

Feasibility and preliminary outcomes of intensive mindfulness and yoga on prisoners with personality disorders: A randomised controlled preliminary study

Ivana Buric^{a,b,e,*}, Miguel Farias^b, Stoyan Kurtev^b, Valerie van Mulukom^b, Christopher Mee^c, Lloyd Gould^d, Sabeela Rehman^d, Barbara Parker^d, Inti A. Brazil^{b,e,f}

^a Department of Psychology, University of Amsterdam, the Netherlands

^b Brain, Belief, and Behaviour Lab, Centre for Trust, Peace and Social Relations, Coventry University, United Kingdom

^c Centre for Sport, Exercise and Life Sciences, Faculty of Health and Life Sciences, Coventry University, United Kingdom

^d HMP Whitemoor, March, United Kingdom

^e Donders Institute for Brain, Cognition and Behaviour, Radboud University, Nijmegen, the Netherlands

^f Forensic Psychiatric Centre Pompestichting, Nijmegen, the Netherlands

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ABSTRACT

This study was the first to test the feasibility of mind-body interventions with a randomised control research design in a sample that contains all ten types of personality disorders, and the first to provide a preliminary evaluation of responses using a combination of psychological, genomic, neural, and behavioural measures. Thirty prisoners with personality disorders were recruited within a clinical unit of a high security prison and assigned to a mindfulness intervention (n = 10), a yoga intervention (n = 10), or a wait-list control group (n = 10). Both mindfulness and yoga interventions were held simultaneously and lasted three hours per day on five consecutive days. At baseline and after the intervention, we measured inflammation-related gene expression through venous blood; attention with a cognitive task; event-related potentials (ERPs) with EEG; and stress, emotion regulation and mindfulness with questionnaires. Here we show that recruitment and dropout rates were satisfactory, and data collection was successful despite its length and complexity. The only exception were blood samples where 60% of participants refused to give blood, but this was expected because 47% of recruited participants had a diagnosis of paranoid personality disorder. Unexpected difficulties occurred when participants did not fully adhere to randomisation procedures, and a riot took place during the final day of the interventions. This study was underpowered to detect changes on primary or secondary outcome measures, but despite that 80% of examined inflammation-related genes showed medium and large effect sizes suggesting this as an important outcome measure in future studies. Minor adjustments to the study design are necessary before a larger scale study can be conducted to precisely determine the effects of mindfulness and yoga as an additional treatment for prisoners with personality disorders.

1. Introduction

Each of the ten types of personality disorders includes behaviours, emotions, and thoughts that are extremely different than that of an average person in their culture, which causes harm to the individual and to people around them (American Psychiatric Association, 2013) (for a full review on personality disorders see (Angstman and Rasmussen, 2011)). Personality disorders are not rare—between 10% and 15% of people have one or more personality disorders (Reich et al., 1989; Torgersen et al.,

2001). Available treatments show limited evidence of effectiveness and include different types of psychotherapy, along with psychotropic medicines for comorbid disorders (Bateman et al., 2015). As an addition to usual treatments, mind-body interventions such as mindfulness or yoga have the potential to aid in managing personality disorders because they improve self-regulation and its subcomponents, such as emotion regulation (Cook-Cottone, 2015; Tang et al., 2015; Kang et al., 2013; Menezes et al., 2015), which is commonly lacking in many personality disorders (American Psychiatric Association, 2013; Steel and Blaszczynski, 1998).

* Corresponding author at: Department of Psychology, University of Amsterdam, the Netherlands
E-mail address: ivanaburic27@gmail.com (I. Buric).

