.05$ ;  $M_{no\ practice} = 69.20$  vs.  $M_{31-50\ min} = 51.50$ ). These differences can be visualized in Figs. 2 and 3. However, no significant differences were found from the third session onwards (all  $p$ -values  $> 0.10$ ).

## 4. Discussion

Mindfulness is a central component of DBT skills training for BPD. Mindfulness practice has often been assumed to be the active component responsible for the positive mental health changes observed in mindfulness interventions (Carmody & Baer, 2009; Creswell, 2017). However, empirical evidence for this effect is mixed, with most studies showing that the effects of mindfulness on expected outcomes are either small or have no effect (Parsons et al., 2017; Vettese et al., 2009; Williams et al., 2014). In this context, we sought to determine whether the practice of DBT mindfulness skills is associated with improvements in ED, a core element of BPD. Our results show that DBT-MFN training led to an overall reduction in ED and this improvement became statistically significant from the fifth session onward. We also observed a bidirectional temporal relationship between mindfulness practice and ED; individuals who engaged in more frequent mindfulness practice experienced an improvement in ED in the subsequent week. However, higher ED levels were predictive of a lower commitment to practice during the following week. When we explored the effects of different levels of practice, we found that practicing mindfulness at least three



**Fig. 1.** Improvement in emotion dysregulation through mindfulness-based DBT skills training sessions (DBT-MFN). The horizontal line represents the mean of the emotion dysregulation measures (mean-centered) during DBT-MFN training.

**Table 2**

Time-lagged analysis of weekly practice of mindfulness skills and emotion dysregulation over time.

Weekly practice	B	SE	p-value	Effect size (r)
<b>Model 1</b>				
DERS (Intercept)	2.21	1.50	0.14	
<b>Practice days (ref: no practice)</b>				
1–2 days	–1.39	1.47	0.34	0.05
3–4 days	–3.03	1.53	<0.05	0.10
5–7 days	–7.20	1.70	<0.001	0.20
DERS <sub>(x-1)</sub>	0.47	0.04	<0.001	0.58
<b>Model 2</b>				
DERS (Intercept)	2.23	1.47	0.13	
<b>Practice time (ref: no practice)</b>				
1–10 min	–0.44	1.65	0.78	0.02
11–20 min	–2.47	1.60	0.12	0.08
21–30 min	–2.44	1.68	0.14	0.07
31–50 min	–5.64	1.73	< 0.01	0.16
+50 min	–6.77	1.76	< 0.001	0.19
DERS <sub>(x-1)</sub>	0.49	0.04	< 0.001	0.63

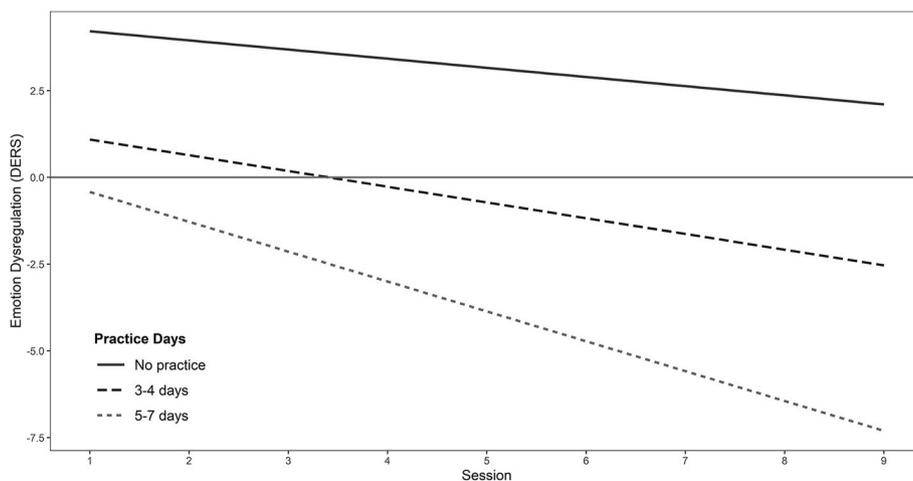
Notes. DERS = Difficulties in Emotion Regulation Scale; DERS<sub>(x-1)</sub> = Difficulties in Emotion Regulation in the previous week.

days and >30 min per week was associated with improved emotion regulation, even after controlling for the ED level of the previous week.

