

Exploring the effects of variety and amount of mindfulness practices on depression, anxiety, and stress symptoms: a longitudinal study on a mental health-focused eHealth system for breast and prostate cancer patients.

Francesca Malandrone, Sara Urru, Paola Berchiolla, Pierre Gilbert Rossini, Francesco Oliva, Silvia Bianchi, Manuel Ottaviano, Sergio Gonzalez-Martinez, Vladimir Carli, Gaetano Valenza, Enzo Pasquale Scilingo, Sara Carletto, Luca Ostacoli

Submitted to: JMIR Mental Health
on: February 20, 2024

Disclaimer: © The authors. All rights reserved. This is a privileged document currently under peer-review/community review. Authors have provided JMIR Publications with an exclusive license to publish this preprint on its website for review purposes only. While the final peer-reviewed paper may be licensed under a CC BY license on publication, at this stage authors and publisher expressly prohibit redistribution of this draft paper other than for review purposes.

Table of Contents

Original Manuscript.....	5
Supplementary Files.....	36
Figures	37
Figure 1.....	38
Figure 2.....	39



Exploring the effects of variety and amount of mindfulness practices on depression, anxiety, and stress symptoms: a longitudinal study on a mental health-focused eHealth system for breast and prostate cancer patients.

Francesca Malandrone¹; Sara Urru²; Paola Berchiolla¹; Pierre Gilbert Rossini¹; Francesco Oliva^{1, 3}; Silvia Bianchi⁴; Manuel Ottaviano⁵; Sergio Gonzalez-Martinez⁵; Vladimir Carli⁶; Gaetano Valenza⁴; Enzo Pasquale Scilingo⁴; Sara Carletto^{1, 3*}; Luca Ostacoli^{1, 3*}

¹Department of Clinical and Biological Sciences University of Turin Orbassano IT

²Department of Cardiac, Thoracic, Vascular Sciences and Public Health Unit of Biostatistics University of Padova Padova IT

³Clinical Psychology Unit University Hospital "Città della Salute e della Scienza di Torino Turin IT

⁴School of Engineering Research Center "E.Piaggio" University of Pisa, Pisa Pisa IT

⁵Life Supporting Technologies Universidad Politécnica de Madrid Madrid ES

⁶Department of Learning, Informatics, Management and Ethics National Centre for Suicide Research and Prevention of Mental Ill-Health Karolinska Institute Stockholm SE

*these authors contributed equally

Corresponding Author:

Pierre Gilbert Rossini

Department of Clinical and Biological Sciences

University of Turin

Regione Gonzole 10

Orbassano

IT

Abstract

Background: Psychological distress like depression and anxiety in cancer patients worsens treatment challenges, impacting compliance and prognosis. Interventions, like Mindfulness-Based Interventions (MBIs), show promise in reducing distress and improving outcomes, with longer durations potentially yielding better results.

Objective: This study aims to investigate the impact of Internet-based Mindfulness-Based Interventions (e-MBIs) on anxiety, depression, and stress symptoms in prostate and breast cancer patients. The primary aims are to assess the association between the amount and variety of e-MBI practices and symptom reduction. Secondly, the study aims to examine how baseline information such as sociodemographic characteristics and dispositional mindfulness (DM) and dispositional self-compassion (DSC) correlate with both app usage and symptom reduction.

Methods: Data from the NEVERMIND project were used, involving 107 patients. A longitudinal design assessed Pearson's correlation to analyse the relationship between the amount and duration of e-MBI practices. Linear regression gauged the dose-response effect, evaluating DM and DSC impact on depression, anxiety, and stress. Negative binomial regression studied sociodemographic factors' influence on e-MBI practice amount.

Results: The participants with more diverse and sustained mindfulness practices (TP=1) experienced significant reductions in depression, anxiety, and stress. A high correlation (0.94) between e-MBI practices and symptom reduction is also highlighted. Male, married, and highly educated patients were more likely to engage in mindfulness. Even if DM and DSC did not impact the amount or variety of practices correlated, they were correlated with symptom reduction, showing that higher levels were associated with significant reductions in depression, anxiety, and stress.

Conclusions: While more e-MBI practice is linked to reduced anxiety, depression, and stress, the study emphasises the crucial role of variety of practice over amount. DM and DSC are key in shaping intervention effectiveness and may act as protectors against psychological distress. Using app log data, our research provides a unique perspective on e-MBI impact, contributing to cancer care understanding and guiding future studies.

(JMIR Preprints 20/02/2024:57415)

DOI: <https://doi.org/10.2196/preprints.57415>

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**

Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.

Only make the preprint title and abstract visible.

No, I do not wish to publish my submitted manuscript as a preprint.

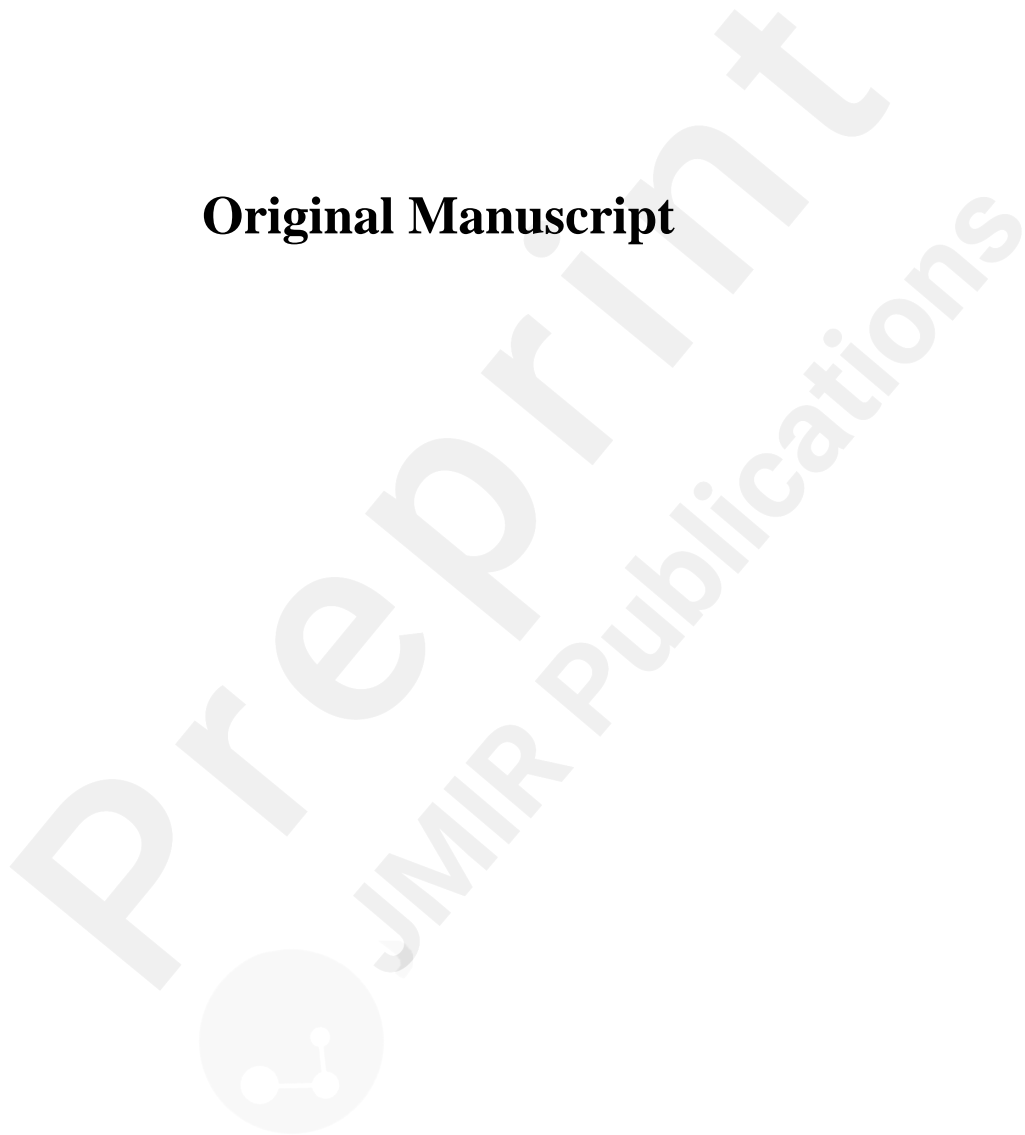
2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**

Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain visible to all users.

Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in [JMIR Publications](#)

Original Manuscript



Title: Exploring the effects of variety and amount of mindfulness practices on depression, anxiety, and stress symptoms: a longitudinal study on a mental health-focused eHealth system for breast and prostate cancer patients.

Francesca Malandrone¹, Sara Urru², Paola Berchiolla¹, Pierre Gilbert Rossini¹, Francesco Oliva^{1,3}, Silvia Bianchi⁶, Manuel Ottaviano⁴, Sergio Gonzalez-Martinez⁴, Vladimir Carli⁵, Gaetano Valenza⁶, Enzo Pasquale Scilingo⁶, Sara Carletto^{1,3*}, Luca Ostacoli^{1,3*}.

¹Department of Clinical and Biological Sciences, University of Turin, Italy.

²Unit of Biostatistics, Epidemiology and Public Health, Department of Cardiac, Thoracic, Vascular Sciences and Public Health, University of Padova, Padova, Italy

³Clinical Psychology Unit, University Hospital "Città della Salute e della Scienza di Torino", Turin, Italy.

⁴Life Supporting Technologies, Universidad Politécnica de Madrid, Madrid, Spain.

⁵National Centre for Suicide Research and Prevention of Mental Ill-Health, Department of Learning, Informatics, Management and Ethics, Karolinska Institute, Stockholm, Sweden.

⁶Research Center "E.Piaggio", School of Engineering, University of Pisa, Pisa, Italy.

*co-last authors.

Francesca Malandrone, ORCID 0000-0002-9438-8637

Sara Urru, ORCID 0000-0002-2912-8214

Francesco Oliva, ORCID 0000-0002-4826-705X

Paola Berchiolla, ORCID 0000-0001-5835-5638

Pierre Gilbert Rossini, ORCID 0000-0001-6657-737X

Gaetano Valenza, ORCID 0000-0001-6574-1879

Enzo Pasquale Scilingo, ORCID 0000-0003-2588-4917

Manuel Ottaviano, ORCID 0000-0003-0002-4988

Sergio Gonzalez-Martinez, ORCID 0000-0003-1256-6389

Vladimir Carli, ORCID 0000-0001-6922-0675

Sara Carletto, ORCID 0000-0002-4951-7479

Luca Ostacoli, ORCID 0000-0002-6874-1396

Corresponding author:

Pierre Gilbert Rossini

Department of Clinical and Biological Science, University of Turin, Italy.

Regione Gonzole 10, 10043 Orbassano (TO), Italy.

Phone number: 00390116334200.

Email: pierregilbert.rossini@unito.it

Abstract

Introduction: Cancer patients often face depression and anxiety, and Mindfulness-Based Interventions (MBIs), including internet-based versions, can effectively reduce these symptoms and improve their quality of life. This study aims to investigate the impact of Internet-based Mindfulness-Based Interventions (e-MBIs) on anxiety, depression, and stress symptoms in prostate and breast cancer patients.