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To this day, not much is known about the effects of mind-body interventions on individuals with personality disorders. The majority of evidence comes from the research of mindfulness on borderline personality disorder (BPD) because mindfulness is a core component of one of the most effective known treatments for BPD: Dialectical Behaviour Therapy (Cristea et al., 2017). Studies shows that mindfulness improves emotion regulation, attention and impulsivity in patients with BPD (Feliu-Soler et al., 2014; Soler et al., 2012; Kounidas and Kastora, 2022; Carmona i Farrés et al., 2019; Carmona i Farrés et al., 2019; Elices et al., 2016). Unfortunately, it is not known how mindfulness-based interventions affect people with personality disorders other than BPD. There are no studies that directly tested the effects of mindfulness or other mind-body interventions in other types of personality disorders other than three case studies of three patients with avoidant, paranoid and/or obsessive-compulsive personality disorders (Chan et al., 2015; Lynch and Cheavens, 2008; Kellett and Hardy, 2014). An indirect line of evidence stems from two observational studies that found violent male prisoners have larger deficits in trait mindfulness, and that trait mindfulness moderates the relationship between the severity of antisocial personality disorder (ASPD) traits and aggression (Velotti et al., 2016; Velotti et al., 2019). However, these prisoners did not have a formal diagnosis of ASPD. In fact, 26.5% of the participants met the diagnostic criteria for ASPD in the first study with 83 prisoners (Elices et al., 2016), and only 6% in the other study with 152 prisoners (Chan et al., 2015). So, these findings cannot be generalised to ASPD diagnosis. Others have suggested that symptoms of ASPD can be reduced through interventions such as mindfulness meditation by targeting neurological mechanism that improve inhibitory control and empathic functioning (Holtzheimer and Bui, 2016), but there are no experimental studies that have directly tested this hypothesis. Therefore, there are only case studies available for mindfulness and other personality disorders other than BPD (Chan et al., 2015; Lynch and Cheavens, 2008; Kellett and Hardy, 2014), and research on the feasibility and effects of yoga on any personality disorder is non-existent to this date. This gap in research is most likely due to the fact that individuals with personality disorders are difficult to recruit because they often remain undiagnosed and rarely seek treatment, unless it is for comorbid disorders (McRae, 2013; Welfel and Ingersoll, 2002), such as substance abuse, depression and post-traumatic stress disorder (Hayward and Moran, 2008). Here, we had an opportunity to conduct a study within a high security prison that has a special clinical unit for prisoners diagnosed with personality disorders. This was a unique gateway into exploring the feasibility and effects of mind-body interventions in a sample that contains a full range of personality disorders. Previous studies of mind-body interventions in prisons showed that they are feasible in prison settings (Samuelson et al., 2007; Sumter et al., 2009), and that even short 10-day mindfulness interventions can reduce substance misuse (Bowen et al., 2006), recidivism (Perelman et al., 2012), and aggressive behaviour (Suarez et al., 2014). Similarly, studies of yoga in prison found increased positive affect, reduced stress, and improved behavioural control in prisoners (Bilderbeck et al., 2013; Kerekes et al., 2017). Although none of the studies included only prisoners with personality disorders, they provided encouragement to test short mind-body interventions in this particular clinical prison population. Evidence-based mind-body interventions are always an important addition to standard treatments, but even more so in a prison setting. Serving a prison sentence increases the risk for the exacerbation of personality disorders (Armour, 2012; Birmingham, 2003) and commonly comorbid psychiatric disorders (Hayward and Moran, 2008). However, it is not clear if mind-body interventions are feasible in clinical prison setting neither if they would be accepted by prisoners with different personality disorders nor if they would show any effects.

The current study is a randomised controlled pilot study that examined four feasibility and acceptability components: 1) if there will be difficulties in recruiting, engaging, and retaining the participants; 2) if participants will adhere to study procedures and attend assigned

sessions; 3) if data collection procedures with multilevel outcome measures are suitable for prison populations with diverse personality disorders. Additionally, this study 4) provides preliminary evaluation of the effects of short mind-body interventions on prisoners with personality disorders on multiple levels: psychological, behavioural, neural, and genomic. The rationale for including genomic measures stems from recent studies that have found that the health-protective effects of mind-body interventions might be due to gene expression changes in inflammation-related genes (Black and Slavich, 2016; Buric et al., 2017), which reduces the risk for neurodegenerative diseases, asthma, arthritis, cardiovascular diseases, some types of cancers, and psychiatric disorders such as depression and posttraumatic stress disorder (Slavich, 2015). It is unknown whether these gene expression changes would also be detected in a prison sample with personality disorders or how they would respond to blood collection. Of course, the effects of mindfulness extend beyond genomics, so we based our selection of questionnaires and a computerised cognitive task on self-regulation theory. This theory proposes that mindfulness targets all three components of self-regulation: attention control, emotion regulation and self-awareness (Tang et al., 2015). During the attention cognitive task, we simultaneously measured brain activity with EEG to detect possible changes in event-related potentials that are commonly associated with mindfulness (Jo et al., 2016).

2. Methods

2.1. Overview of study procedures

The study was preregistered online on ClinicalTrials.gov (identifier: NCT02894203). Following the approval of five different ethics committees (University Ethics Committee, Health Research Authority, National Offenders Management Service, Cambridgeshire and Peterborough NHS Foundation Trust, and HMP Whitemoor), participants were recruited within a clinical unit for prisoners with severe PDs at a high-security prison. There were 59 prisoners who were at various stages of a mandatory 5-year trauma-informed treatment program, which included individual therapy and group work. Leaflets with information about the study were put in prisoners' common areas, and interested prisoners were assessed for eligibility before giving a written consent. To be included, prisoners had to be between 18 and 65 years of age. Prisoners with major neurological disorders or with difficulties in understanding English were excluded.

Prior and then again following the interventions, recruited participants completed pre-intervention assessment that included questionnaires, a cognitive task, EEG recordings and collection of blood samples (see Fig. 1 and supplement S1 for details). The cognitive and EEG assessment was done by the researchers, while the questionnaires were administered by internal clinicians, and blood samples were collected by internal phlebotomists. Blood collection was not a mandatory component of the study.

Participants were allocated to groups (mindfulness, yoga, or wait-list control) in equal ratios by applying stratified random sampling using a random number generator. They were stratified by amount of therapy received (from zero to five years), dominant cluster of personality disorders, comorbid psychiatric disorder (seven had ADHD, two had major depressive disorder, and 21 had no other psychiatric diagnosis), and previous experience in meditation or yoga (five had experience in meditation, two had experience in yoga). Participants were encouraged to contact members of the clinical team if they had any questions or experienced difficulties during the intervention period.

