Mindfulness-Based Stress Reduction (MBSR) increases mental wellbeing and emotion regulation during the first wave of the COVID-19 pandemic: a synchronous online intervention study.

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Abstract

The COVID-19 pandemic imposed extreme living conditions of social distancing and stay-at-home orders, which not only triggered negative mental health problems, but also created challenges in seeking mental health support. Consequently, many support services and programs were forced to rapidly shift into online platforms. Mindfulness-based programs have been found to enhance wellbeing and mental health, by reducing stress and anxiety and improving emotion regulation. Preliminary evidence suggests that online, synchronous mindfulness-based programs may produce beneficial effects similar to face-to-face programs. However, the effectiveness of such online mindfulness programs to support mental health in extremely stressful times such as a global pandemic requires more study.

To test the effect of an online 8-week mindfulness-based program (Mindfulness-Based Stress Reduction, MBSR) on anxiety and stress levels, and on emotion regulation and tolerance of uncertainty abilities during the first wave of the COVID-19 pandemic.

Individuals/Participants (N=92) who expressed interest in discounted online-MBSR programs were recruited to the study. Division into experimental and control groups was based on actual enrollment to the courses. Those who decided to enroll to one of the programs were assigned to the experimental condition and those who decided not to enroll served as controls. Participants were assessed pre-intervention (T1), post-intervention (T2) and one-month post-intervention (T3) for levels of mindfulness, perceived stress, anxiety, emotion regulation and intolerance of uncertainty. The study was conducted in April 2020, at the peak of the first wave of COVID-19 in Israel and ended in July at the beginning of the second wave.

The findings indicate that relative to the control group, MBSR improved mindfulness abilities (p=.004), decreased anxiety (p=.021) and stress (p<.001) and increased emotion regulation (p<.001). These effects persisted even a month after the end of the program, although governmental public-health restrictions due to COVID-19 were worsened at that time. Ability to tolerate uncertainty, a central characteristic of the pandemic, was not significantly affected by the program. The interventions effect on mental health improvement was partially mediated by the improvement in emotion regulation (? = 0.24, CI = [0.054, 0.373])

Overall, our findings provide positive evidence for the feasibility of an online-MBSR program to support mental health of individuals from the general population through the mediation of emotion regulation, in challenging times such as a global pandemic.

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Abstract

Background: The COVID-19 pandemic imposed extreme living conditions of social distancing and stay-at-home orders, which not only triggered negative mental health problems, but also created challenges in seeking mental health support. Consequently, many support services and programs were forced to rapidly shift into online platforms. Mindfulness-based programs have been found to enhance wellbeing and mental health, by reducing stress and anxiety and improving emotion regulation. Preliminary evidence suggests that online, synchronous mindfulness-based programs may produce beneficial effects similar to face-to-face programs. However, the effectiveness of such online mindfulness programs to support mental health in extremely stressful times such as a global pandemic requires more study.

Objectives: To test the effect of an online 8-week mindfulness-based program (Mindfulness-Based Stress Reduction, MBSR) on anxiety and stress levels, and on emotion regulation and tolerance of uncertainty abilities during the first wave of the COVID-19 pandemic.

Methods: Individuals/Participants (N=92) who expressed interest in discounted online-MBSR programs were recruited to the study. Division into experimental and control groups was based on actual enrollment to the courses. Those who decided to enroll to one of the programs were assigned

to the experimental condition and those who decided not to enroll served as controls. Participants were assessed pre-intervention (T1), post-intervention (T2) and one-month post-intervention (T3) for levels of mindfulness, perceived stress, anxiety, emotion regulation and intolerance of uncertainty. The study was conducted in April 2020, at the peak of the first wave of COVID-19 in Israel and ended in July at the beginning of the second wave.

Results: The findings indicate that relative to the control group, MBSR improved mindfulness abilities (p=.004), decreased anxiety (p=.021) and stress (p<.001) and increased emotion regulation (p<.001). These effects persisted even a month after the end of the program, although governmental public-health restrictions due to COVID-19 were worsened at that time. Ability to tolerate uncertainty, a central characteristic of the pandemic, was not significantly affected by the program. The interventions effect on mental health improvement was partially mediated by the improvement in emotion regulation ($\beta = 0.24$, CI = [0.054, 0.373])

Conclusion: Overall, our findings provide positive evidence for the feasibility of an online-MBSR program to support mental health of individuals from the general population through the mediation of emotion regulation, in challenging times such as a global pandemic.

Keywords: Covid-19; Mindfulness; Mbsr; Online; Stress; Emotion Regulation; Anxiety; internet-based intervention

Introduction

The Coronavirus (COVID-19) first appeared in China at the end of 2019, and has evolved into a global crisis with a significant negative impact on the physical and mental health of individuals worldwide [1,2]. In an effort to limit the spread Sars-COV-2 virus, governments worldwide imposed different forms of public health measures ranging from physical distancing recommendations, the closing of non-essential institutions, home quarantine, curfews and lockdowns [3]. Along with the risk of a potentially life-threatening COVID-19 infection, rising unemployment and loss of social connections, many individuals experienced significant disruption in their everyday lives and in their

ability to self-regulate and cope with the rapidly changing situations [4]. These extreme conditions triggered feelings of uncertainty, helplessness, hopelessness, fear, and anxiety in the general population [4–8], thus increasing risk for the development of mental health conditions [9].

