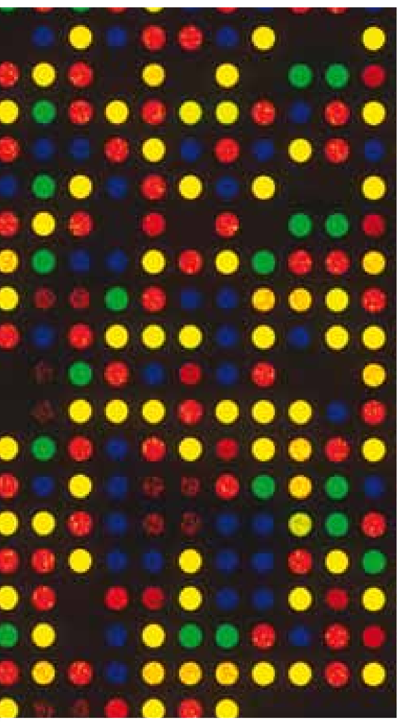
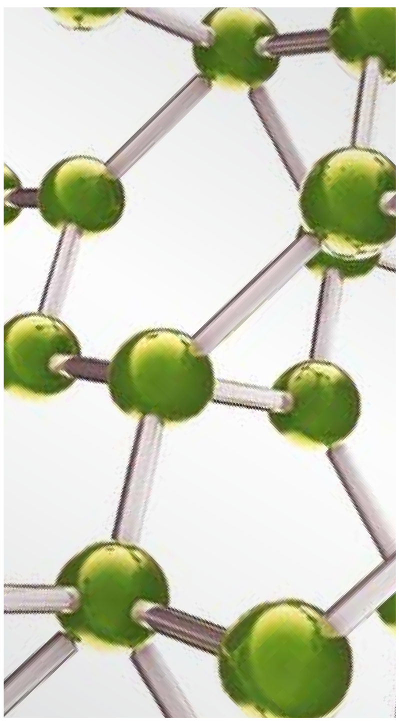
eCAM
Evidence-Based Complementary and Alternative Medicine

Yoga and Rehabilitation: Physical, Psychological, and Social

Guest Editors: Shirley Telles, Elisa Kozasa, Luciano Bernardi, and Marc Cohen






Yoga and Rehabilitation: Physical, Psychological, and Social

Yoga and Rehabilitation: Physical, Psychological, and Social

Guest Editors: Shirley Telles, Elisa Kozasa, Luciano Bernardi, and Marc Cohen

Editorial Board

Contents

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2013, Article ID 624758, 2 pages
http://dx.doi.org/10.1155/2013/624758

Editorial

Yoga and Rehabilitation: Physical, Psychological, and Social

Shirley Telles,[1] Elisa Kozasa,[2,3] Luciano Bernardi,[4,5] and Marc Cohen[6]

[1] *Patanjali Research Foundation, Haridwar, India*
[2] *Hospital Israelita Albert Einstein, 05651-901 São Paulo, SP, Brazil*
[3] *Department of Psychobiology, Universidade Federal de São Paulo, 04023-062 São Paulo, SP, Brazil*
[4] *Department of Internal Medicine, University of Pavia, Italy*
[5] *Folkhälsan Research Center, University of Helsinki, Finland*
[6] *Royal Melbourne Institute of Technology, Melbourne, VIC, Australia*

Correspondence should be addressed to Shirley Telles; shirleytelles@gmail.com

Received 30 September 2013; Accepted 30 September 2013

Yoga was intended for spiritual evolution [1], but increasingly nowadays it is used for its incidental benefits such as stress reduction and managing lifestyle related disorders. Despite its Indian origin, the number of yoga practitioners in Western society is growing: in the United States, for example, a national survey showed that 6.1% of the adults were practicing yoga in 2007 [2].

Apart from the benefits of Yoga practice in preventing and managing disease, yoga has several applications in rehabilitation (*rehabilitare* = to restore, in Latin). Rehabilitation is of different types such as (i) physical, (ii) psychological, and (iii) social. Yoga, as a way of life, has helped persons with physical disorders to return to health, an example being coronary artery disease [3, 4]. Other conditions which have benefitted from yoga practice include stroke after cerebrovascular accidents [5] and patients with heart failure, in whom exercise capacity, oxygen saturation, and parasympathetic activity were restored [6, 7]. Yoga breathing or *pranayama* was especially beneficial for COPD [8]. Practicing yoga has also been used with good results in degenerative disorders such as idiopathic Parkinson's syndrome [9] and muscular dystrophy [10].

With regard to psychological rehabilitation, yoga practice has helped restore the psychological function and mental equilibrium in persons with posttraumatic stress disorder [11] and even certain psychotic conditions [12].

Finally, yoga practice can help people who are at a disadvantage because of their social circumstances. This includes persons in jail [13], those from the "inner city" [14], children in remand homes [15, 16], and older people living in community centers [17, 18]. Social rehabilitation includes dimensions of physical and psychological rehabilitation.

Despite the research cited above, there is a continued need for research. A summary of yoga reviews pointed to the importance of larger-scale, rigorous research with higher methodological quality and adequate control groups.

Additionally, it should be stressed that although research should be aimed at yoga as a whole (hence including postures as well as meditation, respiratory practices, diet, and other aspects) this is obviously very complex, as the contribution of many different aspects cannot be easily identified, and confounding factors may play a decisive role. Also, the complexity and variety of different yoga techniques make a comparison between different studies very difficult. On the other hand, a "reductionist" approach seems to be more feasible from a scientific point of view, due to an easier separation of the specific effects of a single intervention (e.g., the analysis of one posture or the analysis of a single type of *pranayama*), but it is obviously at the risk of missing the whole effect of yoga. As a typical example, if one measures only the energy expenditure of a single yoga session, one may conclude that yoga will be of no use to lose weight, but other crucial effects of yoga related to weight control could be missed, such as the attention to diet and possibly a direct effect of *pranayama* on the hypothalamus, through which yoga does actually lead to weight loss. Thus, a careful balance between these opposite aspects needs to be taken into account when planning research on yoga.

The analyzed reviews suggested a number of areas where yoga may be beneficial, but more research is required for them to really establish such benefits. Nevertheless, some meta-analyses indicated that there are several randomized clinical trials of relatively high quality indicating beneficial effects of yoga for pain-associated disability and mental health [8]. Considering the large number of different yoga techniques and schools of yoga, it is also important for researchers to describe, in detail, the specific method used in a given study.

Yoga is worth investigating as it is relatively cost-effective, its practices can be adapted for different groups of patients, and if well oriented, the risks of side effects are very low. We hope that this special issue will give new insights for the development of novel, well-designed studies in the field of yoga and rehabilitation.

Shirley Telles
Elisa Kozasa
Luciano Bernardi
Marc Cohen

References

[1] G. Feuerstein, *The Yoga Tradition*, Hohm Press, Prescott, Ariz, USA, 3rd edition, 2002.

[2] P. M. Barnes, B. Bloom, and R. L. Nahin, "Complementary and alternative medicine use among adults and children: United States, 2007," National Health Statistics Reports 12, National Center for Health Statistics, Hyattsville, Md, USA, 2008.

[3] D. Ornish, S. E. Brown, L. W. Scherwitz et al., "Can lifestyle changes reverse coronary heart disease?" *The Lancet*, vol. 336, no. 8708, pp. 129–133, 1990.

[4] S. C. Manchanda, R. Narang, K. S. Reddy et al., "Retardation of coronary atherosclerosis with yoga lifestyle intervention," *Journal of Association of Physicians of India*, vol. 48, no. 7, pp. 687–694, 2000.

[5] A. A. Schmid, M. Van Puymbroeck, P. A. Altenburger et al., "Poststroke balance improves with yoga: a pilot study," *Stroke*, vol. 43, no. 9, pp. 2402–2407, 2012.

[6] L. Bernardi, C. Porta, L. Spicuzza et al., "Slow breathing increases arterial baroreflex sensitivity in patients with chronic heart failure," *Circulation*, vol. 105, no. 2, pp. 143–145, 2002.

[7] L. Bernardi, G. Spadacini, J. Bellwon, R. Hajric, H. Roskamm, and A. W. Frey, "Effect of breathing rate on oxygen saturation and exercise performance in chronic heart failure," *The Lancet*, vol. 351, no. 9112, pp. 1308–1311, 1998.

[8] T. Raupach, F. Bahr, P. Herrmann et al., "Slow breathing reduces sympathoexcitation in COPD," *European Respiratory Journal*, vol. 32, no. 2, pp. 387–392, 2008.

[9] E. Hall, G. Verheyden, and A. Ashburn, "Effect of a yoga programme on an individual with Parkinson's disease: a single-subject design," *Disability and Rehabilitation*, vol. 33, no. 15-16, pp. 1483–1489, 2011.

[10] S. Telles, A. Balkrishna, and K. Maharana, "Effect of yoga and ayurveda on duchenne muscular dystrophy," *Indian Journal of Palliative Care*, vol. 17, no. 2, pp. 169–170, 2011.

[11] S. Telles, N. Singh, M. Joshi, and A. Balkrishna, "Post traumatic stress symptoms and heart rate variability in Bihar flood survivors following yoga: a randomized controlled study," *BMC Psychiatry*, vol. 10, article 18, 2010.

[12] S. Varambally, S. Vidyendaran, M. Sajjanar et al., "Yoga-based intervention for caregivers of outpatients with psychosis: a randomized controlled pilot study," *Asian Journal of Psychiatry*, vol. 6, no. 2, pp. 141–145, 2013.

[13] S. V. Vyavahare, "Yoga for jail inmates," in *Proceedings of the 1st International Conference on Frontiers in Yoga Research and Applications*, VKYRF, Bangalore, India, December 1991.

[14] D. L. Berger, E. J. Silver, and R. E. K. Stein, "Effects of yoga on inner-city children's well-being: a pilot study," *Alternative Therapies in Health and Medicine*, vol. 15, no. 5, pp. 36–42, 2009.

[15] S. Telles, S. Narendran, P. Raghuraj, R. Nagarathna, and H. R. Nagendra, "Comparison of changes in autonomic and respiratory parameters of girls after Yoga and games at a community home," *Perceptual and Motor Skills*, vol. 84, no. 1, pp. 251–257, 1997.

[16] P. Raghuraj and S. Telles, "Muscle power, dexterity skill and visual perception in community home girls trained in yoga or sports and in regular school girls," *Indian Journal of Physiology and Pharmacology*, vol. 41, no. 4, pp. 409–415, 1997.

[17] M. N. Krishnamurthy and S. Telles, "Assessing depression following two ancient Indian interventions: effects of Yoga and Ayurveda on older adults in a residential home," *Journal of Gerontological Nursing*, vol. 33, no. 2, pp. 17–23, 2007.

[18] N. K. Manjunath and S. Telles, "Influence of Yoga & Ayurveda on self-rated sleep in a geriatic population," *Indian Journal of Medical Research*, vol. 121, no. 5, pp. 683–690, 2005.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2013, Article ID 984678, 11 pages
http://dx.doi.org/10.1155/2013/984678

Research Article

The Improvement of Emotion and Attention Regulation after a 6-Week Training of Focused Meditation: A Randomized Controlled Trial

Carolina Baptista Menezes,[1,2] Maria Clara de Paula Couto,[3] Luciano G. Buratto,[4] Fátima Erthal,[5] Mirtes G. Pereira,[6] and Lisiane Bizarro[2]

[1] *Faculdade de Psicologia, Universidade Federal de Pelotas, Avenida Duque de Caxias 250, 96030-001 Pelotas, RS, Brazil*
[2] *Laboratório de Psicologia Experimental, Neurociências e Comportamento, Universidade Federal do Rio Grande do Sul, Ramiro Barcelos 2600, Sala 105, 90035-003 Porto Alegre, RS, Brazil*
[3] *Universidade Federal do Rio Grande do Sul, Ramiro Barcelos 2600, Sala 104, 90035-003 Porto Alegre, RS, Brazil*
[4] *Department of Psychology, Durham University (Queen's Campus), Stockton on Tees TS17 6BH, UK*
[5] *Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro, Avenida Carlos Chagas Filho 373, Prédio do CCS, Bloco G, Sala G2-035, Rio de Janeiro, RJ, Brazil*
[6] *Laboratório de Neurofisiologia do Comportamento, Universidade Federal Fluminense, Hernani Pires de Mello 101, São Domingos, 24.210-130 Niterói, RJ, Brazil*

Correspondence should be addressed to Carolina Baptista Menezes; menezescarolina@hotmail.com

Received 21 March 2013; Accepted 17 June 2013

Academic Editor: Marc Cohen

Self-regulatory trainings can be an effective complementary treatment for mental health disorders. We investigated the effects of a six-week-focused meditation training on emotion and attention regulation in undergraduates randomly allocated to a meditation, a relaxation, or a wait-list control group. Assessment comprised a discrimination task that investigates the relationship between attentional load and emotional processing and self-report measures. For emotion regulation, results showed greater reduction in emotional interference in the low attentional load condition in meditators, particularly compared to relaxation. Only meditators presented a significant association between amount of weekly practice and the reduction in emotion interference in the task and significantly reduced image ratings of negative valence and arousal, perceived anxiety and difficulty during the task, and state and trait-anxiety. For attention regulation, response bias during the task was analyzed through signal detection theory. After training, meditation and relaxation significantly reduced bias in the high attentional load condition. Importantly, there was a dose-response effect on general bias: the lowest in meditation, increasing linearly across relaxation and wait-list. Only meditators reduced omissions in a concentrated attention test. Focused meditation seems to be an effective training for emotion and attention regulation and an alternative for treatments in the mental health context.

1. Introduction

From a psychological point of view, meditation is a broad term that refers to a variety of techniques that aim to develop self-regulatory skills in the emotional and cognitive domains [1]. There has been an increased interest in the scientific study of meditation practices, in both its clinical application in the health care context and in the understanding of its mechanisms of action [2, 3].

From a theoretical and practical perspective, meditation seems to be particularly related to greater mental health [4, 5]. In psychological terms, one of the rationales underlying the meditation practice is that it comprises a form of mental training through which practitioners try to develop and increase flexibility and awareness of their mental processes, culminating in mental stability, well-being, and emotional balance [6]. Accordingly, results from randomized trials have demonstrated that meditation interventions as short as one or two months long can promote psychological improvements in patients with disorders such as social anxiety [7, 8], depression [9], and distress [10], as well as in healthy samples [11, 12].

It has been discussed that these outcomes likely reflect more adaptive emotion regulatory strategies, particularly better control of attention allocation, which allows the interruption of negative emotional processing [5, 13]. Noteworthy, attentional training constitutes one of the fundamental principles upon which meditation practices develop [3, 6], and it has been regarded as a cornerstone for any self-regulatory training from a cognitive perspective [14]. Thus, there seems to be an interesting parallel between psychological and meditation premises on how to foster emotion regulation.

Taking these considerations into account, the present study aimed to validate a secular focused meditation training by evaluating its effects on the ability to control attention allocation to negative stimuli in a healthy sample of undergraduates. The technique employed resembles *dharana* meditation [3], but, instead of using a mantra, it consisted of focusing attention on counting the out breath in order to avoid any direct link to a specific philosophy or doctrine in the university environment. The meditation group was compared to a relaxation and a wait-list control group, and the training schedule consisted of six weekly meetings.

Both emotion and attention regulations were assessed through a behavioral paradigm—the discriminative task [15]. The task comprises the random display of either a negative arousing or a neutral picture in the center of the screen, flanked by two peripheral bars. Participants are instructed to direct their eye gaze to the center while ignoring the task-irrelevant image and decide by a key press if the bars have the same orientation or not. There are two conditions, each requiring different levels of processing resources to succeed on the task. These are referred to as easy and difficult load conditions, in which subjects have to discriminate bars with a 90° or 6° difference in orientation, respectively. The emotion impact index is represented by the interference of the irrelevant negative image on the relevant attention task for each condition. According to the load theory [16], greater allocation of attentional resources to a relevant task may help reduce interference from irrelevant emotional stimuli. Thus, attentional deployment away from emotional stimuli, imposed by task constraints, may reduce emotional response and be an effective emotion regulation strategy [17, 18]. In the present study, we did not expect differences among groups for the difficult load condition, given that its exogenous attentional load was probably high enough to modulate emotion interference for all groups (see [15]). However, it was expected that in the easy condition only those trained in meditation would reduce emotion interference after training. Regardless of the low attentional load of the easy task, meditators were expected to have developed endogenous attentional control and greater attentional deployment away from the emotional stimuli [1]. Those trained only in relaxation or the wait-list controls were not expected to show such control.

Additionally, to further explore their attention regulation capacity, given that the task demanded an executive attention operation—paying attention to, discriminating, and deciding about the difference between two peripheral bars, we relied on signal detection theory (SDT) analyses [19]. In particular, the response bias index was used as it has been related to attentional control [20–22]. Response bias can be interpreted as the tendency to prioritize one of two answers, normally indicating that the subject adopts a strategy. In other words, it is a readiness to automatically give the same response [19, 23]. Given that attention training was an exclusive component of the meditation intervention and based on the importance of attention for self-regulation, we expected that only meditators would decrease response bias.

2. Methods

2.1. Participants. College students from the Universidade Federal do Rio Grande do Sul were invited to take part in the study through email and posters spread around its three campuses. Five hundred and twenty four students volunteered. After an online screening survey, participants were excluded if they were not in the range of 20–40 years old, did not have normal or corrected to normal vision, had any psychiatric or neurologic disorder, were taking any psychoactive medication, were undergoing psychotherapy treatment, and had had previous experience with meditation or yoga. One hundred students (57% female, 92% single, 81% with up to five minimum wage income, mean age 25 years, SD = 4.41) eligible for participation were randomly assigned to one of three groups: focused meditation (FM = 35), progressive relaxation (PR = 37), or wait-list control (WLC = 28). Seventy-four participants concluded the experiment (FM = 26, PR = 24, WLC = 24), of whom 41% were female, 70% single, 59% with up to five minimum wage income, and with a mean age of 25 years, SD = 4.44. None of these variables differed among groups ($P \geq .05$), nor did attrition rates [$\chi^2(2) = 3.60$, $P = .16$]. The Federal University of Rio Grande do Sul Ethics Committee (Institutional Review Board) approved this study. Participants provided written informed consent before the data were collected.

2.2. Design. This study comprised a randomized controlled trial. For the discrimination task, we employed a 2 (distractors' emotional load: neutral versus negative) × 2 (trial's attentional load: easy versus difficult) × 3 (group: focused meditation versus progressive relaxation versus wait-list control) design with repeated measures on the first two factors.

2.3. Assessment

2.3.1. Screening

Sociodemographic Questionnaire. Created for the present study in order to investigate sociodemographic variables and exclusion criteria variables.

Self-Report Questionnaire—SRQ [24]. The SRQ consists of 23 questions that investigate minor and psychotic psychiatric symptoms through yes/no answers. The validated Brazilian version, whose sensitivity and specificity coefficients are 83% and 80%, respectively, was used [25]. The cutoff point for female and male was 7 and 6 positive answers, respectively.

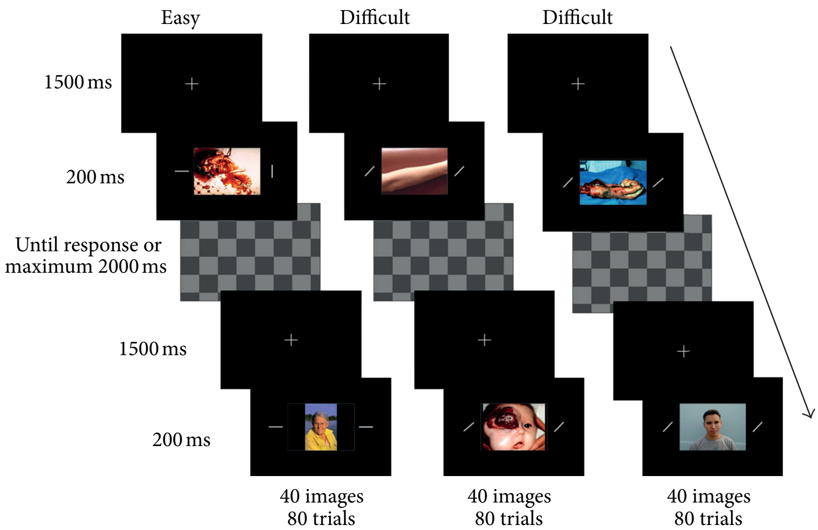


FIGURE 1: Experimental design: a centered fixation cross was presented for 1,500 ms, followed by a central picture and two peripheral bars, presented simultaneously (for 200 ms) to the right and left sides of fixation. Then a checkerboard-like mask was presented; this remained on the screen until the response was made or 2,000 ms had elapsed. Subjects were instructed to ignore the central picture and attend to the peripheral bars, responding with a keypress as quickly and accurately as possible whether the bars were in the same or a different orientation.

2.3.2. Pretest and Posttest

State and Trait Anxiety Inventory (STAI) [26]. The STAI comprises two scales measuring state and trait anxiety through twenty questions each. Answers are given on a 4-point Likert scale (1 = *not at all*, 4 = *very much*). The state and trait questions represent how the person feels at the present moment and normally, respectively. The higher the score, the greater the anxiety levels. The validated Brazilian version was used. Cronbach's alpha for the state scale is .89 and .88 for the trait [27].

Concentrated Attention Test (Teste de Atenção Concentrada—AC) [28]. AC is a Brazilian psychometric test that assesses focused attention, with a test-retest coefficient of .73. For a maximum of 5 minutes, participants should mark only three types of triangles, among many others, all randomly distributed in rows on a paper sheet. Assessment of focused attentional performance includes correct answers, errors, omissions, and total score.

Adult Self-Report Scale—ASRS [29]. The ASRS consists of 18 items, contemplating attention deficit and hyperactivity disorder (ADHD) symptoms adapted to adult life. Answers are given on a 5-point scale (0 = *never*, 1 = *rarely*, 2 = *sometimes*, 3 = *often*, and 4 = *very often*). Positive answers include "often" and "very often," and for some questions (items 3, 4, 5, and 9 for part A and items 2, 7, and 9 for part B) "sometimes." Cut-off point for possible diagnosis includes a minimum of 6 symptoms in at least one domain (inattention items 1–9 from part A and hyperactivity items 1–9 from part B), or both, and a score above 24 is considered highly suggestive of diagnosis. The ASRS was used in order to compare these symptoms across groups. If groups differed, this variable would be controlled for in AC and discrimination task analyses.

Discrimination Task [15]. Figure 1 illustrates the trial structure. Each trial initiated with a fixation cross, shown for 1,500 ms. Next, a central picture ($9^{\circ} \times 12^{\circ}$) and two peripheral bars ($0.3^{\circ} \times 3.0^{\circ}$) were presented for 200 ms. The bars were at 9° to the right and left of the center of the picture. A whole-screen checkerboard mask was then shown, remaining on the screen until the subject responded or for 2,000 ms, which was the response deadline. The subjects were instructed to ignore the task-irrelevant central images and to respond as quickly and as accurately as possible whether or not the orientations of the peripheral bars were the same. Keypresses (with the right or left index finger) corresponding to same/different orientations ("q" or "p") were counterbalanced across subjects. Two classes of images were employed: "neutral" (NE) and "emotional/unpleasant" (EM). Neutral images consisted of photographs of people, and unpleasant images consisted of photographs of mutilated bodies. We chose mutilated bodies because these are considered to be a very impacting category of emotional stimuli, likely to cause interference. Indeed, it has been already demonstrated that these images are efficient in generating an interference effect in the same paradigm used in the present study [15]. One hundred and twenty different images, 60 neutral and 60 unpleasant were utilized. A different set of pictures was used in the pretest and posttest sessions, and in each session pictures were repeated once. Forty-two images (14 neutral and 28 unpleasant) were taken from the International Affective Picture System (IAPS) developed by Lang and colleagues [30], and the remaining ones were obtained from the Internet. For the latter group of images, following the protocol developed by Lang and colleagues, all images were assessed on a 1–9 scale in terms of valence (from *negative* to *positive*) and arousal (from *low* to *high*) by a group of undergraduate students ($N = 20$, $M_{age} = 22.3$ years, SD = 1.8) using the paper-and-pencil version of the

Self-Assessment Manikin [31]. Overall, images in the neutral category had mean valence ratings of 5.0 and mean arousal ratings of 3.3; images in the unpleasant category had mean valence ratings of 2.2 and mean arousal ratings of 6.4. The experimental session started with three training blocks containing 20 trials each, which were followed by three regular blocks of trials (80 trials each). The order of neutral and unpleasant images within a block was randomized. During training blocks, all images were photographs of objects, such as tools and furniture. During each experimental block, the difficulty of the bar-orientation task was fixed. One "easy" (EA) and two "difficult" (DF) blocks were obtained by manipulating the angular difference of the bars on nonmatch trials: 90° in easy blocks and 6° in the difficult blocks. There were two difficult blocks to guarantee the necessary number of correct answers in this condition. Each block contained the same number of match and nonmatch trials and the same number of neutral and unpleasant images. Valence and arousal levels for emotional and neutral images presented in each block type were matched to avoid differences in emotionality between blocks. During the training blocks, participants received feedback, which indicated anticipatory responses (reaction times—RT—less than 100 ms), slow responses (RT greater than 2,000 ms), and whether an incorrect key was pressed; during training, the RT was also indicated on the screen after each trial. Experimental blocks, which followed the training blocks, lasted approximately 5 min each, and their order was randomized across subjects. The subjects sat approximately 60 cm from the display, and the stimuli were presented with the software E-Prime.

Task Ratings. Two analog scales were used to assess how anxious participants felt during the task (anxiety DT) and how difficult they thought the task was (difficulty DT). Answers were given on a 10-point scale (0 = *not at all*, 10 = *very much*).

Picture Ratings. Participants viewed the pictures previously presented in the task in order to assess their valence and arousal. In total, 4 blocks were presented: 20 negative pictures from the easy condition, 20 neutral pictures from the easy condition, 20 negative pictures from the difficult condition, and 20 neutral pictures from the difficult condition. For the difficult condition, because there were two blocks during the behavioral task, the 20 negative and 20 neutral pictures were randomly selected from both blocks. The set of images in the behavioral task was different from pre- to posttest. Thus, the set of images for the ratings was also different for pre- and posttest. For the 4 blocks in the picture rating, images were displayed for 1 sec, and in the end participants had 15 sec to rate the block using the paper-and-pencil version of the Self-Assessment Manikin [31]. For both valence and arousal subjects rated the block from 1 (*very unpleasant and very relaxing, resp.*) to 9 (*very pleasant and very alerting, resp.*).

Program Rating. At the end of the 6-week training, participants rated the meditation and relaxation programs' quality (1 = *very bad*, 2 = *bad*, 3 = *indifferent*, 4 = *good*, and 5 = *very good*) and the usefulness of practices (1 = *not at all*, 2 = *a little*, and 3 = *very much*).

2.3.3. During Intervention

Practice Record. Every week participants received and completed a form to register the frequency and duration of practice at home.

2.4. Procedure. After advertisement, volunteers interested in taking part in the study were sent the screening questionnaires online. Those eligible to participate were contacted to schedule a visit to the laboratory for the pretest session, which occurred during two weeks prior to the beginning of the trainings for all participants. Two assessments, one at pretest and another at posttest (before and after training, resp.), were carried out at the Laboratory of Experimental Psychology, Neuroscience, and Behavior, at the Institute of Psychology, Federal University of Rio Grande do Sul. The following sequence of assessment was used: STAI-S, AC, STAI-T, discrimination task, task ratings, ASRS, and picture ratings. The reason for determining this sequence was twofold: to avoid the influence of the experimental task in the anxiety measures, as well as in the concentrated attention test, and to avoid leaving the task for the last assessment, as this could affect performance due to the amount of previous testing. Students were randomly assigned to one of the three groups. FM and PR trainings included 6 weekly meetings, each lasting one hour and thirty minutes. For each of them, there were four concurrent groups undergoing training at different times during the week. Posttest sessions also occurred during the two weeks after the training, following the same assessment sequence. WLC participants did not have any activity between testing sessions but did receive the meditation training after final testing. Training sessions were conducted by one of the authors, a psychologist with group experience, extensive training, and regular personal practice of yoga and meditation. Meetings were held in classrooms in the three campuses. Training sessions always started with a brief discussion about participants' weekly practice, difficulties, and experiences, followed by instructions, breathing exercises, formal practice—FM or PR—and again a brief discussion about the experience with that particular meeting. In the first and second meetings, formal practice lasted 15 and 20 minutes, respectively. For the following meetings, practices lasted 30 minutes. For the FM, participants could either sit cross-legged on a mat or on a chair with their feet on the ground. Because everyone was a beginner, they were instructed to pay attention to their own breathing, trying to slightly prolong the exhalation. Also, in order to characterize focused meditation, as well as to maintain their focus to this process and to the present moment, they were instructed to count their exhalation (mantras were not used in order to avoid any direct links to a specific philosophical or religious tradition). In the first half of the training, counting consisted of cycles fromof 1 to 10, and, for the next half, participants counted backwards from 100 to 1 (always one number per exhalation). PR sessions were formatted the same way, but all participants lay down on the mat for formal practice, which consisted of successive exercises of tension-relaxation for specific muscle groups [32]. A different muscle group was focused in each session (1st = wrists and arms; 2nd = face—forehead, eyes, nose, mouth, jaw; 3rd = neck; 4th = shoulders, chest, back, and abdomen; 5th = legs, feet; 6th = all together). Many repetitions of tension (±7 sec) and relaxation (±30 sec) were performed, after which people were guided to relax each part of the body, trying to keep alert during the whole process for the remaining time. For both groups, in the first meeting we provided a CD specially recorded for the study, with each guided practice, in order to help the daily training at home, as well as the practice record forms, which were collected in the last meeting or posttest session.

2.5. Statistical Analyses

2.5.1. Pretest. At pretest, a oneway ANOVA was performed to compare all self-report measures among groups and between gender.

For the discrimination task, all anticipatory and slow responses (<100 ms and >2,000 ms, resp.) were excluded from analyses; eliminated trials were infrequent at pre- and posttest (1.01% and 1% of the trials, resp.).

To explore the modulation produced by the emotional pictures we calculated the median reaction time (RT) and error rate (ER) for neutral and negative trials for each participant. These were the dependent variables, included in a factorial general linear model (GLM) for repeated measures considering load (easy versus difficult) and valence (emotional versus neutral) as within factors and group (FM versus PR versus WLC) as a between-subjects factor. We ran separate analyses for RT and ER.

A signal detection theory (SDT) analysis [19] was used to explore the effects of the meditation intervention over attentional control. First we calculated hits and false alarms, and response bias (k) analyses were conducted on the proportion of correct responses ((k) "Same" rate: the tendency to respond "same", regardless of trial status) [19]. These were included in a GLM for repeated measures, with the same factors described above.

2.5.2. Posttest. At posttest, the same GLMs were again carried out but with time as an additional within-subjects factor (pretest versus posttest). ANOVAs, polynomial contrasts, and pairwise comparisons using t-test were applied when appropriate. For all analyses, the SPSS 20.0 was used, and the alpha level for statistical significance was $P = .05$.

3. Results

3.1. Pretest. All measures were compared between drop-outs (i.e., participants who did not complete the study) and completers (i.e., participants who completed training and both testing sessions), and no significant differences were found. There were neither differences nor interactions between completers' groups in any of the variables analyzed. Of particular importance for this study, groups did not differ on attention deficit-hyperactivity disorder symptoms as measured by the ASRS ($F(2, 88) = 1.81$, $P = .17$, FM: $M = 20.4$, SD = 5.20, PR: $M = 21.2$, SD = 3.80; WLC: $M = 22.00$, SD = 3.40).