2.2. Interventions: Mindfulness, yoga, and wait-list control group

We employed two types of mind-body interventions lasting 15 hours over five consecutive days. Shorter and more intensive interventions are also effective in reducing psychological distress (Carmony and Baer,

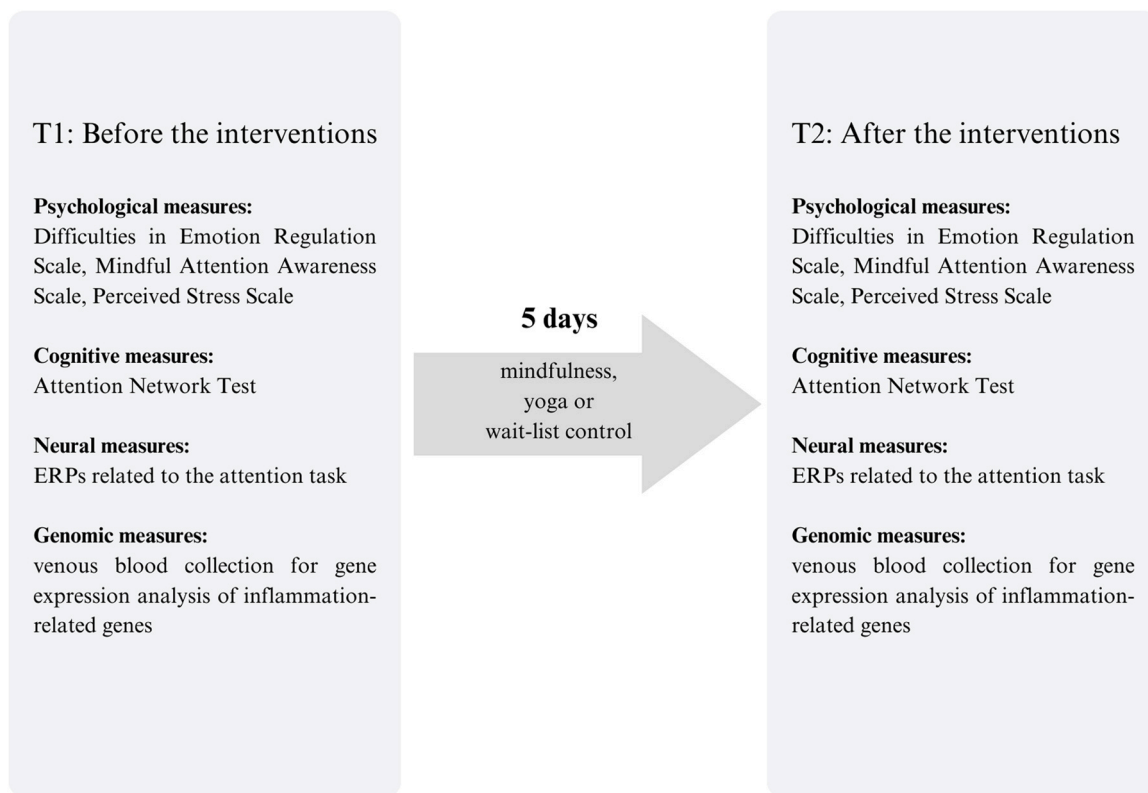


Fig. 1. A graphical representation of the research design.

2009), improving attention (Sethi et al., 2013; Tang et al., 2007), self-regulation (Tang et al., 2007 Oct 23), reducing inflammatory gene expression (Kaliman et al., 2014 Feb; Qu et al., 2013 Apr 17), and in affecting information processing in the brain (Ganpat et al., 2011), at least in other types of populations. The director of the high-security prison where the study took place wanted to introduce mindfulness or yoga (not a combination of both) in the regular schedule of this clinical prison unit so they wanted to see which of these two options, if any, is accepted by the prisoners. Therefore, in this study, mindfulness meditation and yoga are two separate experimental groups, and a wait-list group serves as a control group. Mindfulness meditation and yoga both belong to mind-body interventions, and historically they largely overlap (Singleton, 2010). However, scientific research has shown that they have distinct features, where yoga interventions commonly include a set of physical postures and movement, while mindfulness interventions include seated practices and focus the attention on the present moment without judgment (Singleton, 2010; King, 2021). More specifically, the mindfulness intervention taught awareness of the present moment in an open and non-judgmental manner. It included mindfulness of breath, mindful eating, and open monitoring, talks about the benefits of mindfulness, and daily group discussions where participants could give feedback and ask questions. The yoga intervention covered a set of beginner yoga poses with modifications provided based on the level of fitness and flexibility. Just as for the mindfulness intervention, the yoga intervention also included talks about the benefits of yoga and its history, and daily group discussions. The mindfulness intervention did not include any yoga instructions and vice versa. Both yoga and mindfulness interventions were five days long and consisted of a 1.5-hour long morning session and a 1.5-hour long afternoon session that were held at the same time. Mindfulness and yoga teachers had 3 and 5 years of experience, respectively, including previous work with prison populations. At the same time, the wait-list control group followed their usual regimen, which was different than most of the year because the interventions were delivered during one of the four annual week-long therapy breaks within the unit. During the

annual breaks, prisoners have less duties, and socialise more than usual in comparison with their regular routine. All participants were offered mindfulness and yoga once the data collection was over.

2.3. Outcomes

2.3.1. Feasibility criteria for a successful design

- A recruitment rate of at least 30%, and a dropout rate below 30% (King et al., 1991),
- 70% or more of participants should participate in at least 70% of intervention sessions (Sundquist et al., 2015),
- and data collection should be at least 90% successful for neural, cognitive and questionnaire measures, while blood samples should be given by at least 50% of participants.

