






The Effects of Mindfulness-Focused Internet-Based Cognitive Behavioral Therapy on Elevated Levels of Stress and Symptoms of Exhaustion Disorder: A Randomized Controlled Trial

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Abstract

Background: Internet-based Cognitive Behavior Therapy (ICBT) and mindfulness interventions are commonly used to treat elevated levels of stress. There are however few high-quality studies that examine ICBT with integrated mindfulness components for symptoms of stress and exhaustion, and the role of mindfulness exercises in digital treatment.

Method: The aim of the present study was to evaluate if a mindfulness-focused ICBT-program could reduce symptoms of stress and exhaustion, and increase quality of life, in a randomized controlled trial including 97 self-referred participants between 18 and 65 years who experienced elevated levels of stress.

Results: The intervention group had significantly reduced symptoms of stress and exhaustion, and increased quality of life, compared to the control group. Compared with the controls, participants in the intervention group showed a significant improvement with moderate to large effects on the primary outcome measure perceived stress ($d = 0.79$), and the secondary outcomes, exhaustion ($d = 0.65$), and quality of life ($d = 0.40$). Participants in the ICBT group also increased their level of



mindfulness ($d = 0.66$) during the program. The amount of mindfulness training was significantly associated with an increased level of mindfulness, which in turn was significantly associated with reduced stress symptoms.

Conclusions: Mindfulness-focused ICBT can be an effective method to reduce stress-related mental health problems and the amount of mindfulness training seems to be of importance to increase the level of experienced mindfulness after treatment.

Keywords

CBT, ICBT, stress, mindfulness, exhaustion, internet-based

Highlights

- Combining mindfulness with ICBT is effective when treating individuals with elevated stress.
- Mindfulness-based ICBT can decrease symptoms of exhaustion and increase quality of life.
- The amount of mindfulness training during treatment has an impact on self-rated mindfulness.
- Increased mindfulness is associated with decreased levels of stress.

Perceived stress is conceptualized as an individual's feelings or thoughts about how much stress one is experiencing at a given point in time or during a period of time. To experience stress is a fundamental feature of human beings and can be an adaptive response to various stressors in everyday life. Stress becomes an issue when the body is forced to mobilize energy for an extended period of time without sufficient recovery. During the last decades, rapid advancements in society have transformed how we live, work, and interact, resulting in higher exposure to mental strain (Atroszko et al., 2020). Elevated stress over longer periods of time can have a negative impact on daily life and is associated with other physical and psychological problems such as anxiety, impaired sleep, depression, and exhaustion (Cohen et al., 2007; Grossi et al., 2015). Increased levels of stress are also associated with a negative impact on quality of life (Parsaei et al., 2020), a wider construct of self-perceived satisfaction with important life areas such as work, friendship, creativity, and leisure, that should be measured separately from other mental health symptoms (Lindner et al., 2016). Consequently, stress-related health issues have increasingly been recognized as a significant health issue with prevalence ranging between 4% and 16% (Glise et al., 2010; Höglund et al., 2020). Even though the most common diagnostic manuals ICD-11 and DSM-V contain definitions and categorizations such as post-traumatic stress, acute stress reaction and adjustment disorder, there is still a lack of consensus and well-defined terminology related to stress induced problems that are associated with relational conflicts, economic hardship, or work-related stressors. Another diagnosis close to stress-related disorders is Exhaustion Disorder (ED), which is

similar to the concept of clinical burnout (van Dam, 2021). It is characterized by severe mental and physical fatigue, in combination with lack of initiative and endurance. Mental and physical effort in daily activities lead to long recovery periods and it is a common cause for workplace sick leave in Sweden (Lindsäter et al., 2022). Prolonged exposure to stress has direct effects on people's well-being and leads to immense costs for society (Grossi et al., 2015; Hassard et al., 2018; Kivimäki & Steptoe, 2018; Melchior et al., 2007). Despite these well-known and detrimental consequences, a majority of all individuals suffering from stress and other mental health-related disorders, remain untreated (Ebert et al., 2016). This calls for further development and evaluation of interventions that are accessible, cost-effective, and have the potential in reducing stress.

