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CLINICAL RESEARCH ARTICLE



The role of interoception in reducing trauma-associated distress: a feasibility study

Daria Shatrova , Pablo F. Cáncer and Jose Manuel Caperos

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ABSTRACT

Background: Altered interoception plays an important role in chronic stress and posttraumatic stress disorder. The aim of this study was to evaluate the feasibility of a Trauma Sensitive Yoga (TSY) intervention for improving emotional distress and psychological discomfort in women living under circumstances of social and gender vulnerability. We assessed the effect of the treatment on the interoceptive mechanisms, and whether the psychological improvements were mediated by the changes in these mechanisms.

Methods: The study involved a sample of 62 women who attended public community centres dedicated to supporting women victims of gender-based violence or who were socially and economically disadvantaged because of their gender. Participants underwent a six-week TSY programme. We evaluated dropout rate, adherence, and intervention satisfaction. We measured emotional distress, psychological discomfort, interoceptive mechanisms, and two nonequivalent dependent variables to enhance internal validity. We compared pre-post differences using paired samples *t*-test and a structural equation model (SEM) analysis was performed to compare the changes in the outcomes with the changes in the nonequivalent dependent variables. Mediation models were adjusted to evaluate the role of changes in interoception on outcome changes.

Results: Fourteen (23%) women dropped out, mainly after the first intervention session. Intervention adherence (mean attendance 5.3 over 6 sessions) and acceptability were high (mean satisfaction 3.4 over 4). We observed post-intervention improvements in anxiety, depression, psychological discomfort, body responsiveness, and interoceptive awareness. The changes in the outcomes were larger than the changes in the nonequivalent dependent variables. Additionally, we found that the changes in body responsiveness partially mediated the change in anxiety and psychological discomfort but not in depression.

Conclusions: TSY could be an interesting therapeutic approach for women experiencing chronic posttraumatic stress symptomatology. Our findings underscore the role of interoceptive mechanisms in traumatic stress and emphasize the importance of addressing these aspects.

El papel de la interocepción en la reducción de la perturbación asociada al trauma: un estudio de viabilidad

Antecedentes: La interocepción alterada juega un papel importante en el estrés crónico y en el trastorno de estrés postraumático. El objetivo de este estudio fue evaluar la factibilidad de una intervención de Yoga Sensible al Trauma (TSY por sus siglas en inglés) para mejorar la perturbación emocional y el malestar psicológico en mujeres que viven bajo circunstancias de vulnerabilidad social y género. Evaluamos el efecto del tratamiento en los mecanismos interoceptivos y si la mejoría psicológica estaba mediada por cambios en estos mecanismos.

Métodos: El estudio involucró una muestra de 62 mujeres que asistían a centros públicos comunitarios dedicados a apoyar a mujeres víctimas de violencia por razón de género o que estaban en una situación de desventaja social y económica debido a su género. Las participantes se sometieron a un programa de TSY de seis semanas. Evaluamos las tasas de abandono, adherencia y satisfacción de la intervención. Medimos el malestar emocional y psicológico, los mecanismos interoceptivos y dos variables dependientes no equivalentes para mejorar la validez interna. Comparamos las diferencias pre y post usando la prueba de *t* de muestras pareadas y se realizó un análisis del modelo de ecuaciones estructurales (SEM por sus siglas en inglés) para comparar los cambios en los resultados con los cambios de las variables dependientes no equivalentes. Los modelos de mediación se ajustaron para evaluar el papel de los cambios en la interocepción en los cambios de resultados.

Resultados: Catorce (23%) mujeres abandonaron, principalmente después de la primera sesión de intervención. La adherencia a las intervenciones (asistencia media 5.3 en 6 sesiones) y aceptabilidad fueron altas (satisfacción media 3.4 en 4). Observamos mejorías

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Trastornos de estrés; traumático; estrés postraumático; interocepción; conciencia corporal; yoga; terapias mente-cuerpo

HIGHLIGHTS

- A 6-week Trauma Sensitive Yoga programme is feasible and acceptable to address chronic and trauma-related stress in vulnerable women.
- The intervention reduces emotional distress and psychological discomfort and increases interoceptive awareness.
- Interoceptive mechanisms could play a crucial role in addressing stress-related symptoms, contributing to the overall positive outcomes.

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post intervención en la ansiedad, depresión, malestar emocional, capacidad de respuesta corporal y conciencia interoceptiva. Los cambios en los resultados fueron mayores que los cambios en las variables dependientes no equivalentes. Además, encontramos que los cambios en la responsividad corporal mediaban parcialmente los cambios en la ansiedad y malestar psicológico, pero no en la depresión.

Conclusion: TSY podría ser un enfoque terapéutico interesante para mujeres que han experimentado sintomatología de estrés postraumático crónica. Nuestros hallazgos subrayan el papel de los mecanismos interoceptivos en el estrés traumático y enfatizan la importancia de abordar estos aspectos.

1. Background

Exposure to acute traumatic events and to ongoing existential stressors has a cumulative and global impact on physical, mental, and cognitive functioning (Kira, 2022). Complex traumatic stress reactions are typically associated with repeated or prolonged traumatic experiences occurred within interpersonal and asymmetrical relationships from which victims were unable to escape (Cloitre et al., 2019; Wamser-Nanney, 2016). Complex traumatic stress stems from myriads of situations of victimization, such as physical or sexual abuse within the family or an intimate partnership, childhood neglect, harassment or sustained mistreatment (Courtois, 2004). Although the ICD-11 has incorporated complex post-traumatic stress disorder (CPTSD) as an independent diagnosis (World Health Organisation, 2018), complex traumatic stress reactions are generally regarded as a broad clinical phenomenon that could encompass the symptomatology of various stress-related clinical categories (Resick et al., 2012).