2.3.2. Intervention outcome measures

Attention was measured with the Attention Network Test (ANT) (Fan et al., 2002), which examines three components of attention: alerting network (controls the state of alertness and vigilance), orienting network (controls goal-oriented focusing of attention) and executive network (controls the execution of responses and blocks distracting information) (Fan and Posner, 2004). EEG was recorded during ANT task using a BioSemi ActiveTwo system with 32 electrodes with a “zero-reference” setup and arranged according to the 10–20 system (see supplement S1 for details). We also included the Mindful Attention Awareness Scale (MAAS) (Brown and Ryan, 2003), the Perceived Stress Scale (PSS) (Cohen et al., 1983), and the Difficulties in Emotion Regulation Scale (DERS) (Gratz and Roemer, 2004). Blood was collected for the analysis of changes in gene expression of 38 genes related to inflammation and the immune system (IL-1 signalling pathway) (O’Neill and Dinarello, 2000; Subramaniam, 2004). To provide a preliminary evaluation of participants’ responses to mind-body interventions, data analyses were performed based on intent-to-treat (ITT) principles. Post-intervention missing data of the nine participants who dropped out was

handled by running multiple imputations. A *p*-value of < 0.05 was considered significant and Bonferroni correction was implemented to adjust for multiple comparisons (i.e., < .02 was considered significant in individual 2-group comparisons). The data were analysed with the IBM SPSS 24.0 software (Statistical Package for Social Sciences, SPSS Inc., Chicago, IL). The effectiveness of interventions was tested by calculating change scores and running non-parametric Kruskal-Wallis test for *K* independent samples because the assumptions for ANOVA were not met. If there was a significant difference detected, it was followed with Mann-Whitney U-test and Kolmogorov-Smirnov Z-test to determine specific group differences. Additionally, eta squared was used as a measure of effect size to determine the proportion of variability in outcomes that can be explained by group membership.

3. Results

3.1. Evaluation of feasibility

The 30 recruited participants were all men and had a mean age of 41 (SD = 8.00). All recruited participants had two or more personality disorders, which is commonly observed in clinical practice (Zimmerman et al., 2005), while 90% of recruited participants had ASPD. The recruitment process was facilitated by collaborating with internal research assistants and clinicians who were familiar with prisoners. We monitored several feasibility criteria to evaluate the suitability of a randomised controlled trial with multilevel outcomes. If all the feasibility criteria were fulfilled, we considered that it would be possible to conduct a larger study with sufficiently powered sample size without further changes in the protocol. We enrolled 30 participants out of 59 prisoners who were in the clinical unit for personality disorders within HMP Whitemoor on March 2017, which represented a 51% recruitment rate. This was well over our feasibility criteria of 30% and it shows that prisoners with personality disorders are interested in participating in this kind of study. The most common reason for

refusing to participate in the study were self-reported physical limitations or bad timing (because the interventions were during one of the four annual breaks, and they did not want additional obligations at that time).

The first unexpected challenge we encountered was that seven out of 30 recruited participants demanded to be assigned to their preferred group, which interfered with the standard randomisation procedure. Despite that, there were no differences in group characteristics based on type of personality disorders, perceived stress, emotion regulation, trait mindfulness, age or number of attended psychotherapy session (Table 1). We encountered further challenges on the beginning of the first day of the interventions when four out of 23 recruited participants that agreed to random allocation before signing the consent form decided not to attend sessions of the group they were allocated to, and instead they went to their most preferred group. More specifically, two participants that were allocated to yoga attended mindfulness sessions only, and two participants that were allocated to the control group attended yoga sessions only. Therefore, only 19 participants fully adhered to randomisation procedures, which is 63% out of the total of 30 recruited participants. Other than these changes of assigned groups immediately before the beginning of intervention, participants did not change groups for the whole duration of the interventions.

By the end of the 5-day interventions, 9 out of 30 recruited participants had withdrawn from the study, which is similar to dropout rates in studies of mind-body interventions in other populations (Cramer et al., 2016). Specifically, nine out of 30 participants dropped out of the trial before any follow-up data could be collected: five from the yoga group, three from the mindfulness group, and one from the control group. All in all, the first feasibility criterion was barely met with 32% recruitment rate and 30% dropout rate.

The second feasibility criterion was technically fulfilled as 76% of participants in the mindfulness or yoga group attended 75% (six out of eight) delivered sessions, while the rest attended at least 50% (four sessions). However, the two final scheduled sessions (session nine and

Table 1
Baseline characteristics of participants across conditions (N = 30, 10 per group).