Two established methods for the treatment of mental health problems are Cognitive Behavior Therapy (CBT) and Mindfulness interventions. CBT is considered an evidence-based and cost-effective treatment method for common mental health problems that is often provided individually in face-to-face settings (Bhattacharya et al., 2023; Butler et al., 2006; Myhr & Payne, 2006). It incorporates behavioral and cognitive strategies with the addition of homework assignments between sessions (Wenzel et al., 2016). To this date it is the most researched psychotherapy method, although its effects for stress related problems have been less studied (Nakao et al., 2021). Mindfulness has its roots in Buddhist traditions and can be described as the psychological process of purposefully focusing attention on experiences occurring in the present moment (Kabat-Zinn, 2003). The ability to be mindful is considered a skill that can be trained through practice (Bishop et al., 2004) and mindfulness-based interventions are commonly used to increase wellbeing and treat mental health problems (Sverre et al., 2023). There are also correlational studies examining the role of mindfulness in relation to stress and quality of life (Javaid et al., 2023), some of which are showing that higher levels of present moment awareness and mindful attention can lead to lower levels of perceived stress and increased wellbeing (Hepburn et al., 2021). Further examinations of the amount and duration of mindfulness training and its effects on dispositional mindfulness scale measurements are also warranted (Quaglia et al., 2016).

There is a growing body of evidence to support the efficacy of stress management interventions (SMI) in different populations and on a wide range of outcomes, such as perceived stress, burnout, recovery, and quality of life (Bhui et al., 2012). SMIs based on CBT, have yielded the largest effect sizes (Cohen's $d = 1.16$), followed by mindfulness and relaxation-based interventions (Cohen's $d = 0.50$; Richardson & Rothstein, 2008). Common components in stress-focused CBT vary but interventions commonly include a rationale about stress and how to manage stressors, relaxation techniques, coping and activation techniques, cognitive restructuring, problems solving, and skills training in assertiveness and time management (Ghazavi et al., 2016).

Mindfulness-based stress reduction, focusing on mindfulness techniques (e.g., directed attention to bodily sensations, thoughts, feelings, and daily activities) has been

found to reduce stress symptoms in non-clinical and clinical samples (Chiesa & Serretti, 2009; Shapiro et al., 2005; Smith et al., 2008) as well as in employees (Janssen et al., 2018) and students (Deshpande et al., 2023). Mindfulness has shown similar effects as CBT and pharmacological treatment for stress symptoms (Khoury et al., 2013). Mindfulness has also been incorporated into modern third-wave cognitive behavior therapy approaches, such as Acceptance and Commitment Therapy (ACT; Hayes, 2016), where it is used together with other concepts such as values and acceptance, aimed at increasing psychological flexibility and quality of life. There is data showing that incorporating value-based action in mindfulness interventions could enhance the effects of mindfulness (Christie et al., 2017). Previous trials (e.g., Michel et al., 2014) have also suggested that mindfulness could be an effective segmentation strategy to promote work–life balance for employees struggling with stress-related rumination and psychological preoccupation with work concerns. Although studied separately, few studies have examined the combined effects of integrated CBT and mindfulness-based stress reduction interventions.

Internet-based CBT (ICBT) is a well-established treatment format that offers increased access to effective psychological interventions for a wide range of mental health problems (Andersson, Titov, et al., 2019). Since one of the first studies on internet-based stress interventions (Zetterqvist et al., 2003) a growing body of literature has provided evidence of the efficacy in various populations (Andersson, Carlbring, et al., 2019). It has several advantages compared to face-to-face CBT, including being cost-effective by consuming less therapist time and reducing waiting times (Catarino et al., 2023), as well as being less emotionally stressful and bringing variety to a therapist's daily work (Weineland et al., 2020). The effects are long-lasting (Andersson et al., 2018) and similar to face-to-face treatment (Hedman-Lagerlöf et al., 2023). Meta-analyses have yielded small to moderate effects on outcomes of perceived stress, burnout, exhaustion, depression, and anxiety (Heber et al., 2016; Svärđman et al., 2022). Subgroup analyses have revealed greater improvement in guided interventions (Heber et al., 2017) and recent trials have suggested that ICBT stress interventions could have long-lasting effects (12 months post-treatment) and accelerate recovery and return to work (Asplund et al., 2023).

