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Update to the preregistration on clinicaltrials.gov (23/12/2024)

The study was preregistered on clinicaltrials.gov before creation of the data. We realized that the preregistration on clinicaltrials.gov does not ask investigators to specify the planned statistical analyses in detail. Up until now, we only uploaded the study protocol approved by the ethical committee before the start of data collection that describes the planned statistical analyses but lacks sufficient detail.

Before conducting any (intermediate) analyses of the qualitative data of this study, we decided to provide a detailed statistical analysis plan in an update to the preregistration. This update will prevent that insights gained during the analysis of the qualitative data will influence the data analysis and the results of the quantitative data of this study.

We used the template from the Open Science Framework for this update of the preregistration to ensure that we provide all the necessary information. The parts in black text are copied from the original preregistration on clinicaltrials.gov or the study protocol uploaded to clinicaltrials.gov, and are thus not changed compared to the original preregistration. The parts marked in yellow are additional information that we added to our preregistration to reduce bias in the statistical analysis resulting from the intermediate qualitative data analysis.

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Metadata

Title*

Who fares best with mindfulness meditation – understanding the individual effects of mindfulness

Description*

The overall aim of this observational study is to investigate how individual differences influence the effects of mindfulness meditation to uncover for whom mindfulness is beneficial and for whom it may be harmful. The first objective is to identify the mechanisms underlying the effects of mindfulness meditation on mental health. The second objective is to examine how three candidate factors, namely trauma symptoms, tendency to dissociate, and repetitive negative thinking, influence the effect of mindfulness meditation on mental health.

Adults who enrolled for a Mindfulness-Based Intervention (MBI) at the participating sites (n=120) will be invited to participate. Before the start of the MBI, after half of the sessions, at the end of the MBI and at 3-months follow-up, participants will complete self-report questionnaires. The main outcomes are symptoms of anxiety and depression, quality of life, wellbeing, and adverse effects resulting from the MBI. A subset of participants will be invited for a semi-structured interview after the end of the intervention.

Contributors*

Filip Raes, Merle Kock, Katleen Van der Gucht, Peter Kuppens

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Study Information

Hypotheses*

In a first step towards a better understanding of the effects of mindfulness mediation on each individual, the investigators aim to identify the mechanisms underlying the effects of mindfulness meditation on mental health and wellbeing (first objective). Based on prior research, the investigators hypothesise that mindfulness meditation exerts its effects via internal awareness, decentering, and non-judgment, but the investigators will also explore other mindfulness skills as potential mechanisms.

In a second step, the investigators aim to examine specific characteristics of individuals that may influence whether mindfulness meditation has beneficial or possibly harmful effects. Specifically, the investigators aim to examine how three candidate factors, namely trauma symptoms, tendency to dissociate, and repetitive negative thinking, influence the effect of mindfulness meditation on mental health and wellbeing (second objective).

Previous research suggests that mindfulness may less beneficial or even harmful for individuals with trauma symptoms compared to individuals without trauma symptoms (Valdez et al., 2016; Zhu et al., 2019). In contrast, prior studies indicate that mindfulness may be more beneficial for individuals with high repetitive negative thinking compared to those with low repetitive negative thinking (Prins et al., 2014). Finally, tendency to dissociate was identified as a promising candidate factor because of the shared neurobiological correlates of mindfulness and dissociation. Notably, it is hypothesised that the decentered state of mindfulness is accomplished by activating the specific functions of the inferior parietal lobule that are responsible for dissociation (Farb et al., 2007; Sierra, 2009). Thus, mindfulness practice may induce dissociative experiences in individuals with a tendency to dissociate, while conferring benefits for individuals without this tendency.

With this update to the preregistration, we want to clarify our hypotheses based on what we described in the preregistration on clinicaltrials.gov and in our study protocol (referenced above). This clarification is intended to ensure that the intermediate analysis of the qualitative data does not (introduce) bias (into) our statistical analysis of the quantitative data.

Our hypotheses for the quantitative data analysis are as follows:

Objective 1:

1. The mindfulness intervention will improve symptoms of depression and anxiety, quality of life, and wellbeing via internal awareness, decentering, and non-judgment.

Objective 2:

2. The mindfulness intervention will lead to a greater reduction in symptoms of depression and anxiety, a larger improvement in quality of life and wellbeing, and less frequent meditation-related adverse events for participants with lower levels of PTSD symptoms relative to those with higher levels of PTSD symptoms.
3. The mindfulness intervention will lead to a greater reduction in symptoms of depression and anxiety, a larger improvement in quality of life and wellbeing, and less frequent meditation-related adverse events for participants with higher levels of repetitive negative thinking (RNT) relative to those with lower levels of RNT.

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4. The mindfulness intervention will lead to a greater reduction in symptoms of depression and anxiety, a larger improvement in quality of life and wellbeing, and less frequent meditation-related adverse events for participants with lower dissociative tendencies relative to those with higher dissociative tendencies.

Design Plan

Study type*

- Observational Study - Data is collected from study subjects that are not randomly assigned to a treatment. This includes surveys, “natural experiments,” and regression discontinuity designs.

Blinding*

Blinding describes who is aware of the experimental manipulations within a study.

- No blinding is involved in this study.

Study design*

The study uses a single-arm longitudinal design. Participants who enrolled for a Mindfulness-Based Intervention (MBI) at one of the participating study sites will complete self-report assessments before the start, during, after the mindfulness intervention and at follow-up. A subset of participants will be invited for a semi-structured interview after the end of the intervention.

