Efficacy of the my health too online cognitive behavioral therapy program for healthcare workers during the COVID-19 pandemic: A randomized controlled trial

Amaury C. Mengin [a,b,c,d,e,*], Nathalie Nourry [c,e,f], François Severac [g,h], Fabrice Berna [a,c,d,e], Doha Bemmouna [i], Mădălina Elena Costache [i,j], Aurélie Fritsch [i,j], Isabelle Frey [a], Fabienne Ligier [k,l], Nadia Engel [k,l], Philippe Greth [m], Anastasia Khan [m], Jean-Christophe Chauvet-Gelinier [n], Guillaume Chabridon [n], Emmanuel Haffen [o], Magali Nicolier [o], Anna Zinetti-Bertschy [a,i], Pierre Vidailhet [a,b,c,d,e], Luisa Weiner [a,i,j]

[a] Department of Psychiatry, Mental Health & Addictology, Strasbourg University Hospital, Strasbourg, France
[b] Regional Great East Center for Psychotraumatism, Strasbourg, France
[c] Strasbourg University, Faculty of Medicine, Strasbourg, France
[d] INSERM U1329, Strasbourg Translational NEuroscience and Psychiatry (STEP), Team Psychiatry, Strasbourg, France
[e] Fédération de Médecine Translationnelle de Strasbourg, France
[f] Hôpitaux Universitaires de Strasbourg, Service de Pathologies Professionnelles et Médecine du Travail, Strasbourg, France
[g] Hôpitaux Universitaires de Strasbourg, Département de Santé Publique, GMRC, Strasbourg, France
[h] Université de Strasbourg, Laboratoire de Biostatistique et Informatique Médicale, iCUBE UMR, 7357 Illkirch, France
[i] Strasbourg University, Faculty of Psychology, Strasbourg, France
[j] Laboratoire de Psychologie des Cognitions, Université de Strasbourg, Strasbourg, France
[k] PUPEA, Centre Psychothérapeutique de Nancy, Laxou; EA 4360 APEMAC, Université de Lorraine, Nancy, France
[l] Centre Psychothérapeutique de Nancy, Laxou, France
[m] Pôle de Psychiatrie et Santé Mentale du Groupe Hospitalier Mulhouse Sud Alsace, Mulhouse, France
[n] Service de Psychiatrie Adultes, Centre Hospitalier Universitaire Dijon-Bourgogne, Unité INSERM LNC-UMR 1231, Université de Bourgogne, Dijon, France
[o] Service de Psychiatrie, CIC-1431 INSERM, CHU de Besançon, Laboratoire de Neurosciences, Université Bourgogne-Franche-Comté, Besançon, France

ARTICLE INFO

ABSTRACT

Background: Healthcare workers' mental health has been impacted by the COVID-19 pandemic, emphasizing the need for mental health interventions in this population. Online cognitive behavioral therapy (CBT) is efficient to reduce stress and may reach numerous professionals. We developed "MyHealthToo", an online CBT program to help reduce stress among healthcare workers during the COVID-19 pandemic.

Objective: The aim of our study is to investigate the efficacy of an online CBT program on stress and mental health conditions among healthcare workers during a health crisis.

Methods: We performed a multicentric randomized controlled trial among 155 participants allocated either to the experimental or active control group (bibliotherapy). The primary outcome was the decrease of perceived stress scores (PSS-10) post-treatment. Secondary outcomes included depression, insomnia and PTSD symptoms along with self-reported resilience and ruminations. Assessments were scheduled pretreatment, mid-treatment (4 weeks), post-treatment (8 weeks), and at 1-month and 4-months follow-up.

Results: For both interventions, mean changes on the PSS-10 were significant post-therapy (W8), as at 1-month (W12) and 4-months (W24) follow-ups. The between-group comparison showed no difference at any time point ($ps > 0.88$). Work-related ruminations significantly decreased in the experimental group with a significant between-group difference at W8 ($\Delta = -1.83$ [-3.57; -0.09], $p = 0.04$). Posttraumatic stress symptoms significantly decreased in the experimental group with a significant between-group difference at W12 ($\Delta = -1.41$ [-2.68; -0.14], $p = 0.03$). The decrease in work-related ruminations at W8 mediated the decrease in post-traumatic stress symptoms at W12 ($p = 0.048$).

Conclusion: The "MyHealthToo" online CBT intervention may help reduce ruminations about work and post-traumatic stress symptoms among healthcare workers during a major health crisis. Work-related ruminations may represent a relevant target of online interventions to improve mental health among healthcare workers.

1. Introduction

The COVID-19 pandemic represented a highly stressful event for healthcare workers. The exposure to an increased workload, numerous and inevitable deaths and a permanent risk of infection for themselves and their relatives were among the main factors that could elevate stress levels in this population (Salari et al., 2020; Teo et al., 2021; Trumello et al., 2020). The mental health of healthcare workers has been seriously impacted by the COVID-19 pandemic, emphasizing the need for mental health interventions in this population. Indeed, among healthcare workers, rates of distress, anxiety, depression and posttraumatic stress disorder (PTSD) were estimated at 37 %, 40 %, 37 % and 49 % respectively following the first pandemic peaks (Saragih et al., 2021). Numerous studies have confirmed these findings in nurses (Chew et al., 2020; Maben and Bridges, 2020), physicians and medical staff (Cao et al., 2020; Gavin et al., 2020; Lu et al., 2020; Zhang et al., 2020), as well as trainees and warranted the need for psychological treatments aiming at relieving immediate stress and preventing the onset of psychological disorders in healthcare workers (Lu et al., 2020). In addition to effects on their individual well-being, there may also exist a long-term systemic impact of these mental health problems. A study carried out after the SARS epidemic in 2003 revealed a reduction in patient contact and working time among healthcare workers, more frequent sickness leaves and an increase in behaviors likely to affect their work (Maunder et al., 2006). During pandemics, being highly exposed (frontline), being a female, a nurse, lacking protective equipment, having less experience of healthcare and less social support have been identified as risk factors for mental health disorders among healthcare workers (Chigwedere et al., 2021). In acknowledgement of these risks, many mental healthcare teams developed interventions to support frontline healthcare workers soon after the onset of the COVID-19 pandemic. These interventions encompassed various modalities, such as psychological hotlines, opening of relaxation rooms, mobile mental health teams (Chen et al., 2020; Geoffroy et al., 2020; Muller et al., 2020; Rolling et al., 2021). Due to the risk of contamination during the pandemic, online mental health interventions were considered to be the best way to provide mental healthcare without increasing the risk of spreading the virus. Moreover these interventions allow to reach professionals with variable schedules, an important workload or that might be reluctant to seek classical (face-to-face) mental healthcare (Liu et al., 2020). However, to our knowledge, there were no empirically validated online interventions targeting stress reduction and resilience increase among healthcare workers available at the onset of the pandemic (Weiner et al., 2020).

This highly stressful context may have overcome the abilities of healthcare workers to cope with stress, increasing the levels of perceived stress in this population. Ruminations - a type or perseverative cognition involving repeated and unproductive dwelling on a particular theme - are a frequent cognitive response when individuals face stressful situations (Moulds et al., 2020). Importantly, ruminations are considered as a transdiagnostic feature that participates in the maintenance of psychopathology, including depression, insomnia and posttraumatic symptoms (Beierl et al., 2020; Szabo et al., 2017). In cognitive trauma theories, trauma-related ruminations about the trauma and its consequences are considered a risk factor for the development and the maintenance of PTSD symptomatology (Creamer et al., 1992; Ehlers and Clark, 2000). Accordingly, mediation analysis studies have found that, in the context of women survivors of interpersonal violence, rumination fully mediated the relationship between negative affect and posttraumatic symptoms (Brown et al., 2021). In the situation of healthcare workers during

the COVID-19 pandemic, the stressor was directly related to their work. Hence, work-related ruminations focusing for instance on the risk of contamination were likely to contribute to the emergence and the maintenance of posttraumatic symptoms in healthcare workers.