Objectives: The primary aims are to assess the association between the amount and variety of e-MBI practices and symptom reduction. Secondly, the study aims to examine how baseline information such as sociodemographic characteristics and dispositional mindfulness (DM) and dispositional self-compassion (DSC) correlate with both app usage and symptom reduction.

Methods: Participants included 107 cancer patients (68 women with breast cancer and 38 men with prostate cancer) enrolled in a hospital setting. They were assigned to the intervention group of the NEVERMIND project, using the e-BMI module via the NEVERMIND App. A longitudinal design assessed Pearson's correlation to analyse the relationship between the amount and duration of e-MBI practices. Linear regression gauged the dose-response effect, evaluating DM and DSC impact on depression, anxiety, and stress. Negative binomial regression studied sociodemographic factors' influence on e-MBI practice amount.

Results: The participants with more diverse and sustained mindfulness practices (TP=1) experienced significant reductions in depression, anxiety, and stress. A high correlation (0.94) between e-MBI practices and symptom reduction is also highlighted. Male, married, and highly educated patients were more likely to engage in mindfulness. Even if DM and DSC did not impact the amount or variety of practices correlated, they were correlated with symptom reduction, showing that higher levels were

associated with significant reductions in depression, anxiety, and stress.

Conclusions: While more e-MBI practice is linked to reduced anxiety, depression, and stress, the study emphasises the crucial role of variety of practice over amount. DM and DSC are key in shaping intervention effectiveness and may act as protectors against psychological distress. Using app log data, our research provides a unique perspective on e-MBI impact, contributing to cancer care understanding and guiding future studies.

Keywords: e-MBI, Depression, Anxiety, Stress, Cancer, dose-response.

1. Introduction

Cancer patients often experience psychological problems such as depression and anxiety, which can exacerbate the challenges of their treatment and management [1]. Due to their prevalence, breast cancer in women and prostate cancer in men are the types of cancer most extensively studied in terms of their psychological consequences. Literature reports that both sexual and emotional functions are significantly affected in patients with these cancers, leading to repercussions on quality of life, mental health, and the quality of social relationships [2,3]. These issues can negatively impact treatment compliance, hospitalisation, response, and prognosis, and ultimately, the survival rate [4–6]. Research has shown that interventions to reduce distress (such as depression and anxiety) can have a positive downstream impact on patients, families, cancer outcomes, and the medical system [7,8].

Mindfulness-Based Interventions (MBIs) have emerged as effective approaches for reducing anxiety and depressive symptoms and for enhancing the quality of life among cancer patients [9–12]. The duration of these interventions varied across studies but typically entailed weekly session for five to eight weeks. Notably, certain studies have suggested that the extent of improvement in mindfulness skills is associated with greater reductions in psychological distress following the intervention, highlighting the potential importance of the amount of mindfulness training provided. In the oncological context, the efficacy of MBIs has mainly been studied with breast cancer patients [12–14]. Together with prostate cancer, they are the most prevalent cancer types studied for women and men, respectively [15]. Despite the higher prevalence of these cancers, distinctions between breast, prostate, and other types of cancer are not typically emphasized when considering symptoms such as anxiety, depression, and stress. These psychological issues do not seem to be specific to any particular type of cancer; therefore, most studies and systematic reviews generally address these symptoms uniformly across various cancer types without differentiation. Beyond the oncological context, although the optimal dosage of MBIs required to alleviate psychological symptoms remains unclear, reviews have demonstrated that even low-dose and brief MBIs can yield mental health benefits and improve self-

regulation [16–18]. Recent meta-analyses have further indicated that short mindfulness exercises, when administered as stand-alone programs without extensive introductory or discussion components, exhibit superior effectiveness in reducing anxiety and depression compared to control conditions [19]. Nevertheless, it is generally observed that increased mindfulness instruction and practice (i.e., higher amount) are associated with improved outcomes, as these factors represent crucial elements of MBIs [20–22]. A more recent meta-analysis conducted by Strohmaier and colleagues [23] revealed that while no significant dose-response relationship was found for psychological outcomes such as depression, anxiety, or stress, a significant association was observed between amount of mindfulness practice and the improvement of mindfulness skills.

Several studies have examined the relationship between baseline characteristics and the efficacy of MBIs, identifying certain outcome predictors. For instance, higher levels of baseline depression have been associated with increased treatment response for anxiety, whereas lower levels of baseline self-compassion predicted enhanced treatment response for depression [24]. Similarly, another study found that a strong fear of recurrence or low levels of conscientiousness could reduce adherence [25]. Consistent with this, another study reported that better program adherence, reflected in participants' higher attendance to the MBI program, was a significant predictor of both remission and response [26]. Additionally, self-compassion has been shown to negatively correlate with depression, anxiety, and stress in both clinical [27,28] and nonclinical [29–31] populations. To the best of our knowledge, existing studies primarily focus on the impact of mindfulness on symptom reduction. This study is the first to investigate the moderation of intervention effects, highlighting the novelty of our research.

Internet-based or smartphone-delivered mindfulness-based interventions (e-MBIs) demonstrated effectiveness in supporting mental health and reducing psychological symptoms in various populations, including those with depression, anxiety, and organic diseases [32–38]. In particular, they have shown efficacy in reducing depression, stress, and anxiety not only in breast and prostate cancer patients [39–42] but also across most other types of cancer [24,43–45]. E-MBIs offer a feasible and flexible option for cancer survivors, providing advantages such as easy accessibility, anonymity, 24/7 availability,

reduced reliance on trained therapists, cost-effectiveness, and time-saving benefits [18,46]. Recent systematic reviews and meta-analyses have highlighted the feasibility and efficacy of e-MBIs in improving several outcomes – such as anxiety, depression, PTSD, fatigue, pain - suggesting their potential superiority over traditional face-to-face interventions [18,47–49]. Although attrition rates may be higher in e-MBIs compared to face-to-face programs [50], e-MBIs have shown to be cost-effective and accessible [44] promoting positive changes in subjective levels of stress, anxiety, depression, fatigue, sleep problems, mindfulness, posttraumatic growth, pain, and general health indicators [18,47–49]. However, the existing literature supporting this type of intervention is currently limited and of medium to low quality.

The primary objective of this study was to investigate how a different use of an e-MBI delivered via an e-Health System impacts on anxiety, depression, and stress levels in prostate and breast cancer patients. We aim to 1) examine the relationship between the amount of e-MBI practices completed by participants and the observed reduction in symptoms to test the hypothesis that greater practice amount is associated to a stronger reduction in symptoms of anxiety, depression, and stress; 2) to evaluate the effect of practising a greater variety of e-MBI exercises, i.e. greater amount of more types of practices, on symptoms, to test our hypothesis that a greater assortment of practices may be associated with a greater improvements in symptoms of anxiety, depression, and stress.

Furthermore, this study sought to address the following secondary research objectives: 3) to identify possible predictors of the intensity of use of the e-MBI modules among variables collected at baseline, i.e., socio-demographic characteristics, dispositional mindfulness level, and dispositional self-compassion level. Our hypothesis was that higher mindfulness and self-compassion scores may be associated with the amount of practice; 4) to investigate about a potential association between pre-intervention dispositional mindfulness and dispositional self-compassion levels and the reduction of symptoms. This analysis aims to determine whether these individual features are linked to symptom improvement. We hypothesised that higher dispositional mindfulness and self-compassion may be associated with greater symptom reduction.

2. Methods

2.1. Overview of the NEVERMIND system

This study used data from the NEVERMIND European Union–funded Horizon 2020 project. The NEVERMIND system is a comprehensive solution designed to address depressive symptoms in patients with somatic illnesses (i.e. myocardial infarction, breast cancer, prostate cancer, kidney failure, or lower limb amputation). It consists of two main components: a sensorized shirt and a mobile application (App). The shirt collects physiological data, while the App gathers mental health questionnaires, allowing the system to predict depressive symptom levels and to deliver tailored care based on depressive symptom severity. This approach ensured personalised support for participants at varying levels of need, ultimately aiming to improve their well-being. No mental health indicators resulted in positive feedback, while early signs prompted lifestyle advice in the form of different modules within the App (exercise, sleep hygiene, dietary recommendations) and an e-MBI. Severe symptoms activated online cognitive behavioural therapy. A detailed description of the design, content, and functionality of the NEVERMIND system has been published in previous publications [51,52]. In an RCT involving 425 patients with severe somatic illnesses, such as breast cancer, prostate cancer, myocardial infarction, kidney failure, or leg amputation, the NEVERMIND system was found to be superior to standard care in reducing depressive symptoms [52].

2.2. Study Design

This study used a longitudinal design to explore the effect of the NEVERMIND e-MBI module on symptoms of depression, anxiety, and stress among patients with breast and prostate cancer. The NEVERMIND trial was registered in the German Clinical Trials Register, DRKS00013391. The study was approved by the Ethical Committee of “Città della Salute e della Scienza di Torino” University Hospital, Torino, Italy, and the Ethical Committee of “San Luigi Gonzaga” University Hospital, Orbassano, Italy.

2.3. Participants

Participants included in this study were patients with breast and prostate cancer from the intervention group of the NEVERMIND project, recruited from the Piedmont Oncological Network at San Luigi Gonzaga University Hospital, Turin, Italy, and the Breast Unit-Oncology Department and Urology Department at “Città della Salute e della Scienza” University Hospital, Turin, Italy from November 2017 to December 2019. The inclusion and exclusion criteria for the NEVERMIND trial are included in the published protocol [51] .

The inclusion criteria for the sub-sample in this study encompassed patients with breast or prostate cancer assigned to the NEVERMIND intervention group who completed the study and engaged in at least one e-MBI practice lasting a minimum of 5 minutes. Exclusion criteria involved individuals assigned to the control group in the NEVERMIND study, patients in the NEVERMIND intervention group diagnosed with other severe somatic conditions (e.g., kidney failure, leg amputation, myocardial infarction), and patients in the NEVERMIND intervention group who dropped out of the study before receiving the NEVERMIND system.

2.4. Data Collection

Participants were asked to complete a series of questionnaires at baseline to assess demographic information, symptoms of anxiety, depression and stress, and levels of dispositional mindfulness and self-compassion. Afterwards, participants were informed about how the NEVERMIND system works and were instructed to use the system for a period of 12 weeks, committing to using the App almost every day. Therefore, participants were assessed at the end of the 12-week period of use, which included questionnaires regarding symptoms of anxiety, depression, and stress. A description of each variable used in the present study is provided in the following sections.

2.4.1. Demographic and clinical variables

Sociodemographic data collected for patients recruited in the study included age, gender, education level (dichotomised into low i.e. below high school diploma or degree, and high i.e. degree or higher), marital status, employment and living status (i.e. cohabitant or alone).

Depression symptoms were measured using the Beck Depression Inventory II (BDI-II) scale [53]. BDI-II is a 21-item self-report instrument assessing the presence and severity of depressive symptoms in the past week. The total score (i.e., the sum of all items) indicates the level of depression within a range from 0 to 63, with higher scores indicating higher levels of depressive symptoms.