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Sampling Plan

Existing data*

- Registration prior to analysis of the data: As of the date of submission, the data exist and you have accessed it, though no analysis has been conducted related to the research plan (including calculation of summary statistics). A common situation for this scenario when a large dataset exists that is used for many different studies over time, or when a data set is randomly split into a sample for exploratory analyses, and the other section of data is reserved for later confirmatory data analysis.

Explanation of existing data

Up to this point, the data have been accessed by the investigators solely in the context of supervising two Master's theses. Specifically, MK accessed the recordings of the interviews to create AI transcripts in Dutch. MK accessed the Dutch transcripts to create AI translations of the transcripts from Dutch to English and to provide feedback on the translations of individual sentences that the Master's students were unsure about. MK ensured not to view the interview recordings in full or read the transcripts comprehensively.

Only the Master's students have (re)viewed the complete interview recordings and transcripts. They were tasked with improving the translated transcripts created by AI. An independent researcher was engaged to verify whether the translation of the interviews was of sufficient quality for analysing the English translations of the transcripts. Regarding the quantitative data, MK accessed the data files only to confirm participant completion of assessments and, when necessary, to send reminders to participants.

Data collection procedures*

Recruitment:

Potential candidates will be recruited through services that offer mindfulness-based interventions. Everyone who wishes to enrol for a mindfulness-based intervention at one of the participating sites will be informed about this study by staff working at the respective services. Those who express an interest to participate in the study will be checked for inclusion and exclusion criteria by the research team at KU Leuven and informed about all aspects of the study before providing written consent to participate. Notably, staff at the respective services will not be included in the consent procedure nor in data collection for this study.

Participants will be recruited from two settings that are typical for the delivery of MBIs. The first setting is a mindfulness centre that offers MBIs for the general public. Participants are thus not selected based on any complaints they may have. The second setting is a stress clinic

associated with a hospital that offers mindfulness courses for participants with mild complaints, such as stress or worry. Due to a funding cut, the planned third setting (a mood disorders centre) had to discontinue its mindfulness training offer, preventing data collection at this location.

The following inclusion criteria will be applied:

- The study is open to all adults >18 years of age
- Enrolled in a mindfulness-based intervention at one of the participating sites
- Written informed consent after having been informed on all aspects of the study

The following exclusion criteria will be applied:

- Insufficient knowledge of the Dutch or English language
- No internet access

Baseline assessment:

Participants enrolled for a mindfulness-based intervention will complete a set of self-report questionnaires via Pavlovia Surveys (Open Science Tools, Nottingham, UK) just before the start of the mindfulness-based intervention. At baseline, outcomes (mental health, wellbeing & quality of life), candidate factors, and mechanisms will be assessed. To control for baseline difference in the occurrence of meditation-related adverse events, participants will report on any such events in daily life in the past 4 weeks before the start of the intervention.

Mindfulness intervention:

After the baseline assessment, participants will follow a mindfulness course consisting of group sessions of 2-3h duration that are organized (nearly) weekly and are spread over a period of eight weeks. The specific timeline and organisation of the course may differ between the participating sites but all courses will involve a comparable amount of contact hours with the mindfulness trainer. Each session consists of guided experiential mindfulness exercises (e.g., body scan, breathing space, breath focus, walk meditation), sharing of experiences of these exercises, reflections in small groups, psychoeducation (e.g., stress, depression, self-care), and review of home practices.

The mindfulness courses are based on one of the two most well-known MBIs, Mindfulness-Based Cognitive Therapy (Segal et al., 2002) and Mindfulness-Based Stress Reduction (Kabat-Zinn, 1990), or a combination thereof. Key objectives are to increase awareness of one's experience in the present moment and to teach an open and accepting attitude towards one's experience. Specific implementation will depend on the study site, but all courses teach the same underlying principles of mindfulness, allowing to uncover mechanisms and moderators for MBIs more generally. Courses follow a standardised protocol with (nearly) weekly group sessions and daily homework tasks taught by experienced and certified mindfulness trainers. Courses may take place in person or online depending on the current COVID-19 related measures at the participating sites.

Outcome assessments:

Participants will be assessed at mid-intervention (after half of the sessions), post-intervention (after the last session), and 3-months follow-up. Assessments include self-report

questionnaires measuring outcomes (mental health, wellbeing & quality of life), meditation-related adverse events, and mechanisms. In addition, we will measure mindfulness practice quality, frequency of home practice, session attendance (only at post-intervention), intentions of meditation practice, and expectancy regarding the mindfulness training.

Interviews:

At post-intervention, a subset of participants will additionally be invited for a semi-structured interview. Selection of the subset of participants is iterative and will follow theoretical sampling. This means that in the first sampling step, participants with relevant expertise (those who have experienced at least one unpleasant experience related to their mindfulness practice) will be invited for interview. Data of this first set of participants will be analysed to uncover any gaps in the data. In the following steps, participants will be specifically invited based on their experiences (as gathered in the questionnaires) in order to fill the gaps in the data. During this interview, participants will be asked how they experienced their mindfulness practice, what impact these experiences had on them over the course of the MBI, and what factors contributed to their experience of mindfulness practice. For the interview part of the study, we will seek additional consent as not all participants will be invited for interview. Interviews will all be conducted online to ensure a standardized interview procedure across all participants.

Reimbursement:

As a reward for participation, participants will be reimbursed with a €5/£5 voucher of a local online shop (bol.com for the Belgian sample and Amazon for the UK sample). Additionally, we will donate €1/£1 to a local mental health charity for each participant who completed the study. For participants who participate in the interview part, we will make an additional donation of €1/£1 and these participants will also receive an additional voucher of €5/£5 of a local online shop (bol.com for the Belgian sample and Amazon for the UK sample).