Cognitive behavioral therapy (CBT) has been found to be effective in the prevention of burnout in healthcare workers, in stressful contexts other than the COVID-19 pandemic (Amanullah et al., 2017). Moreover, there is evidence of the effectiveness of CBT in the prevention of a number of psychiatric disorders in at-risk individuals, such as PTSD (Forneris et al., 2013) and depression (Cheng et al., 2019). Before the COVID-19 pandemic, active web-based programs demonstrated their efficacy. A study demonstrated the efficacy of short online CBT or Acceptance and Commitment Therapy (ACT) on stress, burnout and mental health in 42 social and healthcare workers (Barrett and Stewart, 2021). Another online intervention targeting self-efficacy and perceived social support enhancement was shown to be efficacious in reducing job stress but not job burnout among healthcare workers, despite a high dropout rate (82.5 %) (Smoktunowicz et al., 2021). Another cost-effective therapeutic option is online bibliotherapy. However, there is little evidence on the efficacy of online bibliotherapy in occupational contexts (Jeffcoat and Hayes, 2012; Kilfedder et al., 2010). Due to the dramatic impact of the COVID-19 on healthcare professionals and the rapidly changing work conditions that followed, it remains urgent to explore the efficacy and acceptability of online mental health interventions.

To address the needs of healthcare workers, we developed a 7-session online cognitive behavioral therapy (CBT) program - the '*My Health too*' CBT program - targeting the reduction of stress and the reinforcement of adaptive coping behaviors in healthcare workers during the COVID-19 pandemic. The aim of the present randomized controlled trial is to investigate the efficacy and the acceptability of a 7-session web-based CBT program we have developed to address the immediate stress, and prevent its long-term consequences (e.g., depression, PTSD), in healthcare workers during the COVID-19 pandemic. We compared the effects of the web-based '*My Health too*' CBT intervention to that of bibliotherapy on perceived stress. We hypothesized that scores on the 10-item Perceived Stress Scale (Cohen et al., 1983) would significantly decrease in the online CBT group compared to the bibliotherapy group over the course of the 8-week period of treatment. In addition, participants in the online CBT group should present with decreased symptoms of PTSD, insomnia and depression compared to the bibliotherapy group. We assessed acceptability through attrition rates, client satisfaction and therapy credibility. Finally, we investigated whether affective ruminations could mediate the efficacy of CBT on posttraumatic stress symptoms. We also investigated the factors that may moderate the efficacy of online CBT such as demographic, occupational and medical data (e.g., profession and psychiatric history).

2. Materials and methods

2.1. Procedure

Our study was conducted in 6 hospitals in the East of France (i.e., Hôpitaux Universitaires de Strasbourg, Hôpitaux Civils de Colmar, Groupe Hospitalier Régional de Mulhouse Sud-Alsace, Centre Hospitalier Universitaire de Nancy, Centre Hospitalier Universitaire de Besançon, and Centre Hospitalier Universitaire de Dijon). It consisted of a prospective, randomized, open, and parallel group-controlled study with two arms: an experimental arm with 7 online CBT sessions and an active control arm consisting of online bibliotherapy. The study was

approved by the relevant local ethics committee (Comité de Protection des Personnes Ile-de-France VI, May 7, 2020, N 36–20) and registered at ClinicalTrials.gov on 24 March 2020 (study identifier NCT04362358). The study protocol has been published elsewhere (Weiner et al., 2020).

2.2. Study population

The participants were included in the study between July 2020 and March 2021. Participants were recruited via (i) the psychological support hotlines established during the COVID-19 outbreak at the 6 hospital sites participating in the study, (ii) the mental healthcare professionals who received healthcare workers for consultation in their departments, (iii) by billposting, and (iv) by posting on the hospital websites and on targeted Facebook groups. Inclusion criteria included: (1) belonging to one of the following professions: medical doctors, nurses, assistant nurses, physiotherapists, psychologists, hospital porters, ambulance drivers, nursing and healthcare students working in hospitals; (2) being aged 18–70 years old; and (3) fluent in the French language. Exclusion criteria included (1) initial score at the Perceived Stress Scale-10 (PSS-10) < 16 (which means that the participant has a non-significant level of stress), (2) suicidal ideation score assessed by question 9 of the Patient Health Questionnaire-9 (PHQ-9) > 2, and (3) being under guardianship. Demographic information (gender, age, family situation), medical history, occupational characteristics (i.e., position, service, seniority on the job, working time), and COVID-19 infection status of participants was collected. Randomization was performed through an online platform (https://cleanweb.tentelemed.com/) to assign participants in a 1:1 ratio to the experimental or active control group.

2.3. Interventions

2.3.1. CBT Intervention: My Health too

We developed the CBT program "My Health Too" that consisted of 7 video sessions of approximately 20 min. We initially developed a beta version of this program during the early phases of the COVID-19 pandemic and carried out a qualitative study to assess its acceptability and feasibility among healthcare workers (Bureau et al., 2021). Each session of the final version targeted one of the components identified as key to increasing resilience to stress and preventing mental health problems among workers (Joyce et al., 2018): (i) psychoeducation, (ii) functional behavioral and cognitive coping strategies (Lazarus and Folkman, 1984), (iii) mindfulness, (iv) acceptance, (v) promoting action toward values (Hayes et al., 2006), (vi) addressing barriers and motivation to use self-compassion as a psychological skill (Gilbert, 2014) and (vii) self-compassion to soothe difficult emotion (Neff and Germer, 2013). An additional video on sleep problems and problem-solving strategies was available after session 3. A new session was available every 72 h. Participants received e-mail reminders to engage in the therapy if they did not watch the video 72 h after its availability. Both the CBT program and bibliotherapy were available online for 8 weeks. Each session was preceded and followed by visual analogical scales (VAS) to aid participants in identifying their subjective manifestations of stress and assess the utility of the session. In addition, by the end of each video session, participants had the possibility to call a psychologist from the hotline (available from Monday to Friday from 9 a.m. to 5 p.m.) and were invited to practice the strategies learned between sessions using the homework material associated with each video (a total of 30 audio and 8 pdf files), including mindfulness and relaxation exercises (see Weiner et al., 2020 for the content of the sessions).

2.3.2. Active control condition: bibliotherapy

Bibliotherapy consisted of seven short brochures (one illustrated A4 page per brochure) with self-help written relaxation material created by clinical psychologists, providing low-intensity intervention for stress that should be less efficacious than online CBT (Hedman et al., 2016; Ruwaard et al., 2013). Participants could download these brochures in a

pdf format via the MaSanteAussi.fr website. The brochures contained psychoeducation as well as written and illustrated instructions to guide relaxation and mindfulness practices. Unlike the CBT intervention group, participants in the bibliotherapy group received no reminders to engage in the therapy and guided exercises. In addition to the written material, people could call the psychological hotline throughout the 8-week duration of the study.

2.4. Outcome measures

2.4.1. Primary outcomes

The predefined primary outcome was the decrease of the Perceived Stress Scale - 10 items version (PSS-10) (Cohen et al., 1983) score post-therapy (at 8 weeks) (Cronbach's $\alpha = 0.88$). The PSS-10 comprises 10 items ranging from 0 (never) to 4 (very often); higher scores are indicative of higher perceived stress. The PSS-10 is validated in French (Lesage et al., 2012). Its ease of use and psychometric properties have been widely studied in professional contexts (Bellinghausen et al., 2009). The expected PSS-10 values were 23 ± 5 initially with a decrease to 19.6 (control group) and 16 (experimental group).