Chronic and trauma-related stress is associated with a range of psychophysiological manifestations, particularly with dissociative experiences (Zucker et al., 2006). Dissociation implies a degree of discontinuity in the normal integration of information due to alterations in attention or consciousness (Hyland et al., 2020). Dissociation has been linked to symptom severity and poorer response to psychotherapeutic treatments (Bisson et al., 2020; Lyssenko et al., 2018), and can manifest in various ways, including noticeable somatic symptoms (Gupta, 2013). Victims of traumatic and chronic stress may develop somatoform dissociation, an acute form of disconnection from bodily sensations, to help them cope with their constant state of hyperarousal, alertness, and distress (Maaranen et al., 2004; Nijenhuis, 2009). Somatoform dissociation has been associated with reduced interoceptive awareness, which is the ability to adequately perceive and process internal bodily signals (Brown, 2004; Koreki et al., 2020). Alterations in interoceptive mechanisms have been identified as vulnerability factors for various mental health problems (Brewer et al., 2021; Nord & Garfinkel, 2022), linking stress and psychological symptoms (Heim et al., 2023; Schulz & Vögele, 2015).

Understanding interoceptive alterations is key for grasping the underlying mechanisms of trauma's sequelae, including various forms and levels of dissociation, and for informing effective therapeutic strategies aimed at mitigating the traumatic impact in vulnerable individuals. Interoception-based interventions have been applied in several psychological disorders, particularly in posttraumatic stress-related disorders (Heim et al., 2023). Trauma Sensitive Yoga (TSY) is a mind-body therapy that focuses on enhancing individuals' awareness of the inner sensations (interoception) and empowers clients to implement conscious actions that foster their well-being (Emerson, 2015). TSY also aims to guide clients in regulating their nervous system by working with their bodies to alleviate symptoms and distress (Cattie et al., 2021; Nolan, 2016).

The aim of this study was to assess the feasibility of a TSY intervention for reducing emotional distress and psychological discomfort in women facing social and gender vulnerability. A second aim was to determine if TSY induces changes in interoceptive mechanisms and whether those changes mediate the observed psychological improvements.

2. Methods

2.1. Study design

This study was conducted in public community centres in Madrid, Spain, dedicated to supporting women victims of gender-based violence or who face social and economic disadvantages due to their gender. Given the available timeframe to accomplish the intervention, a pre-post-experimental study with no control group was chosen to allow all interested women to access the intervention.

To improve the internal validity of this design, two nonequivalent dependent variables were used as controls (Shadish et al., 2002). A nonequivalent dependent variable is one that, while assessed in a similar manner to the primary outcome variable of the study, is not expected to change as a result of the intervention. This variable is expected to respond to threats to internal validity in the same way the main outcome

variable does (Shadish et al., 2002, pp. 110–111). Therefore, the 6-week TSY intervention was aimed to improve the psychological symptoms associated with posttraumatic stress by enhancing interoceptive mechanisms, but it was not expected to induce changes in the nonequivalent dependent variables. These nonequivalent dependent variables were: (i) an attitudinal variable related to the study population's context of vulnerability and frequently addressed in cross-sectional interventions within the community centres attended by the participants (*benevolent sexism attitude*) and (ii) a variable related to eating disorder symptomatology (*drive for thinness*), associated with the scope of application of mind–body interventions, but not specifically affected by the TSY intervention.

2.2. Participants

The participants in this study were female users of four public community centres of the districts of Vallecas, Villaverde, Chamartín, and Hortaleza in the city of Madrid (Spain). Participants were recruited through a convenience sampling method, with women signing up voluntarily for the activity that had been previously advertised in the monthly programme or following the recommendation of the psychologists of each centre. Inclusion criteria were being of legal age, lacking physical impediments to practice gentle yoga, and sufficient proficiency in the Spanish language. Women who attended fewer than four sessions were considered for the feasibility study but excluded from the subsequent analyses.

2.3. Variables

First, participants completed a questionnaire including sociodemographic and clinical information, as well as details regarding prior yoga practice. To provide an overview of the sample in terms of characteristics and symptomatology associated with posttraumatic stress and complex trauma, the first two parts of the *Traumatic Experiences Questionnaire* (Bobes et al., 2000; Davidson & Smith, 1990) were used. The selected questions were: 18 items listing various potentially stressful events, the age of their occurrence, and their duration; and 9 items referring to the characteristics of the potentially traumatic event selected as the most distressing.

As indicators of feasibility, we considered the retention rate throughout the study and the reasons for dropping out, the mean intervention adherence, and the occurrence of adverse events related to the intervention. We also evaluated participant's satisfaction with the programme with the Client Satisfaction Questionnaire (CSQ-8) (Larsen et al., 1979; Vázquez et al., 2019). CSQ-8 is an 8-item scale with a 4-point Likert response, where 1 indicates very low satisfaction and

4 indicates very high satisfaction (Cronbach's alpha in the study sample: $\alpha = .898$). Finally, we included two open-ended questions to gather feedback on what participants liked most and least about the intervention.