The extreme societal conditions of social distancing and stay-at-home orders not only triggered negative mental health problems [10], but also created challenges in seeking mental-health support since many forms of support services which typically take place face-to-face could not operate under these stringent restrictions. Consequently, many support services and programs were forced to shift rapidly to online platforms and develop new methods to assist their clients [11,12]. The present study examined the mental-health effects of a mindfulness-based program that was administered online during the first wave of the COVID-19 pandemic, with minor adaptations from the face-to-face version.

Mindfulness is a psychological construct drawn from the Buddhist tradition, which refers to a self-regulated attentional stance oriented toward present-moment experience, which is characterized by curiosity, openness, and acceptance [13]. Mindfulness-based interventions (MBIs) cultivate mindfulness by developing skills for dealing with negative thoughts and emotions in an adaptive and flexible manner [14–16]. These skills are believed to reduce the impact of negative emotions, and free up cognitive resources for assessing, observing, and giving meaning to difficult circumstances, which in turn can contribute to the development of personal goals [4,17]. In the last few decades, mindfulness-based programs and platforms have become widespread as self-help preventive interventions for non-clinical individuals seeking to alleviate high levels of personal stress and anxiety, and are considered to be especially relevant in times of crisis [18].

Previous studies conducted before the COVID-19 pandemic suggested that 8-week mindfulness programs, such as the ‘gold-standard’ Mindfulness-Based Stress Reduction (MBSR, Kabat-Zinn, 1995) or the Mindfulness-Based Cognitive Therapy (MBCT), [19] programs, can have positive consequences for psychological health and resilience, and have been found to produce

positive benefits in terms of the reduction of stress and anxiety [20–23]. Some studies have found that these effects can last several months after the end of the program [24,25]. Various mechanisms have been proposed to account for the beneficial effects of mindfulness on mental well-being (Baer, 2009; Brown et al., 2007; Hölzel et al., 2011). These include an increase in emotion regulation [26–30], attention regulation [16], decentering [31], reperceiving (Shapiro et al., 2006), and body awareness [32].Recently, there have also been initial investigations of the effects of mindfulness on the ability to tolerate uncertainty [33,34]. Uncertainty has long been considered pivotal to the experience of anxiety, and it has been argued that extreme responses to uncertainty play a critical role in pathological anxiety [35]. Mindfulness is characterized by a stance in which one gives up the goal of changing one's experience and instead allowing the experience to be as it is [36]. This type of stance may be particularly useful when individuals are called upon to have greater tolerance for uncertain aspects of experience, and may thus reduce the likelihood of dysfunctional uncertainty-related responses that can fuel anxiety [34] Preliminary evidence suggests that mindfulness is inversely associated with self-reported intolerance of uncertainty (IU) and that reactivity to uncertainty mediates the inverse relationship between mindfulness and aspects of anxiety [33,34]. Although no study has directly investigated whether a MBI can positively affect individuals' intolerance of uncertainty, MBIs may be particularly relevant in periods such as the COVID-19 pandemic, since the difficulty in tolerating uncertainty is an experience common to many at these times [37,38].

Importantly, the beneficial effects of MBIs on mental wellbeing have mostly been reported for face-to-face programs. Some of these effects have also been replicated to a certain extent when mindfulness programs were conducted online [39,40]. A recent review and meta-analysis of the effects of MBSR/MBCT conducted via Group Video-conferencing (VC) [41] identified ten empirical studies suggesting that online MBSR/MBCT is not inferior to traditional face-to-face MBCT/MBSR. Despite the limited evidence, these results lend weight to the feasibility and acceptability of MBCT/

MBSR-VC and found similar effects to in-person interventions.

The positive effects of mindfulness practices and the growing understanding of their underlying beneficial mechanisms have pointed to mindfulness as a key protective factor for buffering the psychological impact of the COVID-19 pandemic and increasing coping abilities during these uncertain times [18,42,43]. Dispositional mindfulness has been found to mediate the association between fear of COVID-19 and depression and anxiety [6] and to be related to enhanced wellbeing and a reduction in the psychological distress associated with the pandemic [44–46]. In addition, daily mindfulness practice was found to buffer the effect of COVID-19 on anxiety and sleep duration [47]. To date, only two MBIs studies have been conducted during COVID-19. The first [48] investigated an online synchronous MBSR course as compared to a face-to-face MBSR course conducted during the pandemic and reported positive effects in reducing stress but not in the improvement of sleep quality for both groups. The second study [49] tested the feasibility and efficacy of a brief online mindfulness-based intervention which lasted 13 days (composed of a 2 hour training/psycho-education mindfulness session, followed by 13 days of group-supported mindfulness practice). The findings indicated there were positive effects in reducing psychological distress and anxiety symptoms.

The aim of the present study was to investigate the effect of an online-MBSR program among the general population on measures of mental wellbeing, specifically stress and anxiety. We also assessed how online MBSR affected emotion regulation and intolerance of uncertainty (IU). Increase in emotion regulation and decrease in IU were both suggested as mechanisms by which MBIs will exert their beneficial effects as they are highly relevant for dealing with the anxiety evoked by the challenging COVID -19 times [47].The online MBSR programs were provided by a mindfulness center associated with the university (The Interdisciplinary Center Herzliya). They were initiated in mid-April 2020, less than two months after the first case of COVID-19 was detected in Israel and 4-6 weeks after the government introduced the first series of COVID -19 public health measures ranging

from physical distancing regulations, home quarantines, closing of non-essential institutions, curfews and lockdowns (see Figure 1 for details). When the courses began (T1) these measures were only starting to be withdrawn. Both programs ended two month later (T2), a time characterized by a slow rise in COVID -related cases and deaths and governmental threats that public health measures will be activated again. A month later (T3), COVID-related cases and deaths had risen sharply, non-essential institutions were closed again, and social-distancing was enforced, thus limiting social interaction to ten people.