Sample size*

For the quantitative part of the study, we aim to recruit 120 participants. We aim to recruit between 15 and 25 individuals for the interviews.

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Sample size rationale

The study will employ a single-group longitudinal design with two subsamples, which will be recruited from two different settings typical for MBI delivery mentioned above. Because of the differences in settings, potential participants at each of the centres will differ from each other on relevant measures. Participants recruited at the stress clinic associated with ZNA Antwerp are healthy volunteers but generally experience mild complaints, such as stress or worry, that they aim to address with the mindfulness course. Participants recruited from the mindfulness centre for the general public are healthy volunteers who have an interest in mindfulness or want to further boost their wellbeing with the mindfulness course. Thus, their symptom levels of depression and anxiety are expected to be naturally lower than the symptom levels of participants recruited at the ZNA stress clinic. The opposite holds for their wellbeing levels.

To take these baseline differences into account in the statistical model, a variable will be included to indicate the setting where the participant was tested. This approach allows us to analyse participants from all settings in one statistical model and statistically detect the differences in effects across settings. If we analysed the samples separately, we would not be able to detect statistical differences between the samples and could only compare the results without knowing whether they are statistically different. Moreover, due to the recruitment difficulties we experienced so far, treating the two settings as distinct samples would not be feasible and would mean that we cannot recruit sufficient participants to complete the study. Nevertheless, it is important that both settings are included in this study as they reflect different settings very typical for MBI delivery. Only recruiting from one of the centres would largely limit the generalisability and value of our findings.

In total, 110 participants are needed to detect a medium-sized effect with a power of .80 with α=.05 for all quantitative analyses. We assumed a medium effect size (Cohen's f=0.39) on the basis of prior studies on (a) the effect of the MBI on mindfulness subprocesses (a-path; Gu et al., 2018; Gu et al., 2015; Zou et al., 2020), (b) the effect of mindfulness subprocesses on mental health (b-path; Gu et al., 2018; Gu et al., 2015; Zou et al., 2020), and (c) the moderation effects (Prins et al., 2014; Zhu et al., 2019). The sample size calculation is based on prior simulation studies for the mediation effect (Pan et al., 2018) and a Monte Carlo simulation of 1,000 datasets performed with a power tool designed to estimate power of moderation effects in multilevel models (Mathieu et al., 2012). Even with the highest within-subject correlation (ICC = 0.9), which has been shown to increase the required sample size, the sample size necessary to detect a mediation effect with a power of .80, α=.05 and 4 measurement points assuming a medium effect size for the a-path and b-path is 64 participants according to the simulation study by Pan et al. (2018). For the moderation analysis, we performed our own simulation study using the power tool by Mathieu et al. (2012) and following recommendations of the authors and results in the literature to set parameter values for the simulation. The stimulation suggests that a sample size of 110 participants would allow to detect moderation effects with a power of .808 and α=.05. To enable reproduction of the simulation study, we will attach the R code to this submission. To additionally account for attrition, we will oversample by 10% (i.e., 120 in total).

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For the qualitative analyses, a sample of 30 participants is sufficient based on recommendations in the literature (Thomson, 2010). Due to a halt in recruitment at one site and challenges at the second, all interview participants will now be recruited from the third site (the ZNA stress clinic). This limitation on participant availability means we aim to recruit between 15 and 25 individuals for the interviews.

Variables

Manipulated variables

Mindfulness training
All participants will follow a mindfulness course consisting of group sessions of 2-3h duration that are organized (nearly) weekly and are spread over a period of eight weeks. The specific timeline and organisation of the course may differ between the participating sites but all courses will involve a comparable amount of contact hours with the mindfulness trainer. Each session consists of guided experiential mindfulness exercises (e.g., body scan, breathing space, breath focus, walk meditation), sharing of experiences of these exercises, reflections in small groups, psychoeducation, and review of home practices.

The mindfulness courses are based on one of the two most well-known MBIs, Mindfulness-Based Cognitive Therapy (Segal et al., 2002) and Mindfulness-Based Stress Reduction (Kabat-Zinn, 1990), or a combination thereof. Courses follow a standardised protocol with group sessions and daily homework tasks taught by experienced and certified mindfulness trainers.

Measured variables *

Outcomes

- **Symptoms of emotional distress (depression, anxiety):** measured by the Patient Health Questionnaire-4 (PHQ-4; Kroenke et al., 2009) – 4 items;
- **Quality of life:** measured by the Recovering Quality of Life (ReQoL-10) Questionnaire (Keetharuth et al., 2018) – 10 items;
- **Wellbeing:** measured by the Short Warwick–Edinburgh Mental Well-being Scale (SWEMWBS; Stewart-Brown et al., 2009) – 7 items;

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- **Adverse effects specific to Mindfulness-Based Interventions** (assesses common meditation-related adverse events)**:** measured by the Meditation-Related Adverse Effects Scale, Mindfulness-Based Program version (MRAES-MBP; Britton et al., 2018) – 14 items;

Mechanisms

- **Mindfulness skills:** measured by the Comprehensive Inventory of Mindfulness Experiences – Short Form (CHIME-SF; Cladder-Micus et al., 2019) – 24 items;