There are examples of studies on other disorders that have added mindfulness components in ICBT-programs (Carlbring et al., 2013) but to our knowledge few studies have evaluated the full integration of CBT and mindfulness components delivered in a concise internet-based format for perceived stress and symptoms of exhaustion. There is also a need for further knowledge about the association between the amount and length of mindfulness training in shorter treatment programs, and if increased mindfulness is associated with lower levels of perceived stress. The aim of the present study was to evaluate a six-week mindfulness-focused ICBT program for stress and its effects on stress, exhaustion, quality of life, and mindfulness, and the impact of mindfulness training in reducing stress and increasing experienced mindfulness. We hypothesized that

the internet-based recovery program would produce greater improvements in perceived stress (primary outcome) compared with a waitlist control group. We also hypothesized that the intervention group would differ with regard to stress-related exhaustion and quality of life. Finally, we hypothesized that the ICBT mindfulness training would be associated with increased mindfulness levels and reduction in perceived stress.

Method

Design

In this randomized controlled trial, participants were randomized to an internet-based mindfulness-focused ICBT program or a waitlist control group (WLC). The study followed Consolidated Standards of Reporting Trials (CONSORT) guidelines (Schulz et al., 2010) and was conducted between January 2017 and March 2017. Estimates of sample size were based on calculations in previous controlled trials on ICBT for stress (Ly et al., 2014) where a minimum of 66 participants was needed to achieve a power of 0.80 and detect an effect size of $d = 0.50$ (α level = .05). Self-report outcome measures were collected at pre- and post-treatment (six weeks). Participants who met the study criteria and provided informed consent were allocated randomly by an independent researcher using an online random generator (www.randomizer.org). Participants were randomized to either intervention or to a waitlist control condition. In addition to the pre- and post-assessment, participants reported the intensity of their mindfulness training every week. The study was part of a larger project investigating ICBT for stress and ethical approval was obtained from the local ethics committee (Reference No. 353-31).