2.4.2. Secondary outcomes

The Patient Health Questionnaire - 2 items version (PHQ-2) (Arroll et al., 2010) was used to screen for depression (Cronbach's $\alpha = 0.73$). The Short Form Posttraumatic Stress Disorder Checklist 5 (SF-PCL-5) (Zuromski et al., 2019) was used to screen for post-traumatic stress symptoms (Cronbach's $\alpha = 0.74$). The Connor-Davidson Resilience Scale - 2 items version (CD-RISC 2) (Vaishnavi et al., 2007) was used to measure resilience (Cronbach's $\alpha = 0.72$). A short form of the Insomnia Severity Index (ISI) (Bastien et al., 2001) was used to measure the severity of insomnia (Cronbach's $\alpha = 0.76$). The Affective Rumination Questionnaire (ARQ) (Cropley et al., 2012) was applied to measure work-related rumination (Cronbach's $\alpha = 0.89$). Self-reported credibility of the treatment was assessed via the Credibility and Expectancy Questionnaire (CEQ) (Devilly and Borkovec, 2000) (Cronbach's $\alpha = 0.78$). Finally, the Client Satisfaction Questionnaire (CSQ-8) (Attkisson et al., 1987) was applied as self-report measure assessing participants' satisfaction at the end of the 8-week program (Cronbach's $\alpha = 0.95$). All the measures had good internal consistency – i.e., Cronbach's α ranging from 0.72 to 0.98 – in our sample.

2.5. Assessments

The assessments of our primary and secondary outcomes were conducted at the beginning of the study, at 4 weeks (mid-therapy), 8 weeks (end of the therapy), 12 weeks (1-month follow-up) and 24 weeks (4-months follow-up). These time intervals were chosen as both online CBT program and bibliotherapy were available for 8 weeks. The close follow-up intervals allowed to assess efficacy of both interventions in a reasonable time distance, limiting dropouts. To measure the perceived efficacy and utility of each individual session of the CBT program, stress, sleep, self-efficacy and mood before each video were measured using VAS; perceived stress and session usefulness were assessed after each session, also using VAS. We calculated the difference of perceived stress before and after each session.

2.6. Randomization

The randomization was stratified by investigation center with a 1:1 ratio for allocation to the 2 groups. Blocks of varying sizes (sizes of 4 and 6) were randomly selected. The allocation sequence was configured by our data manager who was blinded to the allocation group.

2.7. Statistical analysis

The expected values of PSS-10 at baseline were $23 +/- 5$ in both

groups with a decrease to 19.6 +/− 5 in the control group and 16 +/− 5 in the experimental group. Simulations using a mixed linear regression model showed that 46 subjects per group, i.e., 92 in total, would be needed to highlight this difference with a power of 90 % and an alpha risk set at 5 %. Considering an estimation of 20 % of drop-outs, the number of subjects in the study was increased to 120 subjects in total. Details on the assumptions for the estimation of the sample size are provided in the protocol (Weiner et al., 2020). As the rate of drop-outs was slightly higher than expected, the sample size was increased to 156 subjects. Continuous variables are described using mean +/− standard deviation or median with first and third quartile depending on the normality of the distribution. Categorical variables are presented with counts and percentages. Multiple imputation using chained equations was performed to handle missing data assuming all variables were missing at random (Van Buuren, 2018; Van Buuren and Groothuis-Oudshoorn, 2011). For all analysis, estimates were calculated for each imputed dataset and then combined using Rubin's rules (Rubin, 1987). The analyses of the scores were carried out using linear mixed model including a group effect (experimental or control), a time effect and interaction term between group and the time. Subjects and center effects were introduced in the model as random effects. The statistical test was performed on the interaction term between group and time, which assessed whether the decrease of the score was greater in the experimental group than in the control group. Goodness of fit for linear mixed model was assessed graphically (normality of residuals, homogeneity of variance and normality of random effects). Subgroup analyses were carried out by introducing in the models a three-way interaction between time, group (experimental or control) and factors of interest in
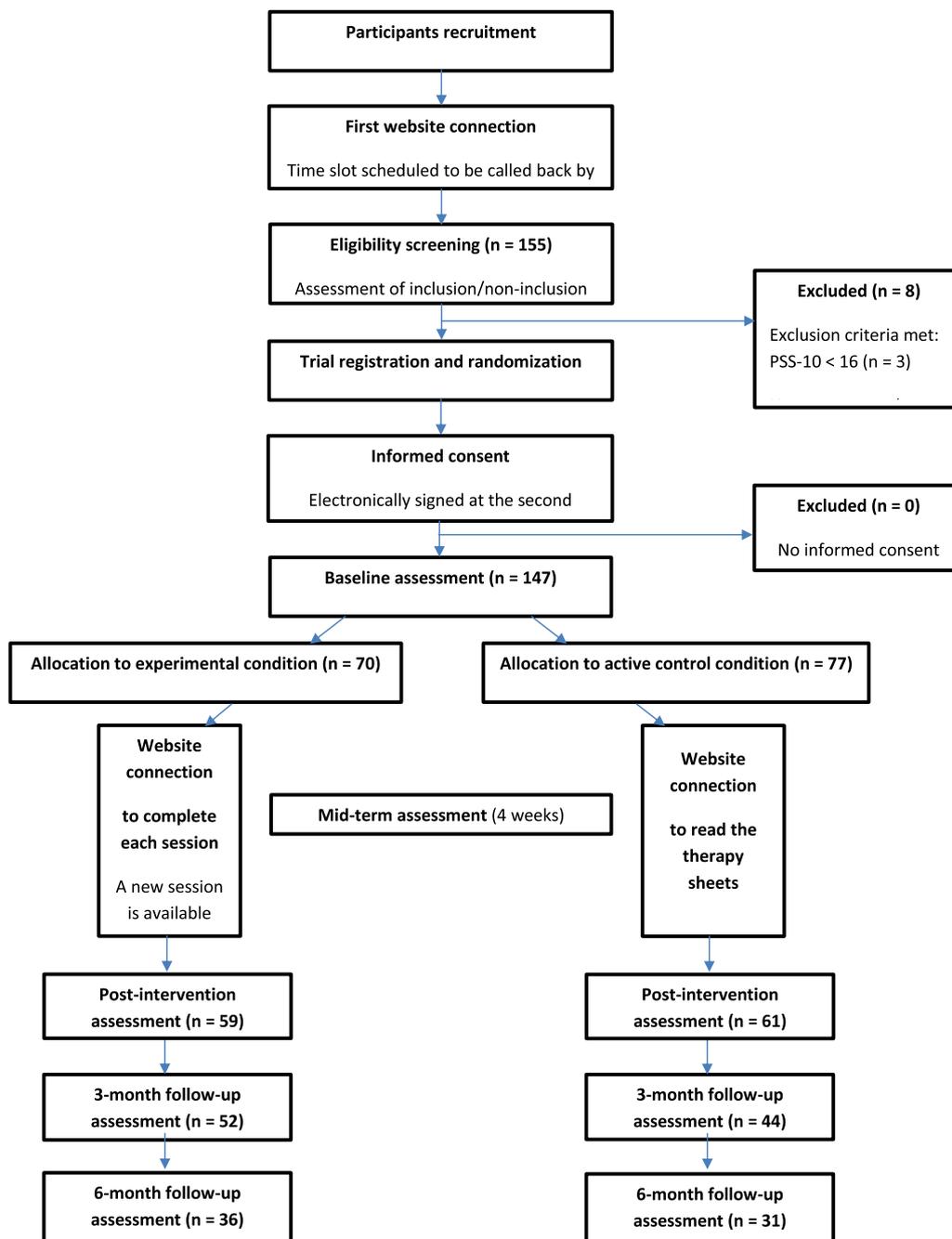

Fig. 1. Flow chart.

order to assess whether the effect of the intervention at a certain time differs in the subgroups. Results are presented as differences with their 95 % confidence intervals. In order to identify the mechanisms underlying the relationship between the intervention and the decrease of certain scores, we performed an estimation of mediation effect using the Baron and Kenny procedure through the quasi-Bayesian approximation (Imai et al., 2010). This allowed us to obtain total, direct, indirect effects and the percentage of mediation.

An allocation error occurred at one center of the study, four patients assigned to the experimental group participated in the control group, and three patients in the control group benefited from the CBT intervention. Since this was a simple inversion of group allocation independent of subject characteristics, we decided to carry out an as treated analysis (these seven patients were classified in the group in which they participated and not in the group in which they were enrolled) so as not to dilute the effect of the intervention. The intention to treat analysis was performed as a sensitivity analysis.