Based on previous research regarding face-to-face and online-MBSR courses, we hypothesized that online-MBSR will reduce perceived stress and anxiety, as well as intolerance to uncertainty, and will increase emotion regulation abilities. We hypothesized these measures will stay relatively unchanged for the control group. In addition, we expected that the MBSR benefits will also endure one month after the ending of the course.

Method

Participants

Participants (N=92) who enrolled to two online synchronous MBSR courses provided by a mindfulness center affiliated with the university (Muda Institute for Mindfulness, Science and Society) were recruited to participate as the intervention group in the study (MBSR group). The courses were presented to participants as part of a study and they could pay a reduced fee in exchange for participating in the study. Participants in the control group were recruited by approaching individuals who expressed interest in these online courses but eventually did not enroll due to personal reasons or lack of space. In exchange for participating in the study, they were eligible to enter a raffle for ten mindfulness books and two vouchers for participation in later MBSR courses. Participants who agreed (N=46 (were allocated to the control group. Demographic characteristics for all participants are displayed in Table 1.

Procedure

After receiving approval from the institutional ethics committee, all participants that agreed to participate in the study signed a consent form and received a link to an online survey with demographic questions and self-report measures to assess mindfulness, state anxiety, perceived stress, difficulties in emotional regulation, intolerance of uncertainty and loneliness. After the MBSR group completed their MBSR programs and one month later all participants were administered the same survey without the demographic questions. The overlap of the study's data acquisition time points with the COVID-19 illness rate is depicted in Figure 1 (based on [50]). Overall, seventy-one participants completed all three measurements divided into control (N=38) and intervention (N=33).

<<<Enter Figure 1 here>>>

MBSR Intervention

The course followed the 'Gold Standard' MBSR protocol developed by Jon Kabat Zinn which includes contemplative practices ranging in body scan, focused attention, open awareness, movement exercises and daily life informal mindfulness practice, as well as psychoeducation that supports the contemplative practices [51]. The MBSR protocol was administered in a group format structured 8-week intervention with weekly 2.5-hour meetings. Registration for the course involved a personally chosen fee on a sliding scale was between 15% to 60% of the pre-Covid price of a MBSR course. Apart from weekly meetings, the intervention protocol also included assignments for daily home practice accompanied by guided meditation recordings and a 4-hour long silent retreat during the 6th week of the program. Due to COVID-19 restrictions the entire intervention was administered online using Zoom software. The study assessed two online MBSR interventions, each led by a certified MBSR instructor with over twenty years of personal mindfulness practice and more than 3-year experience in teaching the MBSR protocol. Adjustment to the online format included: 1. The long silent retreat which usually is 8-hour long, was shortened to four hours and included less mindful movement practices; 2. Two short breaks instead of one longer break were usually provided during

the 2.5-hour weekly meetings; 3. One teacher used PowerPoint slides for the psychoeducation parts.

Measures

Mindfulness

Mindfulness was assessed using the *Freiburg Mindfulness Inventory* (FMI) [52]. A self-report measure consisting of 14 items that measure trait mindfulness (e.g.: "I am open to experience of the present moment"). Participants are asked to refer to the last 14 days when answering. Items are rated on a 4-point Likert scale ranging from 1 ("Rarely") to 4 ("Almost always") with higher scores indicating higher mindfulness levels. In the present study this measure demonstrated high internal consistency across all three times (Mean Cronbach's α = .856).

State Anxiety

State anxiety was measured using the *State-Trait Anxiety Inventory* (STAI) [53]. This self-report measure consists of two subscales examining both State and Trait Anxiety. For this study, we examined only the State subscale due to considerations based on study's length and other measures involved. The State Anxiety subscale consists of 20 items referring to participants feelings *right now* (e.g.: "I feel frightened") rated on a 4-point Likert scale ranging from 1 ("Not at all") to 4 ("very much so") with higher scores indicating higher levels of Anxiety. In the present study this measure demonstrated high internal consistency across all three times (Mean Cronbach's α = .939).

Perceived Stress

Perceived stress was measured using the *Perceived Stress Scale* (PSS) [54]. A 14 item self-report scale on a 5-point Likert scale ranging from 0 "Never" to 4 "Very often". Participants are asked to indicate how often they felt a certain way (e.g.: "In the last month, how often have you been upset because of something that happened unexpectedly?"). In the present study this measure demonstrated high internal consistency across all three measurements (Mean Cronbach's α = .864).

Emotional Regulation

Emotional regulation was assessed using the Difficulties in Emotional Regulation Scale (DERS) 18

item self-report measure [55] based on the original version [56]. Each item is rated on a 5-point Likert scale ranging from 1 "Almost never (0-10%)" to 5 "Almost always (91-100%)" This measure consists of one total score measuring emotional regulation difficulties with higher scores showing higher emotional dysregulation (e.g.: "When I am upset, I become embarrassed for feeling that way"), In the present study the measure demonstrated high internal consistency across all three times (Mean Cronbach's α = .885).