3.1.1. Discrimination Task. There were no differences among groups for any of the task analyses ($P > .05$). A general emotional interference produced by the presence of a negative picture while subjects performed the discriminative task was revealed by the main effect for valence in the RT ($F(1, 94) = 11.59$, $P = .001$). Participants were slower to perform the task when the central picture was negative ($M = 600$ ms, SD = 171) than neutral ($M = 582$ ms, SD = 148). The assumption that the difficulty of the bar orientation task was increased by reducing the angular difference between the bars was corroborated by a main effect of load in the ER outcome ($F(1, 94) = 803.3$, $P < .001$; DF > EA). As expected, error rates were increased during the difficult condition ($M = 45\%$, SD = 8.2) in comparison to the easy condition ($M = 11\%$, SD = 10.9).

Using signal detection theory analysis, results showed that in the difficult condition response bias was significantly greater ($F(1, 96) = 117.6$, $P < .001$; $M = .73$, SD = .18)) than in the easy condition ($M = .50$, SD = .04).

3.1.2. Self-Report Assessments. There were no differences among groups ($P > .05$). Results are presented in Table 1.

3.2. Posttest

3.2.1. Practice Record and Program Ratings. Weekly practice for the FM group varied between 2 and 5 times ($M = 3.01$, SD = 1.06) and 17–115 minutes per week ($M = 50$ min., SD = 26.9). For PR, practice varied between 2 and 4 times ($M = 3.03$, SD = .94) and 17–76 minutes ($M = 48$ min., SD = 16.00). There were no significant group differences for these variables ($P = .96$, and $P = .89$, resp.). Program ratings did not differ between FM (quality: $M = 4.60$, SD = .49; usefulness: $M = 2.80$, SD = .42) and PR (quality: $M = 4.50$, SD = .50; usefulness: $M = 2.80$, SD = .36) (quality: $t(48) = .45$, $P = .65$; usefulness: $t(46) = -.64$, $P = .52$) groups.

3.2.2. Discrimination Task. The reaction time analysis of the emotional interference effect produced by viewing emotional pictures revealed an interaction between valence and time ($F(1, 66) = 4.1$, $P = .045$). Performing the discrimination task in the presence of an emotional picture was significantly different from neutral picture only at pretest ($t(96) = 3.40$, $P = .001$), but not at posttest ($t(70) = 1.7$, $P = .09$).

According to our hypothesis, we expected a reduction of the emotional effect of negative stimuli in the easy condition in the posttest session for the FM group. To test this difference, we created a variable to represent modulations in reaction time due to intervention. The variable was calculated by subtracting the reaction times in the posttest condition from the reaction times in the pretest condition for emotional and neutral images, each separately, and for each load condition (easy and difficult). Thus, there were a variable representing the subtraction in reaction time for the emotional images in the easy and in the difficult condition and a variable representing this subtraction for neutral images in the easy and the difficult condition. Negative values would indicate a reduction of picture interference on the main discrimination task. After performing a GLM for this variable for each load condition separately, results partially corroborated our hypothesis. We analyzed data from each load condition separately because, as discussed previously, they represent conditions with very different levels of neural resources available to

Table 1: General linear model for repeated measures: changes in self-report assessments from Pre- to posttest for each group.

Questionnaires	GLM		Paired t-tests					
			FM		PR		WLC	
	df	F	Pretest M (SD)	Posttest M (SD)	Pretest M (SD)	Posttest M (SD)	Pretest M (SD)	Posttest M (SD)
Anxiety								
STAI state	2.69	9.34*	1.93 (.41)	1.78 (.39)	1.92 (.37)	1.78 (.29)	1.78 (.35)	2.16 (.49)*
STAI trait	2.69	9.75*	1.94 (.44)	1.78 (.33)*	1.95 (.43)	1.83 (.43)	1.90 (.34)	2.16 (.42)*
Attention								
AC-correct answer	2.69	.19	105.7 (20.8)	118.5 (19.4)	101.6 (24.8)	111.3 (23.4)	105.8 (18.8)	117.7 (17.7)
AC-errors	2.69	.58	.53 (.90)	1.19 (4.6)	1.04 (1.9)	.75 (1.6)	.59 (.79)	.41 (.73)
AC-omissions[a]	2.69	.49	10.8 (8.3)	7.1 (5.2)*	10.7 (14.1)	8.4 (7.1)	13.1 (7.8)	12.2 (5.6)
AC-total score	2.68	.35	93.6 (21.9)	111.0 (20.3)	89.8 (29.8)	102.2 (24.7)	92.5 (20.5)	107.2 (20.5)
Task ratings								
Anxiety DT	2.53	4.50*	5.73 (2.62)	3.95 (2.0)*	5.09 (2.2)	5.24 (2.1)	5.81 (2.5)	6.50 (2.0)
Difficulty DT	2.53	5.0*	6.94 (2.0)	5.26 (1.9)**	6.90 (1.8)	6.90 (1.8)	7.25 (2.1)	7.38 (1.3)
VAL-E	2.68	3.86*	1.43 (.47)	1.70 (.55)*	1.44 (.69)	1.70 (.73)	1.81 (.82)	1.47 (.64)
ARO-E	2.68	3.41*	7.75 (1.2)	6.97 (.90)*	7.24 (1.8)	7.40 (.97)	7.36 (1.5)	7.47 (1.3)
VAL-N	2.68	.31	5.68 (.85)	6.18 (1.3)	5.98 (1.3)	6.24 (1.3)	6.18 (.99)	6.43 (1.3)
ARO-N	2.68	.09	2.81 (1.5)	2.77 (1.5)	3.24 (1.8)	3.22 (1.5)	2.47 (1.5)	2.61 (1.3)

GLM: general linear model for repeated measures; FM: focused meditation; PR: progressive relaxation; WLC: wait-list control; STAI: state trait anxiety inventory; AC: atenção concentrada (concentrated attention); DT: discriminant task; VAL-E: assessment of valence in emotional condition; ARO-E: assessment of arousal in emotional condition; VAL-N: assessment of valence in neutral condition; ARO-N: assessment of arousal in neutral condition.
[a]Student's t-test.
$^{*}P < .05$; $^{**}P < .001$.

process the distractive pictures and group effect that were not expected to be present in the difficult load condition. We found a trend towards an interaction between valence and group in the easy condition ($F(2, 66) = 2.38$, $P = .10$) but not in the difficult condition ($F(2, 66) = 1.71$, $P = .20$). To further explore these results, we carried out planned comparisons for emotional and neutral images in the easy condition. Meditators presented a significantly greater reduction of emotion interference in comparison to the relaxation group ($t(46) = 2.69$, $P = 0.01$) but not in comparison to the wait-list control group ($t(43) = -.88$, $P = .37$) (Figure 2). There were no significant differences between groups for neutral images (all Ps > .05).

In order to make sure that this result indicated a reduction in the emotional interference by negative stimuli among meditators and not just a tradeoff between speed and error, we also created the same index subtracting ER for emotion images from pre- to posttest, and there were no group differences ($F(2, 66) = 1.47$, $P = .23$).

Finally, to explore if the amount of meditation practice could predict the ability to reduce the emotional impact of negative stimuli in the easy condition, we conducted a linear regression analysis between mean days of weekly practice and the index of reduction of picture interference described above. Only in the FM group there was a negative relationship between number of days of weekly practice and the variable representing the reduction in RT for emotional images ($r = -.40$, $P = .04$) (Figure 3).

Considering the ER as the outcome, we found only a main effect for load ($F(1, 66) = 689.4$, $P < .001$; DF > EA).

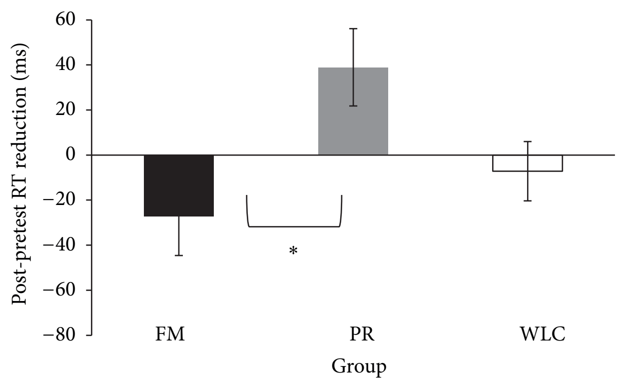


Figure 2: Mean values (ms) representing the subtraction of posttest reaction times from pretest reaction times for emotional images in the easy condition. Negative values indicate a reduction of picture interference in the task. Standard errors are represented by the error bars. FM: focused meditation; PR: progressive relaxation; WLC: wait-list control. A one-way ANOVA indicated a significant difference among groups, and pairwise comparisons revealed that the meditation group presented a significantly greater reduction than the relaxation group. $^{*}P < .05$.

For SDT analysis, response bias remained higher in the difficult condition ($F(1, 68) = 81.1$, $P < .001$; DF > EA) but was significantly reduced at posttest ($F(1, 68) = 23.1$, $P < .001$; pretest > posttest). Importantly, there was a significant three-way interaction (load × time × group: $F(2, 68) = 4.0$, $P = .02$). More specifically, in the easy condition at posttest, there was an increase in response bias only in the WLC (FM: $t(23) = -1.3$, $P = .18$; PR: $t(23) = 1.0$, $P = .28$; WLC: $t(22) =$

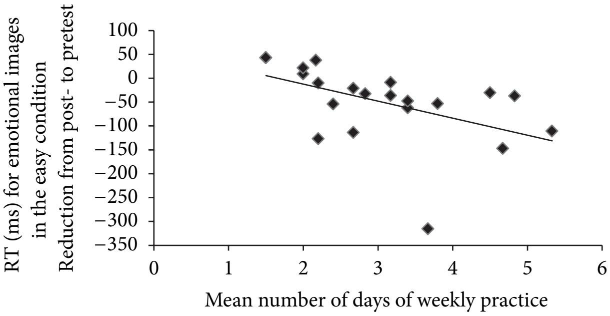


Figure 3: Association between the mean number of days of weekly practice and the variable representing the post-pretest reduction in RT (ms) for emotional images in the easy condition for the FM group. Number of days of practice was not reported by six participants.

-2.7, $P = .01$), and in the difficult condition response bias was significantly reduced in the FM and PR groups (FM: $t(23) = 5.6$, $P < .001$; PR: $t(23) = 3.6$, $P = .001$; WLC: $t(22) = 1.0$, $P = .29$) (Figure 4).

Also, response bias followed a dose-response pattern at posttest, in which meditation practitioners presented the smallest bias, followed by relaxation and wait-list control ($F(2, 68) = 4.0$, linear test $P = .02$) (Figure 5).

3.2.3. Self-Report Assessments. Table 1 shows results for self-report measures. After training, FM showed improvements in trait anxiety and some task ratings. Despite no significant interaction between group and time for concentrated attention parameters, paired comparisons revealed a significant reduction of omission errors only for meditation (FM: $t(25) = 2.17$, $P = .03$; PR: $t(23) = 1.05$, $P = .30$; WLC: $t(21) = .53$, $P = .59$). There were no significant correlations between amount of practice and any of the self-report measures for any of the active groups.

4. Discussion

The present study evaluated the effect of a six-week focused meditation training on emotion and attention regulation in a healthy sample of undergraduates, in comparison to a relaxation and a wait-list control group. Findings indicated that meditators presented greater reduction of emotion interference in the easy condition, which was not explained by a tradeoff with error rate, and which was complemented by a significant reduction in the subjective evaluation of negative valence and arousal of emotional images. Additionally, only meditators presented a significant reduction in state and trait anxiety and an increase in concentrated attention. Most importantly, the frequency of meditation practice predicted the reduction of interference produced by negative stimuli as revealed by a negative relationship between the number of days of weekly practice and the reduction in RT for emotional images. Finally, meditators presented a greater reduction in response bias in the difficult condition, which followed a dose-response pattern.

4.1. Meditation and Emotion Regulation. Behavioral studies show that experimental manipulation of attention reduces emotion interference produced by distractive emotional stimuli, especially when attention load to the main task is high [15, 33]. This idea gives support to the present findings, in which meditators presented the most pronounced reduction in emotional interference after training and group differences were present only in the easy condition. The difficult condition consisted of a high exogenous attentional load task [34], facilitating attentional deployment away from the emotional stimuli. In this condition, task load was so high that it may have exhausted processing resources and reduced the processing of the distractive emotional stimuli for all groups. However, in the easy condition, the task's exogenous demands were lower, freeing up participants' resources to process the distractive pictures. In this condition, it was expected that emotional pictures would produce an interference on behavior, revealed by increased reaction times. The results showed that meditators were better to regulate interference from emotional pictures. Reaction times when negative stimuli were presented were reduced after meditation training. This indicates that meditators were able to control their attention better to perform the bar discrimination task, reducing the interference of emotional distractive information. Their increased ability to control attention allowed them more successfully to deploy attention as an emotional regulation strategy [17, 18].

One limitation, however, was the lack of a memory test for the images after the task. A better recall of emotional images might have indicated a more efficient use of divided attention, instead of better selective attention. Nevertheless, we believe this is not the case, given that meditators produced less negative valence ratings and lower arousal ratings. Also, they specifically practiced focused meditation, in which selective and sustained attentions are trained in order to inhibit distractions—internal or external—or disengage faster from them [1]. Studies investigating the efficacy of different emotion regulation strategies have demonstrated that selective attention allocation helps reducing emotional reactivity [18]. In fact, attention allocation may be more effective than other strategies, such as reappraisal and suppression [35–37], and one possible explanation relates to their temporal distinction, given that attention allocation takes place faster, impacting earlier stages of emotion-generative processes [38].

In line with these assumptions, other studies have also observed the efficacy of meditation for emotion regulation [39–41] and that psychological improvements following meditation training were mediated by enhanced top-down control [12, 42]. Interestingly, meditation can be more effective than distraction—an attention-allocation strategy—in reducing reactivity to negative self-beliefs related to social anxiety disorder [7]. One hypothesis for this outcome is the idea that meditation comprises a combination of an attentive mind with an emotional state of relaxation [3, 43, 44].

Our results showed that only meditators had a significant reduction in trait and state anxiety. This finding is particularly relevant, given that higher levels of anxiety can impair the regulatory process, biasing attention towards negative stimuli [45], or disrupting modulation of negative emotion [46]. Thus, cultivating attention stability along with a relaxation state seems to facilitate regulatory processes, possibly

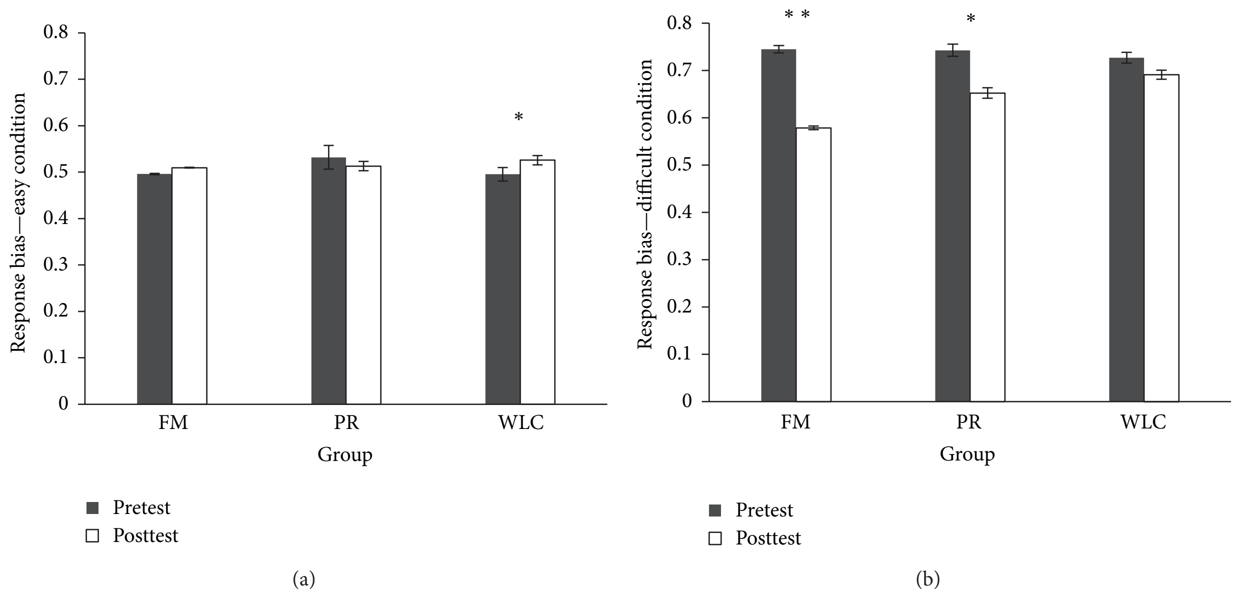


Figure 4: Mean response bias rate at pre- and posttest for each group. FM: focused attention meditation; PR: progressive relaxation; WLC: wait-list control. Standard errors are represented by the error bars. (a) In the easy condition, there was a significant increase in response bias at posttest for the wait-list control group. $^{*}P < .05$. (b) In the difficult condition, participants from both meditation and relaxation groups significantly reduced response bias at posttest. $^{**}P < .001$; $^{*}P < .01$, respectively.

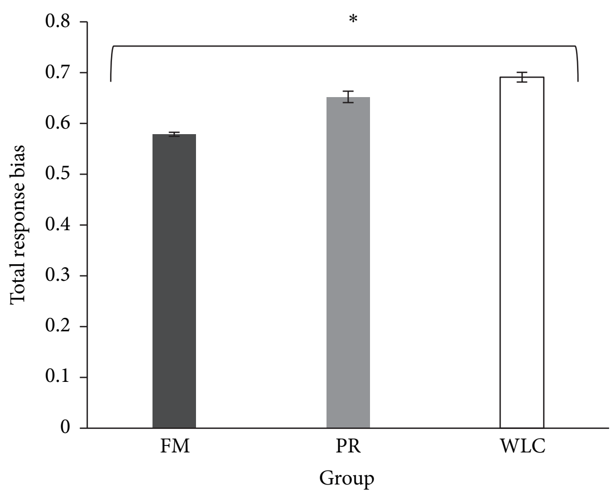


Figure 5: Total mean response bias rate for each group at posttest. FM: focused attention meditation; PR: progressive relaxation; WLC: wait-list control. Standard errors are represented by the error bars. There was a linear significant effect ($^{*}P < .05$), in which the meditation group presented the smallest bias, followed by the relaxation group, and next by the wait-list control group.

explaining why meditation may be distinct from other strategies, such as distraction [7] or relaxation [40].

4.2. Meditation and Attention Regulation. As stated previously, response bias can be interpreted as the tendency to prioritize one of two answers, normally indicating that the subject adopts a strategy. In other words, it is a readiness to respond the same thing in an automated fashion [19, 23]. In the context of repeated two-option forced choices, like in our task, people present less persistence in doing subsequent cognitive tasks, either solvable or unsolvable, indicating that resource depletion is related to impaired executive control [47]. Thus, the fact that in the present study response bias was significantly higher in the difficult condition across groups at pretest, but significantly lower at posttest, particularly in the meditation group, suggests an improvement in their executive control.

This is in line with other studies that have used different selective attention manipulations to investigate response bias [20–22]. For instance, a three-week attention training aiming to help subjects ignore distractors and process the target more efficiently in an auditory selection task produced a significant reduction in response bias after training, which correlated with neural response as indexed by P3 amplitude [21]. In other words, the more attention subjects allocated to the target, the more controlled and less automated were their responses. Likewise, it has been shown that reversing a pattern of response bias was only possible through selective attention training but not through training in which the manipulation involved a high load cognitive operation [22].

Greater executive control has been demonstrated in people who have participated in meditation training programs, as well as in experienced meditators [48–50]. Similarly, areas typically involved in executive control, such as lateral prefrontal cortex and anterior cingulate cortex [51, 52], are more activated during meditation or during the execution of an attentional task by meditators when compared to controls [53–56].

It should be noted that one study which also used a discrimination task to investigate meditation effects on vigilance found no difference for response bias after a three-month meditation training [57]. However, in our results, response bias interacted with difficulty, and the task used by MacLean et al. did not include distractors nor had a condition that was more difficult than the other. Thus, in their study there might have been no reason for participants to adopt a strategy in the first place. In addition, participants were already meditators at pretest [57].

Finally, we highlight that this reduction is likely to have been intentional, goal-oriented, and not simply an inverse strategy or random response, because in the latter situations the result would have been accompanied by a higher error rate, which was not the case. Thus, in the difficult condition at posttest, meditators seem to have had more executive control over their goal-oriented behavior, which is in line with the hypothesis of greater attention efficiency in attention tasks among meditators [50, 58]. This regulation can also be inferred from the finding that only meditators significantly reduced omissions in the concentrated attention test, corroborating studies that used similar [3] as well as different measures of concentrated attention [59]. Importantly, given that a motivational reward, such as money, can facilitate attentional and conflict resolution performance [60], it is worth highlighting that our participants were not paid for their participation and that a potential interaction with this external motivational factor is ruled out in the present study.

4.3. Meditation as a Psychological Rehabilitation. Our results corroborate the idea that emotion and attention regulation are intertwined and that meditation can enhance these skills. Moreover, meditation seems to constitute a particular type of emotion regulation strategy, which can be clinically relevant. It is known that in some psychiatric patients, even in remission, such as remitted depressed patients, there is a difficulty in reducing amygdala's reactivity to negative emotional stimuli when using reappraisal, and this correlates with the report of significantly less use of such strategy on a daily basis [61]. Likewise, there is evidence showing that anxiety patients present a bias favoring amygdala overactivation, as well as under-recruitment of prefrontal areas in the processing of negative stimuli [45].

Thus, self-regulation practices, such as the meditation training proposed in the present work, seem to be an alternative for clinical conditions, especially considering the early effects of attention on emotion response [38], and the fact that early reactivity to emotional stimuli may modulate subsequent processing stages [62]. Accordingly, Farb et al. [13] have recently discussed that among patients with affective disorders, mastering the direction of attention can help limiting the cognitive elaboration of negative emotions and negative self-evaluation.

These assumptions are in accordance with studies that have demonstrated a positive effect of meditation training in psychiatric symptoms and disorders [5, 7, 63, 64]. For instance, a meta-analysis showed that in patients with anxiety and mood disorders the effect sizes of meditation-based interventions were very robust, independent of year of publication, and maintained over follow-up [65]. It should be noted that in addition to its therapeutic effects, meditation could also contribute to mental health practices by fostering therapist's effectiveness, therapeutic alliance, and complementary perspectives on therapeutic processes [4].

Acknowledgment

This study was funded by the National Council for Scientific and Technological Development (CNPq), FAPERJ, and CAPES.

References

[1] A. Lutz, H. A. Slagter, J. D. Dunne, and R. J. Davidson, "Attention regulation and monitoring in meditation," *Trends in Cognitive Sciences*, vol. 12, no. 4, pp. 163–169, 2008.

[2] A. Lutz, J. D. Dunne, and R. J. Davidson, "Meditation and the neuroscience of consciousness: an introduction," in *Cambridge Handbook of Consciousness*, P. Zelazo, M. Moscovitch, and E. Thompson, Eds., pp. 499–554, Cambridge University Press, New York, NY, USA, 2007.

[3] S. Telles and B. R. Raghavendra, "Neurophysiological changes in meditation correlated with descriptions from the ancient texts," *Biofeedback*, vol. 39, no. 2, pp. 56–59, 2011.

[4] S. E. Abbey, "Mindfulness and psychiatry," *The Canadian Journal of Psychiatry*, vol. 57, no. 2, pp. 61–62, 2012.

[5] R. Chambers, E. Gullone, and N. B. Allen, "Mindful emotion regulation: an integrative review," *Clinical Psychology Review*, vol. 29, no. 6, pp. 560–572, 2009.

[6] B. A. Wallace and S. L. Shapiro, "Mental balance and well-being: building bridges between Buddhism and Western psychology," *The American Psychologist*, vol. 61, no. 7, pp. 690–701, 2006.

[7] P. R. Goldin and J. J. Gross, "Effects of Mindfulness-Based Stress Reduction (MBSR) on emotion regulation in social anxiety disorder," *Emotion*, vol. 10, no. 1, pp. 83–91, 2010.

[8] P. Goldin, M. Ziv, H. Jazaieri, K. Hahn, and J. J. Gross, "MBSR Vs. aerobicexercise in social anxiety: fMRI of emotion regulation of negative self-beliefs," *Social and Cognitive Affective Neuroscience*, vol. 8, no. 1, pp. 65–72, 2013, http://scan.oxfordjournals.org/content/8/1/65.long.

[9] J. D. Teasdale, R. G. Moore, H. Hayhurst, M. Pope, S. Williams, and Z. V. Segal, "Metacognitive awareness and prevention of relapse in depression: empirical evidence," *Journal of Consulting and Clinical Psychology*, vol. 70, no. 2, pp. 275–287, 2002.

[10] S. Jain, S. L. Shapiro, S. Swanick et al., "A randomized controlled trial of mindfulness meditation versus relaxation training: effects on distress, positive states of mind, rumination, and distraction," *Annals of Behavioral Medicine*, vol. 33, no. 1, pp. 11–21, 2007.

[11] T. L. Jacobs, E. S. Epel, J. Lin et al., "Intensive meditation training, immune cell telomerase activity, and psychological mediators," *Psychoneuroendocrinology*, vol. 36, no. 5, pp. 664–681, 2011.

[12] B. K. Sahdra, K. A. MacLean, E. Ferrer et al., "Enhanced response inhibition during intensive meditation training predicts improvements in self-reported adaptive socioemotional functioning," *Emotion*, vol. 11, no. 2, pp. 299–312, 2011.

[13] N. A. S. Farb, A. K. Anderson, and Z. V. Segal, "The mindful brain and emotion regulation in mood disorders," *The Canadian Journal of Psychiatry*, vol. 57, no. 2, pp. 70–77, 2012.

[14] H. A. Wadlinger and D. M. Isaacowitz, "Fixing our focus: training attention to regulate emotion," *Personality and Social Psychology Review*, vol. 15, no. 1, pp. 75–102, 2011.

[15] F. S. Erthal, L. de Oliveira, I. Mocaiber et al., "Load-dependent modulation of affective picture processing," *Cognitive, Affective and Behavioral Neuroscience*, vol. 5, no. 4, pp. 388–395, 2005.

[16] N. Lavie, "Distracted and confused?: selective attention under load," *Trends in Cognitive Sciences*, vol. 9, no. 2, pp. 75–82, 2005.

[17] I. Mocaiber, M. G. Pereira, F. S. Erthal et al., "Fact or fiction? An event-related potential study of implicit emotion regulation," *Neuroscience Letters*, vol. 476, no. 2, pp. 84–88, 2010.

[18] K. N. Ochsner and J. J. Gross, "The cognitive control of emotion," *Trends in Cognitive Sciences*, vol. 9, no. 5, pp. 242–249, 2005.

[19] N. A. Macmillan and C. D. Creelman, *Detection Theory: A User's Guide*, Lawrence Erlbaum Associates, Mahwah, NJ, USA, 2nd edition, 2005.

[20] J. Abrams, A. Barbot, and M. Carrasco, "Voluntary attention increases perceived spatial frequency," *Attention, Perception & Psychophysics*, vol. 72, no. 6, pp. 1510–1521, 2010.

[21] R. D. Melara, Y. Tong, and A. Rao, "Control of working memory: effects of attention training on target recognition and distractor salience in an auditory selection task," *Brain Research*, vol. 1430, pp. 68–77, 2012.

[22] J. D. Miles and R. W. Proctor, "Attention is required for acquisition but not expression of new response biases," *Journal of Experimental Psychology*, vol. 36, no. 6, pp. 1554–1560, 2010.

[23] A. Voss, K. Rothermund, and J. Brandtstädter, "Interpreting ambiguous stimuli: separating perceptual and judgmental biases," *Journal of Experimental Social Psychology*, vol. 44, no. 4, pp. 1048–1056, 2008.

[24] T. W. Harding, M. V. de Arango, and J. Baltazar, "Mental disorders in primary health care: a study of their frequency and diagnosis in four developing countries," *Psychological Medicine*, vol. 10, no. 2, pp. 231–241, 1980.

[25] J. de Jesus Mari and P. Williams, "A validity study of a psychiatric screening questionnaire (SRQ-20) in primary care in the city of Sao Paulo," *The British Journal of Psychiatry*, vol. 148, pp. 23–26, 1986.

[26] C. D. Spielberg, R. L. Gorsuch, R. E. Lushene, A. M. B. Biaggio, and L. Natalício, *Inventário de ansiedade Traço-Estado—IDATE*, Cepa, Rio de Janeiro, Brazil, 1979.

[27] A. C. M. Fioravanti, L. F. Santos, S. Maissonette, A. P. M. Cruz, and J. Landeira-Fernandez, "Avaliação da estrutura fatorial da Escala de Ansiedade-Traço do IDATE," *Avaliação Psicológica*, vol. 5, no. 2, pp. 217–224, 2006.

[28] S. V. Cambraia, *Teste AC—Manual*, Vetor, São Paulo, Brazil, 2003.

[29] P. Mattos, D. Segenreich, E. Saboya, M. Louzã, G. Dias, and M. Romano, "Adaptação transcultural para o português da escala Adult Self-Report Scale para avaliação do transtorno de déficit de atenção e hiperatividade (TDAH) em adultos," *Revista De Psiquiatria Clínica*, vol. 33, no. 4, pp. 188–194, 2006.

[30] P. J. Lang, M. M. Bradley, and B. N. Cuthbert, *International Affective Picture System (IAPS): Affective Ratings of Pictures and Instruction Manual*, University of Florida, Gainesville, FL, USA, 2005.

[31] M. M. Bradley, "Measuring emotion: the self-assessment manikin and the semantic differential," *Journal of Behavior Therapy and Experimental Psychiatry*, vol. 25, no. 1, pp. 49–59, 1994.

[32] M. V. Nieves and J. Vila, "Técnicas de Relaxamento," in *Manual de Técnicas de Terapia e Modificação do Comportamento*, V. E. Caballo, Ed., pp. 147–166, Editora Santos, São Paulo, Brazil, 2002.

[33] C. Morawetz, J. Baudewig, S. Treue, and P. Dechent, "Diverting attention suppresses human amygdala responses to faces," *Frontiers in Human Neuroscience*, vol. 4, article 226, 2010.

[34] M. M. Chun, J. D. Golomb, and N. B. Turk-Browne, "A Taxonomy of external and internal attention," *Annual Review of Psychology*, vol. 62, pp. 73–101, 2011.

[35] P. Kanske, J. Heissler, S. Schönfelder, A. Bongers, and M. Wessa, "How to regulate emotion? Neural networks for reappraisal and distraction," *Cerebral Cortex*, vol. 21, no. 6, pp. 1379–1388, 2011.

[36] K. McRae, B. Hughes, S. Chopra, J. D. E. Gabrieli, J. J. Gross, and K. N. Ochsner, "The neural bases of distraction and reappraisal," *Journal of Cognitive Neuroscience*, vol. 22, no. 2, pp. 248–262, 2010.

[37] G. Sheppes and N. Meiran, "Better late than never? on the dynamics of online regulation of sadness using distraction and cognitive reappraisal," *Personality and Social Psychology Bulletin*, vol. 33, no. 11, pp. 1518–1532, 2007.

[38] R. Thiruchselvam, J. Blechert, G. Sheppes, A. Rydstrom, and J. J. Gross, "The temporal dynamics of emotion regulation: an EEG study of distraction and reappraisal," *Biological Psychology*, vol. 87, no. 1, pp. 84–92, 2011.

[39] N. A. S. Farb, A. K. Anderson, H. Mayberg, J. Bean, D. McKeon, and Z. V. Segal, "Minding one's emotions: mindfulness training alters the neural expression of sadness," *Emotion*, vol. 10, no. 1, pp. 25–33, 2010.

[40] C. N. M. Ortner, S. J. Kilner, and P. D. Zelazo, "Mindfulness meditation and reduced emotional interference on a cognitive task," *Motivation and Emotion*, vol. 31, no. 4, pp. 271–283, 2007.

[41] V. A. Taylor, J. Grant, V. Daneault et al., "Impact of mindfulness on the neural responses to emotional pictures in experienced and beginner meditators," *NeuroImage*, vol. 57, no. 4, pp. 1524–1533, 2011.