As indicators of emotional distress and psychological discomfort we employed: The *Hospital Anxiety and Depression Scale* (HADS) (Terol-Cantero et al., 2015; Zigmond & Snaith, 1983), which includes 14 items divided into two subscales: anxiety and depression. Both subscales presented adequate internal consistency in the study sample: $\alpha = .862$ for anxiety and $\alpha = .787$ for depression. The *Clinical Outcomes in Routine Evaluation-Outcome Measure* or CORE-OM-18 (Evans et al., 2000; Feixas et al., 2012), which evaluates: (i) subjective well-being; (ii) problems or symptoms; (iii) general functioning regarding intimate relationships, social relationships, and daily living; and (iv) risk in relation to clinical indicators. As the risk subscale comprises solely two items, only the well-being, problems, and functioning subscales were considered in individual analyses. The total score and the three subscales presented an adequate internal consistency, with $\alpha = .923$, $\alpha = .830$, $\alpha = .875$ and, $\alpha = .745$, respectively. Also, the CORE-OM 10-items version was administered after each TSY session.

To assess interoceptive mechanisms we used *The Body Response Scale* (Alba Maldonado et al., 2021; Daubenmier, 2005), a 7-item 7-point Likert scale, and *The Multidimensional Assessment of Interoceptive Body Awareness* (Mehling, Acree, et al., 2018; Valenzuela-Moguillansky & Reyes-Reyes, 2015), a 32-item 6-point Likert scale. Both scales presented an adequate internal consistency within the study sample, with $\alpha = .818$ and $\alpha = .945$, respectively.

The level of benevolent sexism was evaluated using the benevolent sexism subscale of the *Inventory of Ambivalent Sexism* (Glick & Fiske, 1996; Lemus Martín et al., 2008), a 10-item 6-point Likert-type scale with adequate internal consistency in the study sample ($\alpha = .878$). Drive for thinness was evaluated using the corresponding subscale of the *Eating Disorders Inventory* (Gardner, 1991, 1998). This measure consists of 7 items rated on a 6-point Likert scale, and it also presented an adequate internal consistency ($\alpha = .841$).

2.4. Intervention protocol

The intervention comprised six TSY sessions of 45 min (totalling 4.5 h) administered weekly and conducted in groups of 9 to 19 women at four different community centres. The sessions were led by four facilitators qualified to deliver TSY sessions by the Rádika Foundation (Spain) with experience in working with vulnerable populations. Before the intervention, an informative session was held to introduce participants to the TSY methodology and explain the study's objectives. After the intervention and post-

measurement, a group session was conducted by a psychologist and the TSY facilitator of each community centre. There, participants shared their experience throughout the intervention, posed questions and suggestions, and participated in a group closure of the process, which included a brief mediative practice. Following these discussion groups, a curated list of online resources – such as free TSY sessions provided by the Rādika Foundation (Spain), books, conferences, meditations practices, etc. – was provided to the participants to facilitate further autonomous therapeutic work.

The intervention administered to the four groups adhered to the same protocol with adaptations to each group. Weekly coordination and supervision meetings were conducted, involving the four TSY facilitators, an experienced TSY trainer, and a psychologist. These meetings aimed to ensure consistent application of the practice across all groups. Every TSY session incorporated the following progressive elements that always included different options and graduation: gentle yoga-based movement using a chair and/or a mat, with an emphasis on empowerment and strength; a somatic technique; grounding, orientation and safety tools; interoceptive awareness practices; activities aimed at widening the window of tolerance; attention and regulation of the nervous system activation; self-compassion and self-care gestures and practices; building a shared sense of community; and trauma-adapted mindfulness (body mindfulness and breathwork).

2.5. Data analysis

An initial descriptive analysis of the sample, adherence, dropouts, and satisfaction was performed using means, standard deviations (SD), minimums (MIN) and maximums (MAX) for quantitative variables, as well as frequencies and percentages for categorical variables. Student's *t*-tests for independent samples were used to compare the main variables between participants who completed the intervention and those who dropped out.

Dependent samples Student's *t*-tests were used to compare pre-and post-intervention scores in the outcomes (anxiety, depression, and CORE-OM), the interoceptive mechanisms (body responsiveness and interoceptive awareness), and the nonequivalent dependent variables (benevolent sexism and drive to thinness). Moreover, an examination of clinically significant changes in the outcomes was conducted based on cutoffs that achieved the best performance in terms of sensitivity and specificity in previous studies. These cutoffs were scores of 1.43 and 0.71 in the anxiety and depression subscales of the HADS (Terol-Cantero et al., 2007), respectively, and a score of 1.29 in the CORE-OM (Evans et al., 2002; Feixas et al., 2012).

In all three scales, scores equal to or above the cutoffs were considered 'clinical', while scores below the cutoffs were considered 'non-clinical'. A clinically significant change occurs when an individual transitions from one category to the other.

Additionally, we conducted an intention-to-treat analysis using the total CORE-OM score to evaluate the sensitivity of our results to the exclusion of non-completers and intervention dropouts. All subjects were considered for this analysis, irrespective of the number of sessions attended. In cases where the post-intervention questionnaires were not completed, we used the last recorded post-session CORE-OM-10 measurement. The comparison was conducted with a linear mixed model that allowed us to include the pre-intervention data for subjects who only attended the first session.