	Mindfulness M SD	Yoga M SD	Control M SD	Change Statistic, <i>p</i>
Age in years	37.60 3.24	41.60 7.15	42.60 6.79	<i>H</i> = 4.70, <i>p</i> = .09
Number of psychotherapy sessions	392.10 366.90	403.20 344.55	380.40 293.68	<i>H</i> = .04, <i>p</i> = .98
Psychopathy (PCL-R) Questionnaires	31.75 4.12	29.32 4.99	33.16 6.98	<i>H</i> = .78, <i>p</i> = .76
PSS	24.80 6.65	25.20 6.49	26.10 4.31	<i>H</i> = .57, <i>p</i> = .75
DERS non-acceptance	17.00 3.68	16.80 5.27	19.10 6.64	<i>H</i> = 2.30, <i>p</i> = .32
DERS goal directed behaviour	13.70 4.14	16.50 2.46	16.00 5.48	<i>H</i> = 2.14, <i>p</i> = .34
DERS impulse control	14.50 3.92	15.80 4.94	17.30 6.16	<i>H</i> = 1.77, <i>p</i> = .41
DERS emotional awareness	16.90 3.84	18.30 4.90	19.10 6.21	<i>H</i> = 1.12, <i>p</i> = .57
DERS strategies	21.50 4.70	22.50 7.25	22.40 7.53	<i>H</i> = .07, <i>p</i> = .96
DERS emotional clarity	13.00 3.23	15.00 4.08	15.40 2.27	<i>H</i> = 2.34, <i>p</i> = .31
MAAS	3.13.62	3.23.60	3.24.63	<i>H</i> = .10, <i>p</i> = .95
Personality disorder				
Paranoid PD	4: 4: 2 ^a	5: 3: 2 ^a	5: 2: 3 ^a	<i>X</i> ² = 1.1, <i>p</i> = .90
Schizoid PD	0: 1: 9 ^a	2: 0: 8 ^a	0: 0: 0 ^a	<i>X</i> ² = 6.22, <i>p</i> = .18
Schizotypal PD	0: 0: 10 ^a	2: 0: 8 ^a	1: 0: 9 ^a	<i>X</i> ² = 4.54, <i>p</i> = .34
Anti-social PD	10: 0: 0 ^a	8: 1: 1 ^a	9: 1: 0 ^a	<i>X</i> ² = 3.22, <i>p</i> = .52
Borderline PD	8: 1: 1 ^a	6: 3: 1 ^a	8: 1: 1 ^a	<i>X</i> ² = 1.96, <i>p</i> = .74
Histrionic PD	2: 1: 7 ^a	1: 0: 9 ^a	2: 1: 7 ^a	<i>X</i> ² = 1.75, <i>p</i> = .78
Narcissistic PD	4: 0: 6 ^a	3: 1: 6 ^a	4: 0: 6 ^a	<i>X</i> ² = 2.12, <i>p</i> = .71
Avoidant PD	2: 0: 8 ^a	4: 0: 6 ^a	2: 0: 8 ^a	<i>X</i> ² = 1.36, <i>p</i> = .51
Dependent PD	0: 0: 10 ^a	0: 0: 10 ^a	0: 1: 9 ^a	<i>X</i> ² = 2.07, <i>p</i> = .36
Obsessive-compulsive PD	1: 1: 8 ^a	1: 0: 9 ^a	1: 0: 9 ^a	<i>X</i> ² = 2.08, <i>p</i> = .72

Note: PCL-R – Psychopathy Checklist – revised; PD – personality disorder; PSS – Perceived Stress Scale; DERS – Difficulties in Emotion Regulation Scale; MAAS – Mindful Attention Awareness Scale.

^aFrequency of definite diagnosis: probable diagnosis: no diagnosis in each group,

ten) were not delivered due to a full lockdown within prison caused by problems on another unit, which points to the unpredictable barriers in delivering an interventional study in a prison setting. Therefore, participants spent the final day locked in their cells instead of attending mind-body interventions and it remains unknown if they would continue to attend the sessions at the same rate. Finally, data collection procedures were successful although they lasted two to three hours per participant at each of the two time points and included a vast array of measures: questionnaires, a cognitive task, electroencephalography (EEG) and an optional blood sample collection. All participants had the capacity to complete the entire data procedures without taking a break. Participants understood the questions and tasks but note that researchers or clinicians were always present during data collection to answer questions and clarify items or tasks. Nine (30%) participants requested assistance by having the items or task instructions read out loud to them because they had dyslexia, were visually impaired or had other difficulties with reading so it is important to always provide this option. We expected barriers in obtaining blood samples in this population, so blood collection was not mandatory. Only 40% (12 out of 30) of participants agreed to give blood, which was below our pre-defined feasibility criterion of 50%. The main reason for rejecting blood collection was a fear of misusing their blood sample and a lack of trust in anonymisation of data, which is not unsurprising given the fact that 23 out of 30 included participants had a definite or a probable diagnosis of paranoid personality disorder (see Table 1).

3.2. Preliminary evaluation of multilevel outcomes

Following from self-regulation theory (Tang et al., 2015), we evaluated difficulties in emotion regulation, mindfulness, and inhibition and found no statistically significant difference after either intervention and effect sizes were zero or approaching zero ($H(2,30) = 1.75, p = .43, \eta^2 = .01$; $H(2,30) = 2.06, p = .47, \eta^2 = .00$; $H(2,30) = 1.15, p = .66, \eta^2 = .03$, respectively, Table 2).

Similarly, these interventions showed no preliminary effect on ERPs related to alerting ($H(2,29) = 1.29, p = .55, \eta^2 = .03$; $H(2, 29) = .44, p = .81, \eta^2 = .06$; $H(2, 29) = 3.81, p = .35, \eta^2 = .07$), orienting ($H(2, 29) = 2.74, p = .27, \eta^2 = .03$; $H(2, 29) = .87, p = .72, \eta^2 = .04$; $H(2, 29) = 1.94, p = .47, \eta^2 = .00$) or inhibition ($H(2, 29) = 1.31, p = .60, \eta^2 = .03$; $H(2, 29) = .67, p = .73, \eta^2 = .05$; $H(2, 29) = 1.14, p = .68, \eta^2 = .03$) in parietal regions of the scalp, respectively (Table 3).