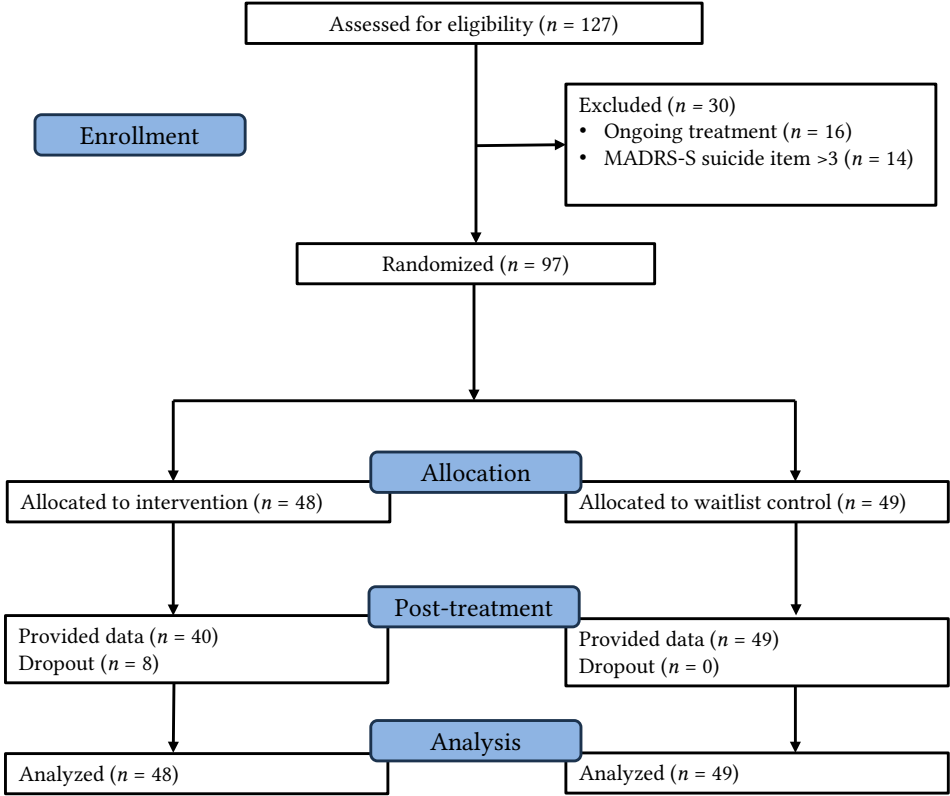
Participants and Recruitment

Participants were recruited by self-referral. Information was distributed by information on websites and social media and by emailing student health centers and human resource staff in some organizations. Those interested in participating were invited to contact the research team by email to receive further information about the study and a link leading to a website with information about the study. Following the link enabled the possibility to give informed consent and answer questions for screening purposes as well as the forms included in the pre-treatment assessment. The questionnaire also included questions about if participants had been diagnosed with exhaustion disorder or another psychiatric diagnose in routine care. Exclusion criteria were ongoing alcohol or drug abuse, ongoing psychological treatment, and a rating of 3 or higher on item 9 (life desire) on the Montgomery Åsberg Depression Rating Scale (MADRS-S; Svanborg & Åsberg, 2001), indicating suicidal ideation. Of the 127 persons completing this phase, 30 were excluded mainly due to ongoing treatment or suicidal ideation. The flowchart of the study is displayed in Figure 1. Individuals with suicidal ideation that were excluded from

the study were informed about appropriate help within the Swedish health care system. Participants did not receive any compensation for their participation in the study.

Figure 1

Flow Diagram of Participants in the Study



In total 97 persons from different parts of Sweden were included. Inclusion criteria were an age between 18 and 65 years, fluency in Swedish, basic computer skills, and the subjective experience of elevated levels of stress. The sample consisted predominantly of females with a mean age around forty years. Roughly one out of four participants reported that they had been diagnosed with stress-induced exhaustion disorder and among other self-reported diagnoses, depression was most prevalent. More detailed demographic information about the sample is shown in Table 1. During the intervention phase eight participants (8.2%) in the treatment group dropped out and none in the control group.

Table 1*Demographic Characteristics of Participants at Pre-Treatment*

Baseline characteristics	Intervention group (n = 48)		Control group (n = 49)	
	M	SD	M	SD
Age	38.33	11.13	42.22	10.78
	n	%	n	%
Sex				
Female	41	85	42	86
Male	7	15	7	14
Comorbidity^a				
Exhaustion disorder	12	25	14	29
Depression	8	17	7	14
Depression and GAD	5	10	6	12
Sleep disorder	1	2	1	2
Bipolarity and Panic disorder	1	2	0	0
Occupation				
Student	9	19	3	6
Full-time employee	23	48	32	65
Part-time employee	6	13	6	12
Job seeker	1	2	1	2
Student and employee	3	6	4	8
Sick leave (full time)	4	8	2	4
Sick leave (part time)	2	4	2	4
Level of education				
Elementary school	0	0	1	2
Upper secondary education, 1-2 years	0	0	4	8
Upper secondary education, 3-4 years	14	30	10	20
University- or college education, 3 years or less	9	18	8	16
University- or college education, >3 years or more	25	52	26	53
Country region				
Northern Sweden	8	17	16	33
Central Sweden	24	50	20	40
Southern Sweden	13	27	11	22
Overseas	3	6	2	4

^aSelf-rating in pre-treatment questionnaire of being diagnosed in routine care.