To compare the change between the outcomes and the nonequivalent dependent variables, individual pre-post changes in each variable were standardized using the standard deviation at the pre-intervention stage. Next, a two-factor SEM was set with the changes in the outcomes loading on one factor, and the changes in the nonequivalent dependent loading on the other (Figure S1, supplementary material). Then, two nested models were compared using likelihood ratio tests: (1) a null model, with the factor means constrained to be equal, and (2) an alternative model, with the factor means freely estimated. A significant difference between these models would indicate that the change in the outcomes differs from the change in the nonequivalent variables. Finally, we conducted pairwise comparisons between the standardized changes in the outcomes and the standardized changes in the nonequivalent dependent variables using a dependent samples' Student *t*-test. Bonferroni correction was applied to control the Type I error rate.

To examine whether the improvements in psychological symptoms were mediated by increases in body responsiveness and interoceptive body awareness, we fitted three separate parallel multiple-mediator models (Montoya & Hayes, 2017) using scores in anxiety, depression, and CORE-OM as dependent variables. In all mediation models, body responsiveness and interoceptive body awareness served as mediators (Figure 1). Because direct and indirect effects are often the focus in mediation analyses, only estimates of these effects were included in the main text. (For the complete model and numerical results, please refer to the supplemental material, Tables S1 and S2.)

Student *t*-tests and linear models were run in SPSS (28.0). Mediation analyses were carried out using a macro designed for within-participant mediation analysis (Montoya & Hayes, 2017). Finally, SEM analyses were performed in R using the package *lavaan* (Rosseel, 2012).

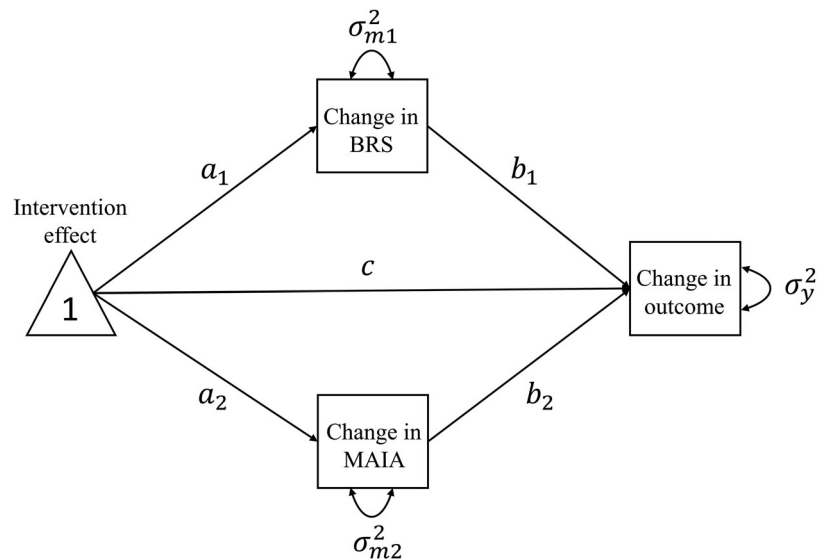


Figure 1. Simplified path diagram of the mediation models tested.

3. Results

3.1. Sample description

Out of the 62 women contacted 61 began the intervention. The mean age of participants was 53.0 years ($SD = 11.8$; $MIN = 28$; $MAX = 75$). Of these, 47 participants (81.0%) had practiced yoga before, and none reported physical impediments that would hinder their practice, nor insufficient command of the Spanish language to follow instructions. Participants reported experiencing an average of 4.9 traumatic events ($SD = 3.2$; $MIN = 0$; $MAX = 14$). The most common events reported were the unexpected death of a family member or a close friend (39 participants, 63.9%) and being a victim or a witness of domestic violence (35 participants, 58.3%) (Table 1). Thirty-eight (65.5%) participants reported receiving psychological (8 13.8%), psychopharmacological (14, 24.1%), or medical treatment (4, 6.9%), or being under more than one of these conditions (12,

20.7%). Of the entire sample, 52.5% ($n = 32$) reported being single, widowed or divorced, and approximately half reported having completed a university degree, bachelor's, master's, or doctoral degree (27, 44.2%). Only 11 (18.0%) participants reported having a full-time job.

3.2. Feasibility and acceptability of the intervention

Fourteen (23.0%) out of 61 women abandoned the intervention. Two dropped out because TSY was not the type of yoga they were accustomed to, and it did not meet their expectations; three left due to a change in their working schedules; one was diagnosed with a medical condition that impaired the practice of yoga; two did not complete the minimum number of sessions required; and six did not report the reasons for dropping out (Figure 2). While we found no statistical differences in age, number of traumatic events or symptom scores between participants who completed the intervention and those who abandoned it (Table 2), the dropouts appeared to be younger and practice yoga more often than completers (77.8% of completers vs. 92.3% of dropouts).

The mean attendance rate among completers was high, with an average of 5.3 sessions ($SD = 0.7$). Specifically, 22 participants (46.8%) attended all sessions, 20 participants (42.6%) attended five sessions, and 5 (10.6%) participants attended four sessions. We did not find any association between the number of sessions attended and demographic, clinical, or outcome variables (Table 2). No participants reported adverse events during the intervention. However, some participants reported emotional discomfort when responding to the trauma questionnaires on the first day of the intervention.

Table 1. Prevalence of traumatic events in the enrolled participants.