[42] A. P. Jha, E. A. Stanley, A. Kiyonaga, L. Wong, and L. Gelfand, "Examining the protective effects of mindfulness training on working memory capacity and affective experience," *Emotion*, vol. 10, no. 1, pp. 54–64, 2010.

[43] Y. Kubota, W. Sato, M. Toichi et al., "Frontal midline theta rhythm is correlated with cardiac autonomic activities during the performance of an attention demanding meditation procedure," *Cognitive Brain Research*, vol. 11, no. 2, pp. 281–287, 2001.

[44] Y.-Y. Tang and M. I. Posner, "Attention training and attention state training," *Trends in Cognitive Sciences*, vol. 13, no. 5, pp. 222–227, 2009.

[45] S. J. Bishop, "Neurocognitive mechanisms of anxiety: an integrative account," *Trends in Cognitive Sciences*, vol. 11, no. 7, pp. 307–316, 2007.

[46] I. Mocaiber, M. G. Pereira, F. S. Erthal, I. Figueira, V. Machado-Pinheiro, M. Cagy et al., "Regulation of negative emotions in high trait anxious individuals: an ERP study," *Psychology & Neuroscience*, vol. 2, no. 2, pp. 211–217, 2009.

[47] K. D. Vohs, R. F. Baumeister, B. J. Schmeichel, J. M. Twenge, N. M. Nelson, and D. M. Tice, "Making choices impairs subsequent self-control: a limited-resource account of decision making, self-regulation, and active initiative," *Journal of Personality and Social Psychology*, vol. 94, no. 5, pp. 883–898, 2008.

[48] D. Chan and M. Woollacott, "Effects of level of meditation experience on attentional focus: is the efficiency of executive or orientation networks improved?" *Journal of Alternative and Complementary Medicine*, vol. 13, no. 6, pp. 651–658, 2007.

[49] B. Froeliger, E. L. Garland, and F. J. McClernon, "Yoga meditation practitioners exhibit greater gray matter volume and fewer reported cognitive failures: results of a preliminary voxel-based morphometric analysis," *Evidence-Based Complementary and Alternative Medicine*, vol. 2012, Article ID 821307, 8 pages, 2012.

[50] E. H. Kozasa, J. R. Sato, S. S. Lacerda et al., "Meditation training increases brain efficiency in an attention task," *NeuroImage*, vol. 59, no. 1, pp. 745–749, 2012.

[51] E. K. Miller and J. D. Cohen, "An integrative theory of prefrontal cortex function," *Annual Review of Neuroscience*, vol. 24, pp. 167–202, 2001.

[52] M. I. Posner and J. Fan, "Attention as an organ system," in *Topics in Integrative Neuroscience: From Cells To Cognition*, J. R. Pomerantz and M. C. Crair, Eds., Cambridge University Press, Cambridge, UK, 2004.

[53] E. B. Short, S. Kose, Q. Mu et al., "Regional brain activation during meditation shows time and practice effects: an exploratory FMRI study," *Evidence-Based Complementary and Alternative Medicine*, vol. 7, no. 1, pp. 121–127, 2010.

[54] J. A. Brefczynski-Lewis, A. Lutz, H. S. Schaefer, D. B. Levinson, and R. J. Davidson, "Neural correlates of attentional expertise in long-term meditation practitioners," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 104, no. 27, pp. 11483–11488, 2007.

[55] J. Dickenson, E. T. Berkman, J. Arch, and M. D. Lieberman, "Neural correlates of focused attention during a brief mindfulness induction," *Social Cognitive and Affective Neuroscience*, vol. 8, no. 1, pp. 40–47, 2013.

[56] N. A. S. Farb, Z. V. Segal, H. Mayberg et al., "Attending to the present: mindfulness meditation reveals distinct neural modes of self-reference," *Social Cognitive and Affective Neuroscience*, vol. 2, no. 4, pp. 313–322, 2007.

[57] K. A. MacLean, E. Ferrer, S. R. Aichele et al., "Intensive meditation training improves perceptual discrimination and sustained attention," *Psychological Science*, vol. 21, no. 6, pp. 829–839, 2010.

[58] H. A. Slagter, A. Lutz, L. L. Greischar, A. D. Francis, S. Nieuwenhuis, J. M. Davis et al., "Mental training affects distribution of limited brain resources," *Plos Biology*, vol. 5, no. 6, article e138, 2007.

[59] A. Lutz, H. A. Slagter, N. B. Rawlings, A. D. Francis, L. L. Greischar, and R. J. Davidson, "Mental training enhances attentional stability: neural and behavioral evidence," *Journal of Neuroscience*, vol. 29, no. 42, pp. 13418–13427, 2009.

[60] S. Padmala and L. Pessoa, "Reward reduces conflict by enhancing attentional control and biasing visual cortical processing," *Journal of Cognitive Neuroscience*, vol. 23, no. 11, pp. 3419–3432, 2011.

[61] P. Kanske, J. Heissler, S. Schönfelder, and M. Wessa, "Neural correlates of emotion regulation deficits in remitted depression: the influence of regulation strategy, habitual regulation use, and emotional valence," *NeuroImage*, vol. 61, no. 3, pp. 686–693, 2012.

[62] S. Moratti, A. Keil, and M. Stolarova, "Motivated attention in emotional picture processing is reflected by activity modulation in cortical attention networks," *NeuroImage*, vol. 21, no. 3, pp. 954–964, 2004.

[63] A. Chiesa and A. Serretti, "A systematic review of neurobiological and clinical features of mindfulness meditations," *Psychological Medicine*, vol. 40, no. 8, pp. 1239–1252, 2010.

[64] N. L. Kocovski, Z. V. Segal, and S. R. Battista, "Mindfulness and psychopathology: problem formulation," in *Clinical Handbook of Mindfulness*, pp. 85–98, Fabrizio Didonna, New York, NY, USA, 2009.

[65] S. G. Hofmann, A. T. Sawyer, A. A. Witt, and D. Oh, "The effect of mindfulness-based therapy on anxiety and depression: a meta-analytic review," *Journal of Consulting and Clinical Psychology*, vol. 78, no. 2, pp. 169–183, 2010.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2013, Article ID 357108, 9 pages
http://dx.doi.org/10.1155/2013/357108

Review Article

Yoga and Mindfulness as Therapeutic Interventions for Stroke Rehabilitation: A Systematic Review

Asimina Lazaridou,[1,2] Phaethon Philbrook,[1,2] and Aria A. Tzika[1,2]

[1] *NMR Surgical Laboratory, Department of Surgery, Division of Burns, Massachusetts General Hospital and Shriners Burn Institute, Harvard Medical School, Boston, MA 02114, USA*
[2] *Radiology, Athinoula A. Martinos Center for Biomedical Imaging, Harvard Medical School, Boston, MA 02114, USA*

Correspondence should be addressed to Aria A. Tzika; aaria_tzika@hms.harvard.edu

Received 28 March 2013; Accepted 8 May 2013

Academic Editor: Marc Cohen

Aim. This paper reports a systematic review and critical appraisal of the evidence on the effectiveness of behavioral therapies such as yoga and mindfulness practices for stroke rehabilitation. *Background*. The experience of stroke can have a negative impact on both psychological and physical health and on quality of life. Yoga and relevant practices are promising therapies that have been used with patients with a variety of conditions. In order to draw conclusions on effectiveness for stroke patients, the evidence requires systematic assessment. *Methods*. A comprehensive search of major biomedical and complementary medicine databases was conducted. Relevant research was categorized by study type and appraised according to study design. *Results*. Five randomized controlled clinical trials and four single case studies were found. Additionally, one qualitative research study was identified. Studies reported positive results, including improvements in cognition, mood, and balance and reductions in stress. Modifications to different yoga practices make comparison between studies difficult, and a lack of controlled studies precludes any firm conclusions on efficacy. *Conclusion*. Yoga and mindfulness could be clinically valuable self-administered intervention options for stroke rehabilitation. Further research is needed to evaluate these specific practices and their suitability in stroke rehabilitation.

1. Introduction

Stroke is one of the most prevalent diseases worldwide causing devastating impairments and negative consequences for survivors [1]. Moreover, it is a main cause of adult-onset disability among people and the cost for care is among one of the fastest-growing Medicare expenses [2]. Poststroke therapy may improve recovery and reduce long-term disability [3], but more psychological therapies for evaluating the specific effects of rehabilitation are needed. Given that many rehabilitation programs currently offer yoga as an option to patients, and that yoga is included as a therapeutic option in a number of rehabilitation medicine texts [4–6], a systematic review of its importance warrants further investigation.

Yoga and mindfulness can be regarded as a main form of alternative medicine therapy [7]. Yoga is an ancient tradition coming from the Sanskrit word "yoga" meaning union or one-pointed awareness. In the Yoga sutras, Patanjali defined the word "yoga" in the first sutra as Atha yoga anushasanam, which means "yoga" is a form of discipline [8]. The word "anushasan" can be broken down into two parts: "anu" meaning "the subtle aspects of human personality," and "shasan" meaning to "rule over" or to "govern" [9]. Therefore, the concept of yogic discipline is knowledge of the subtle dimensions, the aspects of human personality and directing or governing the subtle nature. In the absence of this discipline there will always be a search to find happiness and harmony, a persistent sense of emptiness inside, and a feeling of not fulfilling or deriving the best from life. Yoga practices foster willpower, discipline, and self-control and force the mind and body to work in perfect synergy. Therefore, yoga exercises may have beneficial effects as a stand-alone treatment on stress reduction and overall well-being [10, 11]. In addition, yoga has been seen as a main discipline and practice that has the potential to cultivate mindfulness [12]. However, most literature has focused on mindfulness that is developed through yoga meditation [13], a self-regulation practice that focuses on training attention and awareness in order to exhibit a mental process that reinforces mental health well-being and mental stability.

Dr. John Kabat Zinn, in late 1970, while teaching mindfulness and hatha yoga in Boston, noticed that his trainees were seeking both hatha yoga practices, including asanas (physical exercises), and mindfulness meditation. Therefore, he and his colleagues developed a clinical service that used relatively intensive training in mindfulness meditation practices based on the Vipassana and Zen traditions, along with hatha yoga, for medical patients suffering from a wide range of chronic disorders and diseases [14]. This program evolved into an 8-week course, now known as mindfulness-based stress reduction (MBSR), which is taught worldwide in different centers internationally [15]. Noticeably, practicing mindfulness meditation does not confute the practices of yoga [16]. One practice acts complementary to the other depending on how it is taught and what the needs of the trainees are.

Mindfulness can be defined as a cognitive process that employs the creation of new categories, openness to new information, and awareness of more than one perspective [17]. Dr. Hirst suggests that being mindful requires the person to attend, to be consciously aware of the emergent nature of phenomena in consciousness, and to recognize the nature of attachments made to these phenomena as they occur [18]. Mindfulness, according to Dr. Kabat-Zinn et al. [19], is based on Eastern contemplative tradition and involves "bringing one's attention to the present experience on a moment-by-moment basis" [14, 15]. On the other hand, Professor Langer discusses the cognitive model of mindfulness without emphasis on the meditative part [17]. She believes that mindfulness could be easier understood with the opposite concept: a state of being as if on automatic pilot, involving preoccupation, absent mindedness, carelessness, in attention, disassociation from feelings, thoughts, actions, and habitual responses. Meanwhile, there is now considerable evidence of the effectiveness of mindfulness-based interventions at reducing distress [20, 21] and rehabilitation [22, 23].

Notably, there are many different kinds of hatha yoga and mainstreams based on the multiple traditions that they follow [4, 11, 24]. Thus, the present review will attempt to address this gap within the literature and synthesize the existing research on the positive effects of yoga and relevant meditative practices on stroke rehabilitation.

2. The Present Review

The aim of the present review is to conduct a systematic review of the literature concerning holistic therapies such as yoga and mindfulness as a therapeutic application on stroke rehabilitation. Specifically, only studies evaluating the yoga effects on stroke patients were included.

3. Materials and Methods

3.1. Overview Methodology. The process used for this literature review was highly structured and comprised a number of distinct phases. First, there was the "searching phase," which involves the systematic identification of potentially relevant studies. The second phase was the "screening phase," where a predetermined inclusion and exclusion criteria were applied, allowing us to identify appropriate studies for review. In the third phase, or "data-extraction phase," studies that met the pre-determined inclusion and exclusion criteria were examined in-depth to assess the quality of the study and extract evidence for synthesis. In the fourth stage, or "synthesis phase," the authors developed a framework for analyzing the selected materials. Finally, in the "reporting phase," the authors decide on the most efficient and assessable way to present their findings.

3.2. Search Terms. The terms used for stroke were based primarily on those used by the Cochrane Cancer Field [35]. The terms used were stroke and mindfulness, MBSR, yoga, pranayama, dhyana, asanas, yogic, meditation, meditat*, transcendental meditation, or mindfulness.

3.3. Search Databases. Systematic searches included major biomedical, nursing, and specialist complementary therapy databases including MEDLINE, EMBASE, AMED, CISCOM, CINAHL, PsycINFO, PubMed, Web of Science, Science Direct, EBSCO, Scopus British Nursing Index, and the Cochrane Library. A search of specialist resources included Cochrane Complementary Field Registry and other Cochrane Specialist Registries. Search strategies were developed to accommodate the different indexing approaches used by the databases [36]. Efforts were made to identify unpublished and ongoing research using relevant databases such as the National Research Register (UK) and Clinicaltrials.gov (USA) together with contacting experts in the field. Reference lists of relevant articles were reviewed to identify further studies.

3.4. Filtering. Potential research papers were noted for retrieval and given a preliminary "study type" classification as systematic reviews, randomized controlled trials (RCT), single case reports, qualitative research, or conferences presentations. Animal and basic laboratory-based studies were not included in the categorization process since these settings require a different design procedure. Two reviewers carried out this process independently, notes were compared, and in cases of disagreement these papers were also retrieved.

3.5. Inclusion Criteria. Studies written in English, were conducted between 1990–2013, drawn for published research, used yoga or relative meditative/mindfulness practices as an intervention in stroke rehabilitation, were case control and randomized control trials or cohort studies were included. We included any form of yoga practice, including meditation, pranayama, hatha yoga (which is part of the mindfulness stress reduction program). Posters or oral presentations published in scientific journals were included.

3.6. Exclusion Criteria. Studies that were not conducted in English, were conducted before 1990, drawn from unpublished work, used yoga as an intervention for treating other diseases, or were based on a single person's opinion were excluded from the review.

4. Results

No systematic reviews relating specifically to stroke rehabilitation and yoga therapy were identified except for one combining a systematic review and results from a pilot study [26]. In total ten studies were identified meeting the inclusion and exclusion criteria. Out of ten studies, five were randomized control studies [21, 25, 28, 31, 33, 34], four were single case report studies [26, 27, 30, 32], and one was a qualitative study [29]. These studies were conducted in USA ($n = 5$), Canada ($n = 1$), Switzerland ($n = 1$), Saudi Arabia ($n = 1$), and Australia ($n = 2$) between 2003 and 2013. Among them, there were five randomized control trials (RCTs), which employed two arms. Six of these studies used the sham intervention for the control groups. None of the studies used a double-blind design. Interestingly, all studies found and conducted after 2003 discussed the relative novelty of the specific therapy for stroke rehabilitation. After 2010, a growing interest particularly in stroke rehabilitation and development of novel alternative therapies in stroke survivors was noticed. Therefore, yoga and mindfulness techniques seem to be an increasing topic of interest, urging the need for more focused investigations to evaluate their effectiveness. All studies included are presented in Table 1, together with comments on their methodology and clinical relevance. Trials are also further discussed in narrative form in order to illustrate differences between studies and in an attempt to assist in highlighting the issues to be addressed in future directions. It was not possible to combine the results of studies due to the variation in the interventions and outcome measures.

4.1. Randomized Controlled Trials. Schmid et al. [25] explored whether an 8-week yoga intervention would impact the rehabilitation of veteran stroke survivors. Even though there were no significant differences between the control and experimental groups in the independent tests, within-group tests showed a significant improvement in balance in the yoga group. Chan et al. [37] applied a 6-week yoga intervention in stroke survivors. Depression and anxiety were measured before and after test. Changes in depression and state and trait anxiety did not significantly differ between interventions. However, comparison of individuals' case results indicated clinically relevant improvements in both groups, with members of the intervention group having a greater improvement. Johansson et al. [31] applied an-8 week mindfulness-based stress reduction program (MBSR) for traumatic brain injury and stroke patients focusing on mental fatigue. After the MBSR, improvements in mental fatigue were found in stroke survivors [31]. John et al. [33] explored whether a 6-week yoga intervention would impact disability, balance, fatigue, and depression. Results indicated that the meditation group improved significantly in all measurements after training.

4.2. Single Case Studies. Bastille and Gill-Body [27] examined the effects of a yoga-based therapy intervention on mobility and balance in four stroke patients at least 9 months following stroke. The small number of participants did not allow for statistical analysis on the significance of the findings. However, the authors chose to report the findings in a single subject, before and after study design. The investigators reported improvement on the Berg balance score in two of the participants following the intervention and improvement on the timed movement battery in three of the participants. A measure of improvement was seen as a change of at least two standard deviations from the baseline in each patient. Lynton et al. [26] assigned 3 participants into a Kundalini yoga program for 2 weeks. Dexterity and speech improved significantly after the interventions relative to baseline. However, due to the small sample size, it was impossible to draw definite conclusions, but the positive trends in this study suggest that further research should be conducted. The study designed by McEwen et al. allowed the patients to choose the interventions and goals they wished to set. The three goals selected by one participant were clipping the nails on his left hand by using clippers with his affected right hand, walking while carrying an object in his affected right, hand and learning basic yoga or deep breathing techniques. Improved performance for this participant was maintained at a 1-month followup for all but one goal, yoga [30]. Finally, Hofer et al. [32] applied a treatment for stroke, which was a combination of neuropsychological interventions, psychoeducation, cognitive-behavioral therapy, and mindfulness techniques. For the patients with poststroke fatigue (PSF), the central goal was to learn better coping skills regarding their increased vulnerability to fatigue. The significant changes in the symptoms of PSF as well as the achievement of the individually formulated therapy goals support the notion that mindfulness enhances the adjustment process to PSF.

4.3. Published Posters or Oral Presentations. Van Puymbroeck et al. [34] designed a 10-week yoga intervention for improving quality of life in stroke survivors. To measure activity and participation, the International Classification of Functioning, Disability and Health (ICF) measure of participation and activity (IMPACT) subscales were used. To measure quality of life, the stroke survivor's quality of life (SSQOL) scale was distributed to participants. Results showed significantly improved activity, participation, and quality of life in the yoga group compared to the control group.

4.4. Qualitative Studies. Garrett et al. [29] conducted a qualitative study exploring participants experiences after a yoga program. After the intervention, participants reported greater sensations, feelings of tranquility, and becoming connected to their body and self. These themes respectively revealed perceived physical improvements in terms of strength, range of movement or walking ability, an improved sense of calmness, and the possibility for reconnecting and accepting a different body. This study implies yoga's positive outcomes and sets the base for future quantitative investigations [29].

Table 1: Yoga as a therapeutic intervention for stroke rehabilitation.

Authors	Groups	Outcome measures	N	Sample	Design	Interesting finding
Schmid et al., 2012 [25]	Wait list (control) Yoga	(1) Disability independent (2) Fear of falling (3) Balance (4) Balance self-efficacy (5) QOL	Control $N = 10$ Yoga $N = 37$	Stroke patients Veterans	RCT 8-week intervention	In within-group comparisons, yoga group data demonstrated significant improvement in balance
Lynton et al., 2007 [26]	Yoga	(1) O'Connor tweezer dexterity (2) Boston aphasia exam	$N = 3$	Stroke patients 6 months after stroke Beth Israel Medical Center, NY, USA	Single case study 2 weeks Kundalini yoga practice	All 3 participants showed improvement on dexterity
Bastille and Gill-Body, 2004 [27]	Yoga	(1) Berg balance scale (2) Timed movement battery (3) Stroke impact scale	$N = 4$	Stroke patients <9 months after stroke Keene, NH,USA	Single case study 4–7-week baseline period followed by 8-week intervention yoga practice	3 subjects had improved TMB scores, and 2 subjects had improved BBS scores
Chan and Woollacott, 2007 [28]	Exercise group (control) Yoga exercise group (intervention)	(1) Geriatric depression scale (2) State trait anxiety inventory	Control $N = 6$ Yoga $N = 8$	Poststroke population Royal Adelaide, Hospital South Australia	Single-blinded RCT 6-week standardized program that included home practice	Participants in both groups exhibited a mixture of decreases, increases, and no changes in GDS15, STAI-Y1, and STAI-Y2 over the course of the trial
Garrett et al., 2011 [29]	Wait list (control) Yoga (intervention)	Biopsychosocial model (1) Physiological experiences (2) Psychological experiences	Control ($N = 12$) Yoga ($N = 10$)	Individuals with chronic poststroke hemiparesis 9 months after stroke South Australia	Qualitative RCT 10-week yoga program involving movement, breathing, and meditation practices	Participants reported greater sensation, feeling calmer, and becoming connected
McEwen et al., 2009 [30]	Yoga	(1) Performance quality rating scale (10 pt. scale) (*estimate values*) (2) Canadian occupational performance measure (3) Stroke impact scale (4) Stanford self-efficacy for managing chronic disease(6-item scale) (5) Activity-specific balance confidence	$N = 3$	Rehabilitation center 1 year after stroke Toronto, Canada	Single subject study with 2 replications CO-OP intervention conducted over ~10 sessions	Intervention was associated with significant performance improvements in self-selected functional goals

Table 1: Continued.

Authors	Groups	Outcome measures	N	Sample	Design	Interesting finding
Johansson et al., 2012 [31]	MBSR Treated/ control	(1) Self-assessment of mental fatigue (MBSR) (2) Comprehensive psychopathological rating scale (3) Digit symbol-coding (4) FAS verbal fluency test (5) Trail making test, mental fatigue, and information processing speed	$N = 29$ Stroke ($N = 18$) TBI, ($N = 11$) MBSR ($N = 12$) Wait list control ($N = 14$)	1 year post stroke or TBI patients USA	RCT 8-week MBSR	MBSR may be a promising nonpharmacological treatment for mental fatigue after a stroke or TBI
Hofer et al., 2012 [32]	Yoga	Mental fatigue and related symptoms after neurological disorders and injuries (SQfMF)	$N = 8$	Stroke patients University Hospital of Bern	Single subject study MBCT	Significant pre- to postassessment differences were observed in patients in poststroke fatigue
John et al., 2010 [33]	Group A (film/music) Group B (meditation) Group C (control)	(1) Hamilton rating scale for depression (2) Berg balance scale (3) Barthel ADL index (4) Fatigue severity scale	$N = 60$	Stroke patients Saudi Arabia	RCT 6-week intervention Pre- and postcontrol group design	Music therapy and meditation are more beneficial than conventional physiotherapy management alone
Van Puymbroeck et al., 2012 [34]	Yoga/wait list (control)	Stroke survivor's quality of life (SSQOL)	Yoga ($N = 37$) WL control ($N = 10$)	6 months since last stroke USA	RCT 3 : 1 ratio 8-week yoga intervention	Results showed improved activity, participation, and quality of life relative to controls

nr: not reported, WL: Wait list, RCT: randomized control trial, MBSR: mindfulness-based stress reduction program, MBCT: mindfulness-based cognitive therapy.

5. Discussion

The authors of this systematic review suggest that yoga is a useful tool for the rehabilitation process after stroke. Since stroke is a leading disease, the need for effective tools for rehabilitation is vital. All studies in the systematic review focused on mood, fatigue, stress, cognitive ability, and quality of life after stroke. This review shows that yoga and stroke rehabilitation have seldom been addressed. Therefore, this systematic review highlights the lack of definitive evidence of yoga's efficacy in stroke rehabilitation and suggests that this topic warrants future investigation. Methodological limitations of the studies included in this review were small sample sizes, limited descriptions of the randomized process when applicable, lack of reporting sampling methods, reasons for dropouts, and insufficient description of specific yoga or meditative practices.

Focus on cognitive functionality after stroke is suggested for future studies, since stroke patients suffer from cognitive dysfunction. One of the most vital problems when comparing different yoga interventions or mindfulness programs is that they are multimodal interventions with mindfulness as their focus. In a pragmatic trial this might not play a vital role but it does have implications for replication and transferability of the study. Moreover, yoga interventions and MBSR programs applied for stroke survivors so far have had relatively small samples and may be unpowered. Yoga interventions should therefore be designed to meet patients' different characteristics (time after stroke, level of impairment, function, and mobility). Physical changes in the form of improved mobility, motor coordination and cognitive changes in the form of improvement of speech impairments seem to be the main components that stroke survivors could benefit from [26].

Through the methods of body posture, breathing training, and consciousness meditation, overall well-being could be improved with positive benefits to the nervous system [38], endocrine system [39], cardiovascular system [40], respiratory system [41], and immunity [42]. Few studies have demonstrated the effects of mindfulness and yoga on well-being, somatic effects of stress, immune system and physical symptoms and chronic conditions [43, 44]. After meditation practice, results showed that the density of gray matter increased in regions governing distinctly different activities as memory, self-awareness, and compassion. Additionally, grey matter decreased in the amygdala, the part of the brain associated with fear and stress [45]. In a more recent study, relaxation techniques seem to affect the genes involved in controlling how the body handles free radicals, inflammation processes, and cell death [46]. More specifically, relaxation techniques improve mitochondrial energy production and utilization and thus promoting mitochondrial resiliency through the upregulation of ATPase and insulin function [46].

Interestingly, there was no identified study exploring the neurobiology and plasticity of stroke patients after a yoga or mindfulness-based intervention. There is now considerable evidence of MBSR yoga programs on brain alteration and structural and functional plasticity [45]. Recently, several cross sectional anatomical MRI studies have demonstrated that experienced meditators exhibit a different gray matter morphometry in multiple brain regions suggesting plasticity when compared with nonmeditating individuals [45, 47–52]. Four case control studies recently showed significantly higher levels of selective attention in meditators compared to controls, with some specific differences across trials [37, 53–55]. Other results suggest that mindfulness training may improve attention-related behavioral responses by enhancing functioning of specific subcomponents of attention. Whereas participation in the MBSR course improved the ability to internally orient attention, retreat participation appeared to allow for the development and emergence of receptive attention skills, which improved external alerting-related process. Those findings could have dramatic effects for stroke survivors since cognitive skills (thinking, reasoning, judgment, and memory) are mainly impacted. Emotional liability is another component following stroke where mindfulness could have beneficial effects. Mindfulness training is suggested to decrease cognitive rumination, [56] an important component of self-critical elaboration linked to midline prefrontal cortex (PFC) and reactivity in depression [57–59]. The midline PFC seems to be connected to negative-mood induction [59] and exposure to negative-self beliefs [60]. MBSR programs have been associated with decreased activation of these cortical midline structures [59, 60], and efforts to mindfully attend to experience can reduce cortical midline activity in beginners [59]. Several other studies have observed more extensive reductions in cortical activity during meditation, [45, 61, 62] an effect that appears to increase with greater meditation experience [63]. Thus, it may be deduced that one function of mindfulness training is to reduce negative or self-critical judgment associated with cortical midline activity. Additionally, hatha yoga practices could help in limb rehabilitation in stroke survivors. Mindfulness and yoga practices might improve poststroke hemiparesis, [27] although more focused research is needed to determine their effectiveness.

Finally, these findings are of vital importance since problems of emotional processing, including impaired mood, emotion regulation, and emotion perception, are known to occur following stroke and can detrimentally influence many aspects of social interaction after stroke. We suggest that investigations using magnetic resonance imaging (MRI) and magnetoencephalography (MEG) as biomarkers of cognitive brain functions are needed in stroke survivors. Moreover, targeted interventions such as yoga and mindfulness as forms of cognitive therapy should be used addressing specific patients' needs and contraindications. Yoga and mindfulness interventions are a novel therapeutic approaches to personalized alternative medicine that encourages patients to improve their body and mind health by incorporating both new practices and philosophy in life.

6. Conclusions

Yoga seems to offer a relief from a long list of medical ailments in stroke by alleviating both the mind and the body from stress. Yoga and meditative practices act on both the psychological and physical levels, and improvements

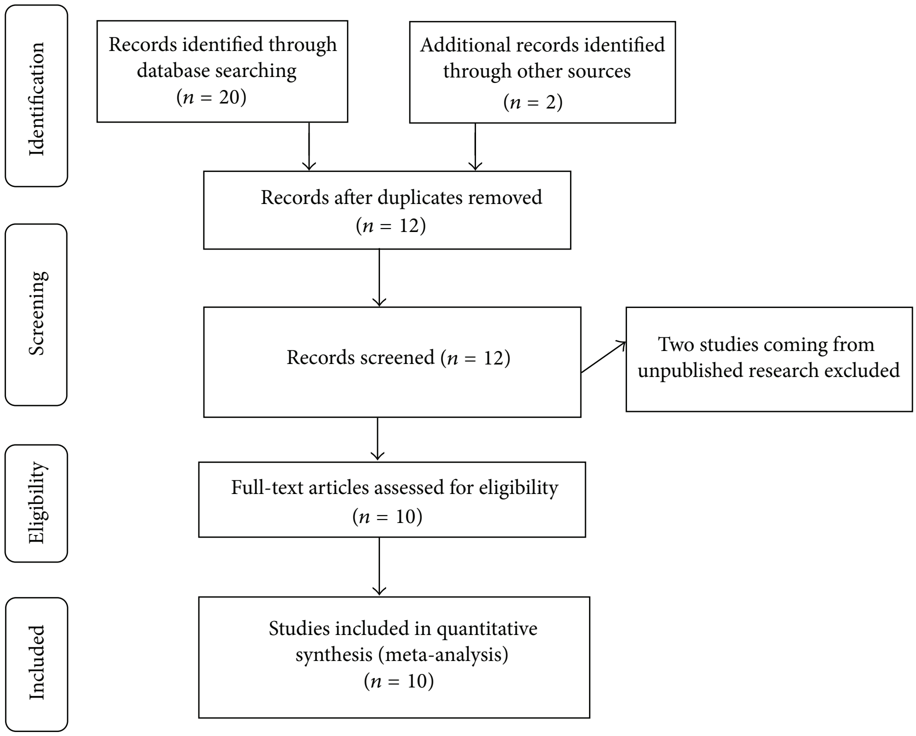


Figure 1: Flow of information through the different phases of a systematic review.

have been noticed in patients' mindsets [25]. For example, participants in one study [25] talked about incorporating physical activity in their everyday lives more than they used to after yoga intervention. These changes in the mindsets of people with disease can potentially lead to a change in behavior and ultimately an improvement in health [17]. Therefore, the moderating role of mindset and its ability to enhance health should be identified further, substantiated, and utilized in future directions.

Appendix

For more details, see Figure 1.

References

[1] G. Saposnik and C. J. Estol, "Translational research: from observational studies to health policy: how a cohort study can help improve outcomes after stroke," *Stroke*, vol. 42, no. 12, pp. 3336–3337, 2011.

[2] D. A. Levine, L. B. Morgenstern, K. M. Langa, J. D. Piette, M. A. Rogers, and S. J. Karve, "Recent trends in cost-related medication nonadherence among US stroke survivors," *Annals of Neurology*, vol. 73, no. 2, pp. 180–188, 2013.

[3] P. Sandercock, E. Berge, M. Dennis et al., "A systematic review of the effectiveness, cost-effectiveness and barriers to implementation of thrombolytic and neuroprotective therapy for acute ischaemic stroke in the NHS," *Health technology assessment (Winchester, England)*, vol. 6, no. 26, pp. 1–112, 2002.

[4] L. Fishman, *Yoga in Medicine. Alternative Medicine and Rehabilitation: A Guide for Practitioners*, Demos Medical Publishing, 2003.