Candidate factors

- **Tendency to dissociate:** measured by the Brief Dissociative Experiences Scale (DES-B; Bernstein & Putnam, 1986) – 8 items;
- **Repetitive negative thinking:** measured by the Perseverative Thinking Questionnaire (PTQ; Ehring et al., 2011) – 15 items;
- **Trauma history:** measured by a modified version of the Life Events Checklist for DSM-5 (LEC-5; Weathers et al., 2013) – 17 items;
- **Trauma symptoms:** measured by the International Trauma Questionnaire (ITQ; Cloitre et al., 2018) – 18 items;
- **Obsessive-compulsive disorder related beliefs:** measured by Obsessive Beliefs Questionnaire (OBQ-9; Gagné et al., 2018) – 9 items;

Additional measures:

- **Sociodemographic data:** age, gender, self-reported diagnoses of psychiatric disorders;
- **Quality of mindfulness practice**: measured by Practice Quality-Mindfulness (PQ-M; Del Re et al., 2013) - 6 items;
- Questions about **previous experience with meditation**, **frequency of home practice**, **intentions of meditation practice**, **training expectancy** and **session attendance**

Indices

Part 2 of the MRAES-MBP consists of 11 items assessing the occurrence and duration of specific meditation-related adverse events. A MRAES-MBP total frequency score will be calculated by summing all 11 items of part 2 of the MRAES-MBP.
Two scores of the cumulated meditation-related adverse events will be calculated. First, a score of the cumulated meditation-related adverse events over the period of the MBI will be computed by summing the MRAES-MBP total frequency scores assessed at mid-MBI and post-MBI. Second, a score of the cumulated meditation-related adverse events over the whole study period will be calculated by summing the MRAES-MBP total frequency scores assessed at mid-MBI, post-MBI, and follow-up.

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Analysis Plan

Statistical models *

Quantitative data

Hypotheses will be examined with intention-to-treat analyses jointly for all subsamples, i.e. both settings. Analyses are based on general linear modelling, multilevel mixed effects modelling, and multiple regression.

To examine mediation effects, a time-lagged mediation model as outlined by Bauer (2006) will be estimated, in which within-person change in each mindfulness subprocess over time (baseline to post-MBI) predicts subsequent change in outcomes (post-MBI to follow-up). We will first test whether change in each mindfulness subprocess from baseline to post-MBI predicts change in outcomes from post-MBI to follow-up. This decision was made because developing mindfulness subprocesses takes time and it is likely that several participants only show a change in mindfulness subprocesses towards the end of the MBI. If we do not find a significant mediation effect, we will then test whether change in mindfulness subprocesses from baseline to mid-MBI or from mid-MBI to post-MBI predicts subsequent change in outcomes.

Thus, to test for potential mechanisms (Objective 1), one separate model will be estimated for each of the outcomes (depression & anxiety symptoms (measured by one combined score), quality of life, and wellbeing). In each outcome model, there are five predictors: the three hypothesised mediators (internal awareness, decentering, and non-judgment), time, and recruitment site. The models for the mediators and the outcome will be specified as follows:

$$M1_{ij} = d_{M1j} + a_{1j} * M\ change_{ij} + e_{M1ij}$$

$$M2_{ij} = d_{M2j} + a_{2j} * M\ change_{ij} + e_{M2ij}$$

$$M3_{ij} = d_{M3j} + a_{3j} * M\ change_{ij} + e_{M3ij}$$

$$Y_{ij} = d_{Yj} + b_{1j} * M1_{(i-1)j} + b_{2j} * M2_{(i-1)j} + b_{3j} * M3_{(i-1)j} + c'_j * Time_{ij} + g_j * site_j + e_{Yij}$$

Mediators M_{ij} of participant j at time point i is modelled with the dummy-coded variable M change (coded as 0, 0, 1, 1 for baseline, mid-MBI, post-MBI, and follow-up, respectively). Outcome Y_{ij} is modelled as a function of the putative mediators at the previous time point t-1, the dummy-coded variables Time (coded as 0, 0, 0, 1 for baseline, mid-MBI, post-MBI, and follow-up, respectively) and recruitment site (coded as 0 for the stress clinic and 1 for the mindfulness centre for the general public). The coefficients a_j describes linear change in the mediators from

baseline to post-MBI (a-path), while the coefficient b_j represents the lagged association between the mediators and the outcome controlling for the effect of time on the outcome. Indirect effects of mindfulness skills will be estimated as the cross-product of the respective a_j and b_j coefficients and the significance of the indirect effects will be tested using bootstrap confidence intervals (Bauer et al., 2006). In the final step, the mediation models will be computed again with outcomes as mediators and mediators as outcomes to test the opposite hypothesis that changes in outcomes mediate changes in mediators.

Reason for update to analyses on personalised effects:

The previously planned analyses tested whether candidate factors influence the effect of the MBI on outcomes at each time point. However, we realized that including the time variables overly complicates the model without providing significant explanatory value. Our aim is to test whether candidate factors predict meditation-related adverse events and overall changes in mental health and wellbeing, rather than focusing on specific time points. For that reason, we updated the analyses on personalised effects to assess whether candidate factors predict change in outcomes over the MBI period or the entire study period rather than at specific time points. We also aim to test to what extent meditation-related adverse events play a role in the relationship between the candidate factors and outcomes such as mental health, quality of life, and wellbeing. This approach will clarify whether candidate factors directly influence outcomes or whether the effect of candidate factors on outcomes is (partly) explained by the frequency of meditation-related adverse events.