Tests were 2-tailed and statistical significance was set at a *p*-value of <0.05. All analyses were performed with R software version 4.1.1. (R Core Team, R, 2013).

3. Results

A total of 155 participants were recruited. Three participants were not randomized as they met an exclusion criterion (PSS-10 < 16) and five never connected to the platform. A total of 147 participants received an intervention (70 experimental group, 77 active control group) (Fig. 1). The sociodemographic characteristics of the included participants are available in Table 1.

3.1. Primary outcome

For both interventions a decrease in the PSS-10 score was present, as mean changes on the PSS-10 scale were significant post-therapy (W8), at W12 and at W24 (see Table 2). The in-between-group comparison showed no difference at any time of measure (*ps* > 0.879).

3.2. Secondary outcomes

Ruminations about work significantly decreased in the experimental group at W8 ($\Delta = -3.06$ [-4.28; -1.84]), with a significant between-group difference ($\Delta = -1.83$ [-3.57; -0.09], $p = 0.04$). Post-traumatic stress disorder symptoms significantly decreased at M3 in the experimental group ($\Delta = -1.99$ [-2.83; -1.14]), with a significant between-group difference ($\Delta = -1.41$ [-2.68; -0.14], $p = 0.029$). No difference was found between groups in terms of depression (*ps* > 0.148), insomnia (*ps* > 0.558), or resilience (*ps* > 0.435). The score on the Credibility/Expectancy questionnaire did not differ between groups at the beginning of the therapy (see Table 1).

3.3. Intermediate measures

Self-reported perceived stress measures on the VAS presented before session 2 until 7 were significantly lower than self-reported stress assessed prior to the first therapy session ($M_{VAS1} = 58.3$; $M_{VAS2-7} = 44.0$, all *ps* < 0.046). Self-reported pre-post perceived stress decreased significantly after each session ($M_{decrease} = -11.79$, 95%CI [-18.27; -5.13], *ps* < 0.001), except for session 5 targeting actions toward values (Decrease = -5.25, 95%CI [-12.01; 1.51], $p = 0.13$). Moreover, at each measurement point starting from session 2, self-reported mood was significantly higher than the first measurement point (*ps* < 0.008). The same is true for sleep quality, starting from session 3 (*ps* < 0.005). Ruminations were significantly lower than the first measurement point (video 1), starting from session 4 (*ps* < 0.001).

Table 1
Sociodemographic characteristics and initial scores.

	Experimental group	Active control group
	(n = 70)	(n = 77)
Mean age (SD)	39.70 (9.46)	39.47 (9.68)
	N (%)	N (%)
Female gender	59 (84.3)	65 (84.4)
Occupation		
Nurse	25 (35.7)	29 (37.7)
Operating room nurse	0 (0.0)	2 (2.6)
Nurse anesthetist	2 (2.9)	2 (2.6)
Nurse student	0 (0.0)	1 (1.3)
Health executive	4 (5.7)	4 (5.2)
Assistant nurse	3 (4.3)	2 (2.6)
Childcare assistant	1 (1.4)	2 (2.6)
Medical doctor	8 (11.4)	8 (10.4)
Resident	2 (2.9)	3 (3.9)
Physiotherapist	3 (4.3)	3 (3.9)
Physiotherapist student	1 (1.4)	0 (0.0)
Midwife	2 (2.9)	1 (1.3)
Psychologist	3 (4.3)	3 (3.9)
Other	16 (22.9)	17 (22.1)
Family situation		
Living alone	18 (25.7)	13 (16.9)
Living in a couple	49 (70.0)	58 (75.3)
Living in a shared flat	0 (0.0)	6 (7.8)
Other	3 (4.3)	0 (0.0)
Children		
Yes, under 12, living at home	26 (37.1)	27 (35.1)
Yes, between 12 and 16, living at home	12 (17.1)	13 (16.9)
Yes, 16 and more, living at home	10 (14.3)	15 (19.5)
Yes, but not living at home	5 (7.1)	9 (11.7)
No	29 (41.4)	25 (32.5)
Your main activity before the COVID-19 pandemic		
Direct healthcare	51 (72.9)	59 (76.6)
Phone consultations, teleworking	2 (2.9)	1 (1.3)
Organization, support	5 (7.1)	5 (6.5)
Other	12 (17.1)	12 (15.6)
Initial scores		
PSS-10 (mean (SD))	24.13 (3.18)	24.00 (3.33)
PHQ-2 > 2 (N (%))	23 (32.9)	27 (35.1)
ISI score (median [Q1, Q3])	10.00 [7.00, 13.00]	10.00 [6.00, 14.00]
SF-PCL-5 (median [Q1, Q3])	6.00 [4.00, 8.00]	5.00 [3.00, 7.00]
ARQ (mean (SD))	16.97 (3.74)	15.48 (4.43)
CEQ Part 1 (mean (SD))	23.64 (5.95)	24.07 (5.53)
CEQ Part 2 (mean (SD))	69.54 (21.52)	66.59 (21.12)

Legend: ARQ, Affective Rumination Questionnaire; CEQ, Credibility Expectancy Questionnaire; ISI, Insomnia Severity Index; PHQ-2, Patient Health Questionnaire – 2 items; PSS-10, Perceived Stress Scale – 10 items; Q1 First quartile; Q3 Third quartile; SF-PCL-5 Short Form- Posttraumatic Stress Checklist for DSM-5.

Table 2
Evolution of PSS-10 score over time.

Time	Experimental group	Active control group	Difference [CI95%]	p
PSS-10 W0 M (SD)	24.1 (3.2)	24.0 (3.3)	–	–
Improvement W8 M [CI95%]	−1.57 [−2.82; −0.32]	−1.64 [−2.69; −0.59]	0.08 [−1.43; 1.58]	0.921
Improvement W12 M [CI95%]	−2.28 [−3.28; −1.29]	−1.69 [−2.90; −0.48]	−0.59 [−2.09; 0.91]	0.436
Improvement W24 M [CI95%]	−1.78 [−3.38; −0.18]	−1.66 [−2.92; −0.39]	−0.12 [−1.74; 1.49]	0.879

3.4. Acceptability and feasibility

In total, 120 participants completed the posttreatment assessment (experimental group = 59 (84 %), active control group = 61 (79 %)) (see Fig. 2). Thirty-two participants (45,7 %) watched all the videos in the experimental group (see Fig. 3). The videos (including the additional video concerning sleep problems) were opened 584 times by the participants in total. The additional audio and pdf materials were opened 729 and 368 times respectively. In the bibliotherapy group, all the participants opened the documents at least once. The seven pdf documents were opened 765 times in total. The satisfaction was high and significantly superior in the experimental group at the end of the therapy (Mean score = 24.7 and 19.7 respectively, $\Delta = 5.0$ [3.3; 6.7], $p < 0.001$).

3.5. Mediation analyses

Mediation analyses showed that the decrease in posttraumatic stress symptoms (SF-PCL-5) at Week 12 was significantly mediated by the decrease in affective ruminations about work at Week 8 (ARQ) ($p = 0.048$) (see Fig. 4). The mediated effect represented 42 % of the total effect. Complementary mediation analyses showed that the decrease in posttraumatic stress symptoms was not mediated by any other factor (decrease in insomnia severity, increase in resilience or credibility) (see Supplementary Fig. S1).

3.6. Subgroup analyses

We performed subgroup analyses to investigate the effect of the intervention in different demographic subgroups or according to occupational factors. The analyses revealed no significant moderating effect of the factors explored (see Supplementary Table S2).

3.7. Sensitivity analysis

In the intention-to-treat sensitivity analysis, the posttraumatic stress symptoms and ruminations decreased more in the experimental group compared to the control group but the difference was no longer significant about work but were no more significant ($\Delta_{PCL-5} = -0.80$ [-1.87; 0.27], $p = 0.44$, $\Delta_{ruminations} =, -1.40$ [-3.50; 0.70], $p = 0.188$) (see Supplementary Tables S3 and S4).