Traumatic event	Number of participants	Percentage
Unexpected death of a family member or a close friend	39	63.9
Witnessing or suffering violence within the family	35	57.4
Being a victim of aggression or assault	27	44.3
Being subjected to threats	25	41.0
Witnessing serious threats or harm to a family member or a close friend	24	39.3
Suffering a spontaneous or an induced abortion	23	37.7
Being a victim of a car, train, or plane accident	22	36.1
Being a victim of physical abuse	21	34.4
Being a victim of sexual harassment	16	26.2
Being close to drowning	15	24.6
Being a witness of serious physical assault to others	14	23.0

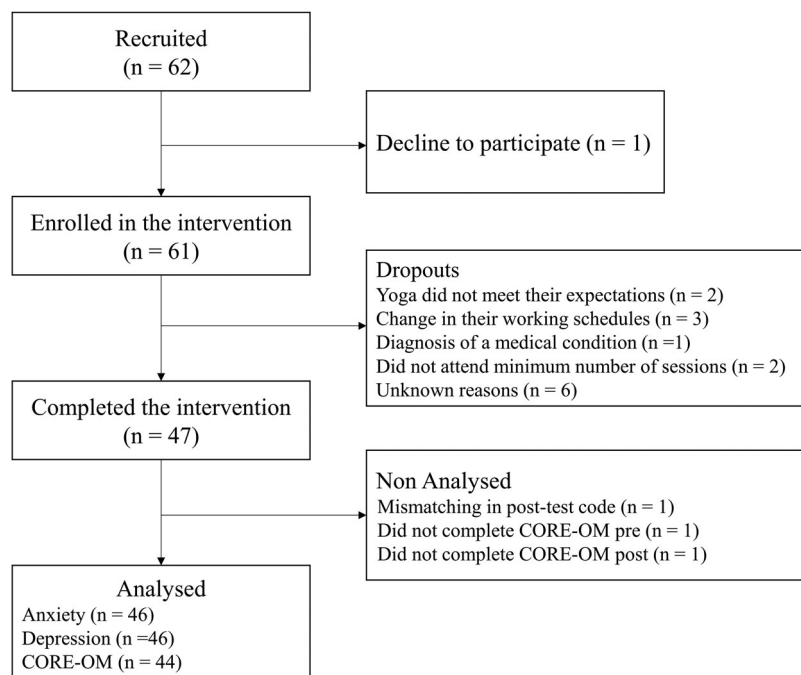


Figure 2. Participants flow diagram.

Acceptability of the intervention was notably high, with participants who completed it reporting a mean satisfaction of 3.4 out of 4 ($SD = 0.4$; $Min = 2.6$; $MAX = 4$). The aspects of the intervention that received the highest ratings (mean score = 3.7) were its quality and overall satisfaction. Remarkably, all but one participant expressed their willingness to repeat the programme if needed. Furthermore, all participants indicated that they would recommend the programme to a friend in need of similar help. The lowest rated item was: *To what extent has our programme helped you to solve your problems* (mean = 2.5), where most women reported that it did not or in most cases not helped them (57.8%).

In the open-ended responses, participants positively valued several aspects of the intervention, such as its open perspective that allowed them to choose movements that suited their condition, its adaptability

to their individual capabilities and needs, or the paced rhythm of the sequence. Participants also highlighted characteristics of the therapists such as their respect, warmth, attentiveness, and professionalism. Furthermore, they acknowledged the positive outcomes of the intervention, which included a greater acceptance towards their own bodies, a feeling of relaxation, and the acquisition of emotional self-regulating strategies. On the other hand, participants demanded a greater number of sessions or longer sessions and noted that poor punctuality of the assistants affected the flow of the sessions. Additionally, participants considered it important to have the option to share their experiences with the group or to complement the intervention with psychological therapy.

Community centre managers reported that the TSY intervention was among the most highly regarded programmes in the centres, leading to higher than usual

Table 2. Differences between completers and dropout participants after the intervention in age, number of traumatic events, and symptoms, and correlations between these variables and the number of sessions attended.

	<i>n</i>	Mean	SD	<i>t</i>	<i>gl</i>	<i>p</i>	<i>d</i>	Number of sessions attended
Age								$r = .178$; $p = .182$
Completers	44	54.16	11.63	1.293	56	.201	0.397	
Dropouts	14	49.50	12.11					
No. of traumatic events								$r = .007$; $p = .956$
Completers	47	4.89	3.20	0.037	59	.971	0.009	
Dropouts	14	4.86	3.46					
Anxiety								$r = .020$; $p = .879$
Completers	47	1.61	0.67	0.367	59	.715	0.112	
Dropouts	14	1.53	0.76					
Depression								$r = .016$; $p = .902$
Completers	47	1.10	0.57	0.227	59	.822	0.069	
Dropouts	14	1.06	0.61					
Psychological discomfort								$r = -.016$; $p = .903$
Completers	46	2.02	0.81	0.219	58	.828	0.067	
Dropouts	14	1.97	0.84					

Note: The last column indicates the correlations of the number of sessions attended with age, no. of traumatic events, and symptoms.

attendance rates. In two of these four community centres, TSY facilitators were recruited to continue conducting TSY sessions regularly after the study concluded. All YST facilitators perceived that the intervention was well-received by the participants and that they were able to guide the sessions without hindrance. They also expressed the need for implementing follow-up sessions to consolidate the changes, reducing the number of participants in numerous groups, and developing a more defined therapeutic framework.

