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Original Article

Yoga as a Complementary Treatment of Depression: Effects of Traits and Moods on Treatment Outcome

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Preliminary findings support the potential of yoga as a complementary treatment of depressed patients who are taking anti-depressant medications but who are only in partial remission. The purpose of this article is to present further data on the intervention, focusing on individual differences in psychological, emotional and biological processes affecting treatment outcome. Twenty-seven women and 10 men were enrolled in the study, of whom 17 completed the intervention and pre- and post-intervention assessment data. The intervention consisted of 20 classes led by senior Iyengar yoga teachers, in three courses of 20 yoga classes each. All participants were diagnosed with unipolar major depression in partial remission. Psychological and biological characteristics were assessed pre- and post-intervention, and participants rated their mood states before and after each class. Significant reductions were shown for depression, anger, anxiety, neurotic symptoms and low frequency heart rate variability in the 17 completers. Eleven out of these completers achieved remission levels post-intervention. Participants who remitted differed from the non-remitters at intake on several traits and on physiological measures indicative of a greater capacity for emotional regulation. Moods improved from before to after the yoga classes. Yoga appears to be a promising intervention for depression; it is cost-effective and easy to implement. It produces many beneficial emotional, psychological and biological effects, as supported by observations in this study. The physiological methods are especially useful as they provide objective markers of the processes and effectiveness of treatment. These observations may help guide further clinical application of yoga in depression and other mental health disorders, and future research on the processes and mechanisms.

Keywords: anger – anxiety – baroreflex sensitivity – heart rate variability – unipolar major depression

Introduction

Yoga as a Complementary and Alternative Treatment of Depression

Approximately 75% of US adults have used some form of complementary or alternative medicine (CAM), and about 5% report depression or anxiety as a motivating factor (1). CAM practices for depression include yoga, acupuncture, massage, St John's Wort (hypericum), s-adenosylmethionine (SAMe) and folate (2). In an unpublished survey of 2133 yoga students conducted by the Iyengar Yoga National Association of the US (IYNAUS), depression ranked among the top five reasons given for participation. Yoga continues to grow in popularity (3). A survey conducted in 1998

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(4) estimated that 15 million American adults used yoga at least once in their lifetime and 7.4 million during the previous year, and concluded that yoga was often regarded as helpful and without expenditure. Despite the popularity of yoga, there is little systematic research on its clinical application to mental or other health conditions and on the processes underlying its therapeutic potential. Khumar *et al.* (5) investigated yoga for depressed university students and found it superior to a no-treatment control; this form of yoga emphasizes deep relaxation and rhythmic breathing. Janakiramaiah *et al.* (6) randomized participants to electroconvulsive therapy, imipramine or a Sudarshan Kriya yoga programme focused on rhythmic breathing. They reported remission rates of 93% for electroconvulsive therapy (ECT), 73% for imipramine and 67% for yoga. Studies of non-clinically depressed adults have unclear implications for patients with mood disorders (7–9). These studies were not placebo-controlled, which is a limitation given the magnitude of placebo effects in the treatment of depression (10). Yoga as a complement to anti-depressant medication has not been studied.

Iyengar Yoga

An important role in making yoga accessible to the West was played by B. K. S. Iyengar (1918–). The approach he articulated (11,12) makes it well suited to biomedical application. First, Iyengar yoga employs 'props' (e.g. mats, blankets, blocks, ropes, chairs) that allow beginners to learn the poses gradually and accurately, despite limited experience and flexibility. Second, Iyengar yoga teachers undergo a 3-year training program and are certified by the organization (IYNAUS) at different ranks (Introductory, Intermediate and Senior, with levels within each) according to years of teaching experience and competence. Qualifications are evaluated by written and teaching performance tests, judged by panels of senior teachers. This standardization supports the reproducibility of the program, somewhat like the 'manualized' psychotherapies. Third, Iyengar theory and practice specifies asanas (poses, postures, positions) and sequences of asanas that have therapeutic value for different conditions and states, including depression. For example, certain asanas have been found to enhance positive mood in healthy (non-depressed) participants (8).