4. Discussion

Our results show that a brief online CBT intervention was not superior to bibliotherapy to reduce perceived stress in healthcare workers during the COVID-19 pandemic. Indeed, self-reported measures of
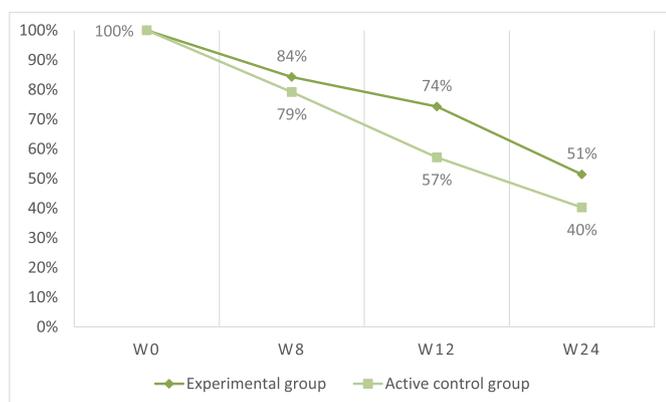

Fig. 2. Rates of participants answering to the questionnaires at each measure point
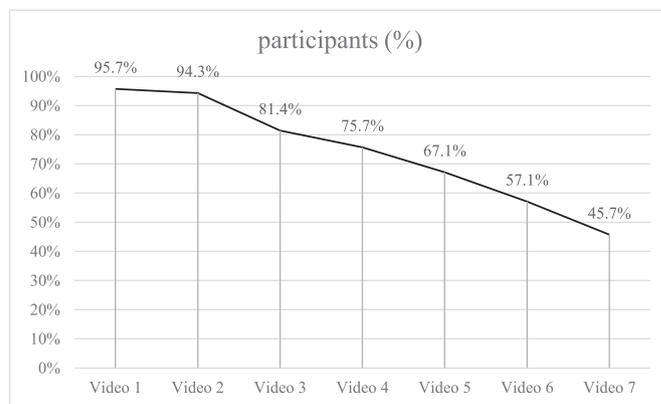*Legend: W, Week.*

Fig. 3. Percentage of participants watching each video (experimental group).

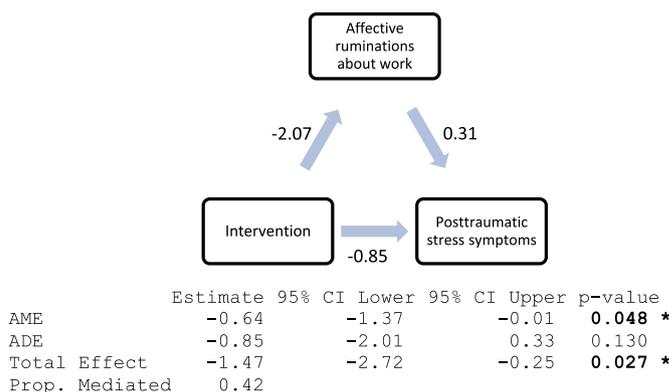|	Estimate	95% CI Lower	95% CI Upper	p-value
AME	−0.64	−1.37	−0.01	**0.048 ***
ADE	−0.85	−2.01	0.33	0.130
Total Effect	−1.47	−2.72	−0.25	**0.027 ***
Prop. Mediated	0.42			

Fig. 4. Mediation analysis with affective ruminations at W8 as a mediating factor of the impact of online CBT on posttraumatic stress symptoms at W12. *Legend: Numbers are expressed in CI95%; *p < 0.05; AME, Average Mediated Effect; ADE, Average Direct Effect.*

stress, mood, sleep quality and ruminations improved post-therapy in both groups and this improvement was sustained at follow-up in the intervention group. However, lower levels of work-related ruminations post-therapy as well as fewer PTSD symptoms at follow-up were observed in the CBT group compared to the active control group. Importantly, the decrease in work-related ruminations significantly mediated the impact of the intervention on posttraumatic stress symptoms. In terms of acceptability, self-reported satisfaction was higher in the online CBT group compared to the active control group, even though the pre-intervention expectancy/credibility was comparable between groups. Moreover, the attrition rate for the online CBT group was low (16 %), and 47 % of participants watched all 7 videos of therapy. Finally, self-reported measures of stress, mood, sleep quality and ruminations improved post-therapy and this improvement was sustained at follow-up in the intervention group.

Concerning the effects on perceived stress, our results suggest that our brief online CBT intervention is not superior to the active control intervention consisting of psychoeducational leaflets. Several explanations may account for this result. First, it is possible that the decrease in perceived stress over time in both groups results from the timeline of the pandemic. Indeed, given that the stress related to the pandemic turned out to be long-lasting the healthcare workers were able to gain knowledge and skills to face the COVID-19 pandemic (Mengin et al., 2022). Indeed, our study started in July 2020, during a respite immediately after the first epidemic peak (Rolling et al., 2021). The second and third COVID-19 peaks occurred during our study, in November 2020 and from January to April 2021. Since the PSS measures immediate stress, it is therefore possible that the availability of protective means (masks,

vaccination) as the increased knowledge and expertise of hospital staff in the treatment of COVID-19 influenced perceived stress levels in both groups. This might have diminished the likelihood of detecting a specific effect of CBT on this measure. Another explanation is related to the PSS measure itself, which might be inadequate to detect significant changes in mental health following CBT. Indeed, our result is consistent with a previous randomized controlled trial which found no superior effects of the experimental condition compared to active control groups. This trial compared a 8-week mindfulness based online intervention to a control group in university students and showed no superior improvement of perceived stress across time in the intervention group, while depression and anxiety symptoms improved (El Morr et al., 2020). Another study compared 2-weeks of Acceptation and Commitment Therapy (ACT) versus online CBT in healthcare and social workers showed a significant decrease in perceive stress across time but no difference between groups (Barrett and Stewart, 2021). It is interesting to note that, in our study, the decrease in perceived stress in the online CBT group post-therapy remained small but comparable to a previous study (−1.57 in comparison to −2.06 in online ACT and CBT groups in the Barrett and Stewart (2021) study).

The post-therapy decrease in post-work ruminations in the intervention group indicates an efficacy of the intervention on a core cognitive mechanism of burnout and PTSD in healthcare workers (Moulds et al., 2020; Vandevala et al., 2017; Zarei and Fooladvand, 2022). Moreover, the decrease of ruminations at the end of the intervention significantly mediated the impact of the intervention on post-traumatic stress symptoms at follow-up. After a stressful event, ruminations may appear deliberately in response to intrusive trauma memories as an emotion regulation strategy, but they may also consist in automatic and unwanted thoughts, involved in the maintenance of PTSD (Creamer et al., 1992; Moulds et al., 2020). Our findings add to previous research that have shown that ruminations are a relevant target of psychotherapy to prevent or relieve PTSD symptoms (LoSavio et al., 2017; Schumm et al., 2022). Given the lack of efficacy of our intervention on perceived stress, these findings might reflect that CBT does not modify the stressful nature of the event but rather the psychological coping mechanisms of healthcare workers.

Our intervention proposed a free psychological hotline to participants, which was reached by zero participants, demonstrating a failure of this tool for our target population. Similar psychological hotlines were proposed to healthcare workers during the COVID-19 pandemic, independent from a specific online CBT program (Geoffroy et al., 2020; Rolling et al., 2021). Though these hotlines demonstrated variable efficacy, they were reached by the professionals, unlike the hotline provided in our intervention. Moreover, the main intervention proposed to the participants in our study was online CBT, thus, the additional psychological hotline might have seemed unnecessary to them. Given that attrition was low in our study, similar to other studies using online CBT programs (van Ballegooijen et al., 2014), and satisfaction was high, it is likely that our standalone online CBT program might have addressed the needs of healthcare workers.