[5] J. Lasater, *Untying the Knot: Yoga as Physical Therapy. Complementary Therapies in Rehabilitation: Holistic Approaches for Prevention and Wellness*, Slack, 1997.

[6] R. Ross, "Yoga therapy for neurological illness," in *Complementary and Alternative Medicine in Rehabilitation*, M. S. Micozzi, Ed., Churchill Livingstone, 2003.

[7] J. R. M. Goyeche, "Yoga as therapy in psychosomatic medicine," *Psychotherapy and Psychosomatics*, vol. 31, no. 1–4, pp. 373–381, 1979.

[8] Patañjali and A. K. Malhotra, *An Introduction to Yoga Philosophy: An Annotated translation of the Yoga Sutras*, Ashgate, Burlington, Vt, USA, 2001.

[9] M. Stone, *The Inner Tradition of Yoga : A Guide to Yoga Philosophy for the Contemporary Practitioner*, Shambhala, Boston, Mass, USA, 2008.

[10] H. J. Shaffer, T. A. LaSalvia, and J. P. Stein, "Comparing Hatha yoga with dynamic group psychotherapy for enhancing methadone maintenance treatment: a randomized clinical trial," *Alternative Therapies in Health and Medicine*, vol. 3, no. 4, pp. 57–66, 1997.

[11] G. Kirkwood, H. Rampes, V. Tuffrey, J. Richardson, and K. Pilkington, "Yoga for anxiety: a systematic review of the research evidence," *British Journal of Sports Medicine*, vol. 39, no. 12, pp. 884–891, 2005.

[12] D. V. Shelov, S. Suchday, and J. P. Friedberg, "A pilot study measuring the impact of yoga on the trait of mindfulness," *Behavioural and Cognitive Psychotherapy*, vol. 37, no. 5, pp. 595–598, 2009.

[13] N. M. Brisbon and G. A. Lowery, "Mindfulness and levels of stress: a comparison of beginner and advanced Hatha Yoga practitioners," *Journal of Religion and Health*, vol. 50, no. 4, pp. 931–941, 2011.

[14] J. Carmody, G. Reed, J. Kristeller, and P. Merriam, "Mindfulness, spirituality, and health-related symptoms," *Journal of Psychosomatic Research*, vol. 64, no. 4, pp. 393–403, 2008.

[15] D. S. Ludwig and J. Kabat-Zinn, "Mindfulness in medicine," *Journal of the American Medical Association*, vol. 300, no. 11, pp. 1350–1352, 2008.

[16] B. K. Bose, "Mindfulness, meditation and yoga: competition or collaboration?" *International Journal of Yoga Therapy*, no. 21, pp. 15–16, 2011.

[17] E. J. Langer, *Mindfulness*, Addison-Wesley, 1989.

[18] I. S. Hirst, "Perspectives of mindfulness," *Journal of Psychiatric and Mental Health Nursing*, vol. 10, no. 3, pp. 359–366, 2003.

[19] J. Kabat-Zinn, L. Lipworth, and R. Burney, "The clinical use of mindfulness meditation for the self-regulation of chronic pain," *Journal of Behavioral Medicine*, vol. 8, no. 2, pp. 163–190, 1985.

[20] R. A. Baer, G. T. Smith, J. Hopkins, J. Krietemeyer, and L. Toney, "Using self-report assessment methods to explore facets of mindfulness," *Assessment*, vol. 13, no. 1, pp. 27–45, 2006.

[21] P. Grossman, L. Niemann, S. Schmidt, and H. Walach, "Mindfulness-based stress reduction and health benefits: a meta-analysis," *Journal of Psychosomatic Research*, vol. 57, no. 1, pp. 35–43, 2004.

[22] K. Griffiths, P. M. Camic, and J. M. Hutton, "Participant experiences of a mindfulness-based cognitive therapy group for cardiac rehabilitation," *Journal of Health Psychology*, vol. 14, no. 5, pp. 675–681, 2009.

[23] C. M. Naber, O. Water-Schmeder, P. S. Bohrer, K. Matonak, A. L. Bernstein, and M. A. Merchant, "Interdisciplinary treatment for vestibular dysfunction: the effectiveness of mindfulness, cognitive-behavioral techniques, and vestibular rehabilitation," *Otolaryngology—Head and Neck Surgery*, vol. 145, no. 1, pp. 117–124, 2011.

[24] K. Curtis, A. Osadchuk, and J. Katz, "An eight-week yoga intervention is associated with improvements in pain, psychological functioning and mindfulness, and changes in cortisol levels in women with fibromyalgia," *Journal of Pain Research*, vol. 4, pp. 189–201, 2011.

[25] A. A. Schmid, M. Van Puymbroeck, P. A. Altenburger et al., "Poststroke balance improves with yoga: a pilot study," *Stroke*, vol. 43, no. 9, pp. 2402–2407, 2012.

[26] H. Lynton, B. Kligler, and S. Shiflett, "Yoga in stroke rehabilitation: a systematic review and results of a pilot study," *Topics in Stroke Rehabilitation*, vol. 14, no. 4, pp. 1–8, 2007.

[27] J. V. Bastille and K. M. Gill-Body, "A yoga-based exercise program for people with chronic poststroke hemiparesis," *Physical Therapy*, vol. 84, no. 1, pp. 33–48, 2004.

[28] D. Chan and M. Woollacott, "Effects of level of meditation experience on attentional focus: is the efficiency of executive or orientation networks improved?" *Journal of Alternative and Complementary Medicine*, vol. 13, no. 6, pp. 651–657, 2007.

[29] R. Garrett, M. A. Immink, and S. Hillier, "Becoming connected: the lived experience of yoga participation after stroke," *Disability and Rehabilitation*, vol. 33, no. 25-26, pp. 2404–2415, 2011.

[30] S. E. McEwen, H. J. Polatajko, M. P. J. Huijbregts, and J. D. Ryan, "Exploring a cognitive-based treatment approach to improve motor-based skill performance in chronic stroke: results of three single case experiments," *Brain Injury*, vol. 23, no. 13-14, pp. 1041–1053, 2009.

[31] B. Johansson, H. Bjuhr, and L. Ronnback, "Mindfulness-based stress reduction (MBSR) improves long-term mental fatigue after stroke or traumatic brain injury," *Brain Injury*, vol. 26, no. 13-14, pp. 1621–1628, 2012.

[32] H. Hofer, M. G. Holtforth, F. Lüthy, E. Frischknecht, H. Znoj, and R. M. Müri, "The potential of a mindfulness-enhanced, integrative neuro-psychotherapy program for treating fatigue following stroke: a preliminary study," *Mindfulness*, 2012.

[33] S. John, G. Khanna, and P. Kotwal, "Effect of music therapy and meditation along with conventional physiotherapy management in sub-acute stroke patients," *British Journal of Sports Medicine*, vol. 44, supplement 1, article i14, 2010.

[34] M. Van Puymbroeck, A. Schmid, K. Miller, and N. Schalk, "OA10.03. improved activity, participation, and quality of life for individuals with chronic stroke following an 8-week yoga intervention," *BMC Complementary and Alternative Medicine*, vol. 12, supplement 1, article O39, 2012.

[35] G. Gubitz and B. Thomas, "Systematic reviews. Cochrane Stroke Group," *Neurology*, vol. 51, no. 6, p. 1778, 1998.

[36] K. Pilkington and A. Boshnakova, "Complementary medicine and safety: a systematic investigation of design and reporting of systematic reviews," *Complementary Therapies in Medicine*, vol. 20, no. 1-2, pp. 73–82, 2012.

[37] W. Chan, M. A. Immink, and S. Hillier, "Yoga and exercise for symptoms of depression and anxiety in people with poststroke disability: a randomized, controlled pilot trial," *Alternative Therapies In Health and Medicine*, vol. 18, no. 3, pp. 34–43, 2012.

[38] C. C. Streeter, P. L. Gerbarg, R. B. Saper, D. A. Ciraulo, and R. P. Brown, "Effects of yoga on the autonomic nervous system, gamma-aminobutyric-acid, and allostasis in epilepsy, depression, and post-traumatic stress disorder," *Medical Hypotheses*, vol. 78, no. 5, pp. 571–579, 2012.

[39] R. Nidhi, V. Padmalatha, R. Nagarathna, and R. Amritanshu, "Effects of a holistic yoga program on endocrine parameters in adolescents with polycystic ovarian syndrome: a randomized controlled trial," *Journal of Alternative and Complementary Medicine*, vol. 19, no. 2, pp. 153–160, 2013.

[40] M. E. Papp, P. Lindfors, N. Storck, and P. E. Wandell, "Increased heart rate variability but no effect on blood pressure from 8 weeks of hatha yoga—a pilot study," *BMC Research Notes*, vol. 6, article 59, 2013.

[41] D. F. Santaella, C. R. Devesa, M. R. Rojo et al., "Yoga respiratory training improves respiratory function and cardiac sympathovagal balance in elderly subjects: a randomised controlled trial," *BMJ Open*, vol. 1, no. 1, Article ID e000085, 2011.

[42] S. Arora and J. Bhattacharjee, "Modulation of immune responses in stress by Yoga," *International Journal of Yoga*, vol. 1, no. 2, pp. 45–55, 2008.

[43] C. A. Lengacher, K. E. Kip, M. Barta et al., "A pilot study evaluating the effect of mindfulness-based stress reduction on psychological status, physical status, salivary cortisol, and interleukin-6 among advanced-stage cancer patients and their caregivers," *Journal of Holistic Nursing*, vol. 30, no. 3, pp. 170–185, 2012.

[44] J. J. Robert-McComb, A. Tacon, P. Randolph, and Y. Caldera, "A pilot study to examine the effects of a mindfulness-based stress-reduction and relaxation program on levels of stress hormones, physical functioning, and submaximal exercise responses," *Journal of Alternative and Complementary Medicine*, vol. 10, no. 5, pp. 819–827, 2004.

[45] S. W. Lazar, C. E. Kerr, R. H. Wasserman et al., "Meditation experience is associated with increased cortical thickness," *NeuroReport*, vol. 16, no. 17, pp. 1893–1897, 2005.

[46] M. K. Bhasin, J. A. Dusek, B. H. Chang et al., "Relaxation response induces temporal transcriptome changes in energy metabolism, insulin secretion and inflammatory pathways," *PLoS One*, vol. 8, no. 5, Article ID e62817, 2013.

[47] J. A. Grant and P. Rainville, "Hypnosis and meditation: similar experiential changes and shared brain mechanisms," *Medical Hypotheses*, vol. 65, no. 3, pp. 625–626, 2005.

[48] B. K. Hölzel, J. Carmody, M. Vangel et al., "Mindfulness practice leads to increases in regional brain gray matter density," *Psychiatry Research*, vol. 191, no. 1, pp. 36–43, 2011.

[49] B. K. Hölzel, U. Ott, T. Gard et al., "Investigation of mindfulness meditation practitioners with voxel-based morphometry," *Social Cognitive and Affective Neuroscience*, vol. 3, no. 1, pp. 55–61, 2008.

[50] E. Luders, K. Clark, K. L. Narr, and A. W. Toga, "Enhanced brain connectivity in long-term meditation practitioners," *NeuroImage*, vol. 57, no. 4, pp. 1308–1316, 2011.

[51] G. Pagnoni and M. Cekic, "Age effects on gray matter volume and attentional performance in Zen meditation," *Neurobiology of Aging*, vol. 28, no. 10, pp. 1623–1627, 2007.

[52] P. Vestergaard-Poulsen, M. Van Beek, J. Skewes et al., "Long-term meditation is associated with increased gray matter density in the brain stem," *NeuroReport*, vol. 20, no. 2, pp. 170–174, 2009.

[53] P. A. M. van den Hurk, B. H. Janssen, F. Giommi, H. P. Barendregt, and S. C. Gielen, "Mindfulness meditation associated with alterations in bottom-up processing: psychophysiological evidence for reduced reactivity," *International Journal of Psychophysiology*, vol. 78, no. 2, pp. 151–157, 2010.

[54] A. Moore and P. Malinowski, "Meditation, mindfulness and cognitive flexibility," *Consciousness and Cognition*, vol. 18, no. 1, pp. 176–186, 2009.

[55] H. S. Hodgins and K. C. Adair, "Attentional processes and meditation," *Consciousness and Cognition*, vol. 19, no. 4, pp. 872–878, 2010.

[56] J. Michalak, A. Hölz, and T. Teismann, "Rumination as a predictor of relapse in mindfulness-based cognitive therapy for depression," *Psychology and Psychotherapy*, vol. 84, no. 2, pp. 230–236, 2011.

[57] S. Grimm, J. Beck, D. Schuepbach et al., "Imbalance between left and right dorsolateral prefrontal cortex in major depression is linked to negative emotional judgment: an fMRI study in severe major depressive disorder," *Biological Psychiatry*, vol. 63, no. 4, pp. 369–376, 2008.

[58] R. E. Cooney, J. Joormann, F. Eugène, E. L. Dennis, and I. H. Gotlib, "Neural correlates of rumination in depression," *Cognitive, Affective and Behavioral Neuroscience*, vol. 10, no. 4, pp. 470–478, 2010.

[59] N. A. S. Farb, A. K. Anderson, R. T. Bloch, and Z. V. Segal, "Mood-linked responses in medial prefrontal cortex predict relapse in patients with recurrent unipolar depression," *Biological Psychiatry*, vol. 70, no. 4, pp. 366–372, 2011.

[60] P. R. Goldin, T. Manber-Ball, K. Werner, R. Heimberg, and J. J. Gross, "Neural mechanisms of cognitive reappraisal of negative self-beliefs in social anxiety disorder," *Biological Psychiatry*, vol. 66, no. 12, pp. 1091–1099, 2009.

[61] H. C. Lou, T. W. Kjaer, L. Friberg, G. Wildschiodtz, S. Holm, and M. Nowak, "A 15O-H2O PET study of meditation and the resting state of normal consciousness," *Human Brain Mapping*, vol. 7, no. 2, pp. 98–105, 1999.

[62] V. L. Ives-Deliperi, M. Solms, and E. M. Meintjes, "The neural substrates of mindfulness: an fMRI investigation," *Social Neuroscience*, vol. 6, no. 3, pp. 231–242, 2011.

[63] J. A. Brefczynski-Lewis, A. Lutz, H. S. Schaefer, D. B. Levinson, and R. J. Davidson, "Neural correlates of attentional expertise in long-term meditation practitioners," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 104, no. 27, pp. 11483–11488, 2007.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2013, Article ID 419496, 13 pages
http://dx.doi.org/10.1155/2013/419496

Research Article

Affect and Mindfulness as Predictors of Change in Mood Disturbance, Stress Symptoms, and Quality of Life in a Community-Based Yoga Program for Cancer Survivors

Michael J. Mackenzie,[1,2] Linda E. Carlson,[3,4] Panteleimon Ekkekakis,[5] David M. Paskevich,[1] and S. Nicole Culos-Reed[1,3,4]

[1] *Faculty of Kinesiology, University of Calgary, 2500 University Drive NW, Calgary AB, Canada T2N 1N4*
[2] *Department of Kinesiology and Community Health, University of Illinois at Urbana-Champaign, USA*
[3] *Department of Psychosocial Resources, Tom Baker Cancer Centre, Alberta Health Services-Cancer Care, Canada*
[4] *Department of Oncology, Faculty of Medicine, University of Calgary, Canada*
[5] *Department of Kinesiology, Iowa State University, USA*

Correspondence should be addressed to Michael J. Mackenzie; mmackenz@illinois.edu and S. Nicole Culos-Reed; nculosre@ucalgary.ca

Received 21 December 2012; Revised 27 March 2013; Accepted 11 April 2013

Academic Editor: Luciano Bernardi

Little attention has been paid to the psychological determinants by which benefits are accrued via yoga practice in cancer-related clinical settings. Using a longitudinal multilevel modeling approach, associations between affect, mindfulness, and patient-reported mental health outcomes, including mood disturbance, stress symptoms, and health-related quality of life (HRQL), were examined in an existing seven-week yoga program for cancer survivors. Participants ($N = 66$) were assessed before and after the yoga program and at three- and six-month follow-ups. Decreases in mood disturbance and stress symptoms and improvements in HRQL were observed upon program completion. Improvements in mood disturbance and stress symptoms were maintained at the three- and six-month follow-ups. HRQL exhibited further improvement at the three-month follow-up, which was maintained at the six-month follow-up. Improvements in measures of well-being were predicted by initial positive yoga beliefs and concurrently assessed affective and mindfulness predictor variables. Previous yoga experience, affect, mindfulness, and HRQL were related to yoga practice maintenance over the course of the study.

1. Introduction

Receiving a cancer diagnosis, undergoing treatment, and the subsequent recovery takes a great toll on many cancer survivors. Psychosocial distress stemming from the cancer experience is a significant problem for up to half of all cancer patients, and many survivors experience lowered overall health-related quality of life (HRQL) during and following active treatment [1]. Regardless of intervention specifics, exercise enhances a variety of HRQL and psychosocial outcomes in various cancer survivor groups both during and after cancer treatment and may also help to manage the long-term side effects of treatment [2].

Within the larger field of exercise and cancer, yoga is often considered a gentle, low-intensity form of exercise [3]. The unique integration of both moving and static sequences (asana), breathing exercises (pranayama), and different meditation tools to withdraw the senses (pratyahara), concentrate the mind (dharana), and develop abilities of impartial awareness (dhyana) have all been used as means of increasing performance and recovery in both general and clinical populations [4]. These practices are routinely modified based on desired outcomes as well as participant health status [5]. Studies comparing the effects of yoga and exercise indicate that, in both healthy individuals and those with various health conditions, yoga may be as effective as more common forms of exercise, including walking, jogging, cycling, and aerobics, at improving a variety of health-related outcome measures [6]. Within clinical cancer settings, those participating in a yoga intervention compared to waitlist control groups or supportive therapy groups showed greater improvements in overall HRQL, psychological health, stress-related symptoms, sleep and fatigue indices [7–12] However, these reported improvements in cancer survivors practicing yoga have not been uniform [13].

2. Theory

As research in the use of yoga in cancer-related clinical settings continues to grow and yoga is integrated into cancer care, it is imperative the clinical benefits of yoga for cancer survivors are better understood. Identifying predictors that explain *how* yoga leads to clinically significant outcomes is the next step in understanding the ability of yoga to *target* desired outcomes. Recommendations from the UK Medical Research Council [14] suggest time spent examining predictors, both theoretically and practically, help to strengthen the causal chain of evidence and further refine both the interventions themselves and research design. The proposed predictors tested in the current study include affect regulation and mind-fulness.

2.1. Affect Regulation. Positive affect is theorized to be an independent, adaptive pathway in the cancer experience [15]. Positive affect can be broadly defined as feelings associated with pleasurable experience that may elicit descriptors such as happiness, joy, contentment, and peacefulness [16]. Both baseline positive affect and the enhancement of positive affect are important components of symptom management and cancer recovery [17]. In general, exercise increases positive affect and reduces negative affect [18] and individuals tend to choose and adhere to physical activity associated with positive affective experiences [19]. In cancer-related clinical settings specifically, fostering positive affective experiences via a structured exercise program is an important target for interventions designed to facilitate postprogram exercise adherence [20].

Participation in a single yoga session has been associated with significant improvements in positive affect and reductions in negative affect, comparable to changes seen with aerobic exercise [21, 22]. Findings from a pilot randomized-controlled trial (RCT) examining the effects of a 10-week restorative yoga program in breast cancer survivors on or off treatment suggest significant benefits favoring the yoga group on positive affect, mental health, depression and spirituality outcomes [23]. Findings from a second pilot RCT examining the effects of a 12-week yoga program in breast cancer outpatients undergoing adjuvant radiotherapy reported significant improvement in positive affect, emotional function and cognitive function, and decreased negative affect in the yoga group as compared to controls [24].

2.1.1. Circumplex Model of Affect. Given the proposed importance of positive affect and exercise and yoga's influence on this phenomenon, the Circumplex Model of Affect [25] offers an encompassing yet parsimonious explanatory approach for conceptualizing and assessing changes in affect. At the heart of mood and emotion are underlying psychophysiological states experienced as simply feeling good or bad, energized or fatigued. According to the Circumplex Model, the affective domain can be represented by a circle defined by two orthogonal and bipolar dimensions: valence (pleasure versus displeasure) and perceived activation or arousal (high versus low). These two dimensions of valence and activation, termed *core affect,* underlie all affective states. Four states derived from the combination of these two dimensions can be described as high-activation pleasure (e.g., energy), low-activation pleasure (e.g., calmness), high-activation displeasure (e.g., tension), and low-activation displeasure (e.g., tiredness) [26] (see Figure 1). Based on these two dimensions and four quadrants, a host of affective responses, emotions and moods are possible. The Circumplex Model of Affect has been recommended as a conceptual framework for measuring core affect given the dimensional approach allows capture of the constituent elements of a larger range of basic affective states [27].

2.2. Mindfulness. Mindfulness is the systematic development of the ability to nonjudgmentally direct attention towards events in the field of consciousness in the present moment [28]. Emerging research findings suggest both trait and state mindfulness are related to affect regulation [29]. Specifically, the various extant measures of mindfulness and practices that engender higher reported mindfulness have been associated with higher reported positive affect and lower reported negative affect, perhaps through engagement of attention upon immediate experience [30].

It has been suggested yoga adds a contemplative element to exercise and can be conceptualized as "mindfulness in motion" [31]. Specifically, the practice of yoga provides an opportunity for sustained attention to physical sensations, breathing, and mental activity through progressive sequences of dynamic movements, restful postures, breathing exercises, and periods of meditative awareness [32]. However, research evidence linking yoga practice to these changes in mindfulness remains equivocal. Lengacher and colleagues [33] found minutes of yoga practice as part of the overall Mindfulness-Based Stress Reduction (MBSR) program was not significantly related to positive changes in psychosocial status and HRQL in a breast cancer survivor population. However, these findings are in contrast to the work of Carmody and Baer [34], whose research in a noncancer heterogeneous medical population found the yoga component of an MBSR program to be most strongly related to improvements of mindfulness measures, psychological symptoms and perceived stress. These findings have more recently been corroborated in a study by Sauer-Zavala and colleagues [35], which reports yoga practice was associated with greater psychological well-being independent of equivalent amounts of a supine body scan or seated meditation practice in an undergraduate student population.

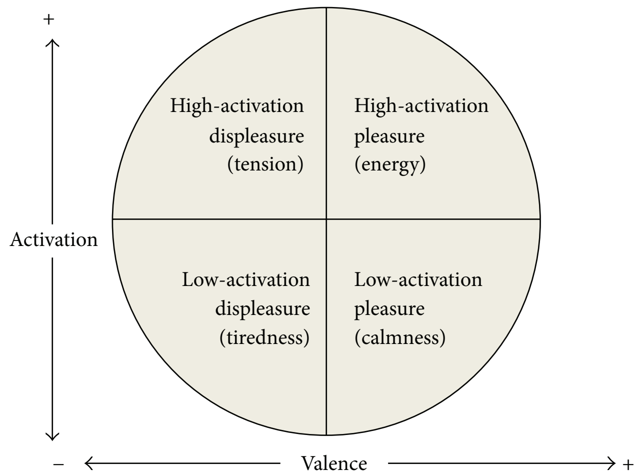


FIGURE 1: Circumplex Model of Affect.

2.2.1. Facets of Mindfulness. Five facets of mindfulness have been described as follows: the ability to (1) observe and (2) describe experiences in the present moment while (3) acting with awareness (4) without judgment or (5) prolonged reaction [36]. In cancer-related clinical settings, work by Bränström and colleagues [37] suggest prepost changes in facets of mindfulness mediate changes in psychological outcomes both post-MBSR program and at a three- but not six-month follow-up [38]. Recent work by Garland and colleagues [39] is consistent with these findings, indicating significant relationships between increased facets of mindfulness and reductions in mood disturbance and stress symptoms.

Cancer-related distress and lower HRQL are prevalent among many cancer survivors. Exercise is effective in ameliorating this distress and improving HRQL. Yoga can be considered a low-intensity form of exercise that has been shown to independently improve HRQL, psychosocial outcomes and symptom indices. Two posited predictors of these improvements are increased positive affect and increased mindfulness.

3. Objectives

Given preliminary evidence that yoga practice is associated with (1) increased positive affect, (2) heightened mindfulness, and (3) improved HRQL and mental health outcomes in cancer survivors, the present study was designed with the following objectives.

3.1. Longitudinal Program Effects. Objective 1a: to examine changes longitudinally, before and after a yoga program and at three- and six-month follow-ups, in measures of mood disturbance (primary outcome), stress symptoms, and HRQL as well as proposed predictor variables, including affect and mindfulness. Objective 1b: to examine whether improvements in mood disturbance, stress symptoms and HRQL were associated with concurrent changes in proposed predictor variables, including affect and mindfulness.

3.2. Yoga Practice Maintenance. Objective 2a: to examine whether participants maintain their yoga practice longitudinally, before and after a yoga program and at three- and six-month follow-ups. Objective 2b: to examine whether maintenance of yoga practice was associated with mood disturbance, stress symptoms and HRQL as well as proposed predictor variables, including affect and mindfulness.

4. Methods

4.1. Participants. Ethical approval was obtained from the Conjoint Health Research Ethics Board of the University of Calgary/Alberta Health Services. Program participants were comprised of a heterogeneous group of cancer survivors enrolled in the ongoing "Yoga Thrive: Therapeutic Yoga for Cancer Survivors" program. Participants were eligible for study inclusion if they were (1) aged 18 years or older and (2) had received a cancer diagnosis at any time in the past. Previous participation in the Yoga Thrive program was not an exclusion criterion but was evaluated as part of the study. Participants were informed of the research study at the time of class registration, either via telephone or online. Those that indicated interest in participating in the research study were contacted by the study coordinator. Baseline, postprogram, three- and six-month follow-up surveys were completed online.

4.2. Program. The Yoga Thrive program is a research-based, therapeutic yoga program for cancer survivors and their support persons. This gentle seven-week yoga program is based on contemporary yoga practices modified for cancer survivors. Details of the program have been previously described [40, 41]. The DVD "Yoga Thrive: Therapeutic Yoga for Cancer Survivors" also includes the entire 7-week program. A typical 75-minute class was as follows.

> 0–10 minutes: gentle breathing and movement, laying supine, with legs flexed at the hip and supported by a wall.
>
> 10–60 minutes: 6–10 modified yoga postures/sequences consisting of gentle stretching and strengthening exercises with attention to breath and bodily sensations. Participants progressed from a series of sitting and kneeling postures to standing postures, including stronger postures, balance work and forward bends, before returning to the floor for a series of supine postures.
>
> 60–75 minutes: guided supine meditation with attention placed on both breathing and bodily sensations. The yoga classes became progressively more challenging over the seven-week course.

4.3. Recruitment. Power calculations were carried out using GPower 3.1 [42]. The sample size/power calculation was based on a clinically significant [43] change in score before-after program on the Profile of Mood States (POMS) Total Mood Disturbance (TMD) score as the primary outcome (Cohen's $d = .50$). With an α of .05 and power of .80, a minimum of 34 participants were to be recruited from the Yoga Thrive program.

4.4. Instruments

4.4.1. Baseline

(1) Demographics. Demographic information included self-reported age, education, marital status, and current employment status. Medical history included self-reported cancer diagnosis, date of diagnosis and type(s) of cancer treatment.

(2) Beliefs about Yoga Scale (BAYS). The BAYS [44] is an 11-item self-report measure developed to examine common positive and negative beliefs about yoga in order to help understand participant expectations related to yoga (baseline $\alpha = .78$).

4.4.2. Longitudinal Effects (Objectives 1a and 1b)

(1) Godin Leisure Time Exercise Questionnaire (GLTEQ). The GLTEQ [45] was used to assess physical activity levels. The Leisure Score Index (LSI) subscale of the GLTEQ contains three questions that assess the frequency of mild, moderate, and strenuous physical activity performed for at least 15 minutes duration in a typical week within the past month. In addition, a weekly total of moderate-to-vigorous physical activity can be computed from the GLTEQ (baseline α: LSI = .88; moderate-to-vigorous physical activity = .86).

(2) Activation-Deactivation Adjective Check List (AD ACL). The AD ACL [46] is a 20-item measure that has been utilized previously to map the four quadrants of circumplex affective space [47]. The energy pole is theorized to map the high-activation pleasure quadrant of the circumplex, tension maps the high-activation displeasure quadrant, tiredness maps the low-activation displeasure quadrant, and calmness maps the low-activation pleasure quadrant [26] (baseline α: energy = .88; tension = .79; tiredness = .84; calmness = .80).

(3) Five-Facet Mindfulness Questionnaire (FFMQ). The FFMQ [48] is a 39-item scale designed to measure five factors that represent elements of trait mindfulness as it is currently conceptualized. The five facets are observing, describing, acting with awareness, nonjudging of, and nonreaction to inner experience. Higher scores indicate higher levels of mindfulness (baseline α: observing = .85; describing = .87; acting with awareness = .89; nonjudgment = .91; nonreaction = .88).

(4) Profile of Mood States-Short Form (POMS-SF). The abbreviated POMS-SF [49] is a 37-item scale designed to assess six distinct mood states (tension, depression, anger, vigor, fatigue, and confusion) over a one-week period. The instrument also provides a total mood disturbance score by summing the five negative mood state scores and subtracting the one positive score (vigor). Only the POMS-SF total score was used.

(5) Calgary Symptoms of Stress Inventory (C-SOSI). The abbreviated C-SOSI [50] is a 56-item scale designed to assess physical, psychological, and behavioral responses to stressful situations. The instrument provides a total stress score as well as eight subscale scores (depression, anger, muscle tension, cardiopulmonary arousal, sympathetic arousal, neurological/GI, cognitive disorganization, and upper respiratory symptoms). Higher scores indicate higher reported levels of stress symptoms. Only the C-SOSI total stress score was used.

(6) Functional Assessment of Cancer Therapy-General Version (FACT-G). FACT-G (version 4) [51] is a 27-item questionnaire that measures HRQL. The instrument provides a total HRQL score as well as four subscale scores (physical, social, emotional, and functional). Higher scores indicate higher reported HRQL. Only the FACT-G total score was used.

4.4.3. Yoga Practice Maintenance (Objectives 2a and 2b). Participants were asked to report weekly frequency of ongoing yoga practice via the Yoga Thrive program, community-based yoga programs, home yoga practice or combinations thereof.

4.5. Data Analysis. All data analyses were conducted using IBM SPSS version 19. Demographics and medical history were described using frequency and descriptive statistics to characterize study participants. Statistical analyses were conducted on the entire sample from baseline ($N = 66$).

4.5.1. Longitudinal Effects (Objectives 1a and 1b). Multilevel modeling provides a powerful, flexible framework for analyzing nested data structures longitudinally and how change over time in one variable may be related to change over time in other variables [52]. Put in another way, multilevel models allow estimation of both growth and assessment of predictors of differences in that growth for any given outcome of interest. Multilevel models are appropriate for analyzing data with dependent observations (such as within-subject repeated measures) [53]. In addition, multilevel models accommodate all available data, retaining cases for which missing data are present, and provide a valid analysis when data are assumed missing at random [54]. This inclusion of all available data is particularly useful when conducting intention-to-treat (ITT) analyses [55].

In the current analyses two sets of multilevel models were employed. Firstly, estimated marginal means models were created to assess overall change in outcome, predictor, and continuous covariates longitudinally, pre-post and at three- and six-month follow-ups (objective 1a). Secondly, multilevel regression analyses were conducted to assess concurrent associations over time between mood disturbance, stress symptoms and HRQL, proposed predictor variables including affect and mindfulness, and covariates including demographics, time since cancer diagnosis, physical activity, beliefs about yoga, previous yoga experience, and yoga program attendance (objective 1b). Correlations among observations from the same individual were modeled using an unstructured covariance matrix across all time points. By fitting each individual growth trajectory to a specific parametric model, the overall trajectory of the study sample was obtained and allowed for further investigation of whether differences in growth parameters were related to other predictor variables [56].