Ability to tolerate Uncertainty

Ability to tolerate uncertainty was measured with the *Intolerance of Uncertainty Scale -Short Version* (IUS12) [57] based on the original 27 item version [58]. Items are rated on a 5-point Likert scale ranging from 1 "Not at all characteristic of me" to 5 "entirely characteristic of me" with higher scores indicating greater difficulties dealing with uncertainty. The scale is constructed from two dimensions: Prospective Anxiety (e.g.: "Unforeseen events upset me greatly"), and Inhibitory Anxiety (e.g.:" Uncertainty keeps me from living a full life"). In the present study the measure's total score demonstrated high internal consistency across all three times (Mean Cronbach's α = .883) as well as high internal consistency for both factors: Prospective Anxiety (Mean Cronbach's α = .802) and Inhibitory Anxiety (Mean Cronbach's α = 0.818).

Statistical analysis

Group differences at T1 were tested using t-test and χ2 analyses. For the correlation matrix of the different measures, we used Pearson correlations.

To examine different effects of the intervention Two-Way Repeated Measures Analyses of Variance (ANOVAs) were used to examine the changes in the mean score over the three different time points and between the intervention groups as well as the interaction between group and time. The dependent variables were the study outcomes (Mindfulness Perceived Stress, State Anxiety, Emotional Regulation Difficulties, and Intolerance of Uncertainty). To assess our study aims and hypothesis the effect of interest was the Group X Time interaction.Simple effects of Time and post

hoc comparisons were corrected for multiple comparisons using the Bonferroni adjustment. Mediation Analyses were conducted using Hayes' (2017)[59] PROCESS macro for SPSS (version 3.5, model 4; with 5000 bootstrap iterations and 95% bias-corrected confidence intervals). The statistical software SPSS 27 (IBM, New York City) was used for all the data processing within this study.

Results

Sample characteristics

A total of ninety-two participants participated in the study with most of the sample (73%) being female. (64%) of participants were either married or in a relationship, with only 15% of participants reported living alone without anyone else. Twenty nine percent of our sample reported bring financially affected by COVID-19 related consequences with them being either fired or in unpaid leave. The vast majority of our sample had at least one academic degree (96%) as well as being secular (87%). All sample characteristics are specified in Table 1.

<<Enter Table 1 here>>

Group differences at T1

Despite the lack of randomization, the intervention and control groups did not exhibit significant differences in demographic characteristics (Table 1). However, at T1 (before the intervention), participants who enrolled in the MBSR courses as compared to participants who decided not to enroll in the MBSR courses (controls) exhibited lower scores on the mindfulness scale [$t(91) = -3.709$, $p<.001$], higher scores on the Emotional regulation Difficulties scale [$t(90) = 2.054$, $p= .043$] and (marginally significant) higher scores on the Perceived Stress scale [$t(90) = 1.91$, $p= .059$]. No

initial differences between groups were found for State Anxiety and Intolerance of Uncertainty.

Analysis of intercorrelations

Correlations between mindfulness, mental wellbeing, emotion regulation and intolerance of uncertainty, were calculated using Pearson correlations with all tested variables at time 1 (see Table 2). As hypothesized, significant correlations between all tested variables were found, similar to finding of previous reports ( ).

<<<Enter table 2 here>>>

Manipulation check: effect of online-MBSR on mindfulness

Central to the study's objectives, a significant Group X Time interaction was detected, indicating that online-MBSR increased mindfulness levels (Table 3). Simple effect analysis with Bonferroni adjustment showed that while there were no significant changes within the control group, in the MBSR group a significant simple effect was found [$F(2, 138) = 21.13$, $p<.001$ *partial* $\eta 2 = .383$.] Pairwise comparisons with Bonferroni adjustment for the MBSR group revealed significant differences in mindfulness scores, which increased from pre-intervention (T1) to post-intervention (T2) ($p<.001$), and remained significantly greater at the one-month follow-up (difference between T1 and T3, $p<.001$) as well.

Effect of online-MBSR on mental health indicators

We first examined the effect of online-MBSR on perceived stress and state anxiety. As hypothesized, the Group X Time interaction was found to be significant for both mental health measures (Table 3). Simple effect analysis with Bonferroni adjustment revealed that while the control group showed no significant changes over time in both measures, for the MBSR group significant effects of time were found for Perceived Stress [$F(2, 138) = 45.621$, $p<.001$ *partial* $\eta 2 = .573$] and State Anxiety [$F(2, 138) = 10.607$, $p<.001$ *partial* $\eta 2 = .238$]. Further examination, using pairwise comparisons with Bonferroni adjustment, showed improvement in both mental health measures as a result of the

online-MBSR intervention. Specifically, significant reductions in Perceived Stress and State Anxiety were found from pre-intervention (T1) to post-intervention (T2) (all *ps*<.001). Remarkably, these reductions remained significant at one-month post-intervention checkup (T3) for both perceived stress (*p*<.001) and state anxiety (*p*=.004). Follow up analyses, to control for the near significant group differences in PSS in T1 and for possible effects of regression to the mean, revealed that above and beyond these initial differences, the observed improvement in the MBSR group remained (see details and Figure S1 and S2 in the supplementary section).

Effect of online-MBSR on emotion regulation and intolerance to uncertainty

To study the effect of online-MBSR on mechanisms associated with the beneficial effects of MBIs we ran an analysis with Difficulties in Emotional Regulation (DERS) and Intolerance of Uncertainty (IU) as the dependent variables.