To determine if prisoners with personality disorders show reduced expression of genes related to inflammation after mind-body interventions as was previously observed in studies with non-clinical and different clinical samples (Buric et al., 2017), we analysed gene expression changes in 38 genes and found no significant change in expression of any measured gene, although some effect sizes were medium and large (e.g., IRF1 $\eta^2 = .42$; NFKB1 $\eta^2 = .26$; STAT1 $\eta^2 = .23$; IKKB $\eta^2 = .21$, Table 4).

Table 2

The results of Kruskal-Wallis test analysis for change scores in self-report measures and on cognitive task.

Outcome	Condition difference statistic	Significance	Effect size
Questionnaires			
Emotion regulation (DERS)	$H(2, 30) = 1.75$	$p = .43$	$\eta^2 = .01$
Non-acceptance	$H(2, 30) = .95$	$p = .70$	$\eta^2 = .04$
Goal directed behaviour	$H(2, 30) = .67$	$p = .73$	$\eta^2 = .05$
Impulse control	$H(2, 30) = 2.75$	$p = .32$	$\eta^2 = .03$
Emotional awareness	$H(2, 30) = 1.50$	$p = .50$	$\eta^2 = .02$
Strategies	$H(2, 30) = .74$	$p = .72$	$\eta^2 = .05$
Emotional clarity	$H(2, 30) = 1.94$	$p = .45$	$\eta^2 = .00$
Mindfulness (MAAS)	$H(2, 30) = 2.06$	$p = .47$	$\eta^2 = .00$
Stress (PSS)	$H(2, 30) = 1.71$	$p = .52$	$\eta^2 = .01$
ANT			
Alerting	$H(2, 30) = 1.07$	$p = .61$	$\eta^2 = .03$
Orienting	$H(2, 30) = 1.08$	$p = .59$	$\eta^2 = .03$
Inhibition	$H(2, 30) = 1.15$	$p = .66$	$\eta^2 = .03$

Table 3

The results of Kruskal-Wallis test analysis for change scores in ERPs.

Outcome	Condition difference statistic	Significance	Effect size
ERPs			
P3 alerting	$H(2, 29) = 1.29$	$p = .55$	$\eta^2 = .03$
P4 alerting	$H(2, 29) = .44$	$p = .81$	$\eta^2 = .06$
Pz alerting	$H(2, 29) = 3.81$	$p = .35$	$\eta^2 = .07$
P3 orienting	$H(2, 29) = 2.74$	$p = .27$	$\eta^2 = .03$
P4 orienting	$H(2, 29) = .87$	$p = .72$	$\eta^2 = .04$
Pz orienting	$H(2, 29) = 1.94$	$p = .47$	$\eta^2 = .00$
P3 inhibition	$H(2, 29) = 1.31$	$p = .60$	$\eta^2 = .03$
P4 inhibition	$H(2, 29) = .67$	$p = .73$	$\eta^2 = .05$
Pz inhibition	$H(2, 29) = 1.14$	$p = .68$	$\eta^2 = .03$

4. Discussion and conclusions

The present study was the first one to date to test if a randomised controlled trial of mindfulness and yoga with psychological, behavioural, neural, and genomic outcomes is a feasible option in a population of prisoners with a full range of personality disorders. We found that recruitment and dropout rates were satisfactory and comparable to mind-body interventions studies in other populations. To achieve these rates, it is important for external researchers to collaborate with internal staff members that have already established a good relationship with the prisoners (including guards, clinicians, or researchers) in order to facilitate recruitment, intervention delivery and data collection. This collaboration led to participants showing excellent cooperation for collecting the required outcome measures, despite the complexity of the measured and even though data collection lasted several hours. However, it was not feasible to obtain blood samples, so future studies should explore other options. For example, researchers should aim to recruit a high number of participants so that the sample is sufficiently powered even when only 50% of participants give blood samples. It remains to be tested in future studies if alternatives to blood samples, such as collecting saliva, urine or hair samples, would be less challenges to assess with this particular population. There were difficulties in implementing a randomisation procedure in two ways: 23% participants demanded to be in a certain group before the intervention started, while 13% demanded that on the first day of intervention. Despite that, it was possible to form groups that did not differ on variables that might influence the outcomes, although this could have happened purely by chance. On the upside, no direct cross-contamination occurred for the whole duration of the intervention because the participants remained in the same groups. However, indirect cross-contamination is always possible in prison or clinical settings where participants from all groups live together within a unit, as this provides opportunities to talk about mindfulness or yoga interventions amongst them.

Researchers conducting larger randomised controlled studies should

Table 4
Mean 2⁻ΔΔCt in mindfulness and yoga group (normalized relative to the control group) and Kruskal-Wallis results of change scores (T2 – T1).