Iyengar yoga classes typically involve the practice of floor, sitting and standing poses, inversions (head stand, shoulder stand), breathing exercises (pranayama) and short periods of relaxation at the end of each class (savasana—corpse pose). Stretches, twists and extensions or expansions of parts of the body such as the chest are common features. The instructions given by teachers are detailed and continuous during classes, with a focus on awareness of the activity of muscles and joints in conjunction with appropriate breathing patterns to achieve the ideal performance of each asana. An important feature of participation in Iyengar yoga is sustained attention and concentration.

Research Objectives

The purpose of this article is to present further data obtained in a study of yoga as a complementary treatment of depressed patients who were taking anti-depressants, but who still had residual symptoms of depression (13) and to provide evidence underlying the potential of yoga as a treatment of depression (14). In the initial sample of 25 adults with major depression, yoga augmentation resulted in significant improvements in mood, and depression severity scores decreased significantly from pre-to post-treatment for these subjects who were taking anti-depressant medications and yet had residual symptoms. An additional group of 12 participants who underwent the same intervention were added to the study sample for the current report.

Psychological and Biological Factors Affecting Treatment Outcome

The focus is on individual characteristics and aspects of the process that affect response to the yoga intervention. We consider various psychological and biological variables related to depression and mood disorders and to presumed effects of psychological and activity-based treatments, including direct measures of depression, demographics, personality tests designed to tap emotional dispositions and symptoms related to depression (such as anger and anxiety), scales of physical and emotional fitness, and measures of autonomic nervous system (ANS) functions.

The ANS measures included blood pressure (BP) and heart rate (HR), and derived indices of heart rate variability (HRV) and baroreflex sensitivity (BRS). High-frequency HRV (HF-HRV) is a measure of respiratory sinus arrhythmia, indicative of parasympathetic control of the heart (vagal tone). The evidence in various studies supports the polyvagal theory of Porges on the role that vagal tone plays in social behavior and the regulation of emotions (15). The baroreflex also contributes to parasympathetic control of the heart, and low BRS may be a marker of increased cardiac risk associated with depression or comorbid anxiety (16–20). HRV and BRS are both relevant to depression, and they are also relevant to the effects of exercise (21–23).

Variations in HRV

Studies have found HF-HRV reflections of vagal tone to be lower in depressed psychiatric patients compared with

controls (24–26), although some have not (27). There is more consistent evidence that HRV is lower in depressed than non-depressed patients with stable coronary disease (22,28) or with a recent history of acute myocardial infarction (29). In a recent study in our laboratory (30), we compared 28 depressed patients from the present sample with 28 healthy controls on whom we had the same measures. Each pair of subjects was matched for age, gender and ethnicity. The patients showed autonomic function imbalance as indicated by higher low-frequency HRV (LF-HRV) and ratio of low to high frequency HRV (LF/HF), reduced HF-HRV and lower BRS. This dysfunctional pattern was associated with higher HR and BP. HF-HRV has also been related to depressed mood during stressors (31). As to the effects of interventions on HRV, research findings are inconsistent. Studies involving pharmacologic treatments for depression (23,32) and psychotherapy (33) report an increase in HRV with successful treatments, whereas electroconvulsive therapy (34) resulted in a decrease in HRV, associated with successful treatment. The discrepancies may reflect the specific intervention employed. As to BRS, in a study of healthy elderly people comparing aerobic exercise and yoga in a 6-week training program, yoga increased BRS but aerobic exercise did not (35).

Yoga and Mood

As mood changes are central in depression and mood disorders more generally, we also evaluated the role in treatment outcome of self reports of mood changes occurring during the yoga classes. This focus derives from previous research on the effects of yoga on mood reports in non-depressed healthy subjects, suggesting the potential of yoga for use in the management of clinical major depression. In a form of yoga (Hatha Yoga) that has a strong exercise dimension much like Iyengar yoga, with stretching, balancing and breathing routines, subjects reported being less anxious, tense, angry, fatigued and confused after classes than just before class and, in a second study, yoga and swimming showed comparable positive effects on mood reports (36,37). More recently, in a non-clinical sample, reductions in negative mood occurring from before to after yoga classes were greater for subjects scoring higher on scales of depression and anxiety than those scoring lower on these traits (8, see also 9,38).

We are reporting on data in a single-group outcome study. Our intention was to estimate the size of the effect, examine process variables and individual differences in treatment outcome, as well as consider practical issues in research of this kind in this population of patients.