In each multilevel regression model, time was measured continuously and included linear, quadratic, and cubic terms as appropriate [56]. The time variable was centered at initial status; therefore the intercept of the regression model was interpreted as participant reports of the outcome variable at baseline. To enhance interpretability of model intercept parameters, all predictor variables were grand-mean centered to allow for inference of average predictor effects [57]. Relationships between predictor and outcome variables were assumed to be constant throughout the study if interaction terms were not significant.

All models were tested step by step. An initial unconditional model was developed for each outcome variable, followed by unconditional growth models. Based on these growth models, predictor variables were tested individually for main effects and for interaction effects with each time term. Significant predictors and their time interactions, if significant, were then tested together as part of their respective overall scale. A final trimmed conditional growth model was developed by entering all significant predictors and their interactions to test overall prediction of outcome variables across time (exclusion $P > .1$). This method of model development has proven robust with smaller sample sizes and ensures these models do not tax the "carrying-capacity" of the dataset [58].

(1) Clinical Significance (Objectives 1a and 1b). In the estimated marginal means models (objective 1a), clinical significance, a marker of program effectiveness, was calculated using Cohen's *d,* a distribution-based method, for each outcome variable between baseline and (a) postprogram (8 weeks), (b) three-month, and (c) six-month follow-up $(Tx - T_1)/(T_1\mathrm{SE} * \sqrt{N})$. These effects were interpreted using Cohen's interpretation of .20 as a small effect .50 as a moderate effect and .80 as a large effect [59]. In the multilevel regression analyses (objective 1b), pseudo R^2 statistics for each model were calculated as unconditional model residual variance − trimmed model residual variance/unconditional model residual variance. These statistics indicate the proportional reduction in residual variance (error) between the unconditional and trimmed model and provide an estimate of effect size similar to traditional ordinary least squares (OLS) regression [60]. These effects can be interpreted using Cohen's criteria of .02 as a small effect .13 as a moderate effect and .26 as a large effect [59].

4.5.2. Yoga Practice Maintenance (Objectives 2a and 2b). Associations of predictor and outcome variables with program maintenance (ongoing yoga participation in either the yoga program for cancer survivors, community-based yoga programming, or engaging in home practice) were assessed via logistic generalized estimating equations (GEE) [61]. In this context, GEE take into consideration the within-subject relationships between predictor and outcome variables. Yoga maintenance was dichotomized as either 0—no yoga or 1—ongoing yoga. To determine whether there was a difference between those who practiced yoga and those who did not at each time point, an initial estimated marginal means model with no predictors was run (objective 2a). Logistic GEE were then run to determine associations between yoga practice and predictor variables (objective 2b). Covariates for demographics, time since diagnosis, beliefs about yoga, previous yoga experience and yoga program attendance were entered individually as main effects, followed by physical activity, affect, mindfulness and health outcomes. A final trimmed model was developed by entering all significant predictors and their interactions to test overall prediction of yoga practice maintenance across time (exclusion $P > .1$).

5. Results

5.1. Demographics. 70 participants were eligible for the current study and 66 completed baseline measures used in the current analyses (see Figure 2). The average participant was approximately 53 years of age. The study sample was 90% female. The sample was comprised primarily of participants had received a breast cancer diagnosis (62.1%). The two other most common diagnoses were lymphoma (10.6%) and colorectal (7.6%). The majority of participants had been diagnosed stages II-III (59.1%) approximately two years prior to study enrollment. Most participants were married (66.7%), highly educated (54.5% had completed university/college), and affluent (60.6% had a combined household income >$80,000 per annum). Many participants (39.4%) had returned to work fulltime. Participants attended an average of five of the seven yoga sessions (see Table 1).

5.2. Longitudinal Program Effects (Objectives 1a and 1b). Estimated marginal means models were computed for covariates including age, time since diagnosis, physical activity, and previous yoga experience, predictor variables including affect and mindfulness, and outcome variables including mood disturbance, stress symptoms, and HRQL (objective 1a).

5.2.1. Covariate Predictors. Participants had already completed Yoga Thrive 1.46 times prior to study enrollment. Most participants reported completing the Yoga Thrive program at eight-weeks, and had completed the program an additional time by the six month follow-up $[F(3, 147.14) = 74.32, P < .001]$. Small significant increases from baseline in moderate-to-vigorous PA were observed at the three- and six-month follow-ups. A small significant increase in total physical activity (LSI) was also observed over time $[F(3, 143.52) = 3.28, P = .023]$ (see Table 2).

5.2.2. Affect. Small increases in energy were observed post-program that became more pronounced at the three- and six-month follow-ups $[F(3, 148.73) = 11.98, P < .001]$. Small decreases in tiredness after-program were not maintained at the 3-month follow-up but again improved at the 6-month follow-up $[F(3, 151.01) = 5.99, P < .001]$. Small decreases

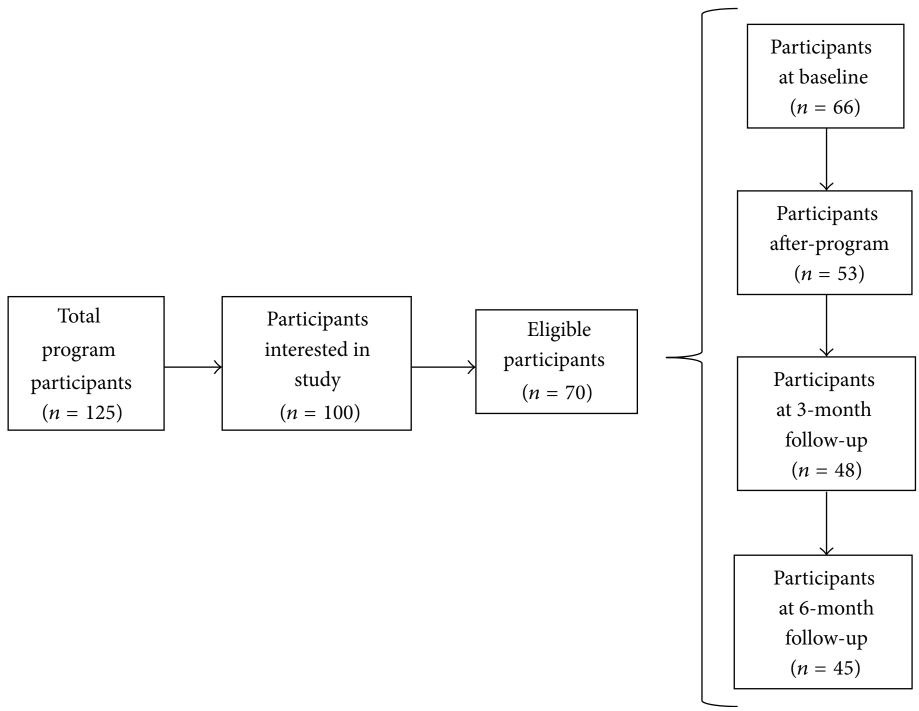


Figure 2: Participant recruitment flow diagram.

Table 1: Demographics.

Baseline (N = 66)	
Age, years (SD)	52.88 (8.11)
Time since diagnosis, months (SD)	23.93 (21.93)
Program attendance, number of sessions (SD)	5.08 (1.94)
	N (%)
Cancer diagnosis: breast	
Breast	41 (62.1%)
Lymphoma	7 (10.6%)
Colorectal	5 (7.6%)
Cancer stage	
II	22 (33.3%)
III	17 (25.8%)
Gender: female	60 (90.9%)
Marital status: married/common-law	44 (66.7%)
Education level: completed university/college	36 (54.5%)
Annual household income: >$80,000	40 (60.6%)
Employment status: full time	26 (39.4%)

in tension were observed after-program, and were not maintained at the three-month follow-up, but again improved at the six-month follow-up [$F(3, 145.19) = 4.53, P = .005$]. There were no changes in patient-reported calmness over time (see Table 2).

5.2.3. Mindfulness. No changes in participants' observational skills or ability to describe events in the field of consciousness were observed throughout the program. Moderate increases in participants' ability to act with awareness were observed after-program that were maintained at the three- and six-month follow-ups [$F(3, 138.05) = 9.46, P < .001$]. Small increases in participants' ability to be nonjudgmental of inner experience were observed after-program that were maintained at the three- and six-month follow-up [$F(3, 138.92) = 3.74, P = .013$]. No significant changes in nonreaction were observed after-program but small significant improvements were observed at the three- and six-month follow-up [$F(3, 138.90) = 4.25, P = .007$] (see Table 2).

5.2.4. Mood Disturbance, Stress Symptoms and Quality of Life. Decreases in mood disturbance were moderate after program. Reductions in mood disturbance were not maintained at the three-month follow-up but improved to postprogram values at the six-month follow-up [$F(3, 139.56) = 5.72, P < .001$]. A moderate decrease in stress symptoms was observed from baseline to after program that was maintained at both the three- and six-month follow-ups [$F(3, 139.12) = 12.21, P < .001$]. A small statistically significant improvement in HRQL was observed after program. However, HRQL significantly improved at the three-month follow-up and was maintained at the six-month follow-up [$F(3, 137.33) = 7.93, P < .001$] (see Table 2).

Follow-up multilevel regression analyses were conducted to explore the associations between mood disturbance, stress symptoms, and HRQL, predictor variables including affect and mindfulness, and covariates including age, time since diagnosis, physical activity, previous yoga experience, and yoga beliefs (objective 1b).

5.2.5. Mood Disturbance. Significant linear, quadratic, and cubic effects were observed for time. Those with more

Table 2: Longitudinal estimated marginal means model.

Measures	Baseline $T1$ ($N = 66$)	8-weeks after $T2$ ($n = 53$)			3-month follow-up $T3$ ($n = 48$)			6-month follow-up $T4$ ($n = 45$)		
	Mean (SE)	Mean (SE)	$T2-T1$ SMD P	d	Mean (SE)	$T3-T1$ SMD P	d	Mean (SE)	$T4-T1$ SMD P	d
Outcome variables										
Mood disturbance										
POMS-SF total	20.20 (2.46)	11.58 (2.61)	.000	−0.47	15.01 (2.67)	.036	−0.27	11.63 (2.74)	.001	−0.44
Stress symptoms										
C-SOSI total	59.08 (3.10)	47.41 (3.26)	.000	−0.63	46.78 (3.31)	.000	−0.64	49.11 (3.35)	.000	−0.51
Quality of life										
FACT-G total	73.51 (1.98)	76.71 (2.06)	.017	0.30	78.97 (2.09)	.000	0.50	79.66 (2.12)	.000	0.54
Predictor variables										
Program experience (Yoga Thrive)										
Enrolment	1.46 (0.29)	2.45 (0.29)	.000	1.00	3.02 (0.30)	.000	1.37	3.49 (0.30)	.000	1.73
Physical activity										
LSI	21.70 (2.03)	23.39 (2.18)	.388	0.11	25.39 (2.22)	.066	0.23	27.83 (2.26)	.003	0.38
GLTEQ	92.94 (13.64)	96.50 (14.52)	.788	0.03	121.74 (15.27)	.042	0.26	120.48 (15.48)	.055	0.24
Affect										
Energy	9.53 (0.52)	10.88 (0.57)	.022	0.29	11.86 (0.59)	.000	0.48	13.11 (0.60)	.000	0.72
Tiredness	11.60 (0.54)	10.16 (0.59)	.023	−0.29	10.62 (0.62)	.136	−0.19	8.82 (0.63)	.000	−0.52
Tension	9.35 (0.43)	7.66 (0.47)	.001	−0.43	8.47 (0.49)	.084	−0.23	7.99 (0.50)	.009	−0.33
Calmness	12.77 (0.43)	13.77 (0.47)	.054	0.24	13.27 (0.49)	.350	0.12	13.23 (0.50)	.399	0.10
Mindfulness										
Observe	24.92 (0.79)	25.81 (0.85)	.244	0.15	26.08 (0.87)	.139	0.18	27.13 (0.90)	.007	0.34
Describe	23.04 (0.85)	23.86 (0.90)	.243	0.16	23.20 (0.92)	.821	0.03	24.12 (0.93)	.151	0.18
Act w/Awareness	18.54 (0.69)	20.40 (0.73)	.000	0.46	20.31 (0.74)	.001	0.42	21.23 (0.75)	.000	0.62
Nonjudgment	20.35 (0.84)	22.47 (0.90)	.006	0.35	21.96 (0.92)	.041	0.34	22.65 (0.94)	.005	0.36
Nonreaction	19.92 (0.63)	20.82 (0.67)	.082	0.22	21.61 (0.68)	.002	0.40	21.51 (0.69)	.004	0.36

T: time, SMD: standard mean difference, SE: standard error, P: significance, and d: Cohen's d.

positive beliefs in yoga at baseline reported lower mood disturbance at all time points. Those who reported higher levels of overall PA, higher energy, and higher levels of the ability to act with awareness and be nonreactive to inner experience also reported lower mood disturbance. Those who reported greater tiredness reported greater mood disturbance. The Pseudo R^2 value suggests inclusion of these variables reduced error in predicting mood disturbance by 31% (see Table 3).

5.2.6. Stress Symptoms. There were significant linear and quadratic effects of time, indicating an initial decline in stress symptoms that slowed over time. Higher positive beliefs about yoga at baseline were associated with lower symptoms of stress. Those who reported higher moderate-to-vigorous PA and a greater ability to act with awareness and be nonjudgmental of inner experience concurrently reported lower stress symptom scores. Higher tension was significantly associated with higher stress symptoms. The Pseudo R^2 value suggests inclusion of these variables reduced error in predicting stress symptoms by 40% (see Table 3).

5.2.7. Quality of Life. A non-significant linear increase in HRQL was observed over time. Higher baseline beliefs about yoga were associated with higher HRQL. Those who reported higher overall PA, energy, and the ability to be nonjudgmental of inner experience reported higher HRQL. Those who reported high levels of tension reported lower levels of HRQL. The Pseudo R^2 value suggests inclusion of these predictor variables reduced error in predicting HRQL by 29% (see Table 3).

5.3. Yoga Practice Maintenance (Objectives 2a and 2b). Longitudinal GEE logistic estimated marginal means models were conducted to examine yoga practice before and after the yoga program and at three- and six-month follow-ups (objective 2a). Upon initiation of the current study, 48% (32 participants) reported previous yoga practice experience either through the Yoga Thrive program, community classes, home practice, or combinations thereof. At the end of the seven-week yoga program, 96% were still practicing yoga in various settings, a significant increase of 48% from baseline. At the three-month follow-up yoga practice had dropped, with 69% of participants were still practicing yoga in various settings, a significant 20% increase from baseline. At the six-month follow-up there was a slight increase in participation rates, with 76% of participants reporting continued yoga practice in various settings, a significant 27% increase from baseline (see Table 4).

Table 3: Longitudinal multilevel regression model.

Predictor	Mood disturbance (POMS-SF total) Est. (SE)	df	t	P	Stress symptoms (C-SOSI total) Est. (SE)	df	t	P	Quality of life (FACT-G total) Est. (SE)	df	t	P
Intercept	16.98 (2.10)	76.35	8.09	.000	54.89 (2.40)	69.19	22.87	.000	76.95 (1.49)	60.94	51.53	.000
Time												
Linear Time	−5.36 (2.22)	91.15	−2.41	.018	−3.90 (0.97)	108.75	−4.04	.000	0.27 (0.16)	60.05	1.65	.104
Time^2	1.59 (0.74)	86.47	2.16	.033	0.41 (0.11)	90.10	3.62	.000	—	—	—	—
Time^3	−0.12 (0.06)	85.68	−1.96	.053	—	—	—	—	—	—	—	—
Predictors												
Beliefs about Yoga	−0.57 (0.22)	52.55	−2.63	.011	−0.79 (0.27)	50.62	−2.87	.006	0.42 (0.19)	57.19	2.23	.030
Physical activity												
Leisure score index	−0.17 (0.08)	161.15	−2.17	.032	—	—	—	—	0.14 (0.05)	173.61	2.86	.005
Mod.-to-vigorous PA	—	—	—	—	−0.03 (0.01)	174.50	−2.10	.037	—	—	—	—
Affect												
Energy	−0.67 (0.34)	178.62	−1.96	.052	—	—	—	—	0.44 (0.17)	158.34	2.62	.010
Tension	—	—	—	—	1.35 (0.33)	158.74	4.07	.000	−0.81 (0.19)	150.36	−4.27	.000
Tiredness	0.75 (0.31)	176.96	2.45	.015	—	—	—	—	—	—	—	—
Mindfulness												
Act w/awareness	−0.58 (0.25)	144.80	−2.33	.021	−0.67 (0.29)	174.16	−2.29	.023	—	—	—	—
Nonjudgment	—	—	—	—	−0.76 (0.24)	185.89	−3.20	.002	0.56 (0.12)	180.77	4.71	.000
Nonreaction	−0.56 (0.26)	140.04	−2.13	.035	—	—	—	—	—	—	—	—
Pseudo R^2	Mood disturbance = 0.31				Stress symptoms = 0.40				Quality of life = 0.29			

Variables excluded ($P > .1$): age, time since diagnosis, previous Yoga Thrive program experience, current Yoga Thrive class attendance, calmness (ADACL), observe and describe (FFMQ), Est.: estimate, df: degrees of freedom, and P: significance.

Table 4: Yoga practice maintenance estimated marginal means model.

Measures	Baseline $T1$ ($N = 66$) Mean (SE)	8-weeks after $T2$ ($n = 53$) Mean (SE)	$T2 - T1$ SMD P	d	3-month follow-up $T3$ ($n = 48$) Mean (SE)	$T3 - T1$ SMD P	d	6-month follow-up $T4$ ($n = 45$) Mean (SE)	$T4 - T1$ SMD P	d
Adherence	0.48 (0.06)	0.96 (0.03)	.000	0.98	0.69 (0.07)	.008	0.41	0.76 (0.06)	.002	0.55

T: time, SMD: standard mean difference, SE: standard error, P: significance, and d: Cohen's d.

Follow-up GEE logistic regression analyses were performed to examine what participant characteristics predicted ongoing yoga practice (objective 2b). In examining associations between yoga practice at each time point and predictor variables, there was an initial positive linear effect for time, reflecting the increased rate of participants reporting yoga practice before-after program. The quadratic trend reflects a significant decline postintervention completion in yoga practice at three- and six-months. Those who reported more frequent participation in the Yoga Thrive program at each time had a greater chance of continuing their yoga practice for each time they completed the Yoga Thrive program. In addition, those who reported higher energy at each time point were more likely to maintain a yoga practice, as were those who reported a greater ability to be nonreactive to inner experience. Finally, those with higher self-reported HRQL at each time point had a greater chance of continuing yoga practice (see Table 5).

6. Discussion

Despite an emerging body of evidence highlighting the benefits of yoga for cancer survivors, little work has been done to bridge these clinical findings with theoretical predictors of change. The current research sought to bridge this gap between determining clinical benefits and describing predictors of these improvements in mood disturbance, stress symptoms and HRQL. Using the Circumplex Model of Affect as it has been applied in exercise settings [62] and emerging work examining the mechanisms of mindfulness [30, 36, 63] and yoga [64–66], a series of multilevel models were developed to examine (1) longitudinal changes in mood disturbance, stress symptoms and HRQL, predictor variables including affect and mindfulness, and whether these variables predicted change in these outcomes (objectives 1a and 1b); and (2) maintenance of yoga practice and whether maintenance could be anticipated by the aforementioned outcome and predictor variables (objectives 2a and 2b).

6.1. Longitudinal Program Effects (Objectives 1a and 1b)

6.1.1. Affect. Current study results suggest a linear increase in energy over time. These findings concur with research in the area of aerobic training [18] which suggest positive improvements in high-activation positive affect (e.g., energy) over time when exercise is of lower intensity and duration. Given

Table 5: Predictors of Yoga practice maintenance.

Parameter	B (SE)	Wald χ^2	Odds ratio (95% CI)	P
(Intercept)	1.50 (0.38)	15.77	4.50 (2.14, 9.45)	.000
Time	0.63 (0.23)	7.11	1.87 (1.18. 2.96)	.008
Time^2	−0.09 (0.03)	10.83	0.91 (0.86, 0.96)	.001
Previous participation in yoga thrive	0.63 (0.22)	8.42	1.88 (1.23, 2.87)	.004
Energy	0.13 (0.06)	4.94	1.14 (1.02, 1.27)	.026
Nonreaction to inner experience	0.08 (0.03)	5.86	1.08 (1.02, 1.16)	.015
Quality of life	0.03 (0.01)	4.23	1.03 (1.00, 1.06)	.040

Excluded variables ($P > .1$): age, time since diagnosis, yoga beliefs, attendance, physical activity, tension, tiredness, calmness (ADACL), observe, describe, act with awareness, nonjudgment (FFMQ), mood disturbance (POMS-SF), and stress symptoms (C-SOSI). B: estimate, SE: standard error, and P: significance.

the burden of fatigue in cancer survivors, improvements in energy are important and corroborate corollary improvements in fatigue indices in both the exercise and cancer [67–69], mindfulness [70, 71] and yoga literature [9].

6.1.2. Mindfulness. Longitudinal findings suggest participants reported improved ability to act with awareness, a mindfulness facet closely related to one's ability to concentrate [36]. Participants also reported increased nonjudging of inner experience, the taking of an impartial stance to thoughts and feelings, and nonreaction to inner experience, the ability to let thoughts and emotions come and go without having to act upon them. Research suggests the mindfulness facets of acting with awareness, nonjudgment, and nonreaction are most closely tied to decreased psychological distress [48]. Similar improvements in these mindfulness facets were also reported by Garland et al. [39] and Bränström et al. [37, 38] although effects reported in these other studies were of a larger magnitude and included improvements in the other facets of mindfulness as well. One potential explanation is that yoga practice may differ from formal mindfulness meditation training in preferentially developing skills of acting with awareness, nonjudging, and nonreactivity but not similarly help to develop other mindfulness skills of observing and describing one's experience.

6.1.3. Mood Disturbance, Stress Symptoms, and Quality of Life. Baseline positive yoga beliefs were consistently associated with lower mood disturbance, stress symptoms, and higher HRQL at all time points. Sohl et al. [44] suggest baseline yoga beliefs are intrinsic to both initial yoga program engagement and reported health outcomes. This speaks to the importance of patient preferences in choosing treatments and the role that positive expectancies play in driving improvements [72]. In addition, those who reported higher physical activity concurrently reported lower mood disturbance, stress symptoms and higher HRQL at all time-points. These findings reflect research suggesting the effects of exercise on mental health and HRQL in cancer survivors [67, 73].

The present research ascribed to Russell's (2003) thesis that when affective dimensions are examined longitudinally, they are no longer tied to a specific context as in acute exercise settings, where the temporal proximity to an exercise session is evident. Rather, these measures become reflective of what Russell (2003) has termed prolonged, objectless *core affect* [25]. It could be argued that including both the POMS-SF and ADACL created measurement redundancies, as both include items that tap the construct of mood. However, the two measures are fundamentally different from a conceptual standpoint. The POMS-SF has been used to measure mood reflecting discrete, largely negative, mood states. On the other hand, the ADACL has been used to tap the two basic affective dimensions of valence and activation, which, when combined, can theoretically provide a representation of the entire affective domain, including positive and negative, as well as high- and low-activation variants of affective experience. Given that yoga theoretically may generate a range of affective states, including both low-activation pleasure (calmness) and high-activation pleasure (energy), and given that cancer survivors experience both low-activation displeasure (tiredness) and high-activation displeasure (tension), it behooves researchers to utilize measures that capture the full range of affective experiences. Furthermore, dimensional measures of affective states may constitute more categorical mood states, including the mood states captured by the POMS-SF [15, 74, 75].

Higher reported ability to act with awareness was associated with lower mood disturbance and stress symptoms at all times. Higher reported nonjudgment of inner experiences was related to lower stress symptoms and higher HRQL. These improvements may reflect an accepting attention strategy in which participants find alternate ways to respond to stressful situations [30]. These findings are similar to the study by Garland et al. [39], in which both acting with awareness and being nonjudgmental of inner experience were correlated with reduced stress and mood disturbance. Higher non-reactivity to inner experience was related to lower mood disturbance. Research with experienced meditators and non-meditators suggests the ability to be nonreactive to inner experience is highly related to meditation experience and is most likely to mediate psychological health outcomes [76].

The present research is congruent with previous work suggesting yoga's effectiveness in reducing psychological distress and improving HRQL in cancer survivors [7, 9]. Continued significant changes in all three measured health outcomes were observed, despite the fact that 48% of participants at baseline were already yoga practitioners and had arguably already derived initial program benefits. Findings suggest improvements in health outcomes are associated with beliefs about yoga, physical activity, affective dimensions of energy, tension and tiredness, and facets of mindfulness, including the ability to act with awareness, be nonjudgmental of and nonreactive to inner experience. Associations between positive affective states and mindfulness are becoming clearer as state and trait measures of both constructs have been found to be highly related [29].

6.2. Yoga Practice Maintenance (Objectives 2a and 2b). Previous participation in the Yoga Thrive program was a significant predictor of yoga practice maintenance at all time points. This finding is similar to Speed-Andrews and colleagues' finding that yoga experience over the past year was significantly related to current yoga adherence in a cancer setting [77]. Positive experiences and increased well-being derived from yoga classes are suggested mechanisms for this increased program adherence [78].

Those reporting higher energy at each time point were also more likely to continue yoga practice. This relationship between positive affect and adherence has been widely reported in the literature [18, 19]. It is hypothesized the positive appraisal of physical activity as pleasurable is likely to bolster participant self-efficacy and lead to increased adherence and maintenance [79]. Recent American College of Sports Medicine (ACSM) guidelines also suggest positive affect may be an important determinant of exercise adherence [80].

Results suggesting those higher in non-reactivity were more likely to adhere to yoga practice are also supported in the literature. Nonreaction refers specifically to the ability to remain calm in the face of distressing thoughts and emotions. This ability to be nonreactive to inner experience has salutary effects and seems to be a key facet of mindfulness as well as one of the facets most affected by contemplative training [76]. Research by Ulmer and colleagues [81] suggests those with higher mindfulness scores are less reactive and better able to accurately appraise and respond to stressors that may impact routine activities, including yoga practice.

Results from the current study suggest a reciprocal relationship in which higher HRQL is associated with yoga practice maintenance. Higher HRQL has been associated with increasing individual self-efficacy to adhere and maintain exercise programs [79]. Maintenance of pre-cancer diagnosis physical activity levels and bodyweight is associated with better HRQL after breast cancer [82] and those who report meeting physical activity requirements in general report higher HRQL across cancer diagnoses [83].

Taken together these results suggest previous yoga experience coupled with higher energy, a greater ability to be nonreactive to inner experience and higher HRQL interact to improve the likelihood participants will maintain yoga practice, arguably further engendering the benefits of these practices. If affect and mindfulness are both associated with improved mental health outcomes and HRQL and cited as leading to increased program adherence, it behooves clinicians to consider developing approaches that focus more exclusively on the inherent psychological benefits of exercise, including yoga [62, 80].

6.3. Limitations. The use of an observational research design, including 48% of study participants who had already completed the program, added complexity to the current analyses. Without a comparison group, it is impossible to determine whether positive program effects were related to the yoga program, or due to the simple passage of time, among other factors. Also, given the high degree of previous yoga experience within the study sample, these findings are not generalizable to a general cancer survivor population. Despite these limitations, a comparison group was not utilized. Rather, the researchers elected to conduct the research in a "real-world" clinical setting given the Yoga Thrive programs' broad community-based implementation and the researchers' stated goal of identifying and developing theory to examine likely predictors of change in participant-reported outcomes [14]. However, as yoga program specific predictors of change are posited, subsequent research designs should include comparative effectiveness studies in which pragmatic trials use real-world comparison conditions rather than attention or waitlist controls using uniformly yoga naïve participants [84]. An additional limitation of the current study is the lack of a measure of home practice. Current work by Ross et al. [85] suggests the addition of home practice predicts mindfulness, subjective well-being, fatigue, sleep, and a variety of behavioral outcomes. In addition, frequency of yoga home practice was a better predictor of health than either total years of practice or class frequency. Given these findings, the thorough assessment of yoga practice outside of class time is imperative. Additional limitations include the self-report nature of all outcomes. While distribution-based markers of clinical significance have been introduced for these outcomes, future research would be better served by including more objective anchor-based methodology as well as supportive biomarkers of change [86]. While the study was powered on detecting a 0.50 difference on the POMS in the estimated marginal means models it was not powered for the multilevel regression analyses. However, research suggests samples of 50 study participants may be sufficient and show little bias in the regression coefficients [87]. In addition, no corrections were made for multiple comparisons. Therefore, care must be exercised in the interpretation of statistical significance due to the potential for false-positive (Type I error) findings.

7. Conclusion

Before yoga can be broadly applied within oncology, carefully designed and executed research that convincingly evaluates not only the effectiveness of yoga in clinical settings but also posits potential predictors of program outcomes are required. Despite the aforementioned limitations, longitudinal multilevel analyses allowed for the integration of theory to develop a novel research design able to examine mental health outcomes, contextual factors, and interactions thereof, within an existing community-based yoga program for cancer survivors. This combined knowledge can be translated directly back into the community to further develop innovative yoga programs and best practices with the express aim of improving mental health and HRQL in cancer survivors, soothing both mind and body.

Acknowledgments

The authors would like to thank all the study participants and yoga teachers involved in this research. They thank Gisela Engels (University of Calgary) for her statistical support. They would also like to thank Laura Labelle, PhD (Tom Baker Cancer Centre), and Sheila Garland, PhD (Perelman School of Medicine), for their editorial contributions to this paper. Michael J. Mackenzie acknowledges Social Sciences and Humanities Research Council of Canada (SSHRC) and Alberta Innovates-Health Solutions (AIHS) for funding his doctoral program of research.

References

[1] L. E. Carlson, A. Waller, S. L. Groff, J. Giese-Davis, and B. D. Bultz, "What goes up does not always come down: patterns of distress, physical and psychosocial morbidity in people with cancer over a one year period," *Psychooncology*, vol. 22, no. 1, pp. 168–176, 2013.

[2] M. Barbaric, E. Brooks, L. Moore, and O. Cheifetz, "Effects of physical activity on cancer survival: a systematic review," *Physiotherapy Canada*, vol. 62, no. 1, pp. 25–34, 2010.

[3] A. E. Speed-Andrews and K. S. Courneya, "Effects of exercise on quality of life and prognosis in cancer survivors," *Current Sports Medicine Reports*, vol. 8, no. 4, pp. 176–181, 2009.

[4] A. Bussing, A. Michalsen, S. B. Khalsa, S. Telles, and K. J. Sherman, "Effects of yoga on mental and physical health: a short summary of reviews," *Evidence-Based Complementary and Alternative Medicine*, vol. 2012, Article ID 165410, 7 pages, 2012.

[5] J. E. Bower, A. Woolery, B. Sternlieb, and D. Garet, "Yoga for cancer patients and survivors," *Cancer Control*, vol. 12, no. 3, pp. 165–171, 2005.

[6] A. Ross and S. Thomas, "The health benefits of yoga and exercise: a review of comparison studies," *Journal of Alternative and Complementary Medicine*, vol. 16, no. 1, pp. 3–12, 2010.

[7] K. Y. Lin, Y. T. Hu, K. J. Chang, H. F. Lin, and J. Y. Tsauo, "Effects of yoga on psychological health, quality of life, and physical health of patients with cancer: a meta-analysis," *Evidence-Based Complementary and Alternative Medicine*, vol. 2011, Article ID 659876, 12 pages, 2011.

[8] K. B. Smith and C. F. Pukall, "An evidence-based review of yoga as a complementary intervention for patients with cancer," *Psycho-Oncology*, vol. 18, no. 5, pp. 465–475, 2009.

[9] S. N. Culos-Reed, M. J. Mackenzie, S. J. Sohl, M. T. Jesse, A. N. Ross-Zahavich, and S. C. Danhauer, "Yoga & cancer interventions: a review of the clinical significance of patient-reported outcomes for cancer survivors," *Evidence-Based Complementary and Alternative Medicine*, vol. 2012, Article ID 642576, 17 pages, 2012.