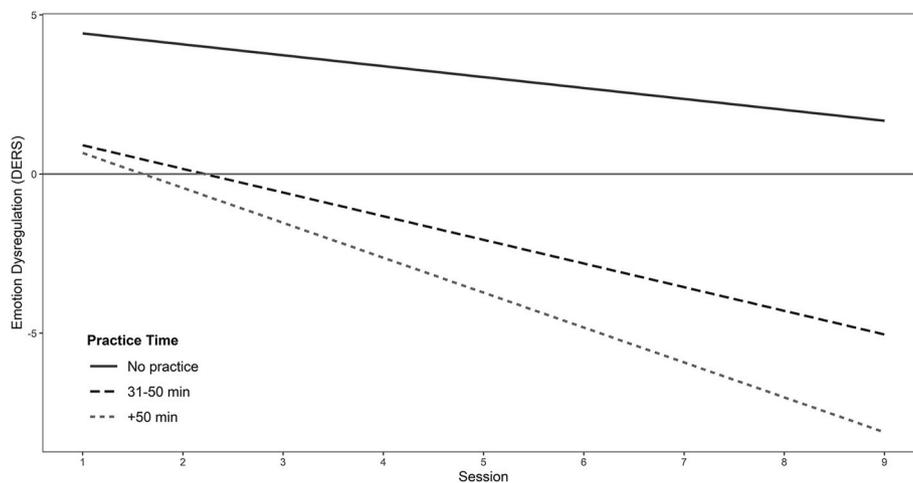
These results show that mindfulness practice is an active component

of DBT-MFN training to improve ED. Mindfulness practice in DBT is defined as the repeated effort to consciously focus attention on the present moment without a judgmental attitude, with the goal of decreasing emotional reactivity to mental events (Linehan, 1993). In addition, the practice of acceptance skills was also part of the mindfulness training in the present study. Acceptance skills are inherent to mindfulness practice in DBT and involve recognizing and accepting reality without judgment (Robins, 2002). Although we did not assess the constructs of mindfulness and acceptance (only practice), both components are taught during training and practice of these skills appear relevant to ameliorating emotional regulation difficulties in BPD. For example, nonjudgmental acceptance is a relevant mediator of changes in clinical outcomes following DBT skills training (Krantz et al., 2018; Zeifman et al., 2019). Furthermore, it is important to note that significant benefits (in terms of reduced ED) occur from the 5th session onwards. Therefore, patients should be informed that the therapeutic benefits will only become apparent about halfway through the 10-week program, in part because the first few sessions involve learning new skills and consolidating practice.

Some studies have shown that some people find that practicing mindfulness generates unpleasant experiences such as anxiety or boredom, at least initially (Cebolla et al., 2017). These sensations may be similar to those experienced by people who start to play a new sport or musical instrument. Consequently, mindfulness instructors should be aware of this in order to better manage the expectations of novice



**Fig. 2.** Effect of mindfulness practice in days per week on emotion dysregulation. The horizontal line represents the mean of the emotion dysregulation measures (mean-centered) during mindfulness-based DBT skills training.