Anxiety and stress symptoms were measured using the anxiety and the stress subscale, respectively, of the Depression Anxiety and Stress Scale (DASS-21) [54]. DASS-21 consists of 21 items, 7 for each of three subscales (i.e. depression, anxiety, and stress). Each item scored from 0 to 3. The total is then doubled to align with the full version of the DASS-21, leading to a possible score range from 0 to 42 for each subscale, with higher scores indicating higher levels of symptoms. In accordance with the methodology outlined in Carli et al., 2022 [52], the BDI-II was selected as the primary outcome measure, while the DASS-21 depression subscale (DASS-D) was administered only at baseline (T0), following the principle of data minimization.

The Mindful Attention Awareness Scale (MAAS) [55] was used to assess dispositional mindfulness, i.e. open or receptive awareness and attention to what is happening in the present with a non-judgmental attitude. The MAAS is a 15-item self-report questionnaire of mindfulness measured on a 6-point Likert scale ranging from 1="almost always" to 6="almost never". Higher scores represent greater dispositional mindfulness.

Self-compassion was measured with the Self-compassion scale - short form (SCS-SF) [56]. It is a 12-item self-report questionnaire on a 5-point Likert scale ranging from 1= "almost never" to 5= "almost always", assessing how often people behave kindly and caringly towards themselves in difficult life situations. The final SCS-SF score ranges from 12 to 70. A higher score indicates a higher level of

self-compassion.

2.4.2. E-MBI amount and variety of practices.

Data regarding the number, duration, and type of e-MBI practices were extracted from the usage log of the NEVERMIND App. The NEVERMIND e-MBI module included different types of mindfulness practices of different durations (5, 10 or 20 minutes), taken from the Mindfulness-Based Stress Reduction protocol [57,58], the Compassion-Focused Therapy protocol [59–61] and the Four Immeasurable of the Buddhist tradition [62–64]. Table S1 in Supplementary Material shows all the practices covered by this module. Each day, the App proposed a recommended practice to the user, based on the preferences expressed by the patient at the time of registration and the mental health symptoms detected by the questionnaires embedded in the App. Completion of the mindfulness practices unlocked access to other types of practices, granting the patient an incremental path over the period of use of the NEVERMIND system (12 weeks). For each patient, the total number, type and duration of e-MBI practices used during the 12 weeks of use of the NEVERMIND system were calculated. Since the amount of practices performed by the patients was associated with the variety of practices unlocked by the App incrementally, we have provided in Table S2 of the Supplementary Material the number of patients per group for each practice type. Additionally, to further delineate this distinction between practice dosage and variety across groups, we introduced an indicator variable named “Time×Practice” (TP). This variable partitions patients into two distinct categories: those who exclusively engaged in the initial practices recommended by the App, encompassing 'sensorial opening', 'body scan 1', 'body scan 2', 'enriching listening to nature', and 'loving presence' (TP=0), and those who embraced a broader array of practices, incorporating both a greater number and variety over successive weeks (TP=1).

2.5. Statistical analysis

Descriptive statistics were reported as mean and standard deviation for continuous variables and frequency and percentage for categorical ones. Kendall's correlation coefficient was used to assess the

correlation between the number of e-MBI practices used by the patients and the amount of time spent practicing. Given the high correlation between the number of e-MBI practices and their total duration ($r=0.88$, 95%CI [0.83,0.91], $p<0.001$), the number of practices was used as independent variable in a linear regression analysis evaluating the dose-response effect on depressive, anxiety, stress symptoms, adjusting for baseline levels. Also, two linear regressions to evaluate the dose-response effect considering the number of practices and adjusting for baseline values of depressive, anxiety, stress symptoms were performed separately for breast and prostate cancer patients. Descriptive statistics about the type of practices were reported including the total number of practices and the number of patients for each type of practice. Linear regression was applied to assess the influence of being in TP=0 and TP=1 groups on symptom reduction (i.e., depression, anxiety, stress). This analysis was also performed separately for breast and prostate cancer patients. Negative binomial regression was performed to estimate the influence of the sociodemographic factors and baseline characteristics on the count of completed e-MBI practices. The two groups, defined on indicator variable TP, were compared for socio-demographic characteristics, psychological features and psychopathology using the χ^2 test for categorical variables and Wilcoxon-Mann-Whitney test for continuous ones. Also, linear regression was applied to evaluate the impact of dispositional mindfulness and self-compassion on psychopathology (i.e., depression, anxiety, stress). All the statistical analyses were performed with the statistical software R version 4.1.2.

3. Results

Out of the initial cohort of 129 breast or prostate cancer patients assigned to the NEVERMIND intervention group, 107 individuals actively engaged in mindfulness practices for at least 5 minutes and constituted the study sample. Table 1 presents the baseline characteristics of this cohort.

Table 1. Sociodemographic characteristics of patients at baseline.

	n (%)
Sex	
Female	68 (63.6)
Male	39 (36.4)
Education	
Low	29 (27.1)
High	78 (72.9)
Marital status	
Single	92 (86.0)
Married	15 (14.0)
Employment_status	
Unemployed	22 (20.6)
Employed	85 (79.4)
Living status	
Cohabitant	56 (52.3)
Alone	51 (47.7)
	Mean (SD)
Age	60.16 (9.30)
BDI	12.54 (9.44)
DASS-21-D	4.48 (4.64)
DASS-21-A	3.03 (3.22)
DASS-21-S	6.50 (4.79)
MAAS	4.43 (0.86)
SCS-SF	3.22 (0.46)

BDI=Beck Depression Inventory; DASS-D=Depression Anxiety and Stress Scale-Depression; DASS-A= Depression Anxiety and Stress Scale-Anxiety; DASS-S=Depression Anxiety and Stress Scale-Stress; MAAS= Mindful Attention Awareness Scale; SCS-SF=Self-Compassion Scale-Short Form.

As illustrated in Figure 1 and Figure 2, patients in TP=0 (N=53) engaged in mindfulness practices less frequently, mainly during the initial period. Conversely, patients in TP=1 (N=54) exhibited more frequent, diverse, and sustained practices over an extended duration. Patients in TP=1 demonstrated a more comprehensive exploration of various practice types, maintaining consistency over time.

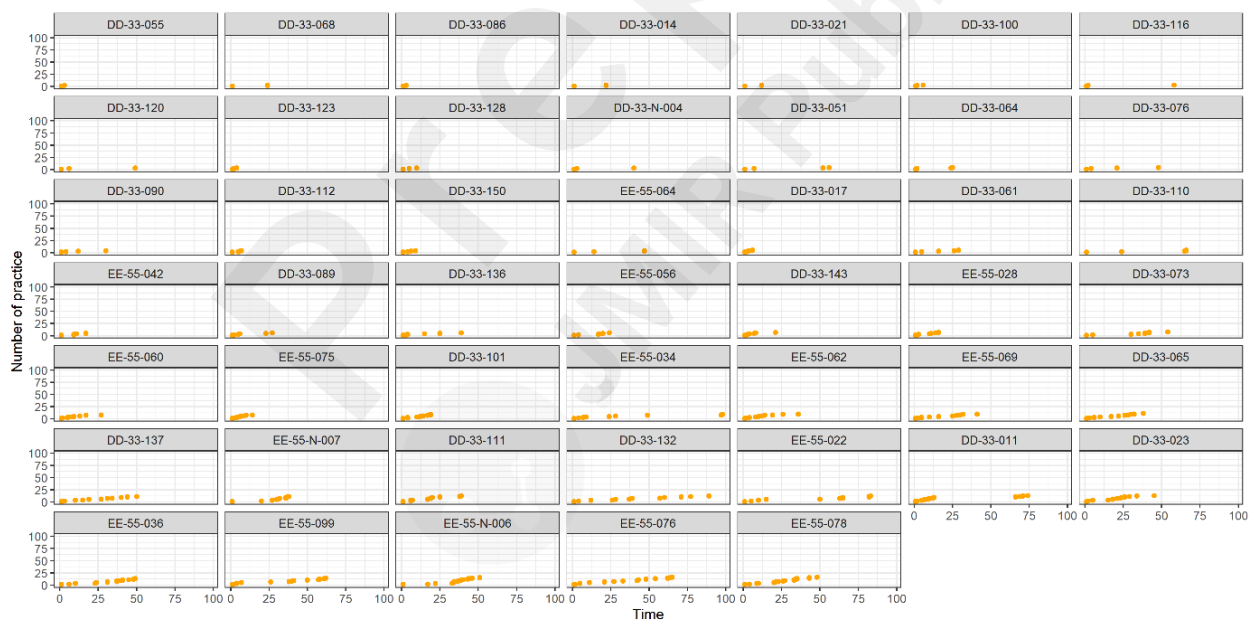


Figure 1 Practice Trajectories for TP=0 Group Patients. The practice trajectories of each patient in the TP=0 group are reported. The horizontal axis shows the number of days of practice, while the vertical axis shows the cumulative number of practices.

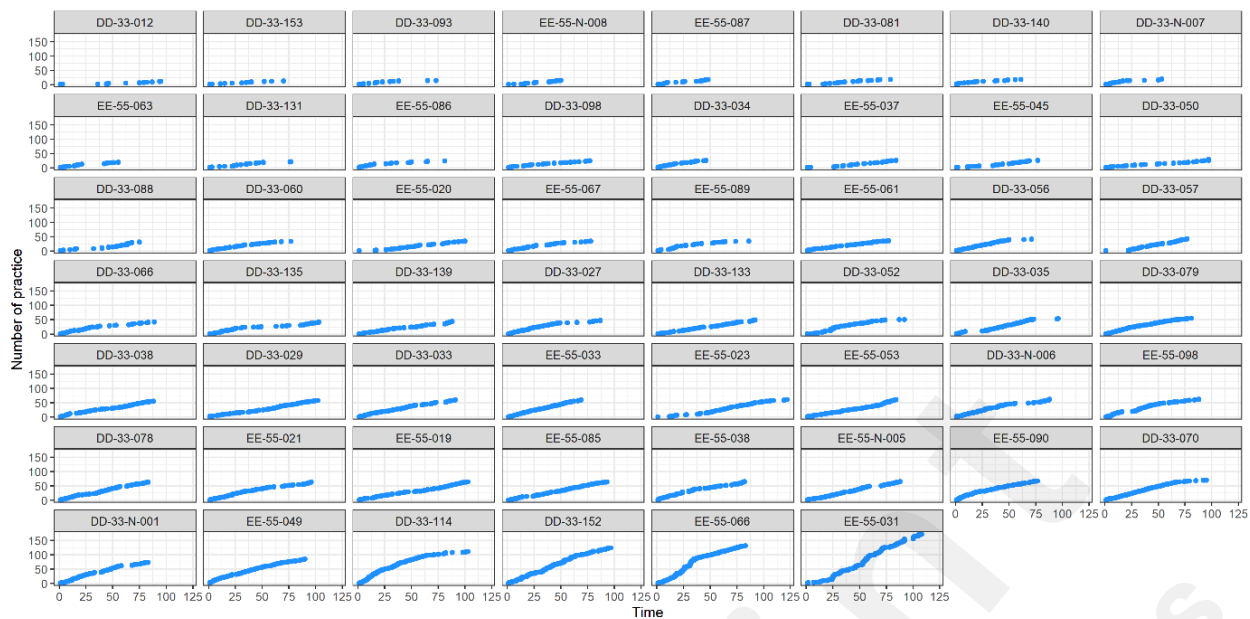


Figure 2 Practice Trajectories for TP=1 Group Patients. The practice trajectories of each patient in the TP=1 group are reported. The horizontal axis shows the number of days of practice, while the vertical axis shows the cumulative number of practices.