[10] H. Cramer, S. Lange, P. Klose, A. Paul, and G. Dobos, "Yoga for breast cancer patients and survivors: a systematic review and meta-analysis," *BMC Cancer*, vol. 12, p. 412, 2012.

[11] H. Cramer, S. Lange, P. Klose, A. Paul, and G. Dobos, "Can yoga improve fatigue in breast cancer patients? a systematic review," *Acta Oncologica*, vol. 51, no. 4, pp. 559–560, 2012.

[12] K. Boehm, T. Ostermann, S. Milazzo, and A. Bussing, "Effects of yoga interventions on fatigue: a meta-analysis," *Evidence-Based Complementary and Alternative Medicine*, vol. 2012, Article ID 124703, 9 pages, 2012.

[13] J. Zhang, K. H. Yang, J. H. Tian, and C. M. Wang, "Effects of yoga on psychologic function and quality of life in women with breast cancer: a meta-analysis of randomized controlled trials," *Journal of Alternative and Complementary Medicine*, vol. 18, no. 11, pp. 994–1002, 2012.

[14] P. Craig, P. Dieppe, S. Macintyre, S. Michie, I. Nazareth, and M. Petticrew, "Developing and evaluating complex interventions: the new Medical Research Council guidance," *British Medical Journal*, vol. 337, p. a1655, 2008.

[15] W. K. Hou, C. C. Law, and Y. T. Fu, "Does change in positive affect mediate and/or moderate the impact of symptom distress on psychological adjustment after cancer diagnosis? A prospective analysis," *Psychology and Health*, vol. 25, no. 4, pp. 417–431, 2010.

[16] S. D. Pressman and S. Cohen, "Does positive affect influence health?" *Psychological Bulletin*, vol. 131, no. 6, pp. 925–971, 2005.

[17] S. Lyubomirsky, L. King, and E. Diener, "The benefits of frequent positive affect: does happiness lead to success?" *Psychological Bulletin*, vol. 131, no. 6, pp. 803–855, 2005.

[18] J. Reed and S. Buck, "The effect of regular aerobic exercise on positive-activated affect: a meta-analysis," *Psychology of Sport and Exercise*, vol. 10, no. 6, pp. 581–594, 2009.

[19] R. E. Rhodes, B. Fiala, and M. Conner, "A review and meta-analysis of affective judgments and physical activity in adult populations," *Annals of Behavioral Medicine*, vol. 38, no. 3, pp. 180–204, 2009.

[20] K. S. Courneya, C. M. Friedenreich, R. A. Sela, H. A. Quinney, R. E. Rhodes, and L. W. Jones, "Exercise motivation and adherence in cancer survivors after participation in a randomized controlled trial: an attribution theory perspective," *International Journal of Behavioral Medicine*, vol. 11, no. 1, pp. 8–17, 2004.

[21] J. West, C. Otte, K. Geher, J. Johnson, and D. C. Mohr, "Effects of Hatha yoga and African dance on perceived stress, affect, and salivary cortisol," *Annals of Behavioral Medicine*, vol. 28, no. 2, pp. 114–118, 2004.

[22] Y. Netz and R. Lidor, "Mood alterations in mindful versus aerobic exercise modes," *Journal of Psychology*, vol. 137, no. 5, pp. 405–419, 2003.

[23] S. C. Danhauer, S. L. Mihalko, G. B. Russell et al., "Restorative yoga for women with breast cancer: finding from a randomized pilot study," *Psycho-Oncology*, vol. 18, no. 4, pp. 360–368, 2009.

[24] H. S. Vadiraja, M. R. Rao, R. Nagarathna et al., "Effects of yoga program on quality of life and affect in early breast cancer patients undergoing adjuvant radiotherapy: a randomized controlled trial," *Complementary Therapies in Medicine*, vol. 17, no. 5-6, pp. 274–280, 2009.

[25] J. A. Russell, "Core affect and the psychological construction of emotion," *Psychological Review*, vol. 110, no. 1, pp. 145–172, 2003.

[26] M. S. M. Yik, J. A. Russell, and L. F. Barrett, "Structure of self-reported current affect: integration and beyond," *Journal of Personality and Social Psychology*, vol. 77, no. 3, pp. 600–619, 1999.

[27] D. M. Williams, "Exercise, affect, and adherence: an integrated model and a case for self-paced exercise," *Journal of Sport and Exercise Psychology*, vol. 30, no. 5, pp. 471–496, 2008.

[28] J. Kabat-Zinn, L. Lipworth, and R. Burney, "The clinical use of mindfulness meditation for the self-regulation of chronic pain," *Journal of Behavioral Medicine*, vol. 8, no. 2, pp. 163–190, 1985.

[29] T. Jislin-Goldberg, G. Tanay, and A. Bernstein, "Mindfulness and positive affect: cross-sectional, prospective intervention,

and real-time relations," *The Journal of Positive Psychology*, vol. 7, no. 5, pp. 349–361, 2012.

[30] K. W. Brown and S. Cordon, "Toward a phenomenology of mindfulness: subjective experience and emotional correlates," in *Clincal Handbook of Mindfulness*, F. Didonna, Ed., pp. 59–81, Springer, New York, NY, USA, 2009.

[31] P. Salmon, E. Lush, M. Jablonski, and S. E. Sephton, "Yoga and mindfulness: clinical aspects of an ancient mind/body practice," *Cognitive and Behavioral Practice*, vol. 16, no. 1, pp. 59–72, 2009.

[32] B. E. Froeliger, E. L. Garland, L. A. Modlin, and F. J. McClernon, "Neurocognitive correlates of the effects of yoga meditation practice on emotion and cognition: a pilot study," *Frontiers in Integrative Neuroscience*, vol. 6, p. 48, 2012.

[33] C. A. Lengacher, V. Johnson-Mallard, J. Post-White et al., "Randomized controlled trial of mindfulness-based stress reduction (MBSR) for survivors of breast cancer," *Psycho-Oncology*, vol. 18, no. 12, pp. 1261–1272, 2009.

[34] J. Carmody and R. A. Baer, "Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program," *Journal of Behavioral Medicine*, vol. 31, no. 1, pp. 23–33, 2008.

[35] S. E. Sauer-Zavala, E. C. Walsh, T. A. Eisenlohr-Moul, and E. L. Lykins, "Comparing mindfulness-based intervention strategies: differential effects of sitting meditation, body scan, and mindful yoga," in *Mindfulness*, pp. 1–6, 2012.

[36] R. A. Baer, "Self-focused attention and mechanisms of change in mindfulness-based treatment," *Cognitive Behaviour Therapy*, vol. 38, supplement 1, pp. 15–20, 2009.

[37] R. Bränström, P. Kvillemo, Y. Brandberg, and J. T. Moskowitz, "Self-report mindfulness as a mediator of psychological well-being in a stress reduction intervention for cancer patients—a randomized study," *Annals of Behavioral Medicine*, vol. 39, no. 2, pp. 151–161, 2010.

[38] R. Bränström, P. Kvillemo, and J. T. Moskowitz, "A randomized study of the effects of mindfulness training on psychological well-being and symptoms of stress in patients treated for cancer at 6-month follow-up," *International Journal of Behavioral Medicine*, vol. 19, no. 4, pp. 535–542, 2012.

[39] S. N. Garland, R. Tamagawa, S. C. Todd, M. Speca, and L. E. Carlson, "Increased mindfulness is related to improved stress and mood following participation in a mindfulness-based stress reduction program in individuals with cancer," *Integrative Cancer Therapies*, vol. 12, no. 1, pp. 31–40, 2013.

[40] S. N. Culos-Reed, L. E. Carlson, L. M. Daroux, and S. Hately-Aldous, "A pilot study of yoga for breast cancer survivors: physical and psychological benefits," *Psycho-Oncology*, vol. 15, no. 10, pp. 891–897, 2006.

[41] A. N. Ross Zahavich, J. A. Robinson, D. Paskevich, and S. N. Culos-Reed, "Examining a therapeutic yoga program for prostate cancer survivors," *Integrative Cancer Therapies*, vol. 12, no. 2, pp. 113–125, 2013.

[42] F. Faul, E. Erdfelder, A. G. Lang, and A. Buchner, "G*power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences," *Behavior Research Methods*, vol. 39, no. 2, pp. 175–191, 2007.

[43] J. A. Sloan, M. H. Frost, R. Berzon et al., "The clinical significance of quality of life assessments in oncology: a summary for clinicians," *Supportive Care in Cancer*, vol. 14, no. 10, pp. 988–998, 2006.

[44] S. J. Sohl, J. B. Schnur, L. Daly, K. Suslov, and G. H. Montgomery, "Development of the beliefs about yoga scale," *International Journal of Yoga Therapy*, vol. 21, pp. 85–91, 2011.

[45] G. Godin and R. J. Shephard, "A simple method to assess exercise behavior in the community," *Canadian Journal of Applied Sport Sciences*, vol. 10, no. 3, pp. 141–146, 1985.

[46] R. E. Thayer, *The Biopsychology of Mood and Arousal*, Oxford University Press, New York, NY, USA, 1989.

[47] P. Ekkekakis, E. E. Hall, and S. J. Petruzzello, "Evaluation of the circumplex structure of the activation deactivation adjective check list before and after a short walk," *Psychology of Sport and Exercise*, vol. 6, no. 1, pp. 83–101, 2005.

[48] R. A. Baer, G. T. Smith, J. Hopkins, J. Krietemeyer, and L. Toney, "Using self-report assessment methods to explore facets of mindfulness," *Assessment*, vol. 13, no. 1, pp. 27–45, 2006.

[49] S. Shacham, "A shortened version of the profile of mood states," *Journal of Personality Assessment*, vol. 47, no. 3, pp. 305–306, 1983.

[50] L. E. Carlson and B. C. Thomas, "Development of the calgary symptoms of stress inventory (C-SOSI)," *International Journal of Behavioral Medicine*, vol. 14, no. 4, pp. 249–256, 2007.

[51] D. F. Cella, D. S. Tulsky, G. Gray et al., "The functional assessment of cancer therapy scale: development and validation of the general measure," *Journal of Clinical Oncology*, vol. 11, no. 3, pp. 570–579, 1993.

[52] M. K. Suvak, S. M. Walling, K. M. Iverson, C. T. Taft, and P. A. Resick, "Multilevel regression analyses to investigate the relationship between two variables over time: examining the longitudinal association between intrusion and avoidance," *Journal of Traumatic Stress*, vol. 22, no. 6, pp. 622–631, 2009.

[53] A. F. Hayes, "A primer on multilevel modeling," *Human Communication Research*, vol. 32, no. 4, pp. 385–410, 2006.

[54] J. H. Kahn, "Multilevel modeling: overview and applications to research in counseling psychology," *Journal of Counseling Psychology*, vol. 58, no. 2, pp. 257–271, 2011.

[55] O. M. Kwok, A. T. Underhill, J. W. Berry, W. Luo, T. R. Elliott, and M. Yoon, "Analyzing longitudinal data with multilevel models: an example with individuals living with lower extremity intra-articular fractures," *Rehabilitation Psychology*, vol. 53, no. 3, pp. 370–386, 2008.

[56] D. T. L. Shek and C. M. S. Ma, "Longitudinal data analyses using linear mixed models in SPSS: concepts, procedures and illustrations," *TheScientificWorldJournal*, vol. 11, pp. 42–76, 2011.

[57] B. T. West, "Analyzing longitudinal data with the linear mixed models procedure in SPSS," *Evaluation and the Health Professions*, vol. 32, no. 3, pp. 207–228, 2009.

[58] J. B. Nezlek, "An introduction to multilevel modeling for social and personality psychology," *Social and Personality Psychology Compass*, vol. 2, no. 2, pp. 842–860, 2008.

[59] J. Cohen, *Statistical Power Analysis for the Behavioral Sciences*, Erlbaum, Mahwah, NJ, USA, 2nd edition, 1988.

[60] J. J. Hox, *Multilevel Analysis: Techniques and Applications*, Routledge, New York, NY, USA, 2010.

[61] D. Huh, B. P. Flaherty, and J. M. Simoni, "Optimizing the analysis of adherence interventions using logistic generalized estimating equations," *AIDS and Behavior*, vol. 16, no. 2, pp. 422–431, 2012.

[62] P. Ekkekakis, G. Parfitt, and S. J. Petruzzello, "The pleasure and displeasure people feel when they exercise at different intensities: decennial update and progress towards a tripartite rationale for exercise intensity prescription," *Sports Medicine*, vol. 41, no. 8, pp. 641–671, 2011.

[63] K. A. Coffey, M. Hartman, and B. L. Fredrickson, "Deconstructing mindfulness and constructing mental health: understanding mindfulness and its mechanisms of action," *Mindfulness*, vol. 1, no. 4, pp. 235–253, 2010.

[64] S. Evans, J. C. I. Tsao, B. Sternlieb, and L. K. Zeltzer, "Using the biopsychosocial model to understand the health benefits of yoga," *Journal of Complementary and Integrative Medicine*, vol. 6, no. 1, pp. 1–22, 2009.

[65] C. C. Streeter, P. L. Gerbarg, R. B. Saper, D. A. Ciraulo, and R. P. Brown, "Effects of yoga on the autonomic nervous system, gamma-aminobutyric-acid, and allostasis in epilepsy, depression, and post-traumatic stress disorder," *Medical Hypotheses*, vol. 78, no. 5, pp. 571–579, 2012.

[66] L. A. Uebelacker, G. Epstein-Lubow, B. A. Gaudiano, G. Tremont, C. L. Battle, and I. W. Miller, "Hatha yoga for depression: critical review of the evidence for efficacy, plausible mechanisms of action, and directions for future research," *Journal of Psychiatric Practice*, vol. 16, no. 1, pp. 22–33, 2010.

[67] S. F. A. Duijts, M. M. Faber, H. S. A. Oldenburg, M. Van Beurden, and N. K. Aaronson, "Effectiveness of behavioral techniques and physical exercise on psychosocial functioning and health-related quality of life in breast cancer patients and survivors-a meta-analysis," *Psycho-Oncology*, vol. 20, no. 2, pp. 115–126, 2011.

[68] L. F. Brown and K. Kroenke, "Cancer-related fatigue and its associations with depression and anxiety: a systematic review," *Psychosomatics*, vol. 50, no. 5, pp. 440–447, 2009.

[69] M. L. McNeely and K. S. Courneya, "Exercise programs for cancer-related fatigue: evidence and clinical guidelines," *Journal of the National Comprehensive Cancer Network*, vol. 8, no. 8, pp. 945–953, 2010.

[70] M. L. van der Lee and B. Garssen, "Mindfulness-based cognitive therapy reduces chronic cancer-related fatigue: a treatment study," *Psycho-Oncology*, vol. 21, no. 3, pp. 264–272, 2012.

[71] L. E. Carlson, T. S. Campbell, S. N. Garland, and P. Grossman, "Associations among salivary cortisol, melatonin, catecholamines, sleep quality and stress in women with breast cancer and healthy controls," *Journal of Behavioral Medicine*, vol. 30, no. 1, pp. 45–58, 2007.

[72] L. W. Jones and K. S. Courneya, "Exercise counseling and programming preferences of cancer survivors," *Cancer Practice*, vol. 10, no. 4, pp. 208–215, 2002.

[73] D. Bicego, K. Brown, M. Ruddick, D. Storey, C. Wong, and S. R. Harris, "Effects of exercise on quality of life in women living with breast cancer: a systematic review," *Breast Journal*, vol. 15, no. 1, pp. 45–51, 2009.

[74] A. D. Bryan, R. E. Magnan, R. Nilsson, B. H. Marcus, S. A. Tompkins, and K. E. Hutchison, "The big picture of individual differences in physical activity behavior change: a transdisciplinary approach," *Psychology of Sport and Exercise*, vol. 12, no. 1, pp. 20–26, 2011.

[75] M. Å. Hallgren, N. D. Moss, and P. Gastin, "Regular exercise participation mediates the affective response to acute bouts of vigorous exercise," *Journal of Sports Science and Medicine*, vol. 9, no. 4, pp. 629–637, 2010.

[76] T. Josefsson, P. Larsman, A. Broberg, and L.-G. Lundh, "Self-reported mindfulness mediates the relation between meditation experience and psychological well-being," *Mindfulness*, pp. 49–58, 2011.

[77] A. E. Speed-Andrews, C. Stevinson, L. J. Belanger, J. J. Mirus, and K. S. Courneya, "Pilot evaluation of an Iyengar yoga program for breast cancer survivors," *Cancer Nursing*, vol. 33, no. 5, pp. 369–381, 2010.

[78] S. Bryan, G. Pinto Zipp, and R. Parasher, "The effects of yoga on psychosocial variables and exercise adherence: a randomized, controlled pilot study," *Alternative Therapies In Health And Medicine*, vol. 18, no. 5, pp. 50–59, 2012.

[79] H. Y. Perkins, G. P. Baum, C. L. C. Taylor, and K. M. Basen-Egquist, "Effects of treatment factors, comorbidities and health-related quality of life on self-efficacy for physical activity in cancer survivors," *Psycho-Oncology*, vol. 18, no. 4, pp. 405–411, 2009.

[80] C. E. Garber, B. Blissmer, M. R. Deschenes et al., "Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise," *Medicine and Science in Sports and Exercise*, vol. 43, no. 7, pp. 1334–1359, 2011.

[81] C. S. Ulmer, B. A. Stetson, and P. G. Salmon, "Mindfulness and acceptance are associated with exercise maintenance in YMCA exercisers," *Behaviour Research and Therapy*, vol. 48, no. 8, pp. 805–809, 2010.

[82] D. W. Voskuil, J. G. H. van Nes, J. M. C. Junggeburt, C. J. H. van de Velde, F. E. van Leeuwen, and J. C. J. M. de Haes, "Maintenance of physical activity and body weight in relation to subsequent quality of life in postmenopausal breast cancer patients," *Annals of Oncology*, vol. 21, no. 10, pp. 2094–2101, 2010.

[83] C. M. Blanchard, K. S. Courneya, and K. Stein, "Cancer survivors' adherence to lifestyle behavior recommendations and associations with health-related quality of life: results from the American Cancer Society's SCS-II," *Journal of Clinical Oncology*, vol. 26, no. 13, pp. 2198–2204, 2008.

[84] K. C. Stange, E. S. Breslau, A. J. Dietrich, and R. E. Glasgow, "State-of-the-art and future directions in multilevel interventions across the cancer control continuum," *Journal of the National Cancer Institute*, no. 44, pp. 20–31, 2012.

[85] A. Ross, E. Friedmann, M. Bevans, and S. Thomas, "Frequency of yoga practice predicts health: results of a National survey of yoga practitioners," *Evidence-Based Complementary and Alternative Medicine*, vol. 2012, Article ID 983258, 10 pages, 2012.

[86] D. Osoba, "Health-related quality of life and cancer clinical trials," *Therapeutic Advances in Medical Oncology*, vol. 3, no. 2, pp. 57–71, 2011.

[87] C. J. M. Maas and J. J. Hox, "Sufficient sample sizes for multilevel modeling," *Methodology*, vol. 1, no. 3, pp. 86–92, 2005.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2013, Article ID 743504, 7 pages
http://dx.doi.org/10.1155/2013/743504

Research Article

Cardiovascular and Respiratory Effect of Yogic Slow Breathing in the Yoga Beginner: What Is the Best Approach?

Heather Mason,[1] Matteo Vandoni,[2] Giacomo deBarbieri,[3] Erwan Codrons,[2] Veena Ugargol,[4] and Luciano Bernardi[2,3]

[1] *Department of Neuroscience, Roehampton University, London, UK*
[2] *Department of Public Health and Neuroscience, University of Pavia, Pavia, Italy*
[3] *Department of Internal Medicine, University of Pavia and IRCCS San Matteo, Pavia, Italy*
[4] *Department of Psychology, The Open University, London, UK*

Correspondence should be addressed to Luciano Bernardi; lbern1ps@unipv.it

Received 18 December 2012; Accepted 22 March 2013

Academic Editor: Elisa Harumi Kozasa

Slow breathing increases cardiac-vagal baroreflex sensitivity (BRS), improves oxygen saturation, lowers blood pressure, and reduces anxiety. Within the yoga tradition slow breathing is often paired with a contraction of the glottis muscles. This resistance breath "ujjayi" is performed at various rates and ratios of inspiration/expiration. To test whether ujjayi had additional positive effects to slow breathing, we compared BRS and ventilatory control under different breathing patterns (equal/unequal inspiration/expiration at 6 breath/min, with/without ujjayi), in 17 yoga-naive young healthy participants. BRS increased with slow breathing techniques with or without expiratory ujjayi ($P < 0.05$ or higher) except with inspiratory + expiratory ujjayi. The maximal increase in BRS and decrease in blood pressure were found in slow breathing with equal inspiration and expiration. This corresponded with a significant improvement in oxygen saturation without increase in heart rate and ventilation. Ujjayi showed similar increase in oxygen saturation but slightly lesser improvement in baroreflex sensitivity with no change in blood pressure. The slow breathing with equal inspiration and expiration seems the best technique for improving baroreflex sensitivity in yoga-naive subjects. The effects of ujjayi seems dependent on increased intrathoracic pressure that requires greater effort than normal slow breathing.

1. Introduction

Respiratory research documents that reduced breathing rate, hovering around 5-6 breaths per minute in the average adult, can increase vagal activation leading to reduction in sympathetic activation, increased cardiac-vagal baroreflex sensitivity (BRS), and increased parasympathetic activation all of which correlated with mental and physical health [1–4]. BRS is a measure of the heart's capacity to efficiently alter and regulate blood pressure in accordance with the requirements of a given situation. A high degree of BRS is thus a good marker of cardiac health [5].

The slow breathing-induced increase in BRS could be due to the increased tidal volume that stimulates the Hering-Breuer reflex, an inhibitory reflex triggered by stretch receptors in the lungs that feed to the vagus [6]. In addition, the slow breathing increases the oxygen absorption that follows greater tidal volume (V_t), as a result of reduction in the effects of anatomical and physiological dead space [7, 8]. This might in turn produce another positive effect, that is, a reduction in the need of breathing. Indeed, a reduction in chemoreflex sensitivity and, via their reciprocal relationships, an increase in BRS, have been documented with slow breathing [9–13].

Ujjayi resistance breathing, a breathing practice taught by the yogic tradition, reduces airflow, and during expiration it increases the intrathoracic pressure due to a slight contraction of the glottis muscles, potentially resulting in intensified vagal activity [14–16]. The increase in expiratory intrathoracic pressure should also enhance oxygen absorption above what is found in slow breathing, potentially elevating blood pressure levels more than with slow breathing alone and inducing greater BRS [17]. Lastly, ujjayi breathing facilitates greater control over airflow and, therefore, breath rate [14]. Consequently, ujjayi may be a more effective method than slow breathing on its own as a means to achieve five breaths per minute for the average person who tends to breathe at 12–18 breaths per minute. On the other hand, the additional effort to exhale, induced by the increased intra-thoracic pressure, might stimulate sympathetic activity, partially reducing the advantages of this technique. Accordingly, we tested whether ujjayi breath would improve oxygen saturation and BRS, more than slow breathing alone.

2. Materials and Methods

2.1. Subjects. The protocol of this study was approved by the Ethics Committee of the University of Pavia, Italy, and all participants gave informed consent to participate in this study. Using a within-participants design, 17 young healthy participants were recruited by word of mouth through university students and staff. Participants provided information pertaining to their general level of fitness, level of sport undertaken (including specialties that lead to practices similar to yoga like diving and martial arts), smoking habits, and average alcohol consumption. These and the anthropometric characteristics of the subjects are shown in Table 1.

2.2. Protocol. The electrocardiogram was recorded using a bipolar precordial lead. Continuous blood pressure was monitored with a digital plethysmograph (Portapres, FMS Medical Systems, Amsterdam, The Netherlands) from the middle finger of the right arm held at heart level. Two respiratory signals were obtained by inductive plethysmography, from belts positioned around the chest and the abdomen. Pulse oximetry and expired carbon dioxide partial pressure (Cosmo, Novametrix, Wallingford, CT, USA) were also obtained.

Pretesting, participants spent approximately 10 minutes learning how to engage ujjayi breath with a qualified yoga teacher. They were then connected to the measuring devices ready for testing. The testing phase comprised 7 conditions distinguished by breathing rate and inclusion or not of ujjayi breath. Although the effects described for ujjayi should essentially occur during expiration (as normally practiced), we also included an evaluation of ujjayi during both inspiration and expiration, as suggested by some yoga teachers. We decided to perform the ujjayi without the addition of so-called “bandhas” (i.e., contractions at the level of perineum or abdomen or tucking the chin close to the chest), since in yoga naive participants these additional movements could be difficult to perform without practice. This is also in agreement with many yoga schools, which do not necessarily associate the bandhas with ujjayi. The recordings were made in the supine position during 3 minutes spontaneous breathing, during 2 minutes controlled breathing at a frequency similar to normal spontaneous breathing (15 breaths/minute), and during 2 minute periods of slow deep breathing at the rate of 6 cycles/minute with either equal or unequal inspiration/expiration ratio and with or without ujjayi (Table 2 reports the methodology for the different recordings).

All recordings were performed in random order, except baseline that was always performed first. Each recording was separated by the previous one by 2 minutes.

Table 1: Characteristics of the participants (mean ± SEM).

Number	17
Sex (men/women)	8/9
Age (years)	27.2 ± 1.1
Weight (kg)	63.4 ± 3.3
Height (m)	1.72 ± 2.5
Body mass index (kg/m^2)	21.1 ± 0.6
Training sessions frequency per week	2.6 ± 0.3
Energy expenditure per week (mets)	14.6 ± 2.1
Smokers	0.0 ± 0.0
Alcohol (glasses/week)	2.2 ± 0.5
Diving and martial arts practitioners	0.0 ± 0.0

All signals were simultaneously acquired on a personal computer with an analog-to-digital converter with a 12-bit resolution at a sampling rate of 400 Hz on a Macintosh computer using a special software written in our laboratory.

2.3. Assessment of BRS. From the original data the time series of RR interval (from each of 2 consecutive *R* waves of the electrocardiogram) and systolic blood pressure (SBP) were obtained. Previous studies have shown a poor correlation between different indices of BRS, while on the other hand, no method has shown clear superior performance over the other [18]. Accordingly, we computed a set of 7 different tests and used their average [19]. BRS was determined from spontaneous fluctuations in the RR interval and SBP during the spontaneous, 15/min and 6/min recordings using the positive and negative sequence methods [20], the alpha coefficient in the low and high frequency bands and its average [21], and the transfer function technique [22]. In the sequence methods, the BRS was estimated by identifying spontaneously occurring sequences of 3 or more consecutive heartbeats in which both the SBP and the subsequent RR intervals changed in the same direction. The minimum criteria for change were 1 mm Hg for SBP and 5 ms for the RR intervals. For identified positive and negative sequences with a correlation coefficient between the RR intervals and the SBP exceeding 0.85, the regression slopes (the slope of the regression line between SBP and RR intervals) were calculated, and the average was taken as a measure of BRS positive and negative slopes, respectively. The other 4 BRS methods were calculated by autoregressive uni- and bivariate spectral analysis. The alpha coefficient was calculated as the square root of the ratio of the powers of RR intervals and SBP in the low frequency range (0.04–0.15 Hz) and in the respiratory (0.15–0.40 Hz) high frequency range when coherence was greater than 0.5, and the phase difference between SBP and RR intervals was negative. In the transfer function method BRS was calculated as the average value of SBP-RR cross-spectrum divided by the SBP spectrum in the low frequency range (0.04–0.15 Hz), when coherence exceeded 0.5. The last method was obtained by the standard deviation of RR interval divided by the standard deviation of SBP after a high-pass filtering at 0.050 Hz corner frequency, 6 dB/octave attenuation, as recently proposed and validated [19].

Table 2: Conditions tested.

Breath rate	Ujjayi/no ujjayi
(1) Spontaneous—baseline measure	No ujjayi
(2) Fast breathing—15 per minute, 2 second inspiration and expiration	No ujjayi
(3) Slow breathing—6 per minute, 5 second inspiration and expiration	No ujjayi
(4) Slow breathing—6 per minute, 5 second inspiration and expiration	Ujjayi
(5) Slow breathing—6 per minute, 5 second inspiration and expiration	Ujjayi on exhalation only
(6) Slow breathing—6 per minute, 3 second inspiration/7 second expiration	No ujjayi
(7) Slow breathing—6 per minute, 3 second inspiration/7 second expiration	Ujjayi on exhalation only

2.4. Analysis of Respiration. The signals from the inductive plethysmographic belt signals were analyzed by an interactive program to identify for each breath the positive and negative respiratory peaks, together with the respiratory period. The sum of the signals obtained by the 2 belts was taken as a relative index of tidal volume. Additionally, the same program automatically identified the end-expiratory (end-tidal) value in the carbon dioxide signal. Using the inductive belt data a semiquantitative intrasubject analysis of ventilation could be obtained, by comparing the relative changes in V_t and minute ventilation (V_E) induced by oxygen inhalation or different breathing patterns. Although the device used for the present study does not allow to obtain V_t and minute ventilation in absolute values (mL and L/min, resp.), we took advantage of the strong linear relationship between V_t and the inductive belt signals [23], thus allowing us to obtain ventilation in relative units. Great care was taken to ascertain that the belts would not be displaced during the experiment. The limitation of the semiquantitative analysis is compensated by the lack of interference with the spontaneous breathing, that typically occurs with mouthpieces [24]. We therefore set the minute ventilation obtained during spontaneous breathing (our baseline) as 100% in each subject and calculated the minute V_E or V_t in % changes from that value for each recording [25].

2.5. Estimates of Chemoreflex Sensitivity. Although it was practically impossible to practice this type of respiration during a typical chemoreflex testing (requiring a rebreathing circuit and a mouthpiece or a face mask) [11], we could still use a previously validated simpler and approximative index of chemoreflex sensitivity, based on the ratio of tidal volume to inspiratory time (V_t/T_i) [26]. Because we evaluated the V_t only in relative units, we used the same normalisation procedure used for ventilation data and thus expressed the values obtained in each recording as variations from the baseline (set to 100% in each subject).

2.6. Statistical Analysis. Data are presented as mean ± standard error of the mean (SEM). Statistical differences between baseline and the different interventions (6/min versus 15/min controlled breathings) were tested by analysis of variance for repeated measures (ANOVA) [27]. Sheffe' test was used to test for significances between different breathing techniques. Statistical significance was defined as a value ≤0.05. All comparisons were done with respect to spontaneous breathing and also with controlled breathing at a frequency similar to the spontaneous (15 breath/min), to identify the effect of controlling respiration per se.

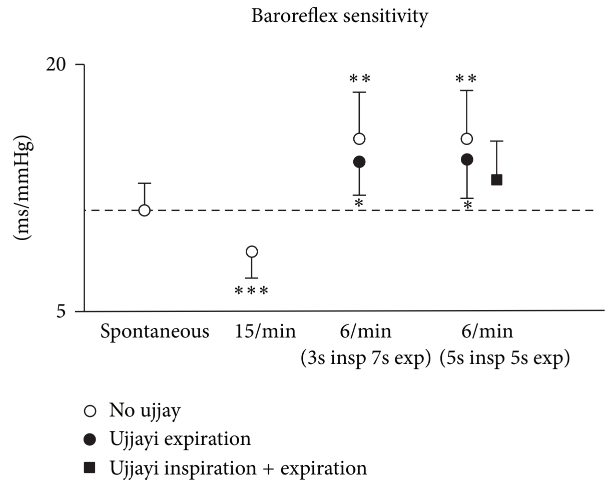


Figure 1: Effect of breathing techniques on BRS values ($^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$, versus spontaneous breathing).

3. Results

Complete results are shown in Table 3 and Figures 1 and 2. Overall, data were consistent, and we did not find significant differences between male and female participants.