Our study has some limits. The inclusion period was longer than expected and the COVID-19 pandemic evolved fast. The level of professional stress might have decreased for all the professionals during this period – the same phenomenon was observed in the general population - though other stressful professional factors remained (overworking, organizational stress, lack of personnel, etc.) (Mengin et al., 2022; Rolling et al., 2021). In addition, recruitment biases existed in our study. First, a healthy worker effect was obvious, as workers on sick leave (possibly due to stress-related mental health problems) may have not been reached (Pearce et al., 2007). Secondly, as our recruitment was based on volunteering, professionals interested by web-based tools were targeted by the study. A diversity of tools should be provided to include participants who are less familiar with online therapeutic tools or prefer other means (e.g., live contact, phone). Moreover, the absence of significant difference between groups concerning perceived stress, along

with the mild difference on secondary outcomes suggest that, for some participants, online self-help tools might not be efficient. Face-to-face CBT interventions might be more relevant for these participants (Kunkle et al., 2021; Yoo, 2022). The lower completion rates at W24 may also have diminished the statistical power in the analyses. Thirdly, though we could monitor how many times the documents were opened by the participants in both groups, we could not monitor how frequently the participants used the resources provided in their daily lives. This limit questions whether the active control group was actually a passive control group. However, unpublished preliminary qualitative data revealed that some participants effectively used the exercises provided in the control group (i.e., "I immediately adopted the materials, which I consulted several times. […] The resources were clear, explicit, concise, visual and very helpful"), ensuring that the control group was not strictly passive. Meanwhile, other participants claimed that they tried to use the materials but gave up (i.e., "It was hard to do it systematically, I quickly gave up"). Fourthly, concerning mediation analyses, this study was not designed to identify causal mechanisms. Given that, we applied mediation analysis to a standardized randomized experiment without any manipulation of the mediator and we cannot guarantee the absence of confounders between the mediator and the outcome. This result should be considered with caution and confirmed using specific experimental designs (Imai et al., 2013). Concerning the online CBT program developed for this research, our results invite us to reconsider some features: the psychological hotline was unnecessary and could be removed; the availability of the program (8 weeks) should be extended giving participants more time to complete it. Also, based on unpublished preliminary qualitative data and the evolution of perceived stress before and after the fifth video, this video should be modified to be more helpful to participants. Finally, online interventions should be part of a holistic prevention policy comprising organizational interventions (adequate human and material resources, facilitated communication, administrative support, etc.), cognitive-behavioral training, mental and physical relaxation aimed at preserving the mental health of healthcare workers (Gray et al., 2019; Rolling et al., 2021; Walton et al., 2020).

5. Conclusion

Our study demonstrated that an online cognitive and behavioral therapy (CBT) may help healthcare workers to reduce their ruminations about work and posttraumatic stress symptoms in a stressful pandemic situation. However, this intervention did not significantly decrease perceived stress compared to bibliotherapy. Given the effects found here on long-term stress-related conditions (i.e., PTSD symptoms) and the evolving nature of the pandemic during the recruitment period of our study, the effects of our online CBT intervention on immediate perceived stress should be investigated beyond the COVID-19 pandemic and its continuously evolving characteristics. This should allow to tackle the effects of the intervention when stress levels are relatively stable. Moreover, these findings need to be completed by further research on online CBT to provide better insights on its mechanisms and on which specific components are useful to participants (e.g., themes, videos, online consultations, etc.) to facilitate its future dissemination.

Funding

CRediT authorship contribution statement

ACM and PV were implicated in Covipsy - a local mental health care

system created to support healthcare workers during the COVID-19 crisis - and brought the original idea. ACM, LW, NN and FB developed the study protocol. ACM and LW wrote the first draft of the manuscript. DB, IF, AF, AZB, LW built the intervention and active control material. FL, NE, PG, AK, JCCG, GC, EH and MN contributed to the investigation and collected the data. EC performed preliminary analyses. FS performed the final statistical analyses. LW, NN, FB and PV provided substantial modifications to the manuscript. All authors have given final approval of the version to be published and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.invent.2024.100736.

References

Amanullah, S., McNally, K., Zelin, J., Cole, J., Cernovsky, Z., 2017. Are burnout prevention programs for hospital physicians needed? Asian J. Psychiatr. 26, 66–69. https://doi.org/10.1016/j.ajp.2017.01.009.

Arroll, B., Goodyear-Smith, F., Crengle, S., Gunn, J., Kerse, N., Fishman, T., Falloon, K., Hatcher, S., 2010. Validation of PHQ-2 and PHQ-9 to screen for major depression in the primary care population. The Annals of Family Medicine 8 (4), 348–353. https://doi.org/10.1370/afm.1139.

Attkisson, C.C., Larsen, D., Hargreaves, W., LeVois, M., Nguyen, R., Stegner, B., 1987. Client satisfaction questionnaire (CSQ-8). A Sourcebook, Measures for Clinical Practice, pp. 120–122.

Barrett, K., Stewart, I., 2021. A preliminary comparison of the efficacy of online acceptance and commitment therapy (ACT) and cognitive Behavioural therapy (CBT) stress management interventions for social and healthcare workers. Health Soc. Care Community 29 (1), 113–126. https://doi.org/10.1111/hsc.13074.

Bastien, C.H., Vallières, A., Morin, C.M., 2001. Validation of the insomnia severity index as an outcome measure for insomnia research. Sleep Med. 2 (4), 297–307. https://doi.org/10.1016/S1389-9457(00)00065-4.

Beierl, E.T., Böllinghaus, I., Clark, D.M., Glucksman, E., Ehlers, A., 2020. Cognitive paths from trauma to posttraumatic stress disorder: A prospective study of Ehlers and Clark's model in survivors of assaults or road traffic collisions. Psychol. Med. 50 (13), 2172–2181. https://doi.org/10.1017/S0033291719002253.

Brown, W.J., Hetzel-Riggin, M.D., Mitchell, M.A., Bruce, S.E., 2021. Rumination mediates the relationship between negative affect and posttraumatic stress disorder symptoms in female interpersonal trauma survivors. J. Interpers. Violence 36 (13–14), 6418–6439. https://doi.org/10.1177/0886260518818434.

Bureau, R., Bemmouna, D., Faria, C.G.F., Goethals, A.-A.C., Douhet, F., Mengin, A.C., Fritsch, A., Zinetti Bertschy, A., Frey, I., Weiner, L., 2021. My health too: investigating the feasibility and the acceptability of an internet-based cognitive-behavioral therapy program developed for healthcare workers. Front. Psychol. 12, 5699. https://doi.org/10.3389/fpsyg.2021.760678.

Cao, J., Wei, J., Zhu, H., Duan, Y., Geng, W., Hong, X., Jiang, J., Zhao, X., Zhu, B., 2020. A study of basic needs and psychological wellbeing of medical Workers in the Fever Clinic of a tertiary general Hospital in Beijing during the COVID-19 outbreak. Psychother. Psychosom. 1–3 https://doi.org/10.1159/000507453.

Chen, Q., Liang, M., Li, Y., Guo, J., Fei, D., Wang, L., He, L., Sheng, C., Cai, Y., Li, X., Wang, J., Zhang, Z., 2020. Mental health care for medical staff in China during the COVID-19 outbreak. The lancet. Psychiatry. https://doi.org/10.1016/S2215-0366(20)30078-X.

Cheng, P., Kalmbach, D.A., Tallent, G., Joseph, C.L., Espie, C.A., Drake, C.L., 2019. Depression prevention via digital cognitive behavioral therapy for insomnia: A randomized controlled trial. Sleep 42 (10). https://doi.org/10.1093/sleep/zsz150.

Chew, N.W.S., Lee, G.K.H., Tan, B.Y.Q., Jing, M., Goh, Y., Ngiam, N.J.H., Yeo, L.L.L., Ahmad, A., Ahmed Khan, F., Napolean Shanmugam, G., Sharma, A.K., Komalkumar, R.N., Meenakshi, P.V., Shah, K., Patel, B., Chan, B.P.L., Sunny, S., Chandra, B., Ong, J.J.Y., Sharma, V.K., 2020. A multinational, multicentre study on the psychological outcomes and associated physical symptoms amongst healthcare workers during COVID-19 outbreak. Brain Behav. Immun. https://doi.org/10.1016/j.bbi.2020.04.049.