To test whether candidate factors influence the effect of the MBI (Objective 2), we will first test whether candidate factors predict frequency of meditation-related adverse events over the whole study period. Multiple regression models will be estimated in which a candidate factor, baseline meditation-related adverse events, and recruitment site predict cumulated meditation-related adverse events over the whole study period. We will estimate separate models for each of three candidate factors (trauma symptoms, repetitive negative thinking, and tendency to dissociate). Significant candidate factors will afterwards be combined into one model to examine unique effects. The model will be specified as:

$$MRAE = \beta_0 + \beta_1 * candidate\ factor + \beta_2 * baseline\ MRAE + \beta_3 * site + e$$

Cumulated meditation-related adverse events MRAE are modelled as a function of a candidate factor, MRAE at baseline, and the dummy-coded variable recruitment site (coded as 0 for the stress clinic and 1 for the mindfulness centre for the general public). The candidate factor is the main predictor of interest to test whether candidate factors influence the frequency of meditation-related adverse events.

Secondly, we will test whether candidate factors predict outcomes and whether this relationship is (partly) explained by meditation-related adverse events. A multiple regression model will be estimated in which a candidate factor predicts the outcome at post-MBI, controlling for the outcome at baseline and recruitment site (coded as 0 for the stress clinic and 1 for the mindfulness centre for the general public). In step 2, the cumulated meditation-related adverse events across the MBI period will be entered as an additional predictor. In this step 2, there are

two main predictors of interest. The first predictor of interest is the candidate factor to test whether the candidate factor still predicts the outcome when controlling for meditation-related adverse events. The second predictor of interest are the meditation-related adverse events to test to what extent meditation-related adverse events predict the outcome.

The models will be specified as:

Step 1:

$$Y = \beta_0 + \beta_1 * candidate\ factor + \beta_2 * baseline\ outcome + \beta_3 * site + e$$

Step 2:

$$Y = \beta_0 + \beta_1 * candidate\ factor + \beta_2 * MRAE + \beta_3 * baseline\ outcome + \beta_4 * site + e$$

A second multiple regression model will be estimated following the two-step procedure above, in which a candidate factor (entered in step 1) and the cumulated meditation-related adverse events across the whole study period (entered in step 2) predict the outcome at follow-up, controlling for the outcome at baseline and recruitment site (entered in step 1).

One separate model will be estimated for each of the outcomes (depression & anxiety symptoms (measured by one combined score), quality of life, and wellbeing). First, we will estimate separate models for each of the three candidate factors (trauma symptoms, repetitive negative thinking, and tendency to dissociate). In the final step, all significant candidate factors from the first step will be combined into one model.

For all mixed regression models, random effect parameters for each outcome will be selected following a top-down process of model selection as recommended by Barr et al. (2013). Starting from a maximal model, we will drop random slopes with the smallest variance until non-convergence and singularity issues are resolved.

Qualitative data

Interviews will be audio-taped and transcribed. For analysis, a grounded theory approach will be followed as this is most suitable for the following reasons: Grounded theory aims to generate a data-based theoretical model and engages in constant comparisons between participants, allowing to identify both mechanisms of change and moderating factors that influence the experience of mindfulness practice across participants and subsamples (Charmaz, 2006; Frank et al., 2019). To simplify comparison between subsamples, the Framework Method using a 7-stage analysis process (Gale et al., 2013) will be applied in combination with the 3-step coding process of grounded theory (Charmaz, 2006). After transcription and familiarisation with the data, open coding will be used to develop categories and hypotheses. During focused coding, the most significant initial codes will be compared to develop a working analytical framework, which will be applied to subsequent interviews. During charting, data will be summarised by

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category and entered into a matrix. Finally, applying theoretical coding, relationships between categories will be integrated into a theory. Qualitative analyses will be performed with Nvivo.

Transformations

For coding of categorical predictors, please see the section on statistical models.

Inference criteria

The standard $p < .05$ criterion will be applied to test our hypotheses. For multiple testing correction, we will follow best practices as outlined by García-Pérez (2023). For every set of tests, a corrected significance level will be calculated according to the method described by Benjamini and Hochberg (1995). Thus, multiple testing correction will be applied separately for the tests pertaining to Objective 1 and for the tests (all combined models after predictor selection) pertaining to Objective 2.

For exploratory analyses, we will apply the same multiple testing correction procedure as outlined above. Thus, we will use the false discovery rate to correct for tests in the same domain of exploratory analyses (e.g., moderated mediation analyses, mediation analyses).

Data exclusion

Outliers will be handled following the recommendations by Aguinis et al. (2013).

Error outliers

First, potential error outliers will be identified using single construct techniques such as box plots and standard deviation analysis with outliers defined as observations above or below 3.29 standard deviation units (Tabachnick et al., 2013). If the distribution is non-normal, outliers will be defined as observations below Q_1 - 2*IQR and above Q_3 + 2*IQR with Q_1 = first quartile, Q_3 = third quartile, and IQR = interquartile range. Next, multiple construct techniques

will be applied to identify additional outliers. These include q-q plots and computing leverage values (with a cut-off of $2(k + 1)/n$ with k = number of predictors and n = sample size) as well as deletion standardized multivariate residuals (with cut-off X^2 with $df = n$ of highest level of analysis j and α level = α/2). Identification techniques are first applied at the highest level of analysis.
Second, the cause of the identified outlier is determined. If the outlier is caused by an error in recording, coding, or data collection, then the outlier is classified as error outlier. These outliers are adjusted to their correct value if possible or removed. All remaining outliers for which the cause is unclear are considered potential interesting outliers.

Interesting outliers
All potential interesting outliers from the previous step will be studied to analyse the differences between potential interesting outliers and other observations.