3.3. Emotional distress and psychological discomfort

After the intervention, participants showed lower anxiety, $t(45) = 4.13$; $p < .001$; $d = 0.609$, depression, $t(45) = 5.47$; $p < .001$; $d = 0.806$, and CORE-OM total score, $t(43) = 4.36$; $p < .001$; $d = 0.657$ (Table 3). Moreover, improvements were observed in the CORE-OM subscales scores, including well-being, $t(43) = 4.21$; $p < .001$; $d = 0.635$, functioning, $t(43) = 3.77$; $p < .001$; $d = 0.569$, and problems, $t(43) = 3.82$; $p < .001$; $d = 0.576$.

At the beginning of the study, 26 participants (56.5%) surpassed the anxiety cut-off point set for non-clinical populations, 30 (65.2%) exceeded the cut-off point for depression, and 35 (76.1%) exceeded the CORE-OM cutting point. After the intervention, these frequencies were reduced to 18 (39.1%), 20 (43.5%) and 26 participants (57.8%) respectively for anxiety, depression, and CORE-OM scores. Likewise, 10, 12 and 10 women, respectively, transitioned from a clinical to a non-clinical score, and only three participants experienced an aggravation in one or more of the scores (one woman showed an increase in all three scores, another one did so in the depression and CORE-OM scores, and another one in the anxiety score).

For the intention-to-treat analyses, a total of 61 participants were considered, although only 53 of them had pre-post measures. Eight participants only completed the premeasurement; in six cases the last CORE-OM-10 post-session measurement was used

as the study endpoint (two in the sixth session, two in the third, and two in the second); and for one participant, who did not complete the CORE-OM questionnaire in the first session, the first post-session response (in session 3) was included as the pre-intervention value for this analysis. A significant reduction in CORE-OM scores was also found in the intention-to-treat sample (pre: 2.0 ± 0.8 ; post: 1.5 ± 0.7), $F(1, 59.3) = 27.68$; $p < .001$; $d = 0.621$.

3.4. Analysis of the nonequivalent control variables

We observed no significant differences between pre- and post-intervention scores in benevolent sexism, $t(45) = 1.20$; $p = .235$; $d = 0.178$, nor in drive for thinness, $t(44) = 1.96$; $p = .057$; $d = 0.292$. Importantly, we found that the mean change in the outcomes significantly differed from the mean change in the nonequivalent dependent variables, $\Delta\chi^2 = 10.61$, $p = .001$. Post-hoc comparisons revealed that, in all cases, the amount of change observed in the outcomes exceeded that of the nonequivalent dependent variables (Table 4).

3.5. Analysis of the interoceptive mechanisms

Post-intervention, we found that participants presented larger scores in body responsiveness, $t(44) = 3.15$; $p = .003$; $d = 0.470$, and in interoceptive awareness, $t(43) = 3.30$; $p = .002$; $d = 0.498$.

All mediation analyses showed a positive intervention effect on body responsiveness and interoceptive awareness. These improvements, in turn, led to a significant decrease in anxiety and psychological discomfort scores, but not in depression. The indirect intervention effects on psychological discomfort and anxiety scores were found to be significant only through their effects on body responsiveness, but not through interoceptive awareness. We also found direct effects of the intervention on both psychological discomfort and anxiety scores. In essence, the intervention yielded improvements in psychological discomfort and anxiety scores and such improvement was partially conveyed through an increase in body responsiveness.

Table 3. Pre- and post-intervention scores in the outcome and in the non-equivalent control variables.

Variable	N	Pre-intervention		Post-intervention		Cohen's <i>d</i>
		Mean	SD	Mean	SD	
Anxiety	46	1.62	0.67	1.25	0.62	0.609
Depression	46	1.11	0.58	0.74	0.48	0.806
Psychological discomfort	44	2.01	0.82	1.54	0.68	0.657
Well-being	44	2.26	0.93	1.80	0.76	0.635
Functioning	44	1.63	0.78	1.22	0.63	0.569
Problems	44	2.23	1.00	1.69	0.88	0.576

Note: Well-being and functioning are reversed scales, meaning that higher scores indicate lower well-being or functioning.

Table 4. Pair differences between outcomes and nonequivalent control variables.

Comparison	Student's		<i>p</i> -value*	Cohen's <i>d</i>
	<i>t</i>	<i>df</i>		
Anxiety – Sexism	2.62	45	.072	0.386
Depression – Sexism	3.66	45	.004	0.540
Psychological discomfort – Sexism	3.14	43	.018	0.473
Anxiety – Drive for thinness	2.94	44	.030	0.439
Depression – Drive for thinness	4.03	44	.001	0.600
Psychological discomfort – Drive for thinness	3.25	43	.012	0.490

Note: **p*-values corrected for six comparisons.

In the mediation model for depression, both indirect effects were non-significant whereas the direct effect of the intervention was significant. In other words, pre-post improvements on depressive symptomatology were not mediated by changes in body responsiveness nor interoceptive awareness but mainly due to the direct effect of the intervention (Table 5).

In our sample, body responsiveness and interoceptive awareness showed strong correlations in pre, $n = 44$, $r = .684$; $p < .001$, post, $n = 44$, $r = .767$; $p < .001$, and change scores, $n = 43$, $r = .532$; $p < .001$. As a result, although in the final model interoceptive awareness did not present a significant mediational effect, as illustrated in the supplementary material (Tables S3 and S4), when it was included as the sole mediator in the model, the mediation of interoceptive awareness became significant. This probably occurs because, when both variables are introduced into the model, body responsiveness overrides interoceptive awareness.