Methods

Participants

This research adhered to ethical research standards and was approved by the UCLA Institutional Review Board.

Participants were recruited by flyers on campus bulletin boards, newspaper advertisements and internet notices, and letters to UCLA clinical faculty. Thirty-seven people qualified for the study after telephone screening and intake diagnostic interview, 27 women and 10 men; 33 White, 1 African, and 3 Asian-American; mean (range), age 44.8 (20–71); years of education 16.8 (12–21); BMI 26.7 (20–55); hours of exercise/week 5.4 (0–30); alcohol drinks/week 1.3 (0–8); 6 students, 3 retirees, 2 unemployed, 26 in professional, technical and white collar occupations.

Based on history and intake diagnostic interview (Mini-International Neuropsychiatric Interview) (39), all participants were diagnosed with unipolar major depression in partial remission; partial remission was operationalized as having self-reported improvement in depression severity with pharmacotherapy, but with residual symptoms reflected by scores on the 17-item Hamilton Depression Scale (HAM-D) of 7–18. Participants had to be under the care of a physician and taking anti-depressant medication for at least 3 months, which continued during the study. The average Hamilton-D17 (HAM-D) score at intake was 12.5 (7–18); number of depressive episodes 2.8 (1–6); months on medication 75.6 (3–336). Participants were excluded (i) for Axis I diagnoses of bipolar disorders, delirium or dementia, schizophrenia or other psychotic disorders, or current substance-related or eating disorders; (ii) for any medical illness or other conditions that would pose a safety concern or limit participation; (iii) for suicidal thoughts or tendencies. Medication type was as follows: selective serotonin reuptake inhibitor (SSRI) ($n = 15$); serotonin-norepinephrine reuptake inhibitor (SNRI) ($n = 4$); Dopaminergic ($n = 4$); augmented/combination drug regimen ($n = 14$). Medication category was unrelated to treatment outcome after the yoga intervention. Individuals with >3 months of prior yoga experience were excluded. The protocol was approved by the UCLA Institutional Review Board, and informed consent was obtained from all participants. Approval for participation in the study was obtained from each participant's own treating physician.

Attendence and Adherence

Out of the 37 people who qualified for the study and completed the intake procedures, six did not attend any classes, six attended one class, two attended two classes, one attended three classes and one attended five classes. None of these 16 participated in the final

assessment and few responded to telephone inquiries. Based on some limited feedback from these people and informal observations of research assistants, the issues were difficult in making a commitment in general, conflicts with other activities, various inconveniences or concern about the physical demands. The remaining 21 attended six or more sessions, which we estimated would be likely to have an effect. These 21 are labeled 'Ins' and the other 16 'Outs'. The 16 Outs included 12 women and 4 men; the 21 Ins included 15 women and 6 men.

Of the 21 Ins, four (19%) did not return for the final assessment or respond to telephone calls. These four dropouts (all women) attended 10, 12, 12 and 17 sessions. The remaining 17 are labeled Completers (11 women, 6 men). Thus, the primary participants were the 17 who attended six or more sessions and who completed both intake and post-intervention assessments.

Eleven participants (65%) ended the study at remission levels (REMISS, <7 on HAM-D); for the remaining six participants (Non-Remiss), one showed a sizable reduction (14–9) and the other five small changes. The REMISS group contained six women and five men; the NON-REMISS group contained five women and one man.

Yoga Procedure

Yoga instruction was provided in three groups of 12–13 participants over an 8-week period, three sessions a week with a total of 20 sessions per group because of holidays and incidental cancellations. The 60–90 min classes were led by three highly experienced certified Iyengar yoga teachers who rotated over the sessions. The three groups did not differ in attendance rates or in the HAM-D or Quick Inventory of Depressive Symptoms (QIDS) scores. Yoga instruction followed sequences of yoga asanas, specifically designed by the teachers for this study to improve mood and alleviate depression, based on the writing and teaching of BKS Iyengar (11,12) and other leaders in the field (40,41). There were three classes every week. One of the classes focused on inverted poses such as *Salamba Sarvangasana* (shoulderstand) and *Viparita Karani* (supported inversion with bolsters and wall). The poses were introduced in stages in a progressive manner week by week according to the ability of the students. The inversion sequence eventually incorporated poses such as *Adho Mukha Vrksasana* (Handstand) and *Sirsasana* (headstand). A second class each week focused on backbends which emphasized the expansive chest opening aspects of back arching *asanas* in both supported (with chairs, bolsters, block, etc.) and unsupported versions. The third class every week focused on restorative poses using props in a specific manner to support the student in backbends, inversions and supine poses in order to be able to hold the poses longer and cultivate the relaxing benefits in the pose in addition to the other properties in the pose that help elevate mood. As in the aforementioned inversion sequence, the back bending and restorative sequences were also taught in a progressive manner. The yoga teachers were not given any information about the participants' individual characteristics or research data. A complete list of the asanas may be obtained on request.