		Mindfulness M SD	Yoga M SD	Control group M SD	Test statistic	p	Effect size
ATF2	Pre	.50.26	.31.25	.96.50	H (2, 12) = .80	p = .67	η ² = .13
	Post	1.16.27	1.06.39	1.16.32			
CHUK	Pre	1.19.06	1.23.81	1.20.82	H (2, 12) = .27	p = .88	η ² = .19
	Post	1.00.39	.65.24	1.00.51			
END1	Pre	.61.27	.72.17	.93.31	H (2, 12) = 2.07	p = .47	η ² = .01
	Post	.94.43	.34.37	1.09.61			
F3	Pre	2.08 2.34	2.17 1.53	1.47 1.27	H (2, 12) = .63	p = .73	η ² = .15
	Post	1.56 1.21	1.17.47	1.44.83			
FOS	Pre	1.73.34	23.08 44.07	1.42 1.31	H (2, 12) = 1.47	p = .49	η ² = .03
	Post	1.09.24	1.37.74	1.00.62			
FOSB	Pre	.61.57	.71.60	4.84 9.30	H (2, 12) = 2.56	p = .28	η ² = .06
	Post	2.55 1.94	2.26 1.73	1.22.74			
FOSL2	Pre	1.20.48	2.19.93	.88.48	H (2, 12) = .44	p = .82	η ² = .17
	Post	1.84 1.72	1.36 1.32	.87.50			
HMOX	Pre	1.06.39	7.15 13.02	1.37.83	H (2, 12) = .28	p = .87	η ² = .19
	Post	.79.36	.84.21	.92.22			
IKBKB	Pre	1.38.40	1.08 1.12	1.34.95	H (2, 12) = .12	p = .94	η ² = .21
	Post	1.11.59	.85.36	1.06.22			
IL1R1	Pre	.75.21	.74.11	1.46.1.22	H (2, 12) = 2.80	p = .34	η ² = .09
	Post	1.40.60	1.56.61	.95.23			
IL1RAP	Pre	.55.04	1.45.89	.92.23	H (2, 12) = 3.73	p = .16	η ² = .19
	Post	1.41.54	1.33.35	1.02.28			
IL6	Pre	1.69.50	3.41 5.73	1.15.81	H (2, 12) = .44	p = .81	η ² = .17
	Post	.71.32	.45.37	1.09.89			
IL8	Pre	1.89 1.40	.74.37	.91.48	H (2, 12) = 1.47	p = .49	η ² = .03
	Post	1.08.77	1.53 1.37	1.67 1.42			
IRAK1	Pre	.85.29	.88.26	1.15.48	H (2, 12) = .33	p = .86	η ² = .19
	Post	.86.39	.85.20	.98.34			
IRF1	Pre	1.11.62	1.18.31	.96.37	H (2, 12) = 5.78	p = .06	η ² = .42
	Post	2.69 2.01	7.63 2.13	2.09 2.88			
JUN	Pre	1.00.38	1.25.94	.91.37	H (2, 12) = 3.29	p = .20	η ² = .14
	Post	.91.25	.83.36	1.74 1.30			
MAP2K3	Pre	.87.14	1.16.83	.84.47	H (2, 12) = 2.95	p = .23	η ² = .11
	Post	.67.04	.30.22	.98.90			
MAP2K4	Pre	1.34.81	2.12 1.45	1.20.85	H (2, 12) = 1.62	p = .45	η ² = .04
	Post	.84.08	.94.18	1.03.25			
MAP2K6	Pre	1.46.64	.89.34	1.18.79	H (2, 12) = .49	p = .78	η ² = .17
	Post	1.33.67	1.12.22	1.04.29			
MAP3K1	Pre	.44.37	.50.47	1.22.51	H (2, 12) = 1.94	p = .38	η ² = .01
	Post	1.05.45	1.07.86	1.00.21			
MAPK14	Pre	.82.47	1.42.57	1.48 1.00	H (2, 12) = 1.97	p = .37	η ² = .00
	Post	1.08.77	1.16.65	.82.44			
MAPK8	Pre	.99.81	.37.25	.89.37	H (2, 12) = 2.68	p = .26	η ² = .08
	Post	.90.48	.78.15	1.53 1.20			
MAPK9	Pre	1.42.87	.83.62	1.08.52	H (2, 12) = .08	p = .96	η ² = .21
	Post	1.03.42	1.10.48	1.07.33			
MYD88	Pre	1.29.49	1.02 1.20	1.06.32	H (2, 12) = 1.47	p = .48	η ² = .06
	Post	1.92 1.61	3.05 1.40	2.11 3.35			
NFKB1	Pre	1.00.20	.65.24	1.26.74	H (2, 12) = 4.35	p = .13	η ² = .26
	Post	1.69 1.04	1.47.67	.96.27			
NFKBIA	Pre	.87.31	5.48 9.05	1.08.30	H (2, 12) = .80	p = .67	η ² = .13
	Post	.68.26	.81.18	.97.28			
NFKBIB	Pre	1.03.45	1.14.68	.96.56	H (2, 12) = 2.94	p = .24	η ² = .10
	Post	.79.24	.69.13	1.47 1.08			
PTGS2	Pre	.90.86	.67.73	.77.42	H (2, 12) = .43	p = .81	η ² = .17
	Post	.86.39	.85.20	.98.34			
RELA	Pre	1.21.79	.48.13	1.06.43	H (2, 12) = .56	p = .76	η ² = .16
	Post	.78.48	.39.14	3.37 4.58			
SERPINE1	Pre	.64.58	.75.78	1.19.67	H (2, 12) = 1.33	p = .52	η ² = .07
	Post	1.03.42	1.10.48	1.01.33			
STAT1	Pre	1.04.40	.65.32	1.06.33	H (2, 12) = 4.03	p = .13	η ² = .23
	Post	.83.12	.75.14	1.49.82			
TNF	Pre	1.10.17	.89.42	1.27.62	H (2, 12) = .67	p = .72	η ² = .15
	Post	1.06.17	1.03.59	1.38.57			
TRAF6	Pre	.90.18	.73.85	1.01.41	H (2, 12) = .73	p = .70	η ² = .14
	Post	.63.01	.61.03	1.03.44			
UBB	Pre	.56.16	.63.31	.86.31	H (2, 12) = .27	p = .88	η ² = .19
	Post	.82.60	.91.06	1.04.11			
UBC	Pre	.85.84	.36.24	1.00.69	H (2, 12) = 2.39	p = .30	η ² = .04
	Post	1.55.95	.89.18	1.10.52			