4. Discussion

Participants reported numerous and repeated stressful life events: 63.4% experienced four or more traumatic events, being five traumatic events the overall mean. According to previous literature, the number of

traumatic events is a positive predictor of CPTSD (Brewin et al., 2022) and having more than four traumatic events has been found to increase by seven the odds of CPTSD diagnosis (Cloitre et al., 2019). At the beginning of the study, 24% of the sample met criteria for a clinical score in all the three outcomes (anxiety, depression, and psychological discomfort) and 78% met criteria for one or more. These findings align with previous research, which associates higher levels of anxiety, depression, and reduced well-being with exposure to complex traumatic stress experiences (Cloitre et al., 2019). These indicators along with lowered interception levels, a high percentage of the sample undergoing psychiatric, psychological, and medical treatments, and the use of public services dedicated to supporting individuals at social risk, might be suggesting that our sample exhibits the psychological and social discomfort typically associated with chronic and complex stress.

We observed a 25% dropout rate among enrolled participants, with many dropping out after the first session. This rate is consistent with dropout rates reported in other feasibility studies of yoga interventions in different populations (ranging from 20% to 40%) (Clark et al., 2014; Kinser et al., 2013; Ravindran et al., 2021). TSY typically involves a paced practice of hatha yoga, focused on providing a deeper experience of interoceptive awareness. While more dynamic sequences may be used, our decision to adapt the TSY sessions to the physical capabilities of most participants may not have been appealing to individuals seeking more dynamic yoga practices. Likewise, given the lower employability and limited economic resources of the study participants, changes in their working conditions or schedules may have adversely affected their adherence. Many of the women were caregivers, and the demands of this role imply time constraints and the need to manage unforeseen events, which often prevented participants from attending all the sessions. These aspects should be considered in future interventions to increase the rate of adherence to the programme.

Despite this, the acceptability of the intervention remained high, with participants who completed the programme attending nearly all the sessions and even requesting more frequent sessions. Notably, participants emphasized the importance of dedicating time to share the psychological aspects of their experiences, either within the group or during psychotherapy sessions. While YST promotes the non-interpretation of the bodily experiences that arise during the sessions (Emerson, 2015), our study suggests that there is an unmet need for symbolizing, expressing, and finding meaning in these experiences, especially in contexts of trauma processing (Matos et al., 2021; Park, 2022). Doing so within the group would allow participants to gather and offer social

Table 5. Direct and indirect effects of the mediation analysis models.

HADS – Anxiety	Est.	SE	Z	p-value	CI – low	CI – upp
Intervention → BR	.47	.14	3.33	.001	.19	.75
Intervention → IA	.32	.10	3.35	.001	.13	.51
BR → Anxiety	–.29	.09	–3.13	.002	–.47	–.11
IA → Anxiety	–.07	.14	–.49	.625	–.33	.20
Direct effect	–.24	.08	–2.82	.005	–.40	–.07
Indirect effect through BR	–.14	.06	–2.28	.022	–.26	–.02
Indirect effect through IA	–.02	.04	–.48	.629	–.11	.07
Indirect total effect	–.16	.06	–2.57	.010	–.28	–.04
Total effect	–.40	.09	–4.63	<.001	–.56	–.23
HADS – Depression						
Intervention → BR	.47	.14	3.33	.001	.19	.75
Intervention → IA	.32	.10	3.35	.001	.13	.51
BR → Depression	–.11	.08	–1.41	.158	–.26	.04
IA → Depression	–.19	.11	–1.71	.087	–.42	.03
Direct effect	–.28	.07	–3.99	<.001	–.42	–.14
Indirect effect through BR	–.05	.04	–1.30	.194	–.13	.03
Indirect effect through IA	–.06	.04	–1.52	.128	–.14	.02
Indirect total effect	–.12	.05	–2.46	.014	–.21	–.02
Total effect	–.40	.07	–5.83	<.001	–.53	–.26
CORE-OM – Psychological discomfort						
Intervention → BR	.46	.14	3.20	.001	.18	.75
Intervention → IA	.31	.10	3.14	.002	.11	.50
BR → CORE-OM	–.33	.11	–3.11	.002	–.54	–.12
IA → CORE-OM	–.25	.16	–1.56	.118	–.56	.06
Direct effect	–.25	.10	–2.58	.010	–.44	–.06
Indirect effect through BR	–.15	.07	–2.23	.026	–.29	–.02
Indirect effect through IA	–.08	.05	–1.40	.162	–.18	.03
Indirect total effect	–.23	.08	–2.87	.004	–.38	–.07
Total effect	–.48	.11	–4.51	<.001	–.69	–.27

Note: BR: Body responsiveness; IA: Interoceptive Awareness.

support, foster collective resilience and rely less on external resources (Garcia & Rimé, 2019; Rimé, 2020). However, implementing this approach safely would require YST facilitators with expertise in group dynamics, especially with vulnerable populations. To our knowledge, structured hybrid interventions of this kind in a group format are currently nonexistent.

After the intervention, participants experienced improvements in anxiety, depression, and psychological discomfort. Physical activity and mindfulness have proven effective in reducing anxiety and depression (Brake et al., 2016; O'Shea et al., 2022), and meditation-based yoga interventions, such as TSY, have shown greater symptom reduction compared to physically oriented yoga (Cramer et al., 2018). These integrated interventions not only provide opportunities for behavioural activation and exposure, but also for thought disputation, acceptance, self-compassion, and the cultivation of other adaptive emotion-regulation strategies (Kananian et al., 2017; Pascoe et al., 2021). Indeed, mindfulness-based interventions have been proposed as a transdiagnostic approach for stress-related disorders, as they help individuals avoid excessive engagement and escalation of negative affect while fostering positive affect (Brake et al., 2016).