Influential outliers
Multiple regression
a) Model fit outliers
Model fit outliers will be identified using a two-step procedure.
In the first step, all outliers which have been identified with multiple construct techniques that are neither error nor interesting outliers are candidates for model fit outliers. In the second step, the observation is removed to test whether the removal changes the statistical significance of overall model fit (e.g., R^2). If the statistical significance of model fit changes the observation constitutes a model fit outlier.

b) Prediction outliers
Prediction outliers will be identified using three techniques. For each potential prediction outlier, we will calculate Cook's D_i using the F distribution with $df = (k+1, n-k-1)$ and $\alpha = .50$ to determine significance for observation i to be considered a potential prediction outlier with k predictors and n observations. Additionally, we will compute difference in beta standardised ($DFBETAS_{ij}$) with cut-off $\pm\frac{2}{\sqrt{n}}$ for observation i to be considered a potential prediction outlier regarding regression coefficient j. Finally, we will compute the standardised difference in fit ($DFFITS_i$) with cut-off $\pm 2\sqrt{\frac{k+1}{n}}$ to determine whether observation i is a potential prediction outlier with k predictors and n observations. If the cut-off is exceeded on any of these techniques the observation is considered a prediction outlier.

Multilevel regression
a) Model fit outliers
Model fit outliers will be identified using a three-step procedure beginning at the highest level of analysis. The goal of this procedure is to determine whether a group of observations affects model fit because of the group itself and/or because of a particular outlier within the group.
In the first step, all outliers which have been identified with multiple construct techniques that are neither error nor interesting outliers are candidates for model outlier groups. In the second step, the candidate group is removed to test whether the removal changes the statistical significance of overall model fit (e.g., AIC or BIC). If the statistical significance of model fit changes the group constitutes a model fit outlier group.
In the third step, we will test whether the outlier group affects model fit because of an outlier in the group and/or because the whole group constitutes an outlier. This involves following the procedure for error outliers and interesting outliers for the lower level cases in each model fit

outlier group. If the lower level outlier is neither an error nor interesting outlier we will check whether the removal of the lower level outlier changes the statistical significance of the model fit index of the model fit outlier group. If the significance changes the lower level outlier is a model fit outlier. If at least one model fit outlier exists within the candidate group and if the exclusion of the model fit outliers within the group causes the exclusion of the group to no longer lead to a statistically significant change in model fit, then the model fit outliers are lower level model fit outliers. If no model fit outlier was identified within the candidate group or if the removal of the group still causes a change in model fit, irrespective of the exclusion of the model fit outliers, then the candidate group is a higher level model fit outlier.

b) Prediction outliers

Prediction outliers will be identified starting at the highest level of analysis. In the first step, the average squared deviation C_j will be calculated for each group *j* of cases and an index plot will be created. For each group with a markedly deviant C_j on the index plot, we will determine whether a group of cases affects the size of C_j because of the group itself and/or because of a particular outlier within the group.

For each prediction outlier within a prediction outlier group, we will calculate Cook's D_i using the *F* distribution with *df* = (*k*+1, *n*-*k*-1) and α = .50 to determine significance for observation *i* to be considered a potential prediction outlier with *k* predictors and *n* observations in the prediction outlier group. Additionally, we will compute difference in beta standardised ($DFBETAS_{ij}$) with cut-off $\pm\frac{2}{\sqrt{n}}$ for observation *i* to be considered a potential prediction outlier regarding regression coefficient *j*. If at least one prediction outlier exists within the candidate group and if the exclusion of the prediction outlier within the group causes the group's C_j value to no longer be notably different from those of the other groups, then the prediction outlier(s) are lower level prediction outlier(s). If no prediction outlier was identified within the candidate group or if the candidate group's C_j value remains notably different from other groups irrespective of the exclusion of the prediction outliers within the group, then the candidate group itself is a higher level prediction outlier.

In case influential outliers are identified, bootstrapping methods will be applied and the results will be reported with and without the bootstrapping method.

Missing data

Participants with incomplete data will be included if possible with the respective analysis method. To account for the missing data, we will use the REML estimator in our mixed regression analyses.

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Exploratory analysis

To explore mindfulness skills other than internal awareness, decentering, and non-judgment as potential mechanisms (Objective 1), we will run the mediation models as outlined in the statistical models with other CHIME-SF subscales as mediators included in the model.

To explore trauma history and obsessive-compulsive disorder related beliefs as potential candidate factors (Objective 2), we will run the moderation analyses as outlined in the statistical models with trauma history and obsessive-compulsive disorder related beliefs as candidate factors.

We aim to explore whether meditation-related adverse events predict subsequent change in outcomes. To test this hypothesis, a multilevel regression model will be estimated with frequency of meditation-related adverse events at time point t-1 predicting the outcome at time point t, controlling for the outcome at time point t-1. Separate models will be estimated for each of the outcomes: depression & anxiety symptoms (measured by one combined score), quality of life, and wellbeing.

We aim to explore whether the effect of a mindfulness skill on the outcomes (depression & anxiety symptoms, quality of life, wellbeing, and frequency of meditation-related adverse events) is moderated by a specific candidate factor (Objectives 1 and 2).

We expect that:
(1) trauma symptoms specifically moderate the effect of inner awareness on outcomes;
(2) RNT moderates the effect of non-judgment on outcomes;
(3) dissociative tendencies moderate the effect of decentering on outcomes.