The results of the dose-response effect adjusted for baseline values are reported in Table 2: a significant slight improvement of depression, anxiety, and stress symptoms with the increase of the number of practices was observed. In the Supplementary Material, further analyses are provided, considering breast and prostate cancer patients separately. Among the breast cancer cohort, the number of e-MBI practices significantly reduced depressive, anxiety, and stress symptoms (Table S3). Conversely, no significant reductions were observed in the prostate cancer cohort (Table S4).

Table 2. Results of linear regression analysis evaluating the dose-response effect of the number of practices on depressive, anxiety, stress symptoms, adjusted for baseline levels.

Outcome	R ²	AIC	Predictors	Estimates	95% CI	P
BDI	0.34	706.13	Baseline	0.48	0.34 – 0.62	<.001
			N. of practices	-0.06	-0.10 – -0.01	.01
DASS-A	0.34	499.27	Baseline	0.53	0.37 – 0.69	<.001
			N. of practices	-0.02	-0.04 – -0.00	.02
DASS-S	0.44	555.65	Baseline	0.58	0.44 – 0.72	<.001
			N. of practices	-0.03	-0.06 – -0.01	.002

BDI=Beck Depression Inventory; DASS-A= Depression Anxiety and Stress Scale-Anxiety; DASS-S=Depression Anxiety and Stress Scale-Stress

Regarding the effect of a greater variety of e-MBI practices on the reduction of symptoms, patients in group TP=1 had statistically significant lower level of depressive, anxiety, and stress symptoms than patients in group TP=0, despite the adjustment for baseline score (Table 3).

Table 3. Results of linear regression analysis evaluating the effect of TP groups on depression, anxiety, stress, adjusted for baseline levels.

Outcome	R ²	AIC	Predictors	Estimates	95% CI	P
BDI	0.35	704.29	Baseline	-3.87	-6.49 – -1.25	.004
			TP=1	0.47	0.33 – 0.61	<.001
DASS-A	0.37	494.73	Baseline	-1.64	-2.63 – -0.64	.001
			TP=1	0.55	0.39 – 0.70	<.001
DASS-S	0.44	556.82	Baseline	-2.02	-3.36 – -0.69	.003
			TP=1	0.58	0.44 – 0.72	<.001

TP-1=Time×Practice- group 1, patients who used a greater number and variety of practices over the weeks; BDI=Beck Depression Inventory; DASS-A= Depression Anxiety and Stress Scale-Anxiety; DASS-S=Depression Anxiety and Stress Scale-Stress

Tables S5 and S6 report the impact of TP groups on depression, anxiety, and stress in breast and prostate cancer patients, respectively. The results indicate that in the breast cancer cohort, patients who engaged in a higher number of e-MBI practices (TP=1) experienced significant reductions in symptoms (Table S5), whereas this effect was not seen in the prostate cancer cohort (Table S6). Table S7 compares the number of practices and baseline symptom values across the cancer cohorts. The analysis revealed that males (i.e., the prostate cancer cohort) engaged in more e-MBI practices than females, as indicated by the negative binomial regression model in Table 4. However, despite this higher engagement, significant symptom reduction was observed only in the breast cancer cohort, likely due to their higher baseline symptom values compared to prostate cancer patients.

Table S8 presented descriptive statistics concerning the types of e-MBI practices, encompassing the total practice count and the number of patients for each practice type. Additionally, Table S9 detailed the sociodemographic and baseline characteristics of the two groups, categorized according to the variable TP. As regards variables associated with the amount of e-MBI practices, results

show that male, married, and highly educated patients were more prone to be engaged in mindfulness practices (Table 4).

Table 4. Results of negative binomial regression analysis evaluating the impact of sociodemographic factors and baseline characteristics on the amount of practices .

Predictors	IRR	95% CI	P
Sex: Male	1.85	1.12 – 3.07	.01
Age	1.00	0.97 – 1.03	.82
Employment: Employed	0.86	0.55 – 1.36	.51
Marital status: Married	2.94	1.47 – 5.57	.001
Living arrangement: Alone	2.19	0.92 – 5.12	.06
Education: High	2.02	1.19 – 3.34	.007
DASS-A	0.97	0.90 – 1.05	.53
DASS-S	0.99	0.93 – 1.06	.81
BDI	1.03	0.99 – 1.06	.13
MAAS	0.97	0.71 – 1.30	.82
SCS-SF	1.16	0.75 – 1.81	.51
R ²	0.37		
AIC	931.35		

BDI=Beck Depression Inventory; DASS-A= Depression Anxiety and Stress Scale-Anxiety; DASS-S=Depression Anxiety and Stress Scale-Stress; MAAS= Mindful Attention Awareness Scale; SCS-SF=Self-Compassion Scale-Short Form.

This result was corroborated by a statistically significant difference in the number of highly educated patients that emerged between the TP=0 and TP=1 groups, showing that highly educated individuals practiced more extensively and with greater variety (Table S9). Regarding the influence of dispositional mindfulness and dispositional self-compassion on the use of e-MBI modules, no association was found between TP=1 group and both dispositional mindfulness and dispositional self-compassion (Table S9).

Finally, this study aimed to explore the potential correlation between pre-intervention dispositional mindfulness and dispositional self-compassion levels and their respective contributions to symptom reduction. Increasing levels of MAAS were associated with a statistically significant reduction in depression, anxiety, and stress. Similarly, higher values of SC were linked to lower levels of depressive,

anxiety, and stress symptoms (Table S10).



4. Discussion

To the best of our knowledge, this study contributed to the existing literature by examining the association between sociodemographic factors, mindfulness practice characteristics, and psychological symptoms reduction in cancer patients. This provides a unique perspective considering these variables within the oncological context, addressing a crucial gap in current research. While cancer patients often encounter psychological challenges impacting treatment outcomes, e-MBIs have shown effectiveness in reducing cancer-related psychological distress, offering flexibility and cost-effectiveness [24,43–45]. Nevertheless, the available literature remains limited in both quality and quantity.

The first aim of our study was to investigate whether the amount of e-MBI practice is related to symptom reduction. Confirming our hypothesis, results indicate that a greater practice dose was associated with a more pronounced reduction in anxiety, depression, and stress symptoms. These results are interesting although the observed reduction in symptoms is relatively modest from a clinical point of view, which is probably related to the baseline low levels of anxiety, depression, and stress symptoms. This was particularly evident when we separated male and female (and thus, breast and prostate cancer patients). Differences in symptoms at baseline, in fact, appear to play a role in showing post-treatment improvement, despite men having practiced more. Specifically, within the breast cancer cohort, the number of e-MBI practices significantly reduced depressive, anxiety, and stress symptoms even though males in the prostate cancer cohort engaged in more practices than females. However, symptom reduction was evident only in the breast cancer cohort, likely due to their notably higher baseline values compared to patients with prostate cancer. The efficacy of MBIs in reducing depression and anxiety symptoms in cancer patients has been emphasised by two recent meta-analyses [9,44]. Regarding e-MBIs, a study recently showed that this type of treatment can be as effective as in-person MBIs, with significant psychological improvements when provided to healthcare workers [65]. Regarding the influence of practice amount on symptoms, the current literature remains limited and unclear, especially within the oncologic field and when investigating e-MBIs. While some studies and reviews have identified a positive link between the amount of MBI practice and symptom reduction [20–22,66],

others have indicated no correlation between practice quantity and symptom alleviation. Strohmaier and colleagues [23,67] found no evidence that larger doses are more beneficial than smaller doses for predicting psychological outcomes, aligning with some previous research in non-clinical populations. Similarly, a review by Cillessen and colleagues [47] on MBIs for psychological and physical health outcomes in cancer patients and survivors found that the measured intervention dose in hours does not appear to be a significant mediator of the effect. The second aim was to investigate how practising a more diverse range of e-MBI exercises, encompassing both the quantity and types of practices, impacts the reduction of symptoms. Our results show that a greater variety of practices, rather than quantity *per se*, was associated with more substantial reductions in symptoms related to anxiety, depression, and stress. As far as we know, this is the first study to have investigated the variety of mindfulness practices' effect on psychological symptoms. Few studies, mainly on non-clinical samples, have investigated the effects of specific mindfulness practices highlighting their differences and similarities in psychological outcomes [68–70] and from a neurobiological point of view [71–73]. For example, Carmody and Baer [74] showed that varying practice times for different meditation exercises, like sitting meditation, body scan, and mindful yoga, are associated with distinct outcomes, indicating the specificity of each practice in addressing different aspects of psychological health within MBIs. Similarly, Sauer-Zavala et al. [75] explored various meditation practices' impact on well-being. Mindful yoga showed greater psychological well-being improvement, and both mindful yoga and sitting meditation were more effective in enhancing emotion regulation compared to body scan. Zeng and colleagues [76] found that different subtypes of Focused Attention Meditation, such as appreciative joy meditation and compassion meditation, had distinct effects on positive emotions in recent laboratory studies. Considering the early stage of research in this field, it's only possible to speculate that our results may be explained by the notion that a greater variety of practices enables the targeting of different psychological abilities and resources, thereby contributing to the reduction of symptoms.

Having explored the impact of both the amount and variety of mindfulness practices on symptoms and confirming the effective reduction of symptoms, the study delved into the examination

of baseline factors. Specifically, it investigated how socio-demographic characteristics, dispositional mindfulness, and dispositional self-compassion at baseline influenced the amount and variety of practice, namely the use of the e-MBI module.

Examining the categories displaying a greater inclination to engage in practice, we found that males, married individuals, and those with higher levels of education exhibited a heightened propensity. Within the oncologic field, the evaluation of socio-demographic characteristics influencing the utilisation of MBIs, and the reduction of psychological symptoms remains limited. Existing literature [47,77,78] lacks adequate evidence to evaluate the relationship with age, gender, and education. In a recent study investigating the perceived usability of the NEVERMIND system among breast and prostate cancer patients, Petros et al. [79] highlighted the potential influence of gender differences on the use and efficacy of eHealth interventions. Notably, their findings suggested that, despite sociodemographic variations, a digital divide did not significantly impact the usability of the NEVERMIND system. The study found that women exhibited higher favourability towards this eHealth intervention, while men demonstrated an increased usage of it. Comparable results were identified in studies beyond the cancer context; for instance, Olano and colleagues [80] explored the impact of sociodemographic factors on mindfulness practices, discovering that higher education correlated with increased engagement, while men were half as likely as women to participate.