be aware that if they emphasise at recruitment that crossing over is not allowed, this might decrease recruitment and retention rates. Based on the large gaps in research of mind-body interventions in patients with personality disorders other than BPD, it is currently more urgent to achieve larger and sufficiently powered sample sizes than to achieve a fully randomised controlled trial with an underpowered sample. Also, it is important to note that prisons can be unpredictable environments, which this study clearly illustrated. We experienced a riot that occurred at another unit on the final day of the interventions. This meant a full lockdown for all prisoners on that day, including for our study participants. It is impossible to predict when a riot will occur, but they are normally resolved within one day, so it might be more feasible to introduce longer and less time intensive interventions where one day less will not cut off 20% of intervention as was the case in this 5-day intervention. Despite their unpredictability, clinical prison units for personality disorders have several unique upsides. First, they provide a gateway to recruit a diverse and ecologically valid sample that contains all ten types of personality disorders. Second, as all participants live in the prison, it is easy to reach them to make sure they arrive to data collections and interventions punctually. Third, it is possible to collaborate with staff members who have a good relationship with prisoners to spark interest for the study and support the motivation of recruited participants to remain in the study until the end. This, of course, must be done ethically without any coercion whatsoever, but instead with a strong emphasis that the participation is completely voluntary, and that stopping at any time is allowed.

Other than an assessment of feasibility, this study also provided a preliminary evaluation of outcomes, but note that this is a preliminary study where the sample size was not large enough to detect statistically significant differences. Although previous studies found that mind-body interventions can improve aspects of self-regulation in people with BPD (Feliu-Soler et al., 2014; Soler et al., 2012) and in prisoners (Samuelson et al., 2007; Sumter et al., 2009; Bilderbeck et al., 2013; Kerekes et al., 2017), this study found no statistically significant improvements in self-regulation following mindfulness and yoga, or in any other measured outcome. Interestingly, while all psychological, behavioural, and neural measures showed very low effect sizes approaching zero, several genes showed markedly larger effect sizes. Most notably, a large effect size was found for the expression of gene IRF1 that suppresses tumour cell growth and stimulates an immune response against tumour cells. Although generally larger sample size is necessary to detect the effects of intervention, randomised control trials with small samples can still offer informative leads, and large effects can still be detected (Friston, 2012). It is possible that gene expression changes are the first observable changes to emerge following mind-body interventions. Despite budget requirements and more effort in data collection, storage and analyses, future studies should explore this in other populations that are more willing to provide blood samples.

In summary, this study contributes to both forensic and psychiatric literature as the first randomised controlled preliminary study of mindfulness and yoga in a population of prisoners with various personality disorders, which is a very rarely studied clinical population despite its prevalence. We found that conducting studies in this complex clinical environment is a feasible option even when it includes extensive data collection. However, the inclusion of blood sample collection and randomisation should be reconsidered until we acquire a larger body of evidence that mind-body interventions truly have a measurable effect in patients with any kind of personality disorders. Because personality disorders vary greatly between and within each type of personality disorder, it is possible that some types of personality disorders are less responsive to these interventions and could benefit more from adaptation of these interventions or different kinds of additional treatments.

All in all, this study shows two main points: First, intensive formats of mindfulness and yoga are feasible interventions in a clinical unit for personality disorders of a high-security prison. Second, participants

adhere well to long data collection procedures that include psychological, cognitive, and neural measures. However, it is not feasible to implement standard randomisation procedures or to obtain blood samples in this population. This study lays ground for a larger multi-centre trial that will determine the effectiveness of mindfulness and yoga on prisoners with various personality disorders and provide clinical recommendations for mind-body interventions as additional treatments in all ten types of personality disorders.

Author contribution

IBu was the project lead. She created the research design, obtained ethical approvals, coordinated the study, collected and analysed data, and wrote the manuscript. MF and IB supervised all aspects of the work of IBu and reviewed the manuscript. LG, SR and BP coordinated some aspects of the study and collected data together with IBu, SK and VM. SK additionally supervised all EEG recordings and cognitive tasks. CM supervised gene expression analysis.

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Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Miguel Farias reports financial support was provided by HMP Whitemoor.

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Gene Expression Omnibus Identifier: GSE134703

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.bbii.2023.100009](https://doi.org/10.1016/j.bbii.2023.100009).

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