To test this hypothesis, a multilevel moderated mediation model will be estimated that is specified as follows:

$$M1_{ij} = d_{M1ij} + a_j * M\ change_{ij} + e_{M1ij}$$

$$M2_{ij} = d_{M2ij} + a_j * M\ change_{ij} + e_{M2ij}$$

$$M3_{ij} = d_{M3ij} + a_j * M\ change_{ij} + e_{M3ij}$$

$$Y_{ij} = d_{Yj} + b_{1j} * M1_{(i-1)j} + w_{1j} * Moderator1_j + f_{1j} * M1_{(i-1)j} * Moderator1_j$$
$$+ b_{2j} * M2_{(i-1)j} + w_{2j} * Moderator2_j + f_{2j} * M2_{(i-1)j} * Moderator2_j$$
$$+ b_{3j} * M3_{(i-1)j} + w_{3j} * Moderator3_j + f_{3j} * M3_{(i-1)j} * Moderator3_j$$
$$+ c'_j * Time_{ij} + g_j * site_j + e_{Yij}$$

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Mediators M_{ij} of participant j at time point i is modelled with the dummy-coded variable M change (coded as 0, 0, 1, 1 for baseline, mid-MBI, post-MBI, and follow-up, respectively). Outcome Y_{ij} is modelled as a function of the putative mediators at the previous time point t-1, the candidate factors, the interaction between the putative mediators and the respective candidate factors, and the dummy-coded variables Time (coded as 0, 0, 0, 1 for baseline, mid-MBI, post-MBI, and follow-up, respectively) and recruitment site (coded as 0 for the stress clinic and 1 for the mindfulness centre for the general public). The model will be tested for those mediators and candidate factors that were significant in the main analyses, non-significant mediators and candidate factors will be omitted from the model.

To test the intervention effect on outcomes (mental health, wellbeing, quality of life, and frequency of adverse effects) and potential mediators (mindfulness skills) over time, piecewise multilevel models with two levels will be used, with time points (Level 1) nested in persons (Level 2). In the models, change is described as separate slopes for each dummy coded time variable (mid-MBI, post-MBI, follow-up). Since this analysis is not addressing the main objectives, we consider it an exploratory analysis.

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Other

References

Aguinis, H., Gottfredson, R. K., & Joo, H. (2013). Best-Practice Recommendations for Defining, Identifying, and Handling Outliers. *Organizational Research Methods*, *16*(2), 270–301. https://doi.org/10.1177/1094428112470848

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, *68*(3), 255–278. https://doi.org/10.1016/j.jml.2012.11.001

Bauer, D. J., Preacher, K. J., & Gil, K. M. (2006). Conceptualizing and testing random indirect effects and moderated mediation in multilevel models: New procedures and recommendations. *Psychological Methods*, *11*(2), 142–163. https://doi.org/10.1037/1082-989X.11.2.142

Benjamini, Y., & Hochberg, Y. (1995). Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing. *Journal of the Royal Statistical Society: Series B (Methodological)*, *57*(1), 289–300. https://doi.org/10.1111/j.2517-6161.1995.tb02031.x

Bernstein, E. M., & Putnam, F. W. (1986). Development, reliability, and validity of a dissociation scale. *The Journal of Nervous and Mental Disease*, *174*(12), 727–735. https://doi.org/10.1097/00005053-198612000-00004

Britton, W. B., Lindahl, J. R., & Cooper, D. J. (2018). *Meditation-Related Adverse Effects Scale, Mindfulness-Based Program version (MRAES-MBP).* Brown University.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Sage.

Cladder-Micus, M. B., Verweij, H., van Ravesteijn, H., van der Gucht, K., Raes, F., & Speckens, A. E. M. (2019). Validation of the Dutch Comprehensive Inventory of Mindfulness Experiences (CHIME) and Development of a Short Form (CHIME-SF). *Mindfulness*, *10*(9), 1893–1904. https://doi.org/10.1007/s12671-019-01125-7

Cloitre, M., Shevlin, M., Brewin, C. R., Bisson, J. I., Roberts, N. P., Maercker, A., Karatzias, T., & Hyland, P. (2018). The International Trauma Questionnaire: development of a self-report measure of ICD-11 PTSD and complex PTSD. *Acta Psychiatrica Scandinavica*, *138*(6), 536–546. https://doi.org/10.1111/acps.12956

Del Re, A. C., Flückiger, C., Goldberg, S. B., & Hoyt, W. T. (2013). Monitoring mindfulness practice quality: An important consideration in mindfulness practice. *Psychotherapy Research*, *23*(1), 54–66. https://doi.org/10.1080/10503307.2012.729275

Ehring, T., Zetsche, U., Weidacker, K., Wahl, K., Schönfeld, S., & Ehlers, A. (2011). The Perseverative Thinking Questionnaire (PTQ): Validation of a content-independent measure of repetitive negative thinking. *Journal of Behavior Therapy and Experimental Psychiatry*, *42*(2), 225–232. https://doi.org/10.1016/j.jbtep.2010.12.003

Farb, N. A. S., Segal, Z. V., Mayberg, H., Bean, J., McKeon, D., Fatima, Z., & Anderson, A. K. (2007). Attending to the present: Mindfulness meditation reveals distinct neural modes of self-reference. *Social Cognitive and Affective Neuroscience*, *2*(4), 313–322. https://doi.org/10.1093/scan/nsm030

OSF Preregistration

Frank, P., Stanszus, L., Fischer, D., Kehnel, K., & Grossman, P. (2019). Cross-Fertilizing Qualitative Perspectives on Effects of a Mindfulness-Based Intervention: An Empirical Comparison of Four Methodical Approaches. *Mindfulness*, *10*(11), 2452–2467. https://doi.org/10.1007/s12671-019-01227-2