Regarding the relationship between pre-intervention dispositional mindfulness and dispositional self-compassion levels and participants' engagement with the mindfulness module, surprisingly, we found that these two dimensions did not impact the use of MBI practices, influencing neither the amount nor variety of practices but solely contributing to the reduction of symptoms. This suggests that dispositional mindfulness and self-compassion could make individuals more receptive to even a lower dose of treatment, serving as protective and facilitating factors that amplify intervention effects. Conversely, low dispositional mindfulness may act as a barrier, diminishing intervention impact. This hypothesis finds partial support in the outcomes pertaining to the fourth aim of this study. The exploration of the correlation between pre-intervention levels of dispositional mindfulness and

dispositional self-compassion with their respective impacts on symptom reduction yielded interesting findings. Specifically, the results indicated a positive association, whereby higher dispositional mindfulness correlated with more pronounced reductions in symptoms of depression, anxiety, and stress, while increased dispositional self-compassion enhanced stress reduction. Despite limited literature on the moderating role of dispositional mindfulness in psychological intervention efficacy, these results align with prior research. Elevated dispositional mindfulness was found to have a buffering effect on anxiety, depression, and stress symptoms [81]. Similarly, a longitudinal study demonstrated that dispositional self-compassion benefited cancer patients, leading to reduced symptoms of depression, anxiety, and fatigue over time [82]. Both dispositional mindfulness and dispositional self-compassion appeared advantageous for psychological well-being, inversely related to depressive symptoms and negative affect [83]. In a recent systematic review, Tomlinson and colleagues [84] highlighted an inverse relationship between dispositional mindfulness and pain catastrophizing in the non-clinical population, suggesting dispositional mindfulness's potential to enhance individuals' resilience and act as a buffer against the development of negative thought patterns predictive of psychological distress.

Limitations and strengths of the study

This study has some limitations. Firstly, it primarily focused on self-help mindfulness interventions, potentially limiting the generalizability of our findings to practitioner-delivered mindfulness programs. Additionally, while app logs provided precise data on the quantity and type of mindfulness practice, the absence of data on individual mindfulness practices hindered our ability to assess the relative impact of different practices on symptom modification. We relied predominantly on demographic data to analyse factors facilitating or obstructing intervention effectiveness, without access to other psychological variables that could enhance our understanding of this aspect. Furthermore, our study exclusively examined two specific cancer types, which may restrict the applicability of our results to a broader range of cancer diagnoses. On the other hand, to the best of our knowledge, this is the first study to benefit from objective data, obtained from app logs, regarding the quantity and type of

mindfulness practice, as opposed to relying solely on patient self-reports as is common in most studies. This approach increased the accuracy and reliability of our findings in this specific aspect of the research.

Research and clinical implication

This study's clinical and scientific implications underscore the need for expanded research within the clinical population, particularly regarding e-MBIs for cancer patients. The findings provide a foundation for structuring e-MBIs in clinical contexts to optimize outcomes with a favourable cost/benefit ratio, emphasizing the importance of tailoring interventions based on individual preferences. Further exploration of mindfulness practices' impact on psychological symptoms across various clinical populations is needed, promoting a more comprehensive understanding of their potential benefits. The data-driven insights from app logs open avenues for future research to delve deeper into refining interventions, leveraging technology, and gathering more diverse and detailed data to enhance the overall effectiveness of e-MBI in clinical settings.

5. Conclusions

In conclusion, we found that greater practice amount of e-MBIs was associated with notable reductions in anxiety, depression, and stress symptoms, aligning with previous literature on the positive effects of MBIs. Additionally, the variety of mindfulness practices, rather than their amount, exhibited a significant impact on symptom reduction, underscoring the multifaceted nature of mindfulness. Dispositional mindfulness and self-compassion emerged as influential factors in shaping the effectiveness of these interventions, further highlighting their potential role as facilitators and protectors against psychological distress. Despite the limitations, our study introduces a unique perspective by utilizing objective data from app logs to better understand the impact of e-MBIs on cancer patients' psychological well-being. Our findings emphasize the importance of mindfulness in addressing the psychological challenges faced by cancer patients and offer insights into the factors that can enhance or

hinder intervention effectiveness. This research contributes to the broader understanding of the role of e-MBI in cancer care and provides a foundation for future studies in this field.

6. Acknowledgments

The authors would like to thank all researchers and affiliated staff who participated in the implementation of the NEVERMIND project.

7. Conflict of interest

Authors declare that they have no competing interests.

8. Abbreviations

BDI-II - Beck Depression Inventory II

DASS-21 - Depression Anxiety and Stress Scale

DM - Dispositional Mindfulness

DSC - Dispositional Self-Compassion

e-MBIs - Internet-based Mindfulness-Based Interventions

MAAS - Mindful Attention Awareness Scale

RCT - Randomized Controlled Trial

SCS-SF - Self-Compassion Scale - Short Form

TP - Time×Practice (indicator variable used in the study)

Preprint
JMIR Publications

9. References

1. Walker, J.; Holm Hansen, C.; Martin, P.; Sawhney, A.; Thekkumpurath, P.; Beale, C.; Symeonides, S.; Wall, L.; Murray, G.; Sharpe, M. Prevalence of Depression in Adults with Cancer: A Systematic Review. *Annals of Oncology* **2013**, *24*, 895–900, doi:10.1093/annonc/mds575.
2. Javan Biparva, A.; Raooft, S.; Rafiei, S.; Pashazadeh Kan, F.; Kazerooni, M.; Bagheribayati, F.; Masoumi, M.; Doustmehraban, M.; Sanaei, M.; Zarabi, F.; et al. Global Quality of Life in Breast Cancer: Systematic Review and Meta-Analysis. *BMJ Support Palliat Care* **2022**, *13*, E528–E536.
3. Østergaard, L.D.; Poulsen, M.H.; Jensen, M.E.; Lund, L.; Hildebrandt, M.G.; Nørgaard, B. Health-Related Quality of Life the First Year after a Prostate Cancer Diagnosis a Systematic Review. *International Journal of Urological Nursing* **2023**, *17*, 15–28, doi:10.1111/IJUN.12340.
4. Arrieta, Ó.; Angulo, L.P.; Núñez-Valencia, C.; Dorantes-Gallareta, Y.; Macedo, E.O.; Martínez-López, D.; Alvarado, S.; Corona-Cruz, J.-F.; Oñate-Ocaña, L.F. Association of Depression and Anxiety on Quality of Life, Treatment Adherence, and Prognosis in Patients with Advanced Non-Small Cell Lung Cancer. *Ann Surg Oncol* **2013**, *20*, 1941–1948, doi:10.1245/s10434-012-2793-5.
5. Niedzwiedz, C.L.; Knifton, L.; Robb, K.A.; Katikireddi, S.V.; Smith, D.J. Depression and Anxiety among People Living with and beyond Cancer: A Growing Clinical and Research Priority. *BMC Cancer* **2019**, *19*, 943, doi:10.1186/s12885-019-6181-4.
6. Wang, X.; Cheng, Z. Cross-Sectional Studies. *Chest* **2020**, *158*, S65–S71, doi:10.1016/j.chest.2020.03.012.
7. Faller, H.; Schuler, M.; Richard, M.; Heckl, U.; Weis, J.; Küffner, R. Effects of Psycho-Oncologic Interventions on Emotional Distress and Quality of Life in Adult Patients With Cancer: Systematic Review and Meta-Analysis. *Journal of Clinical Oncology* **2013**, *31*, 782–793, doi:10.1200/JCO.2011.40.8922.
8. Zebrack, B.; Kayser, K.; Padgett, L.; Jobin, C.; Sundstrom, L. Assessing Institutional Capacity to Implement Psychosocial Support Services: The National Cancer Institute Psychosocial Care Matrix. In Proceedings of the Psycho-Oncology; WILEY-BLACKWELL 111 RIVER ST, HOBOKEN 07030-5774, NJ USA, 2015; Vol. 24, pp. 53–54.
9. Chayadi, E.; Baes, N.; Kiropoulos, L. The Effects of Mindfulness-Based Interventions on Symptoms of Depression, Anxiety, and Cancer-Related Fatigue in Oncology Patients: A Systematic Review and Meta-Analysis. *PLoS One* **2022**, *17*, e0269519, doi:10.1371/JOURNAL.PONE.0269519.
10. Marinovic, D.A.; Hunter, R.L. Examining the Interrelationships between Mindfulness-Based Interventions, Depression, Inflammation, and Cancer Survival. *CA Cancer J Clin* **2022**, *72*, 490–502, doi:10.3322/CAAC.21733.
11. Wu, H.; Li, F.; Zhang, F. The Efficacy of Mindfulness-Based Stress Reduction vs. Standard or Usual Care in Patients with Breast Cancer: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Transl Cancer Res* **2022**, *11*, 4148–4158, doi:10.21037/TCR-22-2530/COIF.
12. Zhang, M.F.; Wen, Y.S.; Liu, W.Y.; Peng, L.F.; Wu, X.D.; Liu, Q.W. Effectiveness of Mindfulness-Based Therapy for Reducing Anxiety and Depression in Patients With Cancer: A Meta-Analysis. *Medicine* **2015**, *94*, e897, doi:10.1097/MD.0000000000000897.
13. Haller, H.; Winkler, M.M.; Klose, P.; Dobos, G.; Kümmel, S.; Cramer, H. Mindfulness-Based Interventions for Women with Breast Cancer: An Updated Systematic Review and Meta-Analysis. *Acta Oncol (Madr)* **2017**, *56*, 1665–1676, doi:10.1080/0284186X.2017.1342862.
14. Xunlin, N.; Lau, Y.; Klainin-Yobas, P. The Effectiveness of Mindfulness-Based Interventions among Cancer Patients and Survivors: A Systematic Review and Meta-Analysis. *Supportive Care in Cancer* **2020**, *28*, 1563–1578, doi:10.1007/S00520-019-05219-9/TABLES/6.
15. European Commission Cancer Cases and Deaths on the Rise in the EU - European Commission Available online: <https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/cancer-cases-and->

deaths-rise-eu-2023-10-02_en (accessed on 4 June 2024).