Given the lack of a control group, an important issue is the degree to which the changes can be attributed to the effect of the intervention. There are a few important considerations. Firstly, subject attrition may bias the results, especially if those who respond less favourably to the intervention are lost or if attrition is associated with the outcomes' scores. In this regard, our results remained consistent when analysing the sample on an intention-to-treat basis. Furthermore, the dropouts did not appear to be different from the completers, and we did not find any association between the number of sessions completed and the main variables at the beginning of the intervention. Secondly, the observed changes could be attributed to confounding variables such as participant maturation, historical events, or test-related effects. To rule out those threats to internal validity we measured two nonequivalent dependent variables, which are expected to reflect changes derived from factors unrelated to the intervention (Shadish et al., 2002). We observed that the changes observed in our primary outcomes (anxiety, depression, and psychological discomfort) were significantly larger than the changes observed in the nonequivalent control variables. While it is possible that sexism and drive for thinness might be less susceptible to change over time, research has shown that even low-intensity stimuli can impact these measures (Fasoli et al., 2023; Fischer, 2006; Quiroga-Garza et al., 2023; Tucci & Peters, 2008). Therefore, we think that these results can be carefully interpreted as evidence of the intervention's efficacy.

We also found an increase in body responsiveness and interoceptive awareness after the treatment. TSY offers a platform for self-observation and exposure to inner sensations, which are expected to improve interoceptive mechanisms (Van Der Kolk et al., 2014). For instance, participants are trained to monitor their body's relaxation and activation, their breathing flow, emotional state, and the impact of sensory stimuli in their bodies. This observation fosters acceptance, trust, regulation, and informs effective decision-making (Fujimoto et al., 2021) – all crucial dimensions of interoceptive awareness and body responsiveness (Mehling, Acree, et al., 2018).

We found that body responsiveness mediated the effect of the intervention on anxiety and psychological discomfort. Interoceptive accuracy and metacognitive awareness are linked to low levels of anxiety (Garfinkel et al., 2016), more intense perception of emotions (Wiens et al., 2000), and better emotion regulation strategies (Füstös et al., 2013; Kever et al., 2015). Therefore, increases in the detection of bodily signals may be key to reducing dissociation and other forms of disconnection from the present moment in trauma survivors (Mehling, Chesney, et al., 2018; Neukirch et al., 2019). Stress can influence interoception, dysregulate physiological processes, alter the perception of bodily sensations, and trigger physical symptoms. These effects, in turn, may contribute to further escalation of stress levels (Schulz & Vögele, 2015). Improving interoceptive mechanisms may be the first step in breaking this cycle. By enhancing interoceptive awareness through practices like TSY, individuals may regain control over how their bodies respond to stress not only within therapy sessions, but also in real-life situations, as reported by many participants during post-intervention group discussions.

We did not find evidence supporting the mediation effect of interoceptive awareness in reducing depression. While some authors have suggested that interoceptive dysfunction may play a role in depression (Harshaw, 2015), interpretations of such findings are not always clear (Eggart et al., 2019). It is possible that TSY improves depression and other distress symptoms through ways other than interoception. First, one may consider the abovementioned effects of exercise, mindfulness, and interoception on mental health. In this regard, the effect of an interoception-based intervention on depression has been found not to differ from the effect of an exercise-oriented intervention (Danielsson et al., 2014). Second, the intervention offered participants opportunities to gather social support and cultivate a sense of belonging to a community that shared similar experiences of trauma and distress. Social support has been found to be a protective factor against numerous mental disorders and to compensate for high levels of

rumination in depressive symptoms and suicidal ideation (McLaren et al., 2007; Turner & McLaren, 2011).

This study has some limitations. First, the pre–post design is not the most appropriate for evaluating intervention efficacy. Fully randomized studies are necessary for a more robust assessment of the efficacy of the intervention. Second, the study sample, although reporting symptoms and a high frequency of recurrent traumatic events, lacked clinically diagnoses. Third, the intervention duration was relatively short compared to other TSY interventions proposed in the literature (Cramer et al., 2018; Hendriks et al., 2017). While this duration was enough to generate changes in the measured outcomes and mediating mechanisms, we cannot assure these changes will be maintained in the absence of a follow-up period. Despite these limitations, the results suggest that the TSY programme may have a positive impact on reducing symptoms of anxiety, depression, and psychological distress in women who have experienced traumatic events. However, it is important to manage group size, align the number of sessions with participants' needs, and define the therapeutic framework of YST facilitators. In future interventions, it may be also interesting to offer a space for participants to share their experiences, individually or collectively, after the sessions.

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Authors' contributions

Conceptualization: DS & JMC; Methodology: PFC & JMC; Formal analysis: DS, PFC & JMC; Investigation: DS; Resources: DS; Data Curation: DS, PFC & JMC; Writing – Original Draft: DS; Writing – Review & Editing: DS, PFC & JMC.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Ethics approval and consent to participate

This research has been approved by the Ethics Committee of the Universidad Pontificia Comillas (Spain), has obtained the authorization of those responsible for the municipal resources involved, and has obtained the informed consent of all the participants.

Data availability statement

The dataset is available at: https://github.com/PFernandez-Cancer/trauma_yoga.

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