**Fig. 3.** Effect of mindfulness practice in time (i.e., minutes) per week on emotion dysregulation. The horizontal line represents the mean of the emotion dysregulation measures (mean-centered) during mindfulness-based DBT skills training.

practitioners, and to inform them of the potential challenges, including the fact that the benefits of practice will likely take time to become apparent (Baer et al., 2021). In order to avoid premature dropouts from such training programs, therapists need to be prepared to employ mechanisms such as therapeutic alliance and validation (Mehlum, 2021). For example, it can be important for therapists to validate the difficulties faced by people who start practicing mindfulness, even as they must also emphasize that these challenges are a necessary part of the process of improving emotion regulation in the medium term. In this regard, it is not surprising to note that most dropouts occur close to the initiation of mindfulness training and that the dropout rate for the mindfulness module of DBT is even higher than that of other modules (e.g., Elices et al., 2016). Notwithstanding these challenges, it is important to note that participants who successfully complete the entire mindfulness module achieve significantly greater clinical benefits than those obtained with the interpersonal effectiveness DBT module (Carmona i Farrés et al., 2019; Schmidt et al., 2021). Importantly, our data suggest that the benefits of mindfulness become apparent from the 5th session, and that these benefits seem to progressively increase over time until the final session. In this regard, since the program only lasted 10 weeks, we do not know if this trend would continue beyond the last session or if a ceiling effect would occur at some point. Nonetheless, one study found that several mindfulness skills continue to increase over time in non-clinical controls, mainly in those who sustain their practice over time (Soler et al., 2014).

As expected, we found a bidirectional association between mindfulness practice and ED. Those who practiced more (in days and minutes) showed greater improvement in ED levels the next week. By contrast, the presence of a high level of ED in the previous week negatively affected practice engagement in the following week, mainly in terms of reduced practice time (i.e., minutes). This bidirectional relationship shows that both practice and mindfulness appear to be mood-dependent, a finding that is consistent with the study by Elices et al. (2019), who found that the attention and acceptance components of mindfulness were differently affected by mood. Nevertheless, our findings indicate that nearly all participants (with only one exception) practiced mindfulness skills at some point and that the time spent practicing mindfulness increased throughout the training. This suggests that teaching and practicing skills in a group setting seems to be an effective strategy that motivates participants, even when experiencing high ED, to cope with difficult experiences and regulate emotions in daily life rather than avoid or suppress them (Linehan, 2014).

Interestingly, we found that the previous week's ED level had a greater influence on the total number of minutes spent on practice than on the number of days. This finding suggests that therapist should tell

patients to focus on ensuring that they practice as many days as possible, even if the duration is only short (e.g., at least one daily, 10-min meditation). This reciprocal relationship among skill use, ED levels, and clinical outcomes has been observed in other studies that have evaluated the change processes involved in DBT skills training (Barnicot et al., 2016; Southward et al., 2022; Wilks et al., 2016). Therefore, it is important for researchers and clinicians to be aware of these bidirectional relationships when assessing and/or performing an intervention in individuals diagnosed with BPD. In addition, future studies should control for these variables (i.e., the extent to which practice depends on the participant's level of ED and its influence on clinical outcomes). Similarly, in therapeutic interventions, therapists should emphasize the need for patients to practice these skills wisely (Linehan's "wise mind skill"): "if I feel more emotionally dysregulated on a given day, I could practice less" (Linehan, 2014).

In the course of any mindfulness intervention, it is clear that the therapist will ask the patients to practice. However, it would be useful to better understand, in a more tangible way, the degree to which the required practice leads to the desired improvement. In the case of rule-governed behaviors, nonspecific demands that lead to nonspecific rewards cause low motivation (Martin & Pear, 2019). In the context of our study, we found that the minimum dose needed to obtain significant improvements in ED is 3–4 days per week and more than 30 min. That said, practicing 5–7 days per week was even more beneficial. It is important that patients be made aware of these findings, which may help motivate them to strive to reach the minimum dose. While this amount of mindfulness practice is much lower than the levels observed in mindfulness-based interventions designed to treat other disorders such as anxiety or depression (i.e., an average of 30 min per day, 6 days per week; Parsons et al., 2017), in a clinical population with high emotion dysregulation such as BPD, it may be more important to get patients to commit to daily (or close to daily) practice (i.e., 5–7 days per week) rather than focusing on the duration of the practice sessions.