Primary Outcome Measure

The Perceived Stress Scale (PSS; [Cohen et al., 1983](#)) was used as primary outcome measure to assess the level of experienced stress. The PSS measures the degree to which situations in one's life are being perceived as stressful. The version used in the study had 14 items which focus on perceived stress during the last month. Individual scores can range from 0 to 56 with higher scores indicating higher perceived stress. The Swedish version of PSS-14 has shown to have good internal consistency ($\alpha = .84 - .90$; [Eklund et al., 2014](#)). Versions of the scale are commonly used in research studies and it has been shown to be responsive to psychological treatment in internet-based interventions for stress ([Svårdman et al., 2022](#); [Zetterqvist et al., 2003](#)). While normative population data for Sweden is unavailable, studies conducted in other countries have indicated mean scores ranging between 20.93 and 25.63 for the PSS-14 in various non-clinical sample groups ([González-Ramírez et al., 2013](#)).

Secondary Outcome Measures

Karolinska Exhaustion Disorder Scale (KEDS; [Besèr et al., 2014](#)) was used to assess exhaustion related consequences of prolonged stress. KEDS is designed to measure symptoms typical in exhaustion disorder, such as exhaustion, cognitive problems, poor sleep and reduced tolerance to further stress. The scale has 9 items, and each item is answered on a 7-point scale (0 – 6). Verbal descriptions are given to answering alternatives 0, 2, 4, and 6. The maximum score is 54 while the cut-off score for incidence of exhaustion disorder is 19. KEDS has good overall psychometric properties including excellent internal consistency (Cronbach's alpha, $\alpha = .94$). Further, KEDS is able to discriminate between exhaustion, depression and anxiety ([Besèr et al., 2014](#)).

Brunnsviken Brief Quality of Life (BBQ; [Lindner et al., 2016](#)) is a self-rating scale for assessment of subjective quality of life. It consists of 12 statements within six areas of life considered relevant for the experience of quality of life. All items are answered on a 5-point scale (0 = don't agree at all to 4 = agree completely), but for a given area of life, satisfaction is rated first and then the importance of the area. Afterwards, scores for satisfaction and importance within respective area are multiplied. The maximum score is 96 implying a high level. The psychometric evaluation of the scale suggests good concurrent and convergent validity. Internal consistency is adequate (Cronbach's alpha, $\alpha = .76$) and test-retest reliability is high (ICC = .82).

The Five Facets Mindfulness Questionnaire – Swedish version (FFMQ-SWE; [Baer et al., 2008](#); [Lilja et al., 2011](#)) has been developed to assess the level of mindfulness. FFMQ-SWE has 29 items distributed on five subscales: Nonreactivity to inner experience, Observing, Acting with awareness, Describing and Nonjudging of experience. The items are rated on a 5-grade likert scale (1 = never or very seldom to 5 = always). The internal

consistency for the global scale is good (Cronbach's alpha, $\alpha = .81$). and it also has a high content validity (Lilja et al., 2011).

Montgomery Åsberg Depression Rating Scale (MADRS-S; Svanborg & Åsberg, 1994) is a widely used self-rating scale measuring depression. In this study, only item nine was used to allow exclusion due to suicidal ideation or low level of life desire.

In addition to the evaluation of treatment effects, the participants' experience considering the functionality of the internet treatment system was assessed by The System Usability Scale (SUS; Brooke, 1996). SUS is a 10-item scale composed of 10 statements scored on a 5-point scale with a final score ranging from 0 to 100. A higher score on the scale indicates better usability of a given product or service. A large empirical evaluation of SUS (Bangor et al., 2008) provided support for the validity of the scale as well as guidelines for the interpretation of the results. A Swedish version of the scale have existed and been used since 2011. There are currently no publications on the Swedish version, but translations to other languages have shown retained psychometric properties and conceptual equivalence (Hvidt et al., 2020).