The Group x Time interaction effect showed significant results for DERS (Table 3). Simple effect analysis with Bonferroni adjustment revealed the hypothesized pattern, with a significant effect of time in the MBSR group [$F(2, 138) = 24.036$, $p<.001$ *partial* $\eta 2 = .414$] but no significant changes in the control group. The MBSR group resulted in improved emotion regulation, showing significant reductions in emotion regulation difficulties from pre-intervention (T1) to post-intervention (T2) (*p*<.001); these differences remained significant at the one-month post-intervention checkup (T3) (*p*<.001). For Intolerance of Uncertainty, on the other hand, no significant effects were found.

<<<Enter Table 3 and Figure 1 here>>>

Emotion Regulation as a mediator between MBSR and improvement in Mental Health

Given these positive findings, we examined whether less difficulties in emotion regulation (DER) mediated the effects of MBSR on mental health indicators (MH). For that aim we conducted a

mediation analysis. The model was specified with the independent variable defined as group (MBSR =0, Control =1). The mediating variable was defined as the difference in DERS between T3 and T1 ($\Delta DER = DER_{T3} - DER_{T1}$); negative scores indicate less emotion regulation difficulties post intervention. The dependent variable was mental health indicators. To achieve MH score, the anxiety and stress scales sums were standardized, and a mean score was computed for both measures. In the model the dependent variable was defined as the difference in MH between T3 and T1 ($\Delta MH = MH_{T3} - MH_{T1}$); with negative scores indicating less stress and anxiety. The total effect of the model ($\beta = 0.91$, CI = [0.387, 1.042], $t = 4.346$, $p < .001$) was reduced when the mediator variable was added ($\beta = 0.67$, CI = [0.187, 0.865], $t = 3.099$, $p = .003$). Zero was not included in the indirect effect ($\beta = 0.24$, CI = [0.054, 0.373]) indicating a significant mediation of MBSR on Mental Health through Emotion Regulation.

<<<Enter Figure 3 here>>>

Discussion

Principal Results

This study investigated the effects of an online synchronous MBSR course during the first four months of the global Covid-19 pandemic. This period was characterized by high levels of uncertainty, unemployment, perceptions of direct threat and loss of social support due to social distancing regulations [4–7]. These extreme conditions not only increased the risk for the development of mental health conditions [9,10], but also created challenges in seeking mental-health support [12]. Specifically, we investigated whether an online MBSR would reduce stress and anxiety, improve the ability to employ emotion regulation in difficult emotional states and reduce intolerance of uncertainty – two mechanisms that are considered to underlie the beneficial effects of MBIs.

The findings indicate that relative to the control group, the online-MBSR improved

mindfulness abilities, which served as the manipulation check. The online-MBSR decreased anxiety and stress and increased emotion regulation. These effects persisted a month after the end of the program (T3), although the pandemic was worse at that time relative to T1 and T2. Moreover, the decrease in mental health measures that was observed at T3 was mediated by the improvement in emotion regulation. Overall, the results provide positive evidence for the feasibility of an online-MBSR program to support the mental wellbeing of individuals from the general population, even in challenging times such as the COVID-19 pandemic.

Comparison to previous literature

The positive effects of MBSR found here are consistent with multiple studies conducted before the pandemic [14,25,60,61] and with several studies taking place during the pandemic [4,18,42,43], all of which suggest a positive link between mindfulness and mental wellbeing. Importantly, most studies conducted during the pandemic were cross-sectional and measured whether individuals with higher trait-mindfulness were more resilient to pandemic-related stress and anxiety. To the best of our knowledge, there have only been two intervention studies that studied the effect of MBI programs during the COVID-19 pandemic [48,49]. The first [48] compared an online MBSR program to a face-to-face MBSR program – both of which were conducted during the pandemic– as well as to a MBSR group conducted prior to the onset of the pandemic. The second study [49] tested the feasibility and efficacy of a brief online mindfulness-based intervention that lasted 13 days. In both cases, online MBIs had positive effects in reducing psychological distress and anxiety symptoms.

The current study contributes to extending these studies in several ways. First, it suggests that the positive mental-health effects of an online MBSR course in in reducing stress and anxiety can be maintained, since the effects here were reported to have lasted one month later. In addition, there was a clear rise in emotion regulation abilities after the online-MBSR and this improvement mediated the positive effects on mental health measures. Previous work conducted prior to COVID-

19 pandemic has that suggested emotion regulation abilities are a central mechanism underlying resilience [62] and mental wellbeing [63,64] and may drive the positive effects of MBIs [15,30,65,66]. As resilient individuals were found to cope better in times of severe stress, such as during a global pandemic [62], our results suggest an online-MBSR in extreme situations such as a global pandemic may not only reduce psychological distress, but may also cultivate abilities to shore up resilience during these times.

Because the first waves of the COVID-19 pandemic were characterized by high levels of uncertainty, this study also investigated the relationship between mindfulness and difficulties tolerating uncertainty. Replicating previous findings [33], we found that across all participants, higher trait-mindfulness was associated with reduced intolerance of uncertainty (IU). However, contrary to some of the other measures, there were no significant differences in IU between groups at T1 and no effect of the online-MBSR intervention. The IU employed in the IU scale was defined as a ‘an individual’s dispositional incapacity to endure the aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty [67]. It is possible that the characteristics of uncertainty in the extreme period of a global pandemics are not well captured by the IU scale, or that they masked the effects of a short-term mindfulness practice. Future studies should develop tools to assess uncertainty conditions that are more characteristic and sensitive to a global pandemic situation.