Gagné, J.-P., van Kirk, N., Hernandez-Vallant, A., Potluri, S., Krompinger, J. W., Cattie, J. E., Garner, L. E., Crosby, J. M., Brennan, B. P., & Elias, J. A. (2018). Validating an abbreviated version of the Obsessive Beliefs Questionnaire. *Journal of Clinical Psychology*, *74*(10), 1791–1807. https://doi.org/10.1002/jclp.22629

Gale, N. K., Heath, G., Cameron, E., Rashid, S., & Redwood, S. (2013). Using the framework method for the analysis of qualitative data in multi-disciplinary health research. *BMC Medical Research Methodology*, *13*, 117. https://doi.org/10.1186/1471-2288-13-117

García-Pérez, M. A. (2023). Use and misuse of corrections for multiple testing. *Methods in Psychology*, *8*, 100120. https://doi.org/10.1016/j.metip.2023.100120

Gu, J., Cavanagh, K., & Strauss, C. (2018). Investigating the Specific Effects of an Online Mindfulness-Based Self-Help Intervention on Stress and Underlying Mechanisms. *Mindfulness*, *9*(4), 1245–1257. https://doi.org/10.1007/s12671-017-0867-y

Gu, J., Strauss, C., Bond, R., & Cavanagh, K. (2015). How do mindfulness-based cognitive therapy and mindfulness-based stress reduction improve mental health and wellbeing? A systematic review and meta-analysis of mediation studies. *Clinical Psychology Review*, *37*, 1–12. https://doi.org/10.1016/j.cpr.2015.01.006

Kabat-Zinn, J. (1990). *Full catastrophe living: How to cope with stress, pain and illness using mindfulness meditation*. Delacorte.

Keetharuth, A. D., Brazier, J., Connell, J., Bjorner, J. B., Carlton, J., Taylor Buck, E., Ricketts, T., McKendrick, K., Browne, J., Croudace, T., & Barkham, M. (2018). Recovering Quality of Life (ReQoL): a new generic self-reported outcome measure for use with people experiencing mental health difficulties. *British Journal of Psychiatry*, *212*(1), 42–49. https://doi.org/10.1192/bjp.2017.10

Kroenke, K., Spitzer, R. L., Williams, J. B., & Löwe, B. (2009). An Ultra-Brief Screening Scale for Anxiety and Depression: The PHQ–4. *Psychosomatics*, *50*(6), 613–621. https://doi.org/10.1016/S0033-3182(09)70864-3

Mathieu, J. E., Aguinis, H., Culpepper, S. A., & Chen, G. (2012). Understanding and estimating the power to detect cross-level interaction effects in multilevel modeling. *The Journal of Applied Psychology*, *97*(5), 951–966. https://doi.org/10.1037/a0028380

Pan, H., Liu, S., Miao, D., & Yuan, Y. (2018). Sample size determination for mediation analysis of longitudinal data. *BMC Medical Research Methodology*, *18*(1), 32. https://doi.org/10.1186/s12874-018-0473-2

Prins, B., Decuypere, A., & van Damme, S. (2014). Effects of mindfulness and distraction on pain depend on individual differences in pain catastrophizing: an experimental study. *European Journal of Pain*, *18*(9), 1307–1315. https://biblio.ugent.be/publication/4345522/file/4345553.pdf

Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2002). *Mindfulness-based cognitive therapy for depression: A new approach to preventing relapse*. *Mindfulness-based cognitive therapy for depression: A new approach to preventing relapse*. Guilford.

OSF Preregistration

Sierra, M. (2009). *Depersonalization: A new look at a neglected syndrome*. Cambridge University Press.

Stewart-Brown, S., Tennant, A., Tennant, R., Platt, S., Parkinson, J., & Weich, S. (2009). Internal construct validity of the Warwick-Edinburgh Mental Well-being Scale (WEMWBS): A Rasch analysis using data from the Scottish Health Education Population Survey. *Health and Quality of Life Outcomes*, *7*(1), 1–8. https://doi.org/10.1186/1477-7525-7-15

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2013). *Using multivariate statistics* (6th ed.). Pearson.

Thomson, S. B. (2010). Sample size and grounded theory. *Journal of Administration and Governance*, *5*(1), 45–52.

Valdez, C. E., Sherrill, A. M., & Lilly, M. (2016). Present Moment Contact and Nonjudgment: Pilot Data on Dismantling Mindful Awareness in Trauma-Related Symptomatology. *Journal of Psychopathology and Behavioral Assessment*, *38*(4), 572–581. https://doi.org/10.1007/s10862-016-9548-8

Weathers, F. W., Blake, D. D., Schnurr, P. P., Kaloupek, D. G., Marx, B. P., & Keane, T. M. (2013). *The Life Events Checklist for DSM-5 (LEC-5)*. https://www.ptsd.va.gov/professional/assessment/te-measures/life_events_checklist.asp

Zhu, J., Wekerle, C., Lanius, R., & Frewen, P. (2019). Trauma- and Stressor-Related History and Symptoms Predict Distress Experienced during a Brief Mindfulness Meditation Sitting: Moving toward Trauma-Informed Care in Mindfulness-Based Therapy. *Mindfulness*, *10*(10), 1985–1996. https://doi.org/10.1007/s12671-019-01173-z

Zou, Y., Li, P., Hofmann, S. G., & Liu, X. (2020). The Mediating Role of Non-reactivity to Mindfulness Training and Cognitive Flexibility: A Randomized Controlled Trial. *Frontiers in Psychology*, *11*, 1053. https://doi.org/10.3389/fpsyg.2020.01053