The Intervention

The treatment program, *Stresshjälpen*, was developed by the private Swedish psychology company Psykologpartners. It contains CBT-components for the treatment of stress-related problems such as psychoeducation about stress, functional analysis of stressful situations, strategies for self-care and healthy habits, time-management strategies, how to handle perfectionism and setting up a plan for setbacks. Mindfulness components and weekly mindfulness exercises are integrated into the treatment from module two and onwards. The modules and their content are further described in Table 2. The intervention is delivered through six online modules containing text, video, audio, and free-form text input boxes. In the beginning of each new module, participants were asked to reflect upon the previous module and how they managed the homework assignments. To keep track of the participants' mood and motivational level, a few short questions in the end of each module were included covering quality of life, stress, compliance with the treatment and sleep problems.

The two therapists had access to the treatment content in advance and could familiarize themselves with the material. Therapists also underwent a two-day training program in internet-based CBT and had regular supervision with an ICBT-proficient clinical psychologist during the whole study. The study participants were instructed to complete one module per week, and they had access to the treatment website for eight weeks. Two-factor authentication was used for logging in and accessing the material. The communication between the therapists and the participants took place via a secure messaging function in the portal. Once a week the participants received a message with comments on their previous work and further instructions. Therapists aimed to motivate participants, validate and reinforce functional behavior, answer questions and solve

problems. Participants who had not been logged in for a longer period were reminded by email or telephone.

Table 2

Description of the Content in Stresshjälpen

Module	Content
Module 1 – What is stress?	<ul style="list-style-type: none"> • Psychoeducation about stress • Stressful situations • Reactions in stressful situations • Homework: map current experiences of stress and coping strategies, and a 7-day diary with ratings of stress level
Module 2 – Functional analysis and mindfulness	<ul style="list-style-type: none"> • Functional analysis of stressful situations • Introduction to mindfulness • Homework: functional analysis and mindfulness exercises
Module 3 – Mindfulness and values	<ul style="list-style-type: none"> • Mindfulness • Values and valued living • Homework: values in specified life domains and mindfulness exercises
Module 4 – Self-care	<ul style="list-style-type: none"> • Committed action • Healthy habits: sleep, exercise, and healthy eating • Mindfulness to create healthy habits • Homework: change an important habit
Module 5 – Time-management and setting boundaries	<ul style="list-style-type: none"> • Time-management strategies • Values, functional analysis and strategies for setting boundaries • Homework: setting boundaries and mindfulness exercises
Module 6 – Maintaining treatment effects	<ul style="list-style-type: none"> • How to handle perfectionism • Summarize the treatment: lessons learned, obstacles and important behaviors • Create a maintenance plan and a plan for setbacks • Valued living

Procedure

There was no face-to-face contact between therapists and participants and all activities were conducted online. The intervention was delivered through a website and the assessments were done via an encrypted website. The randomization via randomizer.org resulted in 48 participants in the intervention group and 49 in the waitlist control group. The treatment started in January 2017 and continued to March 2017. After the post-assessment, participants in the control group were offered the online treatment.

All data analyses were carried out using IBM SPSS Statistics v.29 software. Pretreatment differences on demographic and outcome variables were analyzed with *t*-test and χ^2 -test. Intention to treat (ITT) was employed by using multiple imputation to handle missing data including 20 imputations, as recommended by Enders (Enders, 2017). Analysis of Covariance (ANCOVA) was used with pre-treatment scores as covariates for all the self-report measures to investigate treatment effects (Vickers & Altman, 2001). Effect sizes with Cohen's *d* with confidence intervals were calculated based on the post-treatment imputed means. The relationship between mindfulness training (assessed weekly) and the change in the level of mindfulness from pre- to post-treatment was analyzed using Spearman's Rho, due to the skewed distribution of the number of training sessions and the total duration of training. The association between changes in mindfulness levels and experienced stress was analyzed using the Pearson correlation coefficient.