16. Leyland, A.; Rowse, G.; Emerson, L.-M. Experimental Effects of Mindfulness Inductions on Self-Regulation: Systematic Review and Meta-Analysis. *Emotion* **2019**, *19*, 108–122, doi:10.1037/emo0000425.
17. Schumer, M.C.; Lindsay, E.K.; Creswell, J.D. Brief Mindfulness Training for Negative Affectivity: A Systematic Review and Meta-Analysis. *J Consult Clin Psychol* **2018**, *86*, 569–583, doi:10.1037/ccp0000324.
18. Spijkerman, M.P.J.; Pots, W.T.M.; Bohlmeijer, E.T. Effectiveness of Online Mindfulness-Based Interventions in Improving Mental Health: A Review and Meta-Analysis of Randomised Controlled Trials. *Clin Psychol Rev* **2016**, *45*, 102–114, doi:10.1016/j.cpr.2016.03.009.
19. Blanck, P.; Perleth, S.; Heidenreich, T.; Kröger, P.; Ditzen, B.; Bents, H.; Mander, J. Effects of Mindfulness Exercises as Stand-Alone Intervention on Symptoms of Anxiety and Depression: Systematic Review and Meta-Analysis. *Behaviour Research and Therapy* **2018**, *102*, 25–35, doi:10.1016/j.brat.2017.12.002.
20. Beblo, T.; Schulte, J. Mindfulness: More Practice–Better Results. *Neurology and Rehabilitation* **2017**, *23*, 19–26.
21. Crane, C.; Crane, R.S.; Eames, C.; Fennell, M.J.V.; Silverton, S.; Williams, J.M.G.; Barnhofer, T. The Effects of Amount of Home Meditation Practice in Mindfulness Based Cognitive Therapy on Hazard of Relapse to Depression in the Staying Well after Depression Trial. *Behaviour Research and Therapy* **2014**, *63*, 17–24, doi:10.1016/j.brat.2014.08.015.
22. Parsons, C.E.; Crane, C.; Parsons, L.J.; Fjorback, L.O.; Kuyken, W. Home Practice in Mindfulness-Based Cognitive Therapy and Mindfulness-Based Stress Reduction: A Systematic Review and Meta-Analysis of Participants’ Mindfulness Practice and Its Association with Outcomes. *Behaviour Research and Therapy* **2017**, *95*, 29–41, doi:10.1016/j.brat.2017.05.004.
23. Strohmaier, S. The Relationship Between Doses of Mindfulness-Based Programs and Depression, Anxiety, Stress, and Mindfulness: A Dose-Response Meta-Regression of Randomized Controlled Trials. *Mindfulness (N Y)* **2020**, *11*, 1315–1335, doi:10.1007/S12671-020-01319-4/TABLES/4.
24. Nissen, E.R.; Zachariae, R.; O’Connor, M.; Kaldo, V.; Jørgensen, C.R.; Højris, I.; Borre, M.; Mehlsen, M. Internet-Delivered Mindfulness-Based Cognitive Therapy for Anxiety and Depression in Cancer Survivors: Predictors of Treatment Response. *Internet Interv* **2021**, *23*, doi:10.1016/J.INVENT.2021.100365.
25. Cillessen, L.; van de Ven, M.O.; Compen, F.R.; Bisseling, E.M.; van der Lee, M.L.; Speckens, A.E.M. Predictors and Effects of Usage of an Online Mindfulness Intervention for Distressed Cancer Patients: Usability Study. *J Med Internet Res* **2020**, *22*, e17526, doi:10.2196/17526.
26. Tamura, N.; Park, S.; Sato, Y.; Sato, Y.; Takita, Y.; Ninomiya, A.; Sado, M.; Mimura, M.; Fujisawa, D. Predictors and Moderators of Outcomes in Mindfulness-Based Cognitive Therapy Intervention for Early Breast Cancer Patients. *Palliat Support Care* **2022**, *20*, 159–166, doi:10.1017/S147895152100078X.
27. Costa, J.; Pinto-Gouveia, J. Acceptance of Pain, Self-compassion and Psychopathology: Using the Chronic Pain Acceptance Questionnaire to Identify Patients’ Subgroups. *Clin Psychol Psychother* **2011**, *18*, 292–302, doi:10.1002/cpp.718.
28. Van Dam, N.T.; Sheppard, S.C.; Forsyth, J.P.; Earleywine, M. Self-Compassion Is a Better Predictor than Mindfulness of Symptom Severity and Quality of Life in Mixed Anxiety and Depression. *J Anxiety Disord* **2011**, *25*, 123–130, doi:10.1016/j.janxdis.2010.08.011.
29. Körner, A.; Coroiu, A.; Copeland, L.; Gomez-Garibello, C.; Albani, C.; Zenger, M.; Brähler, E. The Role of Self-Compassion in Buffering Symptoms of Depression in the General Population. *PLoS One* **2015**, *10*, e0136598, doi:10.1371/journal.pone.0136598.
30. Roemer, L.; Lee, J.K.; Salters-Pedneault, K.; Erisman, S.M.; Orsillo, S.M.; Mennin, D.S. Mindfulness and Emotion Regulation Difficulties in Generalized Anxiety Disorder: Preliminary Evidence for Independent and Overlapping Contributions. *Behav Ther* **2009**, *40*, 142–154,

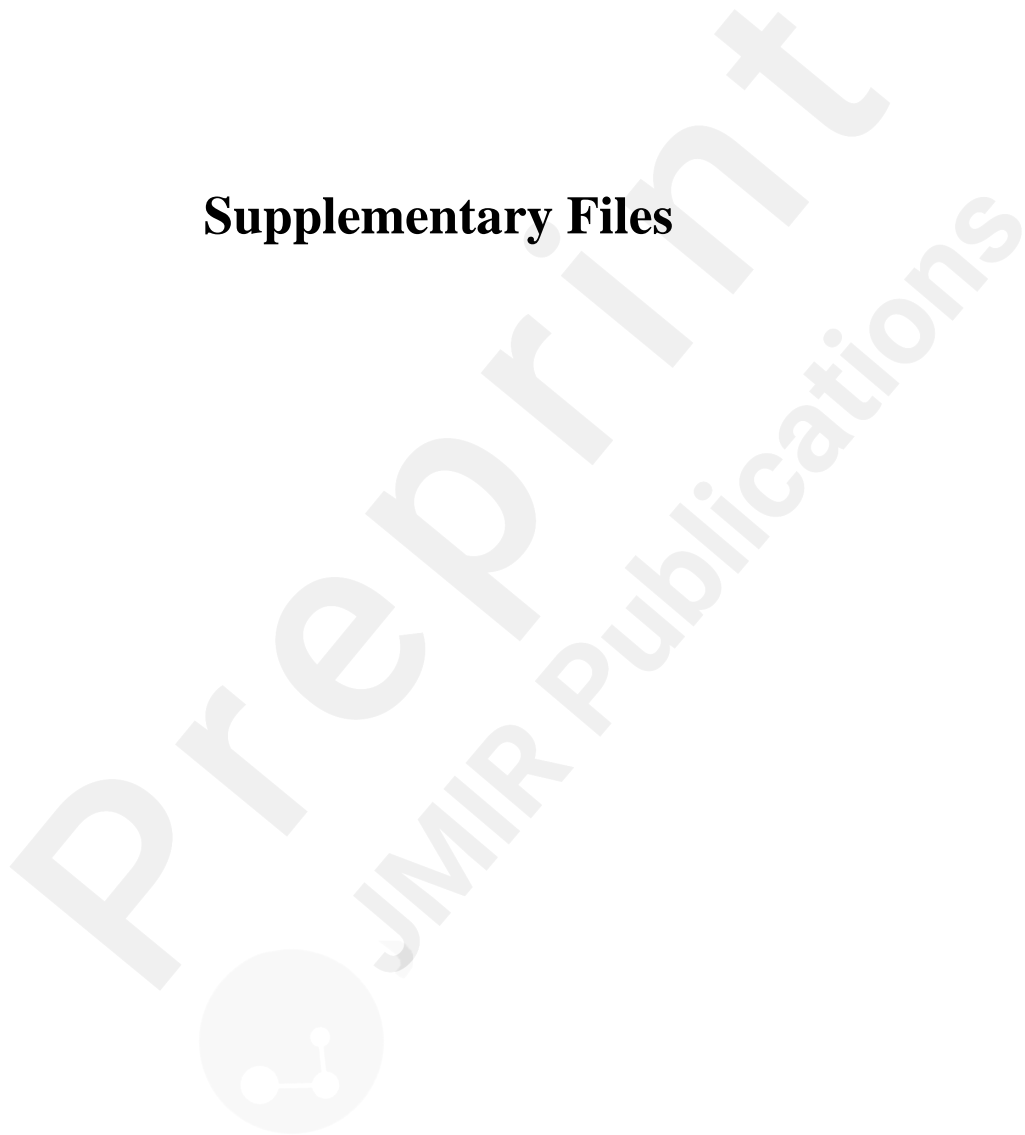
- doi:10.1016/j.beth.2008.04.001.
31. Gilbert, P.; McEwan, K.; Matos, M.; Rivas, A. Fears of Compassion: Development of Three Self-report Measures. *Psychology and Psychotherapy: Theory, Research and Practice* **2011**, *84*, 239–255, doi:10.1348/147608310X526511.
 32. Cavanagh, K.; Churchar, A.; O’Hanlon, P.; Mundy, T.; Votolato, P.; Jones, F.; Gu, J.; Strauss, C. A Randomised Controlled Trial of a Brief Online Mindfulness-Based Intervention in a Non-Clinical Population: Replication and Extension. *Mindfulness (N Y)* **2018**, *9*, 1191–1205, doi:10.1007/S12671-017-0856-1.
 33. Fish, J.; Brimson, J.; Lynch, S. Mindfulness Interventions Delivered by Technology Without Facilitator Involvement: What Research Exists and What Are the Clinical Outcomes? *Mindfulness (N Y)* **2016**, *7*, 1011–1023, doi:10.1007/S12671-016-0548-2/TABLES/2.
 34. Krusche, A.; Cyhlarova, E.; Williams, J.M.G. Mindfulness Online: An Evaluation of the Feasibility of a Web-Based Mindfulness Course for Stress, Anxiety and Depression. *BMJ Open* **2013**, *3*, e003498, doi:10.1136/BMJOPEN-2013-003498.
 35. Kubo, A.; Altschuler, A.; Kurtovich, E.; Hendlish, S.; Laurent, C.A.; Kolevska, T.; Li, Y.; Avins, A. A Pilot Mobile-Based Mindfulness Intervention for Cancer Patients and Their Informal Caregivers. *Mindfulness (N Y)* **2018**, *9*, 1885–1894, doi:10.1007/s12671-018-0931-2.
 36. Lappalainen, P.; Langrial, S.; Oinas-Kukkonen, H.; Tolvanen, A.; Lappalainen, R. Web-Based Acceptance and Commitment Therapy for Depressive Symptoms with Minimal Support: A Randomized Controlled Trial. *Behav Modif* **2015**, *39*, 805–834, doi:10.1177/0145445515598142.
 37. Querstret, D.; Copley, M.; Fife-Schaw, C. The Effects of an Online Mindfulness Intervention on Perceived Stress, Depression and Anxiety in a Non-Clinical Sample: A Randomised Waitlist Control Trial. *Mindfulness (N Y)* **2018**, *9*, 1825–1836, doi:10.1007/S12671-018-0925-0.
 38. Toivonen, K.I.; Zernicke, K.; Carlson, L.E. Web-Based Mindfulness Interventions for People With Physical Health Conditions: Systematic Review. *J Med Internet Res* **2017**; *19*(8):e303 <https://www.jmir.org/2017/8/e303> **2017**, *19*, e7487, doi:10.2196/JMIR.7487.
 39. Hughes, S.; Kassianos, A.P.; Everitt, H.A.; Stuart, B.; Band, R. Planning and Developing a Web-Based Intervention for Active Surveillance in Prostate Cancer: An Integrated Self-Care Programme for Managing Psychological Distress. *Pilot Feasibility Stud* **2022**, *8*, 1–18, doi:10.1186/S40814-022-01124-X/FIGURES/3.
 40. Singleton, A.C.; Raeside, R.; Hyun, K.K.; Partridge, S.R.; Di Tanna, G.L.; Hafiz, N.; Tu, Q.; Tat-Ko, J.; Sum, S.C.M.; Sherman, K.A.; et al. Electronic Health Interventions for Patients With Breast Cancer: Systematic Review and Meta-Analyses. *Journal of Clinical Oncology* **2022**, *40*, 2257, doi:10.1200/JCO.21.01171.
 41. Gyawali, B.; Bowman, M.; Sharpe, I.; Jalink, M.; Srivastava, S.; Wijeratne, D.T. A Systematic Review of EHealth Technologies for Breast Cancer Supportive Care. *Cancer Treat Rev* **2023**, *114*, 102519, doi:10.1016/J.CTRV.2023.102519.
 42. Wang, L.; Chen, X.; Peng, Y.; Zhang, K.; Ma, J.; Xu, L.; Liu, Z.; Liu, L.; Luo, Y.; Gu, C. Effect of a 4-Week Internet-Delivered Mindfulness-Based Cancer Recovery Intervention on the Symptom Burden and Quality of Life of Patients With Breast Cancer: Randomized Controlled Trial. *J Med Internet Res* **2022**, *24*, e40059, doi:10.2196/40059.
 43. Bäuerle, A.; Martus, P.; Erim, Y.; Schug, C.; Heinen, J.; Krakowczyk, J.B.; Steinbach, J.; Damerau, M.; Bethge, W.; Dinkel, A.; et al. Web-Based Mindfulness and Skills-Based Distress Reduction for Patients with Cancer: Study Protocol of the Multicentre, Randomised, Controlled Confirmatory Intervention Trial Reduct. *BMJ Open* **2022**, *12*, e056973, doi:10.1136/bmjopen-2021-056973.
 44. Fung, J.Y.T.; Lim, H.; Vongsirimas, N.; Klainin-Yobas, P. Effectiveness of EHealth Mindfulness-Based Interventions on Cancer-Related Symptoms among Cancer Patients and Survivors: A Systematic Review and Meta-Analysis. *J Telemed Telecare* **2022**, 1357633X2210784, doi:10.1177/1357633X221078490.
 45. Nissen, E.R.; O’Connor, M.; Kaldo, V.; Højris, I.; Borre, M.; Zachariae, R.; Mehlsen, M. Internet-