Chigwedere, O.C., Sadath, A., Kabir, Z., Arensman, E., 2021. The impact of epidemics and pandemics on the mental health of healthcare workers: A systematic review. Int. J. Environ. Res. Public Health 18 (13), 6695. https://doi.org/10.3390/ijerph18136695.

Cohen, S., Kamarck, T., Mermelstein, R., 1983. A global measure of perceived stress. J. Health Soc. Behav. 24 (4), 385–396.

Creamer, M., Burgess, P., Pattison, P., 1992. Reaction to trauma: A cognitive processing model. J. Abnorm. Psychol. 101 (3), 452–459. https://doi.org/10.1037/0021-843X.101.3.452.

Cropley, M., Michalianou, G., Pravettoni, G., Millward, L.J., 2012. The relation of post-work ruminative thinking with eating behaviour. Stress and Health: Journal of the International Society for the Investigation of Stress 28 (1), 23–30. https://doi.org/10.1002/smi.1397.

Devilly, G.J., Borkovec, T.D., 2000. Psychometric properties of the credibility/expectancy questionnaire. J. Behav. Ther. Exp. Psychiatry 31 (2), 73–86.

Ehlers, A., Clark, D.M., 2000. A cognitive model of posttraumatic stress disorder. Behav. Res. Ther. 38 (4), 319–345. https://doi.org/10.1016/S0005-7967(99)00123-0.

El Morr, C., Ritvo, P., Ahmad, F., Moineddin, R., MVC Team, 2020. Effectiveness of an 8-week web-based mindfulness virtual community intervention for university students on symptoms of stress, anxiety, and depression: randomized controlled trial. JMIR Mental Health 7 (7), e18595. https://doi.org/10.2196/18595.

Forneris, C.A., Gartlehner, G., Brownley, K.A., Gaynes, B.N., Sonis, J., Coker-Schwimmer, E., Lohr, K.N., 2013. Interventions to prevent post-traumatic stress disorder: a systematic review. Am. J. Prev. Med. 44 (6), 635–650.

Gavin, B., Hayden, J., Adamis, D., McNicholas, F., 2020. Caring for the psychological well-being of healthcare professionals in the Covid-19 pandemic crisis. Ir. Med. J. 113 (4), 51.

Geoffroy, P.A., Le Goanvic, V., Sabbagh, O., Richoux, C., Weinstein, A., Dufayet, G., Lejoyeux, M., 2020. Psychological support system for hospital workers during the Covid-19 outbreak: rapid design and implementation of the Covid-Psy hotline. Front. Psych. 11, 511.

Gilbert, P., 2014. Compassion-focused therapy: preface and introduction for special section. Br. J. Clin. Psychol. 53 (1), 1–5.

Gray, P., Senabe, S., Naicker, N., Kgalamono, S., Yassi, A., Spiegel, J.M., 2019. Workplace-based organizational interventions promoting mental health and happiness among healthcare workers: A realist review. Int. J. Environ. Res. Public Health 16 (22), 4396. https://doi.org/10.3390/ijerph16224396.

Hayes, S.C., Luoma, J.B., Bond, F.W., Masuda, A., Lillis, J., 2006. Acceptance and commitment therapy: model, processes and outcomes. Behav. Res. Ther. 44 (1), 1–25.

Hedman, E., Axelsson, E., Andersson, E., Lekander, M., Ljótsson, B., 2016. Exposure-based cognitive-behavioural therapy via the internet and as bibliotherapy for somatic symptom disorder and illness anxiety disorder: randomised controlled trial. Br. J. Psychiatry J. Ment. Sci. 209 (5), 407–413. https://doi.org/10.1192/bjp.bp.116.181396.

Imai, K., Keele, L., Tingley, D., Yamamoto, T., 2010. Causal mediation analysis using R. In: Vinod, H.D. (Ed.), Advances in Social Science Research Using R. Springer, pp. 129–154. https://doi.org/10.1007/978-1-4419-1764-5_8.

Imai, K., Tingley, D., Yamamoto, T., 2013. Experimental designs for identifying causal mechanisms. Journal of the Royal Statistical Society. Series A (Statistics in Society) 176 (1), 5–32.

Jeffcoat, T., Hayes, S.C., 2012. A randomized trial of ACT bibliotherapy on the mental health of K-12 teachers and staff. Behav. Res. Ther. 50 (9), 571–579. https://doi.org/10.1016/j.brat.2012.05.008.

Joyce, S., Shand, F., Bryant, R.A., Lal, T.J., Harvey, S.B., 2018. Mindfulness-based resilience training in the workplace: pilot study of the internet-based resilience@work (RAW) mindfulness program. J. Med. Internet Res. 20 (9) https://doi.org/10.2196/10326.

Kilfedder, C., Power, K., Karatzias, T., McCafferty, A., Niven, K., Chouliara, Z., Galloway, L., Sharp, S., 2010. A randomized trial of face-to-face counselling versus telephone counselling versus bibliotherapy for occupational stress. Psychol. Psychother. 83 (Pt 3), 223–242. https://doi.org/10.1348/147608309X476348.

Bellinghausen, L., Collange, J., Botella, M., Emery, J.-L., Albert, É., 2009. Factorial validation of the French scale for perceived stress in the workplace. Sante Publique 21 (4), 365–373.

Kunkle, S., Yip, M., Hunt, J., Ξ, W., Udall, D., Arean, P., Nierenberg, A., & Naslund, J. A. (2021). Association between care utilization and anxiety outcomes in an on-demand

mental health system: retrospective observational study. JMIR Formative Research, 5(1), e24662. doi:https://doi.org/10.2196/24662.

Lazarus, R.S., Folkman, S., 1984. Stress, Appraisal, and Coping. Springer publishing company.

Lesage, F.-X., Berjot, S., Deschamps, F., 2012. Psychometric properties of the French versions of the perceived stress scale. Int. J. Occup. Med. Environ. Health 25 (2), 178–184.

Liu, S., Yang, L., Zhang, C., Xiang, Y.-T., Liu, Z., Hu, S., Zhang, B., 2020. Online mental health services in China during the COVID-19 outbreak. Lancet Psychiatry 7 (4), e17–e18. https://doi.org/10.1016/S2215-0366(20)30077-8.

LoSavio, S.T., Dillon, K.H., Resick, P.A., 2017. Cognitive factors in the development, maintenance, and treatment of post-traumatic stress disorder. Curr. Opin. Psychol. 14, 18–22. https://doi.org/10.1016/j.copsyc.2016.09.006.

Lu, W., Wang, H., Lin, Y., Li, L., 2020. Psychological status of medical workforce during the COVID-19 pandemic: A cross-sectional study. Psychiatry Res. 288, 112936 https://doi.org/10.1016/j.psychres.2020.112936.

Maben, J., Bridges, J., 2020. Covid-19: supporting nurses' psychological and mental health. J. Clin. Nurs. https://doi.org/10.1111/jocn.15307.

Maunder, R.G., Lancee, W.J., Balderson, K.E., Bennett, J.P., Borgundvaag, B., Evans, S., Fernandes, C.M.B., Goldbloom, D.S., Gupta, M., Hunter, J.J., Hall, L.M., Nagle, L.M., Pain, C., Peczeniuk, S.S., Raymond, G., Read, N., Rourke, S.B., Steinberg, R.J., Stewart, T.E., Wasylenki, D.A., 2006. Long-term psychological and occupational effects of providing hospital healthcare during SARS outbreak. Emerg. Infect. Dis. 12 (12), 1924–1932. https://doi.org/10.3201/eid1212.060584.

Mengin, A.C., Allé, M.C., Koning, E., Pham, B., Park, S., Berna, F., Giersch, A., 2022. Facing the pandemic and lockdown: an insight on mental health from a longitudinal study using diaries. NPJ Schizophr. 8 (1), 22. https://doi.org/10.1038/s41537-022-00222-2.