Results

Baseline Differences, Ratings of Usability, and Adherence

There were no differences between the study groups at the pretreatment considering demographic or outcome variables. The overall rating for the internet treatment system assessed by SUS was 86 points which is considered excellent (Bangor et al., 2008).

The average number of completed modules in the intervention group was 4.7 of six modules ($SD = 2.26$, range 0-6) and 71% ($n = 34$) of the participants completed all modules. The self-estimated number of times engaging in mindfulness sessions during the course of treatment was 18.7 ($SD = 14.52$, range 0-62) and the self-estimated time in minutes engaging in mindfulness was 73.68 minutes ($SD = 78.76$, range 0-376).

Treatment Effects

Means and standard deviations including ANCOVA *F*-values and effect sizes are presented in Table 3. A large between-group effect size was found at posttreatment, $d = 0.79$, 95% CI [0.36, 1.23], on the primary outcome PSS-14 measuring perceived levels of stress. The secondary outcome measure KEDS assessing exhaustion-related symptoms demonstrated a similar change. The ANCOVA was statistically significant with a moderate effect size of $d = 0.65$, 95% CI [0.24, 1.06]. For the BBQ measuring quality of life the ANCOVA was statistically significant, but with a smaller effect size of $d = 0.40$, 95% CI [0.03, 0.81]. Regarding the FFMQ-SWE measuring mindfulness there was an effect in favor of the treatment group with a moderate effect size of $d = 0.66$, 95% CI [0.26, 1.07]. The reported increase in the level of mindfulness was positively correlated with both the number of training sessions ($\rho = .38$, $p = .016$) and the total duration of training ($\rho = .31$, $p = .049$). There was also a significant negative correlation between reported changes in the level of mindfulness and experienced level of stress, respectively. Those achieving

a higher level of mindfulness reported a larger decrease in their stress level ($r = .36, p = .023$).

Table 3

Means (M), Standard Deviations (SD), Effect Sizes (Cohen's d), and ANCOVA Results for Stress, Exhaustion, Quality of Life, and Mindfulness Measures in Treatment (n = 48) and Control (n = 49) Groups

Measure / Group	Pre		Post		Cohen's d	ANCOVA F(1, 96)
	M	SD	M	SD		
PSS					0.79	28.4***
Treatment	33.09	6.66	23.46	8.98		
Control	33.96	6.24	29.82	7.04		
KEDS					0.65	25.3***
Treatment	26.06	8.94	18.33	9.17		
Control	27.45	8.14	23.95	7.93		
BBQ					0.40	6.4*
Treatment	44.90	18.22	54.37	19.89		
Control	42.82	16.78	46.80	17.27		
FFMQ-SWE					0.66	19.9***
Treatment	83.79	12.00	93.18	9.60		
Control	84.12	9.40	86.10	11.42		

Note. ANCOVA = analysis of covariance; PSS = Perceived Stress Scale; KEDS = Karolinska Exhaustion Disorder Scale; BBQ = Brunnsviken Brief Quality of Life; FFMQ-SWE = Five Facets of Mindfulness, Swedish version.

* $p < .05$. *** $p < .001$.

Discussion

The present study evaluated the effects of a mindfulness-focused ICBT program on elevated stress- and exhaustion symptoms, and quality of life. The study also investigated the effect of the number of mindfulness sessions and the total amount of training with regard to changes in the level of mindfulness, as well as the association between changes in the level of mindfulness and symptoms of stress. The study results show that the treatment group reduced their perceived levels of stress, such as experiences of not having control and feelings of being overloaded, significantly more than the waitlist control group. This is in line with previous research on CBT-based stress management (Richardson & Rothstein, 2008), mindfulness interventions (Khoury et al., 2013), and results from other ICBT-studies, showing that digital interventions for stress related problems can be effective with moderate to large effect sizes (Svärdman et al., 2022). Results also showed that the intervention group had significant effects in comparison with the control group on symptoms of exhaustions, such as memory, ability to concentrate

and fatigue. In Sweden, exhaustion disorder accounts for more instances of long-term sick leave than any other diagnose and there is a limited amount of treatment research and limited evidence (Lindsäter et al., 2022). The findings in this study adds to the literature showing that ICBT interventions have the potential to influence work related outcomes such as levels of exhaustion (Asplund et al., 2023) and can be a cost-effective treatment option (Lindsäter et al., 2019). We also investigated if the treatment program would increase quality of life compared to the waitlist control group, which it did. The significant small to moderate effect on quality of life is in line with the effects usually obtained in CBT-studies on this measure (Kolovos et al., 2016).