As reported, there was a significant difference between groups in mindfulness, emotion regulation abilities and perceived stress measures at T1. However, all participants in both groups expressed interest in the MBSR courses and requested details and information during the first lockdown. Our findings suggest that individuals with lower trait-mindfulness and emotion regulation, but higher actual and perceived stress were more likely to decide to finally enroll and pay the tuition fee to be in the MBSR intervention group. In other words, not only did lower trait-mindfulness and emotion regulation abilities increase vulnerability to stressful situations, but it may

also affect behaviors related to seeking self-help in times of crisis. Future studies should examine whether the relationships between these constructs affect the decision to enroll in MBIs in extreme global situations.

Limitations

There are several limitations to the current study that warrant further consideration. First, the population was not sampled randomly but rather was based on the participants' preliminary interest in enrolling in a MBSR course during the first lockdown. This common interest in mindfulness may suggest that the sample has specific personality attributes that might have affected the outcomes and not necessarily reflect the general population. Second, in order to conduct the study in the very special conditions of the first stages of a pandemic, the allocation of control and experimental groups were not randomized due to time constraints. Although, demographic characteristics did not differ between groups, the control group displayed less difficulties in emotion regulation and more mindfulness (which may explain their lower motivation to enroll in the program). Our general findings persisted even after balancing the groups for initial perceived stress. Since this is not a fully randomized study, it may be claimed that the conclusions of this study are limited to the sub set of participants who, at special times such a global pandemic, presented with reduced mental health and emotion regulation parameters. Still, as these people are most at risk [68], the positive effects we found suggest they can benefit from an online-MBSR. Another limitation of the study is the fact that we assessed only outcomes a month after the end of the intervention and not at additional time points. Although positive outcomes remained high despite the worsening of the pandemic, it is not clear whether the gains would be sustained for longer periods without further structured support (group setting, instructor). Finally, Canby et al., 2021, showed that instructor -and group- related factors play a role in the therapeutic effects of MBIs. Naturally, a group formed at the beginning of a global pandemic may share the common cohesive experience of difficulty that can make a positive contribution to the overall effect of the program. Since the MBSR group was not compared to an

active control, we cannot eliminate the possibility that the positive effects we found were due to the specific teachers who led the courses and/or the group dynamics.

Conclusions

Overall, the findings suggest that an online synchronous MBI can successfully reduce stress and anxiety while improving emotion regulation in participants during extremely stressful conditions caused by a global pandemic. The improved outcomes continued to last one month after the intervention, even when the COVID-19 situation took a turn for the worse. These findings are especially meaningful given the scarce evidence [41] on online stress reduction interventions during COVID-19 characterized by the lack of access to face-to-face mental health support.

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Conflicts of Interest

None declared.