Moulds, M.L., Bisby, M.A., Wild, J., Bryant, R.A., 2020. Rumination in posttraumatic stress disorder: A systematic review. Clin. Psychol. Rev. 82, 101910 https://doi.org/10.1016/j.cpr.2020.101910.

Muller, A.E., Hafstad, E.V., Himmels, J.P.W., Smedslund, G., Flottorp, S., Stensland, S.Ø., Stroobants, S., Van de Velde, S., Vist, G.E., 2020. The mental health impact of the covid-19 pandemic on healthcare workers, and interventions to help them: A rapid systematic review. Psychiatry Res. 293, 113441 https://doi.org/10.1016/j.psychres.2020.113441.

Neff, K.D., Germer, C.K., 2013. A pilot study and randomized controlled trial of the mindful self-compassion program. J. Clin. Psychol. 69 (1), 28–44.

Pearce, N., Checkoway, H., Kriebel, D., 2007. Bias in occupational epidemiology studies. Occup. Environ. Med. 64 (8), 562–568.

R Core Team, R. (2013). *R: A language and environment for statistical computing.*

Rolling, J., Mengin, A.C., Palacio, C., Fath, M., Mastelli, D., Gras, A., Von Hunolstein, J.-J., Schroder, C.M., Vidailhet, P., 2021. COVID-19 and the psychological crisis in the most impacted French epidemic territory: an innovative and transposable primary prevention and care system in mental health for healthcare professionals. Front. Psych. 12 https://doi.org/10.3389/fpsyt.2021.566740.

Rubin, D., 1987. Multiple Imputation for Nonresponse Iin Surveys.

Ruwaard, J., Lange, A., Broeksteeg, J., Renteria-Agirre, A., Schrieken, B., Dolan, C.V., Emmelkamp, P., 2013. Online cognitive–behavioural treatment of bulimic symptoms: A randomized controlled trial. Clin. Psychol. Psychother. 20 (4), 308–318.

Salari, N., Hosseinian-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulpoor, S., Mohammadi, M., Rasoulpoor, S., Khaledi-Paveh, B., 2020. Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: A systematic review and meta-analysis. Glob. Health 16 (1), 57. https://doi.org/10.1186/s12992-020-00589-w.

Saragih, I.D., Tonapa, S.I., Saragih, I.S., Advani, S., Batubara, S.O., Suarilah, I., Lin, C.-J., 2021. Global prevalence of mental health problems among healthcare workers during the Covid-19 pandemic: A systematic review and meta-analysis. Int. J. Nurs. Stud. 121, 104002 https://doi.org/10.1016/j.ijnurstu.2021.104002.

Schumm, H., Krüger-Gottschalk, A., Dyer, A., Pittig, A., Cludius, B., Takano, K., Alpers, G.W., Ehring, T., 2022. Mechanisms of change in trauma-focused treatment for PTSD: the role of rumination. Behav. Res. Ther. 148, 104009 https://doi.org/10.1016/j.brat.2021.104009.

Smoktunowicz, E., Lesnierowska, M., Carlbring, P., Andersson, G., Cieslak, R., 2021. Resource-based internet intervention (med-stress) to improve well-being among medical professionals: randomized controlled trial. J. Med. Internet Res. 23 (1), e21445 https://doi.org/10.2196/21445.

Szabo, Y.Z., Warnecke, A.J., Newton, T.L., Valentine, J.C., 2017. Rumination and posttraumatic stress symptoms in trauma-exposed adults: A systematic review and meta-analysis. Anxiety Stress Coping 30 (4), 396–414. https://doi.org/10.1080/10615806.2017.1313835.

Teo, I., Chay, J., Cheung, Y.B., Sung, S.C., Tewani, K.G., Yeo, L.F., Yang, G.M., Pan, F.T., Ng, J.Y., Aloweni, Abu Bakar, F., Ang, H. G., Ayre, T. C., Chai-Lim, C., Chen, R. C., Heng, A. L., Nadarajan, G. D., Ong, M. E. H., See, B., Soh, C. R., … Tan, H. K., 2021. Healthcare worker stress, anxiety and burnout during the COVID-19 pandemic in Singapore: A 6-month multi-Centre prospective study. PloS One 16 (10), e0258866. https://doi.org/10.1371/journal.pone.0258866.

Trumello, C., Bramanti, S.M., Ballarotto, G., Candelori, C., Cerniglia, L., Cimino, S., Crudele, M., Lombardi, L., Pignataro, S., Viceconti, M.L., Babore, A., 2020. Psychological adjustment of healthcare Workers in Italy during the COVID-19 pandemic: differences in stress, anxiety, depression, burnout, secondary trauma, and compassion satisfaction between frontline and non-frontline professionals. Int. J. Environ. Res. Public Health 17 (22), 8358. https://doi.org/10.3390/ijerph17228358.

Vaishnavi, S., Connor, K., Davidson, J.R.T., 2007. An abbreviated version of the Connor-Davidson resilience scale (CD-RISC), the CD-RISC2: psychometric properties and applications in psychopharmacological trials. Psychiatry Res. 152 (2), 293–297. https://doi.org/10.1016/j.psychres.2007.01.006.

van Ballegooijen, W., Cuijpers, P., van Straten, A., Karyotaki, E., Andersson, G., Smit, J. H., Riper, H., 2014. Adherence to internet-based and face-to-face cognitive Behavioural therapy for depression: A Meta-analysis. PloS One 9 (7), e100674. https://doi.org/10.1371/journal.pone.0100674.

Van Buuren, S., 2018. Flexible Imputation of Missing Data Second edition. *(No Title)* 29.

Van Buuren, S., Groothuis-Oudshoorn, K., 2011. Mice: multivariate imputation by chained equations in R. J. Stat. Softw. 45, 1–67.

Vandevala, T., Pavey, L., Chelidoni, O., Chang, N.-F., Creagh-Brown, B., Cox, A., 2017. Psychological rumination and recovery from work in intensive care professionals: associations with stress, burnout, depression and health. J. Intensive Care 5, 16. https://doi.org/10.1186/s40560-017-0209-0.

Walton, M., Murray, E., Christian, M.D., 2020. Mental health care for medical staff and affiliated healthcare workers during the COVID-19 pandemic. Eur. Heart J. Acute Cardiovasc. Care 9 (3), 241–247. https://doi.org/10.1177/2048872620922795.

Weiner, L., Berna, F., Nourry, N., Severac, F., Vidailhet, P., Mengin, A.C., 2020. Efficacy of an online cognitive behavioral therapy program developed for healthcare workers during the COVID-19 pandemic: the REduction of STress (REST) study protocol for a randomized controlled trial. Trials 21 (1), 870. https://doi.org/10.1186/s13063-020-04772-7.

Yoo, I.G., 2022. The effects of the type of delivery of cognitive-behavioral therapy for healthcare workers: A systematic review. J. Clin. Psychol. 78 (2), 149–166. https://doi.org/10.1002/jclp.23215.

Zarei, S., Fooladvand, K., 2022. Mediating effect of sleep disturbance and rumination on work-related burnout of nurses treating patients with coronavirus disease. BMC Psychology 10 (1), 197. https://doi.org/10.1186/s40359-022-00905-6.

Zhang, C., Yang, L., Liu, S., Ma, S., Wang, Y., Cai, Z., Du, H., Li, R., Kang, L., Su, M., Zhang, J., Liu, Z., Zhang, B., 2020. Survey of insomnia and related social psychological factors among medical staff involved in the 2019 novel coronavirus disease outbreak. Front. Psych. 11, 306. https://doi.org/10.3389/fpsyt.2020.00306.

Zuromski, K.L., Ustun, B., Hwang, I., Keane, T.M., Marx, B.P., Stein, M.B., Ursano, R.J., Kessler, R.C., 2019. Developing an optimal short-form of the PTSD checklist for DSM-5 (PCL-5). Depress. Anxiety 36 (9), 790–800. https://doi.org/10.1002/da.22942.