Despite the short period of time for the intervention, participants in the treatment group increased their level of mindfulness significantly compared to the waitlist during the program. This is interesting as mindfulness is known to take long time and much effort to practice before effects can be shown (Brand et al., 2012). We found that the amount of mindfulness training, both number of sessions and total length, was significantly associated with increased self-reported mindfulness. This finding is confirmed by meta-analytic evidence showing that training in mindfulness can affect the dimensions of mindfulness captured by FFMQ (Quaglia et al., 2016). It should be mentioned that there could be a methodological problem as the measure of amount of mindfulness practice was self-estimated and could be influenced by social desirability.

We also found that the level of mindfulness was significantly associated with reduced levels of perceived stress symptoms. This may be because individuals who improve their ability to have a non-reactive approach to inner experiences, and the ability to observe and describe the present situation in a non-judging manner, experience less stress symptoms. This is in line with previous literature (Chiesa & Serretti, 2009; Shapiro et al., 2005; Smith et al., 2008) showing an effect of mindfulness techniques on reduced level of perceived stress symptoms in a clinical as well as a non-clinical population. Nevertheless, due to the absence of information regarding the direction of this association, it is equally plausible that reduced stress symptoms heighten individuals' awareness of their internal context.

Compared to other internet-based treatment programs, the intervention used in this study was less text-driven, shorter in length (length and number of modules) and developed to be interactive and motivating to work with for participants. There is indicative evidence that more condensed internet-based interventions are equally as effective (Karlsson-Good et al., 2023) and it could also be that the user experience had an effect on motivation and the use of treatment content, which is supported by the fact that the overall rating of the user experience was considered excellent by participants (Bangor et al., 2008). This topic needs to be further investigated, as the use of technology for increased effect and compliance in digital interventions are still under-researched (Balcombe & Leo, 2022; Wildeboer et al., 2016).

The limitations and strengths in the present study should be mentioned. First, there were no follow-up measurement. Thus, long-term effects were not measured which should be valuable to investigate in future studies. However, the robust design of RCT and the high number of individuals who completed the program are strengths in the study. The study also has high generalizability to the clinical population as the inclusion criteria for individuals recruited in the study were broad and there were no exclusions of individuals due to comorbidity. A possible limitation is the inclusion of a subclinical population as there are no norms available for PSS-14 and we did not exclude participants based on a certain lower threshold on the scale, although the data from this sample shows that the participants experienced elevated levels of perceived stress and exhaustion comparable to what is seen in other studies (Asplund et al., 2018). Other limitations are the possibility of selection bias using an open recruitment strategy and that we have no information on the direction of the associations being studied and they should therefore be interpreted with caution.

The present randomized controlled study provides knowledge that a mindfulness-focused ICBT stress program can reduce perceived stress and symptoms of exhaustion, and also increase quality of life and the experience of mindfulness. This shows that short internet-based interventions combining CBT and mindfulness have the potential to lessen the burden of stress-related problems.

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Competing Interests: Ella Radvugin and Kristofer Vernmark were employed by Psykologpartners at the time of the study.

Ethics Statement: The study protocol was approved by the local ethics board (Reference No. 353-31).

Preregistration: The trial was not preregistered.

Reporting Guidelines: The study followed Consolidated Standards of Reporting Trials (CONSORT) guidelines.

Data Availability: Data, material and analysis methods from the trial can be made available for other researchers upon request.

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