Tables and Graphs

Figure 1

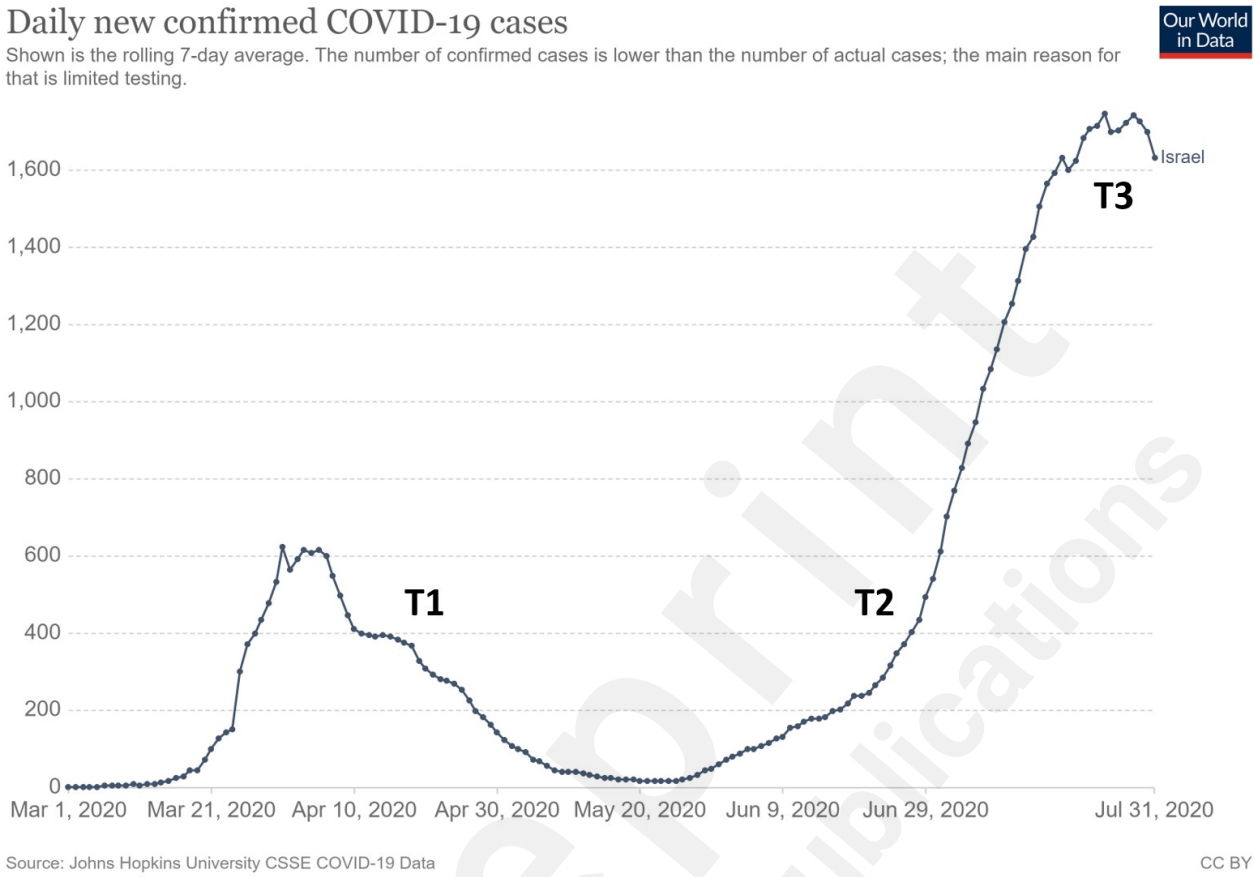

Figure 1: Daily changes in confirmed COVID-19 cases during the time of the study (extracted from [50]). The study's three time-points are marked along the time-line.

Table 1

Demographic characteristics of participants preintervention

Demographic characteristics	Intervention group		Control group		Full sample	
	(N=46)		(N=46)		(N=92)*	
	N	%	N	%	N	%
Age in years [M (SD)]	44.37 (14.07)		39.22 (15.403)		41.79 (14.897)	
Gender						
Male	13	28	11	24	24	26
Female	33	72	34	74	67	73
Other	0	0	1	2	1	1
Marital Status						
Single	8	17	19	41	27	29
In a relationship	6	13	7	15	13	14
Married	28	61	18	39	46	50
Divorced	4	9	2	4	6	7
Education Status (in years)						

Up to 12 years	3	7	1	2	4	4
12-15 years	8	17	11	24	19	21
16-18 years	16	35	18	39	34	37
Over 18 years	19	41	16	35	35	38
Religious Status						
Secular	39	89	39	85	78	87
Traditional	4	9	5	11	9	10
Religious	1	2	1	2	2	2
Orthodox	0	0	1	2	1	1
Living Situation						
Living alone	6	13	8	17	14	15
Roommates	2	4	6	13	8	9
Parents	5	11	5	11	10	11
Significant other	18	39	16	35	34	37
Significant other and children	13	28	11	24	24	26
Only with children	2	4	0	0	2	2
Employment Status						
Working	26	57	31	67	57	62
Unpaid vacation	5	11	8	17	13	14
Unemployed	10	22	4	9	14	15
Other[a]	5	11	3	7	8	9

Note. *N*=92 apart from Religious status for which *N* = 90 (control *n*= 46 MBSR *n*= 44).

[a] 'Other types of working status such as pension, sick leave, etc.

Table 2

Correlations for Study Dependent Variables at T1

Variable	1	2	3	4	5
1. Mindfulness	—				
2. Perceived Stress	-.600**	—			
3. State Anxiety	-.509**	.651***	—		
4. Difficulties in Emotional Regualtion	-.646**	.695***	.547***	—	
3. Intolerance of Uncertainty	-.495**	.485***	.344**	.534***	—

**p=.003. ***p<.001.

Table 3

Means, Standard Deviations, and One-Way Analyses of Variance Interaction Effects of online-MBSR

Group X Time			month-*1* post		Post-intervention		Pre-intervention		Measure
η^2	*p*	F(2,138)	*SD*	*M*	*SD*	*M*	*SD*	*M*	
.077	.004	68.87							**Mindfulness**
			4.82	35.48	5.49	36.00	5.32	30.97	MBSR
			6.96	37.47	6.86	37.92	6.55	36.16	Control
									Perceived
.238	<.001	21.503							**Stress**
			5.13	28.73	6.08	28.18	5.52	35.36	MBSR
			6.78	30.82	6.98	30.42	7.03	31.76	Control
.054	.021	3.969							**State Anxiety**
			8.89	38.03	10.23	36.15	11.58	44.64	MBSR
			13.09	41.71	10.28	38.29	10.51	41.42	Control
									Emotional
									Regulation
.158	<.001	12.926							**Difficulties**
			8.95	35.64	8.34	34.67	11.62	43.51	MBSR
			10.91	37.00	11.07	36.89	10.99	37.82	Control
									Intolerance of
.027	NS	1.945							**Uncertainty**
			8.84	30.18	7.70	30.97	8.62	32.85	MBSR
			8.84	29.32	8.72	28.89	7.99	28.74	Control

Note. NS = Not Significant

Figure 2:

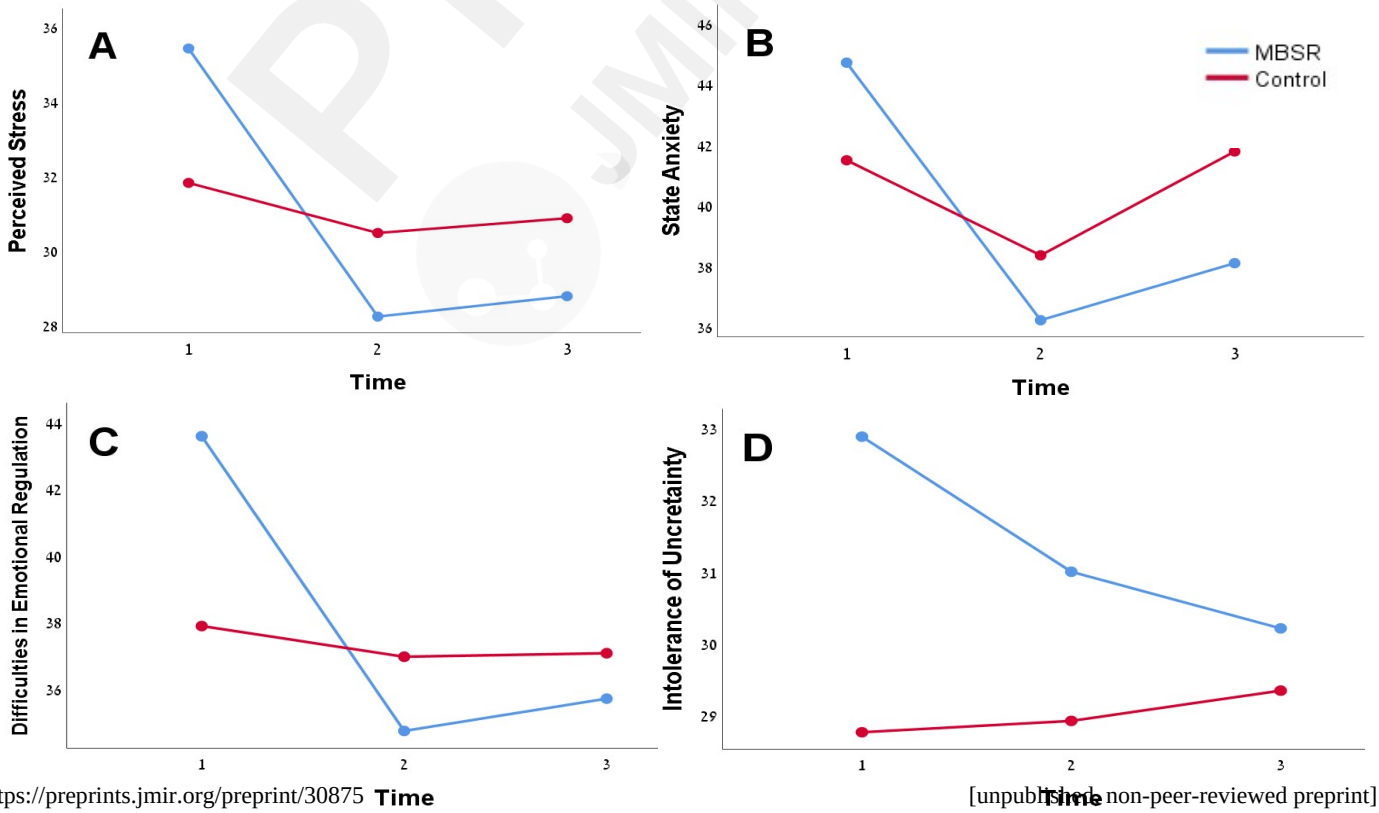

Figure 2: Changes in outcomes across the three time points for (A) Perceived Stress, (B) State Anxiety, (C) Difficulties in Emotional Regulation (DERS), (D) Intolerance of Uncertainty (IU). For all measures, no effect of time was observed for the control group. On the other hand, in the MBSR group, for all measures, except IU, a significant difference was found between T1 and T2 and between T1 and T3.

Figure 3

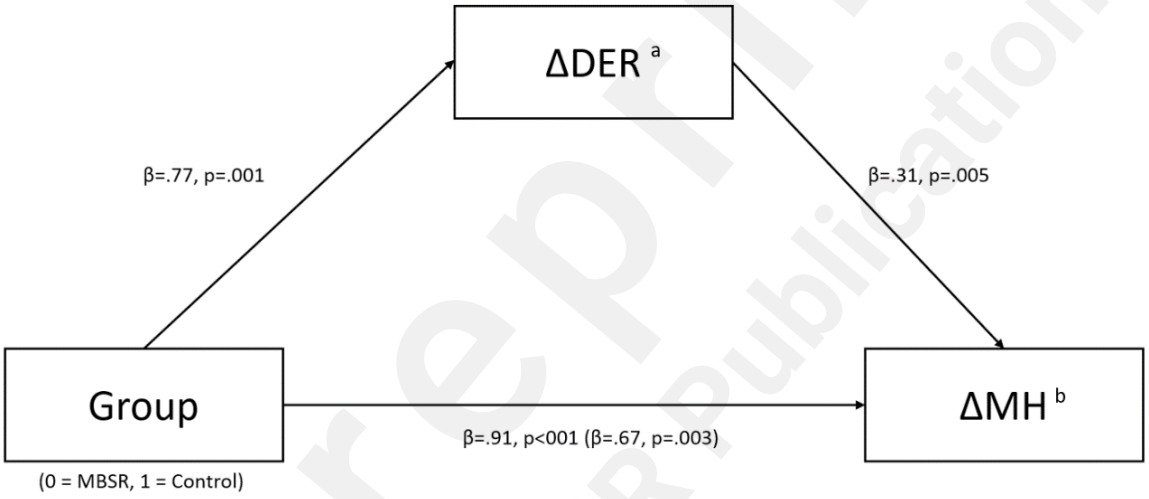

Figure 3: Mediation of intervention group on changes in mental health through changes in difficulties in emotion regulation (the models present standardized beta coefficients).
[a]ΔDER = difficulties in emotion regulation measured at T3 – difficulties in emotion regulation measured at T1.
[b]ΔMH = the combined standardized score of state anxiety and perceived stress at T3 – the combined standardized score of state anxiety and perceived stress at T1.

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Supplementary Files