3.1. BRS (Figure 1). In comparison to spontaneous breathing, fast breathing led to a reduction in BRS, whilst all slow breathing (with or without ujjayi breathing) increased BRS. This increase was seen in both the symmetrical (5 second inspiration and expiration) and asymmetrical (3 second inspiration and 7 second expiration) slow breathing conditions. Engaging ujjayi breathing on the exhalation had the effect of reducing the increase in BRS of slow breathing alone, and this was further reduced with ujjayi on the inspiration and expiration (which was not significantly higher than baseline). These differences were even more pronounced with respect to controlled breathing at 15 breath/minute, which also showed highly significant differences with respect to spontaneous breathing, but in the opposite direction.

Table 3: Effects respiratory patterns on cardiorespiratory variables.

Variable	Spontaneous	15/min	6/min (3 s inspiration + 7 s expiration)		6/min (5 s inspiration + 5 s expiration)		
	No ujjayi	No ujjayi	No ujjayi	Ujjayi exp	No ujjayi	Ujjayi exp	Ujjayi ins + exp
RR interval (ms)	830 ± 32	769 ± 26***	802 ± 25*	789 ± 24*	832 ± 26¶¶¶	809 ± 25$^{\#\#}$	797 ± 20$^{*\#\#}$
Systolic blood pressure (mmHg)	121.84 ± 5.67	113.96 ± 5.67*	117.91 ± 5.21	120.06 ± 4.58	111.34 ± 4.91***¶¶	118.46 ± 4.77$^{\#}$	116.25 ± 4.97$^{\#}$
Diastolic blood pressure (mmHg)	54.78 ± 3.69	51.93 ± 2.88*	53.99 ± 3.14	55.77 ± 3.01	55.14 ± 3.23*	54.55 ± 3.29$^{\#}$	54.28 ± 2.91$^{\#}$
Oxygen saturation (%)	98.37 ± 0.17	99.19 ± 0.17***	98.90 ± 0.18$^{\#\#}$	98.91 ± 0.14**	98.90 ± 0.19*	98.95 ± 0.17**	98.88 ± 0.18*
End-tidal carbon dioxide (mmHg)	36.26 ± 1.27	26.11 ± 0.98***	31.14 ± 1.13**	30.23 ± 0.97***	30.24 ± 0.68***	29.76 ± 1.22***	29.69 ± 0.90***
V_t (normalized to spontaneous breathing)	100.00 ± 0.00	152.82 ± 14.33**	318.40 ± 28.48***	368.48 ± 38.32$^{***\#}$	249.12 ± 24.39***¶¶¶	318.88 ± 34.01$^{***\ \#\#\#\ \P\P}$	293.91 ± 30.56$^{***\ \#\P\P}$
V_E (normalized to spontaneous breathing)	100.00 ± 0.00	190.88 ± 17.02***	158.81 ± 11.82***	183.35 ± 15.33***	125.12 ± 9.96¶¶¶	160.69 ± 14.88$^{***\ \#\#\#\ \P\P}$	149.77 ± 14.71$^{**\ \#\ \P\P}$

$^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$, versus spontaneous breathing.
$^{\#}P < 0.05$; $^{\#\#}P < 0.01$; $^{\#\#\#}P < 0.001$, versus no ujjayi.
$^{\P}P < 0.05$; $^{\P\P}P < 0.01$; $^{\P\P\P}P < 0.001$, versus 6/min (3 s inspiration + 7 s expiration).

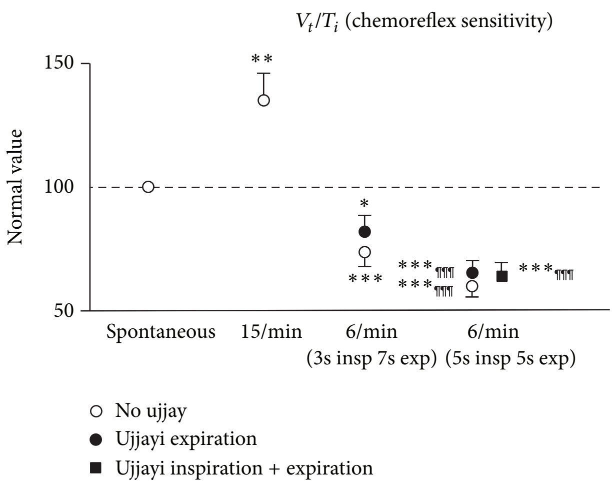


Figure 2: Effect of breathing techniques on estimated chemoreflex sensitivity values ($^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$, versus spontaneous breathing; ¶¶¶$P < 0.001$, versus 6/min (3 s inspiration + 7 s expiration)).

3.2. Oxygen Saturation, Carbon Dioxide, and Ventilation. Both slow breathing and 15 breath/minute controlled breathing increased oxygen saturation as compared to baseline. When slow breathing was done in conjunction with ujjayi breathing, oxygen saturation further increased, though only slightly. Overall, however, this was a highly significant change given that baseline oxygen saturation was already high approximately 98.3% (Table 3). The increase in oxygen saturation during slow breathing was lower than that observed during fast breathing. However, with 15 breath/minute controlled breathing the increase in oxygen saturation occurred with a large relative increase in V_E and a marked drop in end-tidal carbon dioxide. Conversely, with slow breathing, the increase in oxygen saturation occurred with only a moderate increase in V_E and drop in carbon dioxide. Actually, the slow breathing with equal inspiration and expiration time showed a similar increase in oxygen saturation without a significant increase in V_E as compared to baseline.

3.3. Heart Rate and Blood Pressure. Except slow breathing with equal inspiration and expiration time, all slow breathing reduced RR interval (increased heart rate). Ujjayi breathing increased heart rate more in comparison to slow breathing alone. Slow breathing reduced both SBP and diastolic blood pressures, particularly when performed with equal inspiration and expiration time. Ujjayi reduced the drop in blood pressure induced by simple slow breathing (Table 3).

3.4. Estimates of Chemoreflex Sensitivity (Figure 2). The ratio V_t/T_i, a simplified marker of chemoreflex sensitivity, increased with 15 breath/minute controlled breathing and lowered with slow breathing, with a pattern clearly opposite to that of BRS. Accordingly, the largest decrease in V_t/T_i was observed during slow breathing with equal inspiration and expiration time (Figure 2).

As slow breathing showed in general opposite results than 15 breath/minute controlled breathing (Table 3 and Figures 1 and 2), all observed changes were more significant when slow breathing with and without ujjayi was compared to fast breathing for all the variables considered.

4. Discussion

The present study found that, in nearly all forms of slow breathing performed in yogic breathing naive participants, there were increased BRS (only slow breathing with ujjayi during inspiration and expiration did not result statistically significant) and oxygen saturation, with reduced blood pressures and chemoreflex sensitivity. The greatest improvement was found in slow breathing without ujjayi, while breathing controlled at a rate of 15/min caused a drop in BRS. In all forms of slow breathing there was a statistically significant increase in oxygen saturation from the mean baseline of 98.3%, confirming the relationship between high levels of oxygen absorption and BRS. However, ujjayi breath showed the greatest saturation (albeit only 0.1–.0.2% percent greater), but it did not correspond to the greatest improvement in BRS, likely due to the increased respiratory effort (as seen by the increased heart rate). The increase in BRS was mirrored by a reciprocal drop in chemoreflex estimate. No significant difference was found between asymmetrical versus symmetrical breathing at 6 breaths per minute. These results show that simple slow breathing with equal inspiration/expiration is the best compromise to obtain positive cardiorespiratory effects in yoga naive subjects.

4.1. Oxygen Absorption and BRS. In this study, we show that slow breathing and increased oxygen absorption lead to enhanced BRS. This might result from several possible factors, all interrelated. In theory, the increase in arterial oxygen partial pressure increases blood pressure, which in turn could stimulate the baroreceptors and improve the BRS gain. This was recently observed in healthy [28] and diabetic subjects [25]. The seemingly small extent of the increase in oxygen saturation should not be overlooked. In fact, the haemoglobin dissociation curves states that at higher saturation values small changes reflex large changes in the partial pressure of oxygen.

Because the oxygen tension (and not oxygen saturation) is the chemoreflex input signal, this explains why in a previous study the administration of oxygen in normoxia induced a significant increase in BRS and parasympathetic activity despite a small increase in oxygen saturation [25]. Thus, the increased oxygen absorption may inhibit the chemoreflex and, by this reciprocal relationship [9, 10], increase BRS. Bernardi et al. (2001) demonstrated that slow breathing reduced chemoreflex sensitivity to both hypoxia and hypercapnia, in part attributing this to an inverse relationship with BRS [11]. It is well understood that the chemoreflex is a mechanism to stabilize blood pH by increasing ventilation. Possibly, the increase in oxygen in ujjayi and slow breathing may inhibit the chemoreflex necessarily stimulating greater BRS. Our findings of the reciprocal BRS and chemoreflex changes are in full support of this concept, within the limitations of the chemoreflex method adopted. Secondly, slow breathing with its increased V_t might induce changes in venous return, altering stroke volume, and enhancing phasic changes in systolic blood pressure, synchronous with breathing, that may in turn enhance BRS [11, 29]. Lastly, a central effect of slow breathing with a direct stimulation of parasympathetic activity could not be excluded. These last factors might explain why in this study the increase in oxygen induced by the slow breathing was associated with a reduction in blood pressures, suggesting some important differences with the simple administration of oxygen.

4.2. Ujjayi Breath and BRS. Although ujjayi breath showed the greatest increase in oxygen saturation, it did not coincide with the greatest improvement in BRS when done just on the expiration. We believe that this phenomenon is connected to the necessary effort to perform this type of breath. In agreement with this idea, we found that RR interval dropped by effect of ujjayi with respect to slow breathing alone. Accordingly, the improvement in oxygenation induced by ujjayi could have been counteracted by the increased effort and reduced the effect of parasympathetic stimulation induced by slow breathing alone. When done also on inspiration the increase in BRS was not significantly improved with respect to baseline. In this case, the effects could have mimicked a Mueller manoeuvre. The Mueller manoeuvre is known to strain the heart and would potentially override the parasympathetic effects found in slow breathing [30–32]. Tracing potential neural correlates of ujjayi breath it was suggested that in animals ujjayi-like inspiration is found in conditions of threat and may serve to promote vigilance, thereby mitigating the effects of increased BRS [14].

4.3. Asymmetrical versus Symmetrical Breathing. We did not find any significant difference between asymmetrical and symmetrical breathing during slow breathing. We suggest that most of these results could be due to the prolonged expiratory time (in fact the 3-second inspiratory time of the asymmetrical breathing was very close to the spontaneous breathing). In the yoga tradition several degrees of asymmetries were adopted. While some of these could have specific effects (and could be matter for further investigations), our results suggest that an expiratory time of at least 5 seconds was sufficient to elicit most of the results observed.

4.4. Limitations. In this study, due to the need of avoiding a mouthpiece, we used a simplified, though validated, technique to assess the chemoreflex sensitivity, the V_t/T_i ratio [26]. While using this approach we did impose one term of the ratio by fixing the T_i, and we nevertheless leaved V_t free to change. If the manoeuvre was not altering the chemoreflex, then we would have expected a change in V_t, such that the ratio would stabilise to the same value as the one at baseline. Since this did not happen, it is likely that this ratio was indeed reflecting some change in the chemoreflex. Additionally, these findings are in full agreement with previous studies [11, 33] in which it was shown by us and others that the slow breathing markedly reduced the chemoreflex sensitivity in yoga naive subjects and also in yoga trainees during spontaneous breathing. Being obtained in yoga naive young participants, it is not obvious that our findings could be exactly replicated in older patients or in patients with long-term practice in yoga. It is logical to expect that habitude in practicing breathing exercise will allow to perform them with less effort and thus with perhaps better results (e.g., lower changes in heart rate), particularly during ujjayi. However, to our best knowledge such information is still lacking, and then it should be tested in future investigations. In this study, we observed the effects of these breathing techniques during their application only. The long-term effects of yoga practice could be of high interest, but the specific contribution of each breathing technique cannot be easily identified, as in general yoga trainees use a variety of many different breathing techniques in addition to postures and mediation. However, the same directional changes have been confirmed both for yoga practice [33–35] and also for the specific effects of slow breathing alone [7].

5. Conclusions

Based on our findings, slow breathing with similar inspiration and expiration times appears the most effective and simple way to heighten the BRS and improve oxygenation in normoxia. Ujjayi breath demonstrates limited added benefit over slow breathing done at 6/min in normoxia; however, the effects could be more pronounced in hypoxia, and this could be matter for future investigations. As we did not find a significant difference in symmetrical versus asymmetrical breathing, it is suggested that practitioners can engage in a ratio that is personally comfortable and achieve the same BRS benefit. These findings might be relevant for selecting the optimal strategy to train patients undergoing yoga-based rehabilitation programs, as previous studies have shown that patients with different pathologic conditions (such as heart failure, hypertension, and COPD) may benefit from practice in these slow breathing [2–4, 7], while no contraindications to date have been reported.

Conflict of Interests

The authors declared that there is no conflict of interests.

Acknowledgment

The gratefully acknowledge the help of Engineer Michele Neri (Ambiter, Parma, Italy) for writing part of the software used for this study.

References

[1] R. P. Brown and P. L. Gerbarg, "Sudarshan Kriya Yogic breathing in the treatment of stress, anxiety, and depression: Part II—clinical applications and guidelines," *Journal of Alternative and Complementary Medicine*, vol. 11, no. 4, pp. 711–717, 2005.

[2] L. Bernardi, C. Porta, L. Spicuzza et al., "Slow breathing increases arterial baroreflex sensitivity in patients with chronic heart failure," *Circulation*, vol. 105, no. 2, pp. 143–145, 2002.

[3] C. N. Joseph, C. Porta, G. Casucci et al., "Slow breathing improves arterial baroreflex sensitivity and decreases blood

pressure in essential hypertension," *Hypertension*, vol. 46, no. 4, pp. 714–718, 2005.

[4] T. Raupach, F. Bahr, P. Herrmann et al., "Slow breathing reduces sympathoexcitation in COPD," *The European Respiratory Journal*, vol. 32, no. 2, pp. 387–392, 2008.

[5] G. M. De Ferrari, A. Sanzo, A. Bertoletti, G. Specchia, E. Vanoli, and P. J. Schwartz, "Baroreflex sensitivity predicts long-term cardiovascular mortality after myocardial infarction even in patients with preserved left ventricular function," *Journal of the American College of Cardiology*, vol. 50, no. 24, pp. 2285–2290, 2007.

[6] H. Wang, H. Zhang, G. Song, and C. S. Poon, "Modulation of hering-breuer reflex by ventrolateral pons," *Advances in Experimental Medicine and Biology*, vol. 605, pp. 387–392, 2008.

[7] L. Bernardi, G. Spadacini, J. Bellwon, R. Hajric, H. Roskamm, and A. W. Frey, "Effect of breathing rate on oxygen saturation and exercise performance in chronic heart failure," *The Lancet*, vol. 351, no. 9112, pp. 1308–1311, 1998.

[8] B. Oneda, K. C. Ortega, J. L. Gusmão et al., "Sympathetic nerve activity is decreased during device-guided slow breathing," *Hypertension Research*, vol. 33, no. 7, pp. 708–712, 2010.

[9] K. Narkiewicz, P. van de Borne, N. Montano, D. Hering, T. Kara, and V. K. Somers, "Sympathetic neural outflow and chemoreflex sensitivity are related to spontaneous breathing rate in normal men," *Hypertension*, vol. 47, no. 1, pp. 51–55, 2006.

[10] V. K. Somers, A. L. Mark, and F. M. Abboud, "Interaction of baroreceptor and chemoreceptor reflex control of sympathetic nerve activity in normal humans," *Journal of Clinical Investigation*, vol. 87, no. 6, pp. 1953–1957, 1991.

[11] L. Bernardi, A. Gabutti, C. Porta, and L. Spicuzza, "Slow breathing reduces chemoreflex response to hypoxia and hypercapnia, and increases baroreflex sensitivity," *Journal of Hypertension*, vol. 19, no. 12, pp. 2221–2229, 2001.

[12] C. D. Steinback, D. Salzer, P. J. Medeiros, J. Kowalchuk, and J. K. Shoemaker, "Hypercapnic vs. hypoxic control of cardiovascular, cardiovagal, and sympathetic function," *The American Journal of Physiology*, vol. 296, no. 2, pp. R402–R410, 2009.

[13] D. P. Francis, L. C. Davies, K. Willson, P. Ponikowski, A. J. S. Coats, and M. Piepoli, "Very-low-frequency oscillations in heart rate and blood pressure in periodic breathing: Role of the cardiovascular limb of the hypoxic chemoreflex," *Clinical Science*, vol. 99, no. 2, pp. 125–132, 2000.

[14] R. P. Brown and P. L. Gerbarg, "Sudarshan Kriya yogic breathing in the treatment of stress, anxiety, and depression: Part I—neurophysiologic model," *Journal of Alternative and Complementary Medicine*, vol. 11, no. 1, pp. 189–201, 2005.

[15] E. Jovanov, "On spectral analysis of heart rate variability during very slow yogic breathing," in *Proceedings of the 27th Annual International Conference of the Engineering in Medicine and Biology Society (IEEE-EMBS '05)*, pp. 2467–2470, September 2005.

[16] T. Ruan, C. Y. Ho, and Y. R. Kou, "Afferent vagal pathways mediating respiratory reflexes evoked by ROS in the lungs of anesthetized rats," *Journal of Applied Physiology*, vol. 94, no. 5, pp. 1987–1998, 2003.

[17] S. Telles and K. V. Naveen, "Voluntary breath regulation in yoga: its relevance and physiological effects," *Biofeedback*, vol. 36, pp. 70–73, 2008.

[18] D. Laude, J. L. Elghozi, A. Girard et al., "Comparison of various techniques used to estimate spontaneous baroreflex sensitivity (the EuroBaVar study)," *The American Journal of Physiology*, vol. 286, no. 1, pp. R226–R231, 2004.

[19] L. Bernardi, G. de Barbieri, M. Rosengård-Bärlund et al., "New method to measure and improve consistency of baroreflex sensitivity values," *Clinical Autonomic Research*, vol. 20, no. 6, pp. 353–361, 2010.

[20] G. Bertinieri, M. di Rienzo, and A. Cavallazzi, "A new approach to analysis of the arterial baroreflex," *Journal of Hypertension*, vol. 3, no. 3, pp. S79–S81, 1985.

[21] M. Pagani, V. Somers, R. Furlan et al., "Changes in autonomic regulation induced by physical training in mild hypertension," *Hypertension*, vol. 12, no. 6, pp. 600–610, 1988.

[22] G. D. Pinna and R. Maestri, "Reliability of transfer function estimates in cardiovascular variability analysis," *Medical and Biological Engineering and Computing*, vol. 39, no. 3, pp. 338–347, 2001.

[23] M. J. Tobin, G. Jenouri, and B. Lind, "Validation of respiratory inductive plethysmography in patients with pulmonary disease," *Chest*, vol. 83, no. 4, pp. 615–620, 1983.

[24] J. Askanazi, P. A. Silverberg, and R. J. Foster, "Effects of respiratory apparatus on breathing pattern," *Journal of Applied Physiology Respiratory Environmental and Exercise Physiology*, vol. 48, no. 4, pp. 577–580, 1980.

[25] L. Bernardi, M. Rosengård-Bärlund, A. Sandelin et al., "Short-term oxygen administration restores blunted baroreflex sensitivity in patients with type 1 diabetes," *Diabetologia*, vol. 54, no. 8, pp. 2164–2173, 2011.

[26] J. G. van den Aardweg and J. M. Karemaker, "Influence of chemoreflexes on respiratory variability in healthy subjects," *The American Journal of Respiratory and Critical Care Medicine*, vol. 165, no. 8, pp. 1041–1047, 2002.

[27] J. L. Bruning and B. L. Kintz, *Computational Handbook of Statistics*, Scott Foresman, Glenview, IL, USA, 1968.

[28] W. S. Waring, A. J. Thomson, S. H. Adwani et al., "Cardiovascular effects of acute oxygen administration in healthy adults," *Journal of Cardiovascular Pharmacology*, vol. 42, no. 2, pp. 245–250, 2003.

[29] L. Bernardi, C. Passino, V. Wilmerding et al., "Breathing patterns and cardiovascular autonomic modulation during hypoxia induced by simulated altitude," *Journal of Hypertension*, vol. 19, no. 5, pp. 947–958, 2001.

[30] A. J. Buda, M. R. Pinsky, and N. B. Ingels Jr., "Effect of intrathoracic pressure on left ventricular performance," *New England Journal of Medicine*, vol. 301, no. 9, pp. 453–459, 1979.

[31] R. Jerath, J. W. Edry, V. A. Barnes, and V. Jerath, "Physiology of long pranayamic breathing: Neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system," *Medical Hypotheses*, vol. 67, no. 3, pp. 566–571, 2006.

[32] P. Calabrese, T. P. Dinh, A. Eberhard, J. P. Bachy, and G. Benchetrit, "Effects of resistive loading on the pattern of breathing," *Respiration Physiology*, vol. 113, no. 2, pp. 167–179, 1998.

[33] L. Spicuzza, A. Gabutti, C. Porta, N. Montano, and L. Bernardi, "Yoga and chemoreflex response to hypoxia and hypercapnia," *The Lancet*, vol. 356, no. 9240, pp. 1495–1496, 2000.

[34] D. C. Stanescu, B. Nemery, C. Veriter, and C. Maréchal, "Pattern of breathing and ventilatory response to CO_2 in subjects practicing hatha-yoga," *Journal of Applied Physiology*, vol. 51, no. 6, pp. 1625–1629, 1981.

[35] A. J. Bowman, R. H. Clayton, A. Murray, J. W. Reed, M. F. Feisal Subhan, and G. A. Ford, "Baroreflex function in sedentary and endurance-trained elderly people," *Age and Ageing*, vol. 26, no. 4, pp. 289–294, 1997.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2013, Article ID 513149, 8 pages
http://dx.doi.org/10.1155/2013/513149

Research Article

A Yoga and Compassion Meditation Program Reduces Stress in Familial Caregivers of Alzheimer's Disease Patients

M. A. D. Danucalov,[1,2] E. H. Kozasa,[1,3] K. T. Ribas,[2] J. C. F. Galduróz,[1] M. C. Garcia,[1] I. T. N. Verreschi,[4] K. C. Oliveira,[4] L. Romani de Oliveira,[1] and J. R. Leite[1]

[1] *Department of Psychobiology, Universidade Federal de São Paulo-UNIFESP, 925, Rua Napoleão de Barros, 04024-002 São Paulo, SP, Brazil*
[2] *Departiment of Research, Instituto Appana Mind de Desenvolvimento Humano, 05436-020 São Paulo, SP, Brazil*
[3] *Instituto do Cérebro, Hospital Israelita Albert Einstein, 05601-901 São Paulo, SP, Brazil*
[4] *Department of Medicine, Division of Endocrinology, Universidade Federal de São Paulo-UNIFESP, 04023-062 São Paulo, SP, Brazil*

Correspondence should be addressed to E. H. Kozasa; ehkozasa@gmail.com

Received 13 December 2012; Accepted 29 March 2013

Academic Editor: Luciano Bernardi

Familial caregivers of patients with Alzheimer's disease exhibit reduced quality of life and increased stress levels. The aim of this study was to investigate the effects of an 8-week yoga and compassion meditation program on the perceived stress, anxiety, depression, and salivary cortisol levels in familial caregivers. A total of 46 volunteers were randomly assigned to participate in a stress-reduction program for a 2-month period (*yoga and compassion meditation program*—YCMP group) ($n = 25$) or an untreated group for the same period of time (control group) ($n = 21$). The levels of stress, anxiety, depression, and morning salivary cortisol of the participants were measured before and after intervention. The groups were initially homogeneous; however, after intervention, the groups diverged significantly. The YCMP group exhibited a reduction of the stress ($P < 0.05$), anxiety ($P < 0.000001$), and depression ($P < 0.00001$) levels, as well as a reduction in the concentration of salivary cortisol ($P < 0.05$). Our study suggests that an 8-week yoga and compassion meditation program may offer an effective intervention for reducing perceived stress, anxiety, depression, and salivary cortisol in familial caregivers.

1. Introduction

The aging of the worldwide population has contributed to the increasing incidence of dementia-causing chronic degenerative diseases, notably Alzheimer's disease [1]. Alzheimer's disease is the most common form of dementia and is characterized as a progressive brain disorder with loss of reasoning, memory, language skills, and the ability to maintain an independent life [2]. The caregivers of Alzheimer's disease patients are typically family members [3]. The physical and mental burden imposed on caregivers frequently results in poor quality of life [4]. The physical, mental, social, and financial burden to which caregivers are exposed to might result in an increased risk of acute myocardial infarction and death [5–7]. Among the several psychosocial contexts experienced by caregivers, the following are particularly noteworthy: stress, social exclusion, depression, emotional isolation, burnout of personal relationships, loss of life perspectives, sleep disorders, and abuse of psychotropic substances [8–13]. Several studies of Alzheimer's disease patients and caregivers stress the importance of the medical team orienting the familial caregivers beginning in the earliest stages of disease, and plans for such support interventions have been suggested in the literature [14–16]. Yoga and meditation are among the modalities of intervention that might be applied to this population.

One of the most appropriate definitions of yoga is found in documents dated approximately 2,000 years ago, namely, Patanjali's Yoga sutras. One of such sutras defines yoga as follows: yoga is the restriction of the fluctuations of mind-stuff [17]. Thus, one of the aims of yoga is the development of mindfulness; several meditation techniques exhibit similar goals. Although meditation is a component of yoga, there are other approaches to meditation, such as compassion meditation, which originated in Buddhism, that are not associated with bodily practices, as in yoga. For this reason, both terms, yoga and meditation, will be used throughout the present paper.

Practices related with yoga and meditation have been investigated as potential techniques for reducing stress [18–21], anxiety [21–23], and depression [21, 23]; for improving physical and mental wellbeing and several domains of cognition [23, 24]; and for enhancing quality of life [25, 26]. During these practices, the participant develops the ability of focused attention to the present moment, instead of being arrested by thoughts and ruminations [18]. This mental stability seems to be related to sympathetic reduction and conversely improvement in the parasympathetic activity contributing to stress and anxiety reductions [18–20, 27].

Few studies investigated the stress levels of the caregivers of patients with chronic diseases before and after such interventions as yoga and meditation. A pilot study applied a program known as Inner Resources as therapy to 12 women responsible for the care of relatives with dementia. The protocol developed by that program included meditation, yoga body positions and respiration techniques, and visualizations and repetitions of specific sounds, which are known as mantras. The application of specific questionnaires allowed the researchers to detect improvement in the caregivers' state of depression and anxiety [22]. A more recent study found similar results upon assessing the effects of meditation on perceived stress and related indices of psychological status in Alzheimer's disease patients and their caregivers [27]. However, these results must be interpreted cautiously, as neither study included a control group, and the sample sizes were small in both cases.

In addition to the emotional stress that caregivers suffer upon seeing their relative deteriorate physically and mentally, caregivers of patients with Alzheimer's disease must perform physical labor. Therefore, the aim of the present study was to investigate whether the practice of a yoga and compassion meditation program might alter the stress, anxiety, and depression levels of familial caregivers of patients with Alzheimer's disease, as measured on standardized questionnaires. The present study also sought to assess whether the intervention modified the caregivers' morning cortisol level.

2. Methods

2.1. Study Participants. The present study was approved by the Research Ethics Committee of UNIFESP, Protocol no. 1528/07. The study volunteers were recruited by means of announcements on radios and newspapers placed the Press Consultancy of UNIFESP and were also referred by the Brazil Alzheimer's Association (Associação Brasileira de Alzheimer—ABRAZ). The inclusion criteria were as follows: older than 18 years of age, minimum educational level corresponding to complete elementary education, and exhibiting at least the resistance stage of stress on Lipp's Stress Symptoms Inventory for Adults (LSSI) [28]. The exclusion criteria were as the following: diagnosis of Cushing's syndrome; ongoing treatment with corticoids per any route, including the topical and nasal ones in the previous 30 days; diagnosis of asthma or chronic obstructive pulmonary diseases (COPD); use of alcohol (more than five drinks per week) or drugs of abuse; and regular practice of yoga, meditation, or similar techniques. The use of tranquilizers was not an exclusion criterion, provided that the volunteers started it before the study and did not discontinue it during the study period. A total of 53 familial caregivers of Alzheimer's disease patients were selected. Forty-six of the subjects completed all of the stages of the study after random allocation into 2 groups: 25 volunteers (22 females and 3 males) participated in the yoga and compassion meditation program (YCMP group), and 21 (19 females and two males) volunteers made up the control group (CG), which was a nontreated group. For ethical reasons, after the end of the study, the volunteers in the CG also participated in the suggested intervention. The participants visited the Psychobiology Department of UNIFESP, where they were subjected to clinical examination to assess their overall health, filled in identification questionnaires, and signed a free and informed consent form. Next, the volunteers filled in the psychological scales and inventories and were instructed to the procedures to collect salivary samples to measure cortisol levels. These same assessments were performed two months later in both groups.

2.2. Outcome Measures. The following instruments were used to measure the psychological aspects.

(a) Lipp's Stress Symptoms Inventory for Adults (LSSI), which has been frequently used in Brazil in recent years and categorizes stress according to a four-phase model, namely, alertness, resistance, quasiexhaustion, and exhaustion according to the amount of physical and psychological stress symptoms [28].

(b) Beck Depression Inventory (BDI) and Beck Anxiety Inventory (BAI), both comprising 21 questions describing depression and anxiety symptoms to which subjects respond on a four-point scale [29–32].

(c) In addition, the salivary cortisol level was used as a measure of physiological stress. For that purpose, 8 samples were collected from each participant. Four samples were collected before the intervention: two samples were collected on 2 consecutive days, both immediately and 30 minutes after waking up, under fasting conditions. Additional 4 samples were collected following the same procedures after intervention. Morning was selected as the time for sample collection because it corresponds to the maximum peak of cortisol throughout the day [33–36]. As the morning cortisol level is sensitive to light—the greater the luminosity, the higher the cortisol concentration—[35], the volunteers were oriented to perform the first sample collection immediately upon waking up and in the dark, and the second sample was collected 30 minutes later under exposure to natural light. We analyzed the results based on the average results of the first day samples, the second day samples, and the overall average of both days. The samples were processed at the Laboratory of Steroids of the Department of Endocrinology of UNIFESP. The samples were centrifuged at 3,000 rpm for 5 minutes, and the supernatant was stored at −20°C until testing, which was performed by means of radioimmunoassay (RIA). Each sample was tested in duplicate using 100 μL of supernatant without any previous extraction [37]. An antibody (cortisol-3-(O-carboxymethyl)-oxime-bovine) highly specific for cortisol (100%) but without significant cross-reactivity with other steroids (<1%) was used.

2.3. Intervention. The stress reduction program lasted 2 months, with sessions lasting 1 hour and 15 minutes, 3 times per week. The participants had to attend 1 live session per week, totaling eight live sessions, whereas the other 2 weekly sessions (16 sessions) were performed at home with the aid of a DVD. The program included the following traditional *Hatha Yoga* exercises.