- Delivered Mindfulness-Based Cognitive Therapy for Anxiety and Depression in Cancer Survivors: A Randomized Controlled Trial. *Psychooncology* **2020**, *29*, 68–75, doi:10.1002/PON.5237.
46. Andersson, G.; Cuijpers, P. Internet-Based and Other Computerized Psychological Treatments for Adult Depression: A Meta-Analysis. *Cogn Behav Ther* **2009**, *38*, 196–205, doi:10.1080/16506070903318960.
 47. Cillessen, L.; Johannsen, M.; Speckens, A.E.M.; Zachariae, R. Mindfulness-Based Interventions for Psychological and Physical Health Outcomes in Cancer Patients and Survivors: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Psychooncology* **2019**, *28*, 2257–2269, doi:10.1002/PON.5214.
 48. Matis, J.; Svetlak, M.; Slezackova, A.; Svoboda, M.; Šumec, R. Mindfulness-Based Programs for Patients With Cancer via EHealth and Mobile Health: Systematic Review and Synthesis of Quantitative Research. *J Med Internet Res* **2020**; *22(11)*:e20709 <https://www.jmir.org/2020/11/e20709> **2020**, *22*, e20709, doi:10.2196/20709.
 49. Piet, J.; Würtzen, H.; Zachariae, R. The Effect of Mindfulness-Based Therapy on Symptoms of Anxiety and Depression in Adult Cancer Patients and Survivors: A Systematic Review and Meta-Analysis. *J Consult Clin Psychol* **2012**, *80*, 1007–1020, doi:10.1037/A0028329.
 50. Compen, F.; Bisseling, E.; Schellekens, M.; Donders, R.; Carlson, L.; van der Lee, M.; Speckens, A. Face-to-Face and Internet-Based Mindfulness-Based Cognitive Therapy Compared With Treatment as Usual in Reducing Psychological Distress in Patients With Cancer: A Multicenter Randomized Controlled Trial. *J Clin Oncol* **2018**, *36*, 2413–2421, doi:10.1200/JCO.2017.76.5669.
 51. Carli, V.; Wasserman, D.; Hadlaczky, G.; Petros, N.G.; Carletto, S.; Citi, L.; Dinis, S.; Gentili, C.; Gonzalez-Martinez, S.; Aldo De Leonibus; et al. A Protocol for a Multicentre, Parallel-Group, Pragmatic Randomised Controlled Trial to Evaluate the NEVERMIND System in Preventing and Treating Depression in Patients with Severe Somatic Conditions. *BMC Psychiatry* **2020**, *20*, doi:10.1186/S12888-020-02494-3.
 52. Carli, V.; Petros, N.G.; Hadlaczky, G.; Vitcheva, T.; Berchiolla, P.; Bianchi, S.; Carletto, S.; Christinaki, E.; Citi, L.; Dinis, S.; et al. The NEVERMIND E-Health System in the Treatment of Depressive Symptoms among Patients with Severe Somatic Conditions: A Multicentre, Pragmatic Randomised Controlled Trial. *EClinicalMedicine* **2022**, *48*, doi:10.1016/J.ECLINM.2022.101423.
 53. Beck, A.; Steer, R. Manual for the Beck Depression Inventory. *Psychological Corporation* **1992**.
 54. Lovibond, P.F.; Lovibond, S.H. The Structure of Negative Emotional States: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy* **1995**, *33*, 335–343, doi:10.1016/0005-7967(94)00075-U.
 55. Brown, K.W.; Ryan, R.M. The Benefits of Being Present: Mindfulness and Its Role in Psychological Well-Being. *J Pers Soc Psychol* **2003**, *84*, 822–848, doi:10.1037/0022-3514.84.4.822.
 56. Raes, F.; Pommier, E.; Neff, K.D.; Van Gucht, D. Construction and Factorial Validation of a Short Form of the Self-Compassion Scale. *Clin Psychol Psychother* **2011**, *18*, 250–255, doi:10.1002/cpp.702.
 57. Kabat-Zinn, J. Full Catastrophe Living: Using the Wisdom Books of Your Body and Mind to Face Stress, Pain, and Illness. . *Delta Books* **1990**.
 58. Lutz, A.; Slagter, H.A.; Dunne, J.D.; Davidson, R.J. Attention Regulation and Monitoring in Meditation. *Trends Cogn Sci* **2008**, *12*, 163, doi:10.1016/J.TICS.2008.01.005.
 59. Gilbert, P. *Compassion Focused Therapy: Distinctive Features*; Routledge, 2010; ISBN 9780415448079.
 60. NEFF, K. Self-Compassion: An Alternative Conceptualization of a Healthy Attitude Toward Oneself. *Self and Identity* **2003**, *2*, 85–101, doi:10.1080/15298860309032.
 61. Rinpoche, S. *Il Libro Tibetano Del Vivere e Del Morire.*; Ubaldini Editore: Roma, 2015;
 62. Hofmann, S.G.; Grossman, P.; Hinton, D.E. Loving-Kindness and Compassion Meditation: Potential for Psychological Interventions. *Clin Psychol Rev* **2011**, *31*, 1126–1132, doi:10.1016/j.cpr.2011.07.003.