The importance of mindfulness skills use as a behavioral component in DBT to improve ED is supported by data from several studies (Mehlum, 2021; Wyatt et al., 2023). However, some mechanisms of change common to DBT not assessed in the present study may also improve ED. Mindfulness is not the only approach to effecting changes in emotion regulation, as evidenced by the fact that some people who did not practice at all or only very little also showed improvement in ED at completion of this program. Common factors such as expectations about the intervention or the therapeutic alliance may have influenced the expected outcomes (Wampold, 2016). It also seems probable that the group effect played a role in effecting improvement in these patients. In DBT skills training—as Chapman et al. (2019) pointed out—patients

with BPD often face overwhelming emotions upon joining a skills training group, and they must also face the potentially challenging group dynamics. Therefore, an important part of the therapist's role is to advise patients on how best to avoid dropping out, to avoid harmful behaviors, stay focused, and contribute to group discussions, despite their emotionality. These experiences provide patients with lessons in self-regulation within a structured environment, which in turn may help them to develop capabilities that will be useful in other, less structured environments, including everyday life.

This study presents several limitations. First, it was a nonrandomized single-arm trial, and the absence of an active control group raises uncertainty about whether the observed improvements in ED in BPD are exclusively attributed to mindfulness practice. For example, other DBT modules have also been shown to independently yield improvements in ED (Heath et al., 2021), although probably by different pathways. It would be interesting to assess how time spent practicing other DBT skills (e.g., distress tolerance or interpersonal effectiveness) contributes to emotion regulation in BPD. Therefore, future studies could incorporate an active control group (e.g., another DBT module). This approach would enable the comparison of different components, shedding light on their potential contributions. This would provide insight into the specificities of each DBT module in ameliorating emotion regulation difficulties in individuals with BPD. Second, the relatively short evaluation period, performed once per week for 10 weeks, may be insufficient, as a longer, more intensive intervention may be needed for mindfulness to exert a more robust effect on ED. A third limitation is related to the use of the DERS-18 to assess different maladaptive regulation processes (Victor & Klonsky, 2016) and measure the participants' level of ED. Given the characteristics of BPD patients, the DERS-18 may have captured ED as a trait rather than a temporal capacity to regulate emotions at a given moment in time. Fourth, while we did assess the quantity of mindfulness practice, we did not assess the quality of that practice, nor the effectiveness of skills use. This may be relevant given that quality and efficacy of skill use have been shown to influence outcomes in mindfulness and DBT interventions (Goldberg et al., 2020; Southward et al., 2022). A final limitation is that we did not assess the level of ED in the first session (introduction/orientation). Therefore, we could not assess whether participants improved their level of ED until the first week of training, even though they had not yet started mindfulness practices. For example, common therapy factors (e.g., motivation) could have also driven ED changes.

In conclusion, these results show that mindfulness practice can improve emotion regulation in BPD outpatients, provided that patients practice these skills with a certain frequency. In this regard, therapists should inform patients about the minimum dose of practice needed in order to adjust their expectations and increase motivation for practice. These findings may be useful for DBT therapists, both to help motivate patients and to help decide how much practice time they should ask of their patients. A strong commitment to practice appears to be one of the main behavioral component at the core of mindfulness training, and a certain level of commitment is necessary to improve ED. In short, the amount of practice is crucial and therapists should keep this in mind when performing interventions focused on improving emotional regulation.

### Ethics approval and consent to participate

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of Hospital de la Santa Creu i Sant Pau. Informed consent was obtained from all participants.

### Consent for publication

Not applicable.

### Availability of data and materials

Data are available upon reasonable request.

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### CRedit authorship contribution statement

**Carlos Schmidt:** Conceptualization, Formal analysis. **Joaquim Soler:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Daniel Vega:** Investigation, Methodology. **Juan C. Pascual:** Conceptualization, Supervision, Writing – review & editing.

### Declaration of competing interest

The authors declare that they have no competing financial interests or personal relationships that may have influenced the work reported in this study.

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### Appendix A. Supplementary data

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