(a) Yoga body poses (*asanas*) (25 min): *Sukhasana*—practitioner sits with the legs crossed and the back straight. *Vajrasana*—practitioner sits on the heels, keeping the legs and thighs together, and the back straight. *Yoga-Mudra*—practitioner sits on the heels, keeping the legs and thighs together, and the back bent forward. *Paschimottanasana*—practitioner sits with the knees stretched, feet together, and back bent forward. *Ardha-Matsyendrasana*—practitioner sits intertwining the legs, the back straight, and twists the back to look behind; this movement is performed in both directions. *Shavasana*—practitioner lies on the floor, on the back, with the arms along the body, and the knees extended. *Naukasana*—practitioner lies on the floor, on the back, then raises the legs and trunk from the floor, and keeps this position as long as it is comfortable. *Bhujangasana*—practitioner lies on the floor, on the abdomen, with the palms of the hands on the floor, at the pectoral level. Upon the instructor's command, the practitioner raises the trunk gently from the floor while stretching the back. *Ardha-Shalabhasana*—practitioner lies on the floor, on the abdomen, with the arms along the body, legs together, and knees stretched. Upon the instructor's command, the practitioner raises one thigh from the floor; this movement is performed on both sides. *Standing Chakrasana*—practitioner stands with the feet together, raises the right arm, and bends the trunk toward the left side; this movement is performed on both sides. *Vrikasana*—practitioner stands with the feet together, removes the right foot from the floor, and places it on the internal side of the left thigh. Next, he/she joins the palms of the hands in front of the chest, raises the arms above the head, and remains in this position, keeping the balance, as long as it is comfortable. This movement is performed on both sides. *Sarvangasana*—at the beginning of this movement, the practitioner lies on the floor, on the back. The aim of this exercise is to raise the legs, thighs, and hips from the floor, that is, to attain an upside-down position, while supporting the body on the upper part of the back, upper arms up to the elbows, and the back of the head. The *asanas*' average duration of each movement was approximately one and a half minutes [38, 39].

(b) Exercises involving awareness and voluntary regulation of breath (*pranayamas*) (25 min): *Adhama Pranayama*—free, predominantly abdominal respiration. *Bhastrika*—forceful expirations through the nose followed by passive inspirations. *Ujjayi*—slow and complete inspiration, retention of the air in the lungs, and slow expiration through partially closed glottis. *Surya Bhedana*—inspiration through the right nostril followed by expiration through the left nostril. *Chandra bhedana*—inspiration through the left nostril followed by expiration through the right nostril. *Nadi Shodhana*—inspiration through the left nostril, retention of air in the lungs, expiration through the right nostril, inspiration through the right nostril, retention of air in the lungs, and expiration through the left nostril. *Kapalbhati*—forceful, short, and fast expiration through the nostrils followed by passive inspiration [38, 39]. The pranayamas' average duration of each one was approximately three minutes [40, 41] (12.5 min).

(c.1) Meditational practices: mindfulness meditation adapted for Western psychology, originating in Buddhist meditation, involves paying sustained attention to sensations, perceptions, and thoughts with suspension of judgment [18].

(c.2) Compassion meditation: compassion meditation (*karuna*) emphasizes the voluntary production of compassionate feelings for all living beings based on the assumption that all beings aspire to happiness and seek to release themselves from suffering and its causes [42, 43] (12.5 min).

2.4. Statistical Analysis. To establish whether the groups were similar before the intervention, the chi-square (χ^2) test was applied to the nominal and ordinal qualitative variables, and Student's t-test was applied to the quantitative variables. To analyze the psychological (BDI and BAI) and physiological (cortisol level) measurements, 2-way ANOVA was applied (YCMP and CG groups) (before and after intervention) followed by Tukey's test when necessary. The differences between the groups and the time-points were investigated according to their statistical significance and as was the interaction between these factors. With respect to LSSI, the chi-square test (χ^2) was used to compare the groups before and after intervention. To assess the effect of intervention, that is, to compare the results after intervention to the ones before intervention, McNemar's test was applied to each category of phases of stress. All of the statistical analyses were performed using software Statistica version 10.1, and the significance level was established as $P \leq 0.05$.

3. Results

Before the intervention, both groups were statistically homogeneous with respect to the following variables: male gender (YCMP, $n = 3$, 12%) (CG, $n = 2$, 10%) and female gender (YCMP, $n = 22$, 88%) (CG, $n = 19$, 90%); educational level, complete elementary education (YCMP, $n = 1$, 4%) (CG, $n = 0$, 0%), complete secondary education (YCMP, $n = 11$, 44%) (CG, $n = 5$, 24%), and complete higher education (YCMP, $n = 13$, 52%) (CG, $n = 16$, 76%); family income (minimum wage, MW = BRL 622.00) up to five times the MW (BRL 3,110.00) (YCMP, $n = 6$) (CG, $n = 7$), more than five and up to 10 times the MW (BRL 3,110.00 to BRL 6,220.00) (YCMP, $n = 11$) (CG, $n = 6$), over 10 times the MW (above BRL 6,220.00) (YCMP, $n = 8$), (CG, $n = 8$); age (YCMP, 55.5 ± 8.1 years), (CG, 53.4±8.2 years); and length of caregiving (YCMP, 4.2 ± 3.3 years) (CG, 5.7 ± 3.7 years).

The participants in the YCMP group reported 100% commitment to the suggested program. This level of adherence was most likely facilitated by the relative flexibility of the program, as the live sessions could be attended at five different times and at three different locations in the city of São Paulo. Further, the use of the DVD for practice at home facilitated the optimal rate of adherence to the protocol.

Table 1 shows the frequency of distribution of the phases of stress manifestation in both groups. Before the intervention, the groups were statistically similar in this regard: χ^2 ($P > 0.05$). No participant in any group was in either the absent or alert stages, 86% in the CG and 80% in the YCMP group were in the phase of resistance, 14% in the CG, and 12% in the YCMP group were in the phase of quasi-exhaustion, and only 2 individuals in the YCMP group were in the phase of exhaustion. However, after intervention, the groups exhibited statistically significant differences: χ^2 ($P < 0.05$). No participant in the CG group was in either the absent or alert phase, whereas 68% of the participants in the YCMP shifted to the phase characterized by absence of stress manifestations. Table 1 further demonstrates that statistically significant diagnostic changes occurred in the YCMP group. Before the intervention, 20 volunteers were in the phase of resistance, and none of the volunteers was in the phase of absence. After the intervention, only 8 volunteers were in the phase of resistance, and the other 17 volunteers were in the phase of absence of stress: *McNemar*'s test ($P < 0.05$). Conversely, the CG did not exhibit any statistically significant change between the beginning and the end of intervention.

Table 2 demonstrates that the average depression (BDI) and anxiety (BAI) scores exhibited statistically significant interactions with the time point and group factors. These interactions suggest that the groups' profiles differed over time. Both variables exhibited a significant reduction in the YCMP group in addition to a difference between the groups after the intervention. The YCMP group exhibited a 51.2% reduction in the BDI score after the intervention, whereas the CG exhibited an increase of 9.5% at the same time point.

Table 1: Frequency of the distribution of the phases of stress manifestation among the sampled individuals according to group before and after intervention.

Phases of stress manifestation	Before intervention	After intervention
	Control group	Control group
Absence	0 (0)	0 (0)
Alert	0 (0)	0 (0)
Resistance	18 (86)	16 (76)
Quasiexhaustion	3 (14)	4 (19)
Exhaustion	0 (0)	1 (5)
	YCMP group	YCMP group$^{\&}$
Absent	0 (0)	17 (68)*
Alert	0 (0)	0 (0)
Resistance	20 (80)	8 (32)*
Quasiexhaustion	3 (12)	0 (0)
Exhaustion	2 (8)	0 (0)

Data described as frequency (percentage); $^{\&}P < 0.05$: differs from control group, chi-square test; $^{*}P < 0.05$: differs from time-point before intervention, *McNemar*'s test.
YCMP: yoga and compassion meditation program.

The YCMP group exhibited a 49.4% reduction in the BAI score, whereas the CG exhibited an increase of 10% at the same time point.

Table 3 presents the salivary cortisol concentration values corresponding to the average of the two measurements on the first sampling day (day one), the average of the two measurements on the second sampling day (day two), and the average of the four measurements performed over both days (day one and day two). The YCMP group exhibited a statistically significant reduction in the salivary cortisol level on day two (not in day one), as well as a reduction in the average of day one + day two before and after intervention. The differences, according to the table, are not significant in group factor, but they are significant in time and interaction factors. The control group did not exhibit any significant change. Some samples had an insufficient volume of saliva to perform cortisol analysis and were lost as a result. On the first day of the preintervention phase for the YCMG group, we lost 20% of the saliva samples for cortisol analysis, and on the second day we lost 18%, giving an overall loss of 19%. In the same group, in the post-intervention phase, we lost 30%, 26% and 28% of saliva samples, respectively, for the same reason. There were also losses in the CG: on the first day of the preintervention phase there was a loss of 11.90% of the samples, 14.29% on the second day, giving an overall loss of 13.10%. In the post-intervention phase, we lost 14.29%, 28.57% and 21.43%, respectively.

4. Discussion

The present study sought to establish whether an intervention using yoga and compassion meditation exercises could change stress, anxiety, and depression scores and reduce the salivary cortisol levels of familial caregivers of Alzheimer's

Table 2: Scores of depression and anxiety measured by BDI and BAI of familial caregivers of Alzheimer's disease patients before and after intervention.

	Before	After	$F_{\text{time-point}(1.44)}$	$F_{\text{group}(1.44)}$	$F_{\text{inter}(1.44)}$
BDI					
Control group	14.7 (±9.5)	16.1 (±10.2)	16.5	2.0	34.7
YCMP group	16.0 (±7.8)	8.2 (±4.6)$^{*\&}$	$P < 0.001$	$P = 0.16$	$P < 0.000001$
BAI					
Control group	19.9 (±10.2)	21.9 (±10.6)	12.9	9.6	32.3
YCMP group	17.6 (±9.4)	8.7 (±5.5)$^{*\&}$	$P < 0.001$	$P < 0.001$	$P < 0.00001$

Data are described as the mean (±standard deviation); $^{*}P < 0.001$ differs from the time point before the intervention in the corresponding group—*Tukey's* test; $^{\&}P < 0.001$ differs from the control group in the corresponding time point—*Tukey*'s test.
YCMP: yoga and compassion meditation program.

Table 3: Salivary cortisol concentration (ng/dL) of familial caregivers of Alzheimer's disease patients before and after intervention.

	Before	After	$F_{\text{time-point}(1.35)}$	$F_{\text{group}(1.35)}$	$F_{\text{inter}(1.35)}$
Cortisol day 1					
Control group	539.4 (±152.6)	531.1 (±53.7)	3.64	0.10	3.31
YCMP group	743.9 (±140.7)	404.4 (±49.5)	$P = 0.06$	$P = 0.76$	$P = 0.08$
	Before	After	$F_{\text{time-point}(1.32)}$	$F_{\text{group}(1.32)}$	$F_{\text{inter}(1.32)}$
Cortisol day 2					
Control group	674.7 (±181.7)	673.2 (±86.3)	7.42	0.00004	7.33
YCMP group	937.6 (±171.3)	408.1 (±81.3)*	$P < 0.05$	$P = 0.99$	$P < 0.05$
	Before	After	$F_{\text{time-point}(1.40)}$	$F_{\text{group}(1.40)}$	$F_{\text{inter}(1.40)}$
Cortisol days 1 and 2					
Control group	641.5 (±137.6)	568.0 (±58.03)	8.38	0.02	3.97
YCMP group	823.0 (±131.2)	424.6 (±55.3)*	$P < 0.001$	$P = 0.88$	$P < 0.05$

Data are described as the mean (±standard deviation); $^{*}P < 0.05$ differs from the time point before the intervention in the corresponding group—*Tukey's* test.
YCMP: yoga and compassion meditation program.

disease patients. Among the most relevant findings were the changes in the stress manifestation phases of the participants in the YCMP group from the categories of resistance ($N = 20$), quasiexhaustion ($N = 3$), and exhaustion ($N = 2$) to absence ($N = 17$) and resistance ($N = 8$), thereby demonstrating the effectiveness of the intervention. The changes exhibited by the YCMP group in the stress indices measured by LSSI suggest that our program was able to reverse the stress-related symptoms exhibited by that group (Table 1).

Elevations in the hypothalamic pituitary adrenal (HPA) axis are common occurrences under conditions of chronic psychological stress and result in increased cortisol levels. Such occurrences are associated with hippocampal volume loss and memory impairment and might increase the risk of dementia in older adults [44–46], eventually creating a vicious circle, whereby familial caregivers of patients with Alzheimer's disease become future patients. Kang et al. [47] applied a program similar to the one used in this study and observed a statistically significant reduction in the stress and anxiety levels of 16 nursing students paired with 16 volunteers, who constituted the control group. In the study, the intervention group performed the suggested program, comprising one weekly session, with each session lasting from one hour and a half to two hours over two months. The intervention group exhibited a statistically significant reduction in the stress and anxiety scores, thus indicating that this type of intervention might be useful to reduce stress in the healthcare professionals directly involved with patient care tasks [47]. The literature includes further evidence indicating that the application of these practices might be useful when applied to caregivers [22, 27], and our study corroborates such findings.

Our data demonstrate statistically significant reduction in the depressive symptoms among the participants in the YCMP group. An emergent body of evidence points to the possible therapeutic effects of the practice of aerobic or anaerobic exercises on depression [48–50]. Such exercises, meanwhile, might be either mindful or nonmindful physical exercises. A systematic review analyzed possible therapeutic differences between these two types of exercise. The analyzed results were provided by 12 studies that complied with the methodological criteria applied by the authors for inclusion in that review. According to the authors, both mindful and nonmindful exercises proved to be effective in reducing depression symptoms [50]. It is worth noting that among other activities, the volunteers in our study were subjected to the practice of hatha yoga, which includes physical exercise, most of them anaerobic, to achieve that same goal. Nevertheless, our results cannot be discussed on the grounds of the therapeutic effects of the practice of physical exercise alone because our purpose was to subject the volunteers to a program that included mindful exercises and compassion meditation. Therefore, our results must be attributed to the program as such and not merely to one of its parts. In addition, Kozasa et al. investigated the efficiency of a program that included mantra meditation and pranayamas, known as Siddha Samadhi Yoga, in reducing scores of anxiety and depression in participants with anxiety complaints. This program includes meditation exercises associated with exercises of respiration (pranayamas). A total of 22 volunteers participated in that study, with 14 volunteers being allocated to the intervention group and eight to the control group. The volunteers in the intervention group were oriented to practice the exercise protocol every day of the week, three times per day, in 15-minute sessions. At the end of the study, as in ours, the intervention group exhibited a significant reduction in the anxiety and depression scores compared to the control group [51].

A relationship between practices involving meditation and the endocrine and immune systems has been analyzed in the scientific literature. Witek-Janusek et al. observed a reduction in cortisol concentrations and an improvement of immune system function among women diagnosed with breast cancer who were subjected to the mindfulness-based stress reduction (MBSR) program compared to a control group also comprising women with breast cancer [52]. In the present study, we chose to measure the salivary cortisol levels as a physiological variable sensitive to the behavioral modifications to which the volunteers were subjected. As presented in Table 3, our results indicate that the changes exhibited by the YCMP group, with respect to the cortisol levels of the samples collected on the second day and the total average of the samples collected on the first and second days, were higher compared to the control group. Our results indicate that the participants in the YCMP group developed psychophysiological adaptations associated with the participation in the indicated program, although we did not find statistically significant differences between the groups in the measurements of salivary cortisol performed after the intervention.

During the study, we hypothesized that the caregivers' menstrual cycle phase might interfere with the results; however, we were not able to control this variable. However, one study investigated the morning salivary cortisol levels in 99 women and did not find any correlation between the menstrual cycle phase and salivary cortisol levels [53]. It is also worth noting that, according to the literature, the earlier individuals wake, the higher the morning cortisol levels are [54, 55]. As a function of the characteristics of our study sample, all of the participants awoke between 7:00 and 8:00 am. Although this fact most likely reduced the probability of interferences related to different waking times, we were not able to control this variable in a more rigorous manner. One issue deserving discussion is the fact that nicotine is known to be a powerful stimulator of the hypothalamic-pituitary-adrenal axis (HPA) [56]. Consequently, smoking could interfere with the correlation between cortisol levels and stress. Nevertheless, only two volunteers (both in the YCMP group) in our total sample (46 familial caregivers) were smokers. We believed that this low number noticeably reduced the possibility of interference associated with smoking.

Comparing to previous studies with familial caregivers, [22, 27], the present study is randomized and controlled and has a bigger sample. However, the CG had no treatment, and it could be a limitation of the study. We suggest that similar studies include an active control group which can be a stress discussion group, for example. Another interesting data not collected in this study was the impact of the caregiver's stress reduction on the Alzheimer's patients.

Like mentioned in the introduction, the mental stability could be related to sympathetic reduction and improvement in the parasympathetic activity contributing to stress and anxiety reductions. Many other studies about the effects of meditation practice have been indicating a number of physiological changes, such as increased GABA concentration [57], adrenalin and noradrenalin reductions [58], increased serotonin [59] and melatonin concentrations [60], which can be related to improvements on mood, reductions in body temperature [61, 62] and increased galvanic skin resistance [63], may be related to stress management, and also increased gray matter density in brain regions related to emotional regulation [64]. New studies with familial caregivers would evaluate more physiological parameters than presented in this study.

5. Conclusions

The results our study demonstrate are that the practice of yoga and the suggested meditation techniques may represent an effective intervention for caregivers of relatives with Alzheimer's disease to reduce their stress, anxiety, and depression symptoms and to decrease their cortisol levels.

Acknowledgment

The authors thank Associação Fundo de Incentivo à Pesquisa-AFIP for providing financial support.

References

[1] A. F. Jorm and D. Jolley, "The incidence of dementia: a meta-analysis," *Neurology*, vol. 51, no. 3, pp. 728–733, 1998.

[2] S. Gauthier, "Should we encourage the use of high-dose vitamin E in persons with memory complaints as a preventive strategy against Alzheimer's disease?" *Journal of Psychiatry and Neuroscience*, vol. 25, no. 4, p. 394, 2000.

[3] R. Stone, G. L. Cafferata, and J. Sangl, "Caregivers of the frail elderly: a national profile," *Gerontologist*, vol. 27, no. 5, pp. 616–626, 1987.

[4] R. Schulz and S. R. Beach, "Caregiving as a risk factor for mortality: the caregiver health effects study," *Journal of the American Medical Association*, vol. 282, no. 23, pp. 2215–2219, 1999.

[5] B. Collopy, N. Dubler, and C. Zuckerman, "The ethics of home care: autonomy and accommodation," *The Hastings Center report*, vol. 20, supplement 2, pp. 1–16, 1990.

[6] J. D. Arras and N. N. Dubler, "Bringing the hospital home. Ethical and social implications of high-tech home care," *The Hastings Center report*, vol. 24, no. 5, pp. S19–28, 1994.

[7] S. Lee, G. A. Colditz, L. F. Berkman, and I. Kawachi, "Caregiving and risk of coronary heart disease in U.S. women: a prospective study," *American Journal of Preventive Medicine*, vol. 24, no. 2, pp. 113–119, 2003.

[8] C. Eisdorfer, "Caregiving: an emerging risk factor for emotional and physical pathology," *Bulletin of the Menninger Clinic*, vol. 55, no. 2, pp. 238–247, 1991.

[9] C. Pitceathly and P. Maguire, "The psychological impact of cancer on patients' partners and other key relatives: a review," *European Journal of Cancer*, vol. 39, no. 11, pp. 1517–1524, 2003.

[10] L. W. Caswell, P. P. Vitaliano, K. L. Croyle, J. M. Scanlan, J. Zhang, and A. Daruwala, "Negative associations of chronic stress and cognitive performance in older adult spouse caregivers," *Experimental Aging Research*, vol. 29, no. 3, pp. 303–318, 2003.

[11] S. M. McCurry, R. G. Logsdon, L. Teri, and M. V. Vitiello, "Sleep disturbances in caregivers of persons with dementia: contributing factors and treatment implications," *Sleep Medicine Reviews*, vol. 11, no. 2, pp. 143–153, 2007.

[12] S. M. McCurry, L. E. Gibbons, R. G. Logsdon, M. V. Vitiello, and L. Teri, "Insomnia in caregivers of persons with dementia: who is at risk and what can be done about it?" *Sleep Medicine Clinics*, vol. 4, no. 4, pp. 519–526, 2009.

[13] G. Tremont, "Family caregiving in dementia," *Medicine and Health, Rhode Island*, vol. 94, no. 2, pp. 36–38, 2011.

[14] K. Soothill, S. M. Morris, J. C. Harman, C. Thomas, B. Francis, and M. B. McIllmurray, "Cancer and faith. Having faith-does it make a difference among patients and their informal carers?" *Scandinavian Journal of Caring Sciences*, vol. 16, no. 3, pp. 256–263, 2002.

[15] C. Thomas and S. M. Morris, "Informal carers in cancer contexts," *European Journal of Cancer Care*, vol. 11, no. 3, pp. 178–182, 2002.

[16] C. Thomas, S. M. Morris, and J. C. Harman, "Companions through cancer: the care given by informal carers in cancer contexts," *Social Science and Medicine*, vol. 54, no. 4, pp. 529–544, 2002.

[17] R. C. Lanman, *The Yoga-System of Patanjali*, vol. 17 of *Harvard Oriental Series*, The Harvard University Press, Cambridge, Mass, USA, 1927.

[18] P. Grossman, L. Niemann, S. Schmidt, and H. Walach, "Mindfulness-based stress reduction and health benefits: a meta-analysis," *Journal of Psychosomatic Research*, vol. 57, no. 1, pp. 35–43, 2004.

[19] L. E. Carlson and S. N. Garland, "Impact of mindfulness-based stress reduction (MBSR) on sleep, mood, stress and fatigue symptoms in cancer outpatients," *International Journal of Behavioral Medicine*, vol. 12, no. 4, pp. 278–285, 2005.

[20] R. H. Schneider, K. G. Walton, J. W. Salerno, and S. I. Nidich, "Cardiovascular disease prevention and health promotion with the transcendental meditation program and Maharishi consciousness-based health care," *Ethnicity and Disease*, vol. 16, no. 3, supplement 4, pp. S15–S26, 2006.

[21] J. D. Lane, J. E. Seskevich, and C. F. Pieper, "Brief meditation training can improve perceived stress and negative mood," *Alternative Therapies in Health and Medicine*, vol. 13, no. 1, pp. 38–44, 2007.

[22] L. C. Waelde, L. Thompson, and D. Gallagher-Thompson, "A pilot study of a yoga and meditation intervention for dementia caregiver stress," *Journal of Clinical Psychology*, vol. 60, no. 6, pp. 677–687, 2004.

[23] V. K. Sharma, S. Das, S. Mondal, U. Goswami, and A. Gandhi, "Effect of Sahaj Yoga on neuro-cognitive functions in patients suffering from major depression," *Indian Journal of Physiology and Pharmacology*, vol. 50, no. 4, pp. 375–383, 2006.

[24] R. Bonadonna, "Meditation's impact on chronic illness," *Holistic Nursing Practice*, vol. 17, no. 6, pp. 309–319, 2003.

[25] R. Jayadevappa, J. C. Johnson, B. S. Bloom et al., "Erratum: effectiveness of transcendental meditation on functional capacity and quality of life of African Americans with congestive heart failure: a randomized control study (Ethnicity and Disease (2007) 17, 72–77))," *Ethnicity and Disease*, vol. 17, no. 3, p. 595, 2007.

[26] T. K. Selfe and K. E. Innes, "Mind-body therapies and osteoarthritis of the knee," *Current Rheumatology Reviews*, vol. 5, no. 4, pp. 204–211, 2009.

[27] K. E. Innes, T. K. Selfe, C. J. Brown, K. M. Rose, and A. Thompson-Heisterman, "The Effects of meditation on perceived stress and related indices of psychological status and sympathetic activation in persons with Alzheimer's disease and their caregivers: a pilot study," *Evidence-Based Complementary and Alternative Medicine*, vol. 2012, Article ID 927509, 9 pages, 2012.

[28] M. L. Lipp, *Manual do Inventário de Sintomas de Estresse para Adultos de Lipp*, Casa do Psicólogo, São Paulo, Brazil, 2000.

[29] A. T. Beck, N. Epstein, G. Brown, and R. A. Steer, "An inventory for measuring clinical anxiety: psychometric properties," *Journal of Consulting and Clinical Psychology*, vol. 56, no. 6, pp. 893–897, 1988.

[30] A. T. Beck and R. A. Steer, *Beck Depression Inventory Manual*, Psychological Corporation, San Antonio, Tex, USA, 1993.

[31] C. L. Gorenstein and L. Andrade, "Validation of a portuguese version of the beck depression inventory and the state-trait anxiety inventory in Brazilian subjects," *Brazilian Journal of Medical and Biological Research*, vol. 29, no. 4, pp. 453–457, 1996.

[32] C. L. Gorenstein, "Psychometric properties of the Portuguese version of the Beck depression inventory on Brazilian college students," *Journal of Clinical Psychology*, vol. 55, no. 5, pp. 553–562, 1999.

[33] F. A. Scheer and R. M. Buijs, "Light affects morning salivary cortisol in humans," *Journal of Clinical Endocrinology and Metabolism*, vol. 84, no. 9, pp. 3395–3398, 1999.

[34] B. M. Kudielka and C. Kirschbaum, "Awakening cortisol responses are influenced by health status and awakening time but not by menstrual cycle phase," *Psychoneuroendocrinology*, vol. 28, no. 1, pp. 35–47, 2003.

[35] A. Clow, L. Thorn, P. Evans, and F. Hucklebridge, "The awakening cortisol response: methodological issues and significance," *Stress*, vol. 7, no. 1, pp. 29–37, 2004.

[36] C. Garcia-Leal, A. Parente, C. M. Del-Ben et al., "Anxiety and salivary cortisol in symptomatic and nonsymptomatic panic patients and healthy volunteers performing simulated public speaking," *Psychiatry Research*, vol. 133, no. 2-3, pp. 239–252, 2005.

[37] L. B. Santiago, S. M. Jorge, and A. C. Moreira, "Longitudinal evaluation of the development of salivary cortisol circadian rhythm in infancy," *Clinical Endocrinology*, vol. 44, no. 2, pp. 157–161, 1996.

[38] M. L. Gharote, *Hathapradipika of Svatmarama*, Lonavla Yoga Institute, Lonavla, India, 2010.

[39] S. Kuvalayananda, *Pranayam*, Michigan University, Michigan, Mich, USA; Popular Prakashan, Mumbai, India, 1966.

[40] R. A. Baer, "Mindfulness training as a clinical intervention: a conceptual and empirical review," *Clinical Psychology*, vol. 10, no. 2, pp. 125–143, 2003.

[41] R. J. Davidson, J. Kabat-Zinn, J. Schumacher et al., "Alterations in brain and immune function produced by mindfulness meditation," *Psychosomatic Medicine*, vol. 65, no. 4, pp. 564–570, 2003.

[42] A. Lutz, L. L. Greischar, N. B. Rawlings, M. Ricard, and R. J. Davidson, "Long-term meditators self-induce high-amplitude gamma synchrony during mental practice," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 101, no. 46, pp. 16369–16373, 2004.

[43] T. W. W. Pace, L. T. Negi, D. D. Adame et al., "Effect of compassion meditation on neuroendocrine, innate immune and behavioral responses to psychosocial stress," *Psychoneuroendocrinology*, vol. 34, no. 1, pp. 87–98, 2009.

[44] B. S. McEwen, "Sex, stress and the hippocampus: allostasis, allostatic load and the aging process," *Neurobiology of Aging*, vol. 23, no. 5, pp. 921–939, 2002.

[45] R. S. Wilson, S. E. Arnold, J. A. Schneider, Y. Li, and D. A. Bennett, "Chronic distress, age-related neuropathology, and late-life dementia," *Psychosomatic Medicine*, vol. 69, no. 1, pp. 47–53, 2007.

[46] K. E. Innes, H. K. Vincent, and A. G. Taylor, "Chronic stress and insulin resistance-related indices of cardiovascular disease risk, part I: neurophysiological responses and pathological sequelae," *Alternative Therapies in Health and Medicine*, vol. 13, no. 4, pp. 46–52, 2007.

[47] Y. S. Kang, S. Y. Choi, and E. Ryu, "The effectiveness of a stress coping program based on mindfulness meditation on the stress, anxiety, and depression experienced by nursing students in Korea," *Nurse Education Today*, vol. 29, no. 5, pp. 538–543, 2009.

[48] E. W. Martinsem, "Physical activity and depression: clinical experience," *Acta Psychiatrica Scandinavica*, vol. 377, pp. 23–27, 1994.

[49] J. A. Palmer, L. K. Palmer, K. Michiels, and B. Thigpen, "Effects of type of exercise on depression in recovering substance abusers," *Perceptual and Motor Skills*, vol. 80, no. 2, pp. 523–530, 1995.

[50] H. W. Tsang, E. P. Chan, and W. M. Cheung, "Effects of mindful and non-mindful exercises on people with depression: a systematic review," *British Journal of Clinical Psychology*, vol. 47, no. 3, pp. 303–322, 2008.

[51] E. H. Kozasa, R. F. Santos, A. D. Rueda, A. A. Benedito-Silva, F. L. De Moraes Ornellas, and J. R. Leite, "Evaluation of Siddha Samadhi yoga for anxiety and depression symptoms: a preliminary study," *Psychological Reports*, vol. 103, no. 1, pp. 271–274, 2008.

[52] L. Witek-Janusek, K. Albuquerque, K. R. Chroniak, C. Chroniak, R. Durazo-Arvizu, and H. L. Mathews, "Effect of mindfulness based stress reduction on immune function, quality of life and coping in women newly diagnosed with early stage breast cancer," *Brain, Behavior, and Immunity*, vol. 22, no. 6, pp. 969–981, 2008.

[53] B. M. Kudielka and C. Kirschbaum, "Awakening cortisol responses are influenced by health status and awakening time but not by menstrual cycle phase," *Psychoneuroendocrinology*, vol. 28, no. 1, pp. 35–47, 2003.

[54] S. Edwards, A. Clow, P. Evans, and F. Hucklebridge, "Exploration of the awakening cortisol response in relation to diurnal cortisol secretory activity," *Life Sciences*, vol. 68, no. 18, pp. 2093–2103, 2001.

[55] I. Federenko, R. Dechoux, D. H. Hellhammer, S. Wust, and C. Kirschbaum, "Impact of time of day on free cortisol levels after awaking," *Psychosomatic Medicine*, vol. 63, pp. 160–168, 2001.

[56] C. Kirschbaum and D. H. Hellhammer, "Salivary cortisol in psychoneuroendocrine research: recent developments and applications," *Psychoneuroendocrinology*, vol. 19, no. 4, pp. 313–333, 1994.

[57] A. N. Elias, S. Guich, and A. F. Wilson, "Ketosis with enhanced GABAergic tone promotes physiological changes in transcendental meditation," *Medical Hypotheses*, vol. 54, no. 4, pp. 660–662, 2000.

[58] J. R. Infante, M. Torres-Avisbal, P. Pinel et al., "Catecholamine levels in practitioners of the transcendental meditation technique," *Physiology and Behavior*, vol. 72, no. 1-2, pp. 141–146, 2001.

[59] M. Bujatti and P. Riederer, "Serotonin, noradrenaline, dopamine metabolites in transcendental meditation technique," *Journal of Neural Transmission*, vol. 39, no. 3, pp. 257–267, 1976.

[60] E. E. Solberg, A. Holen, Ø. Ekeberg, B. Østerud, R. Halvorsen, and L. Sandvik, "The effects of long meditation on plasma melatonin and blood serotonin," *Medical Science Monitor*, vol. 10, no. 3, pp. CR96–CR101, 2004.

[61] R. K. Wallace, "Physiological effects of transcendental meditation," *Science*, vol. 167, no. 3926, pp. 1751–1754, 1970.

[62] L. K. Kothari, A. Bordia, and O. P. Gupta, "Studies on a yogi during an eight-day confinement in a sealed underground pit," *Indian Journal of Medical Research*, vol. 61, no. 11, pp. 1645–1650, 1973.

[63] J. D. E. Young and E. Taylor, "Meditation as a voluntary hypometabolic state of biological estivation," *News in Physiological Sciences*, vol. 13, no. 3, pp. 149–153, 1998.

[64] E. Luders, A. W. Toga, N. Lepore, and C. Gaser, "The underlying anatomical correlates of long-term meditation: larger hippocampal and frontal volumes of gray matter," *NeuroImage*, vol. 45, no. 3, pp. 672–678, 2009.