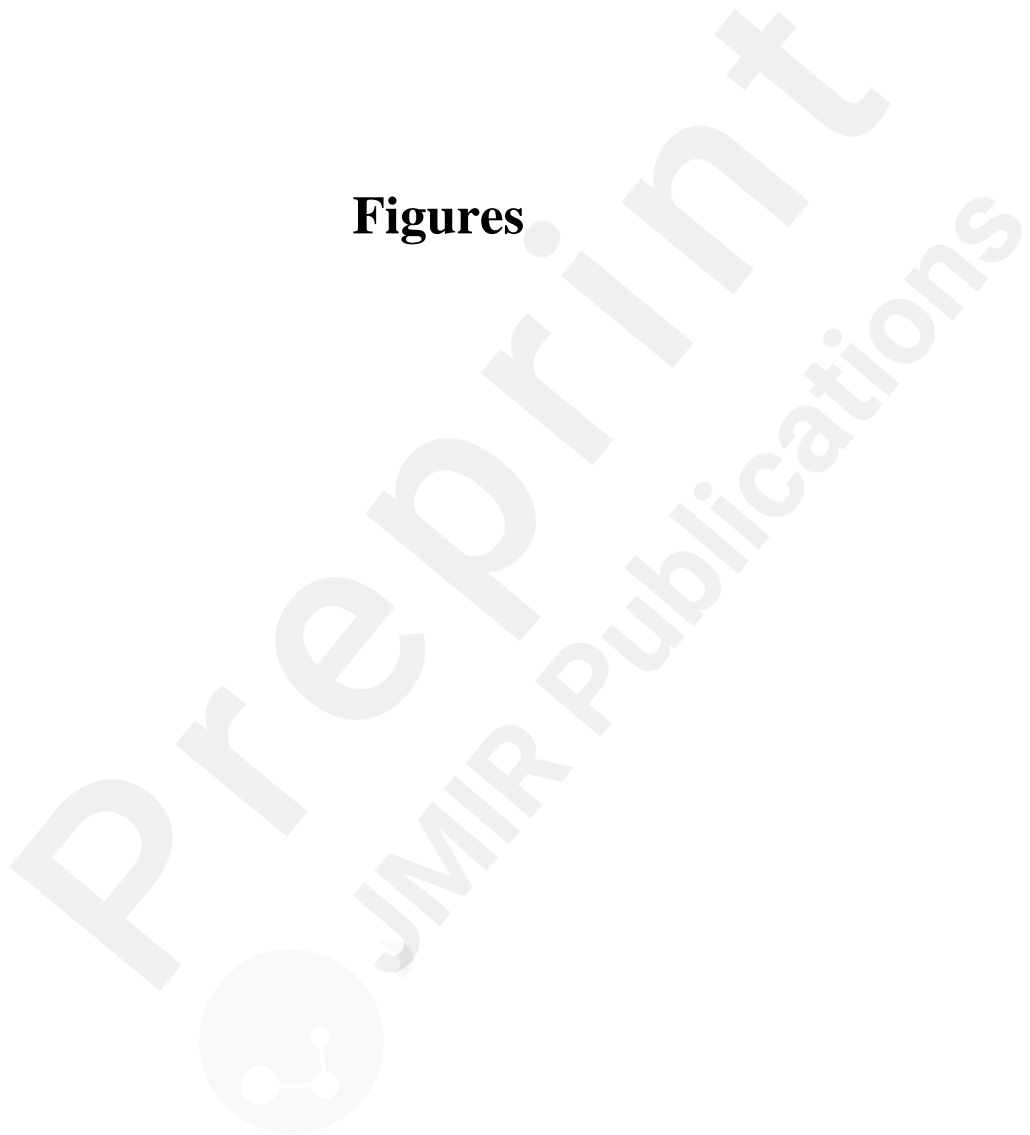
63. Kraus, S.; Sears, S. Measuring the Immeasurables: Development and Initial Validation of the Self-Other Four Immeasurables (SOFI) Scale Based on Buddhist Teachings on Loving Kindness, Compassion, Joy, and Equanimity. *Soc Indic Res* **2009**, *92*, 169–181, doi:10.1007/S11205-008-9300-1.
64. Royzman, E.B.; Rozin, P. Limits of Symhedonia: The Differential Role of Prior Emotional Attachment in Sympathy and Sympathetic Joy. *Emotion* **2006**, *6*, 82–93, doi:10.1037/1528-3542.6.1.82.
65. Keng, S.-L.; Chin, J.W.E.; Mammadova, M.; Teo, I. Effects of Mobile App-Based Mindfulness Practice on Healthcare Workers: A Randomized Active Controlled Trial. *Mindfulness (N Y)* **2022**, *13*, 2691–2704, doi:10.1007/s12671-022-01975-8.
66. Kang, S.S.; Sponheim, S.R.; Lim, K.O. Interoception Underlies Therapeutic Effects of Mindfulness Meditation for Posttraumatic Stress Disorder: A Randomized Clinical Trial. *Biol Psychiatry Cogn Neurosci Neuroimaging* **2021**, doi:10.1016/J.BPSC.2021.10.005.
67. Strohmaier, S.; Jones, F.W.; Cane, J.E. Effects of Length of Mindfulness Practice on Mindfulness, Depression, Anxiety, and Stress: A Randomized Controlled Experiment. *Mindfulness (N Y)* **2021**, *12*, 198–214, doi:10.1007/S12671-020-01512-5/FIGURES/7.
68. Bolognino, S.J.; Renshaw, T.L.; Phan, M.L. Differential Effects of Mindful Breathing and Loving Kindness Meditations: A Component Analysis Study. *Advances in Mental Health* **2023**, *21*, 129–149, doi:10.1080/18387357.2023.2166855.
69. Feruglio, S.; Matiz, A.; Grecucci, A.; Pascut, S.; Fabbro, F.; Crescentini, C. Differential Effects of Mindfulness Meditation Conditions on Repetitive Negative Thinking and Subjective Time Perspective: A Randomized Active-Controlled Study. *Psychol Health* **2021**, *36*, 1275–1298, doi:10.1080/08870446.2020.1836178.
70. Ooishi, Y.; Fujino, M.; Inoue, V.; Nomura, M.; Kitagawa, N. Differential Effects of Focused Attention and Open Monitoring Meditation on Autonomic Cardiac Modulation and Cortisol Secretion. *Front Physiol* **2021**, *12*, doi:10.3389/fphys.2021.675899.
71. Kok, B.E.; Singer, T. Phenomenological Fingerprints of Four Meditations: Differential State Changes in Affect, Mind-Wandering, Meta-Cognition, and Interoception Before and After Daily Practice Across 9 Months of Training. *Mindfulness (N Y)* **2017**, *8*, 218–231, doi:10.1007/s12671-016-0594-9.
72. Singer, T.; Kok, B.E.; Bornemann, B.; Bolz, M.; Bochow, C. The ReSource Project: Background, Design, Samples, and Measurements. **2015**.
73. Singer, T.; Engert, V. It Matters What You Practice: Differential Training Effects on Subjective Experience, Behavior, Brain and Body in the ReSource Project. *Curr Opin Psychol* **2019**, *28*, 151–158, doi:10.1016/j.copsyc.2018.12.005.
74. Carmody, J.; Baer, R.A. Relationships between Mindfulness Practice and Levels of Mindfulness, Medical and Psychological Symptoms and Well-Being in a Mindfulness-Based Stress Reduction Program. *J Behav Med* **2008**, *31*, 23–33, doi:10.1007/S10865-007-9130-7.
75. Sauer-Zavala, S.E.; Walsh, E.C.; Eisenlohr-Moul, T.A.; Lykins, E.L.B. Comparing Mindfulness-Based Intervention Strategies: Differential Effects of Sitting Meditation, Body Scan, and Mindful Yoga. *Mindfulness (N Y)* **2013**, *4*, 383–388, doi:10.1007/S12671-012-0139-9/TABLES/1.
76. Zeng, X.; Chan, V.Y.L.; Liu, X.; Oei, T.P.S.; Leung, F.Y.K. The Four Immeasurables Meditations: Differential Effects of Appreciative Joy and Compassion Meditations on Emotions. *Mindfulness (N Y)* **2017**, *8*, 949–959, doi:10.1007/s12671-016-0671-0.
77. Baydoun, M.; Moran, C.; McLennan, A.; Piedalue, K.A.L.; Oberoi, D.; Carlson, L.E. Mindfulness-Based Interventions in Cancer Survivors: A Systematic Review of Participants' Adherence to Home Practice. *Patient Prefer Adherence* **2021**, *15*, 1225–1242, doi:10.2147/PPA.S267064.
78. Forbes, L.; Gutierrez, D.; Johnson, S.K. Investigating Adherence to an Online Introductory Mindfulness Program. *Mindfulness (N Y)* **2018**, *9*, 271–282, doi:10.1007/S12671-017-0772-4/FIGURES/2.
79. Petros, N.G.; Hadlaczky, G.; Carletto, S.; Martinez, S.G.; Ostacoli, L.; Ottaviano, M.; Meyer, B.;

- Scilingo, E.P.; Carli, V. Sociodemographic Characteristics Associated With an EHealth System Designed to Reduce Depressive Symptoms Among Patients With Breast or Prostate Cancer: Prospective Study. *JMIR Form Res* 2022;6(6):e33734 <https://formative.jmir.org/2022/6/e33734> 2022, 6, e33734, doi:10.2196/33734.
80. Olano, H.A.; Kachan, D.; Tannenbaum, S.L.; Mehta, A.; Annane, D.; Lee, D.J. Engagement in Mindfulness Practices by U.S. Adults: Sociodemographic Barriers. <https://home.liebertpub.com/acm> 2015, 21, 100–102, doi:10.1089/ACM.2014.0269.
81. Beshai, S.; Salimuddin, S.; Refaie, N.; Maierhoffer, J. Dispositional Mindfulness and Self-Compassion Buffer the Effects of COVID-19 Stress on Depression and Anxiety Symptoms. *Mindfulness (N Y)* 2022, 13, 3028–3042, doi:10.1007/s12671-022-02008-0.
82. Zhu, L.; Yao, J.; Wang, J.; Wu, L.; Gao, Y.; Xie, J.; Liu, A.; Ranchor, A. V.; Schroevers, M.J. The Predictive Role of Self-Compassion in Cancer Patients' Symptoms of Depression, Anxiety, and Fatigue: A Longitudinal Study. *Psychooncology* 2019, 28, 1918–1925, doi:10.1002/PON.5174.
83. van der Donk, L.J.; Fler, J.; Tovote, A.; Ranchor, A. V.; Smink, A.; Mul, V.E.M.; Sanderman, R.; Schroevers, M.J. The Role of Mindfulness and Self-Compassion in Depressive Symptoms and Affect: A Comparison between Cancer Patients and Healthy Controls. *Mindfulness (N Y)* 2020, 11, 883–894, doi:10.1007/S12671-019-01298-1/TABLES/5.
84. Tomlinson, E.R.; Yousaf, O.; Vittersø, A.D.; Jones, L. Dispositional Mindfulness and Psychological Health: A Systematic Review. *Mindfulness (N Y)* 2018, 9, 23–43, doi:10.1007/s12671-017-0762-6.

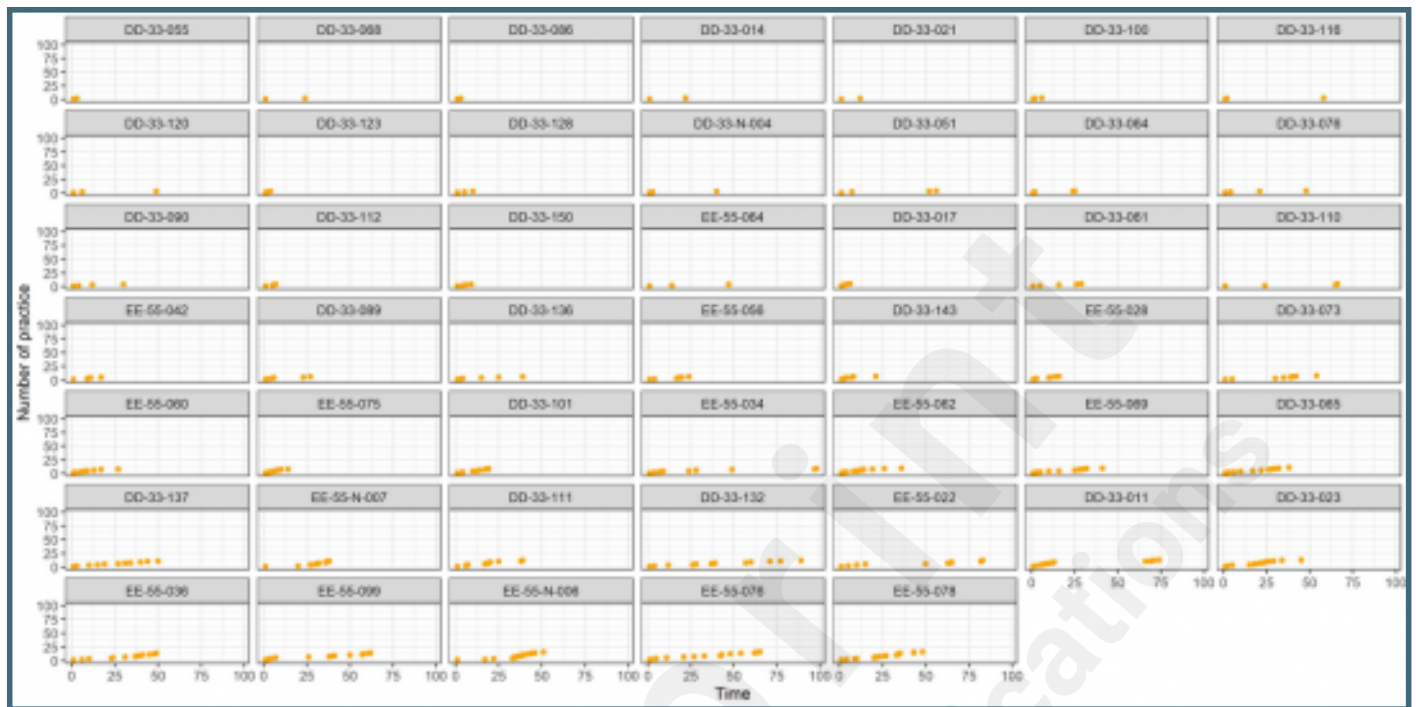
Supplementary Files



Figures



The practice trajectories of each patient are reported. The horizontal axis shows the number of days of practice, the vertical axis shows instead the cumulative number of practices. Orange trajectories correspond to TP=0 group's patients.



The practice trajectories of each patient are reported. The horizontal axis shows the number of days of practice, the vertical axis shows instead the cumulative number of practices. Blue trajectories correspond to TP=1 group's patients.