Assessments

Psychological Measures

The intake and post-intervention assessment consisted of a diagnostic interview and health history, demographic questionnaire and the following personality tests: 17-item HAM-D, QIDS, SCL, Spielberger Anger Expression Scale providing indices of Anger In (suppression of anger, ANGIN) and Anger Out (expression of anger, ANGOUT), Spielberger Trait Anxiety Inventory (STAI), Cook–Medley Hostility Scale (indirect hostility), Pittsburgh Sleep Scale (SLEEP), and the SF-36 short-form health survey, which includes eight dimensions related to physical and emotional limitations on functioning, bodily pain, general mental health, vitality, general health, limitations in usual role activities related to physical and to emotional problems. As significant effects were found only for the last dimension on emotional limitations in role activities (RESF36), for simplicity data for the other SF-36 dimensions will not be presented. The primary outcome measure of therapeutic effect was the change in HAM-D score from intake to post-intervention.

The electrocardiogram and continuous BP (Finapres) were measured for 20 min in a soundproof laboratory under resting conditions with no other tasks or stimulation. Aside from measures of HR and BP, the HR variances of residual time series (the filtered waveforms) after a band-pass optimal FIR (finite impulse response) filtering for alien frequencies and baseline trend were used to calculate HR variability (HRV, ms^2) in two frequency bands: low frequency (LF-HRV, 0.075–0.125 Hz) and high frequency (HF-HRV, 0.125–0.50 Hz); LF-HRV measures both sympathetic (SNS) and parasympathetic (PNS) and HF-HRV measures PNS influences on the heart. The specific indices were the log-transformed variance of HF-HRV and LF-HRV, ratio of the log-transformed variance of LF-HRV to the sum of the logs of the two bands (LFTOT-HRV), ratio of log-transformed variance of HF-HRV to the sum of the logs of the two bands (HFTOT-HRV) and ratio of log-transformed variance of LF-HRV to log-transformed HF-HRV (LFHF-HRV).

A measure of BRS was obtained by the Sequence Method developed by Andrew Steptoe (42). BRS indicates how the ANS adapts to fast changes in BP by measuring the slope of the change in the cardiac interbeat interval to a successive increase or decrease in BP over a minimum of three beats. For further details of the physiological recording and data processing methods see reference (30).

Mood Ratings

Participants were asked to rate their moods before and after each class from 1 = not at all to 5 = very much for each of the 20 mood items. The moods were selected to tap three dimensions of affective state: positive (happy, relaxed, optimistic, confident, content), negative (stressed, sad, frustrated, irritated, depressed, anxious, blue, angry, pessimistic) and energy-arousal (attentive, fatigued, alert, tired, energetic, sleepy) (43).

Data Analysis

Systat (v. 10) was used to analyze the data using within- and between-group *t*-tests and general linear models (GLM). An example of the latter is the analysis of the effects of an independent variable, such as whether participants achieved remission levels or not versus the repeated measure of change in HAM-D scores from pre- to post-intervention. Random regression models (SAS, Proc Mixed) were used to analyze the longitudinal mood ratings obtained over the course of the yoga sessions. These models consider both within- and between-subject variability, and allow for random and fixed effects (mixed modeling) as well as a variable number of observations per subject and missing data, such as missed sessions.

Results

Predictors of Failure to Complete Yoga Intervention

The 21 Ins and 16 Outs were compared by *t*-test and chi-square test on all measures at baseline. They differed only on one measure; Ins had higher scores on the Anger In scale (19.3 versus 15.8; $P<0.02$). Scores on the Anger In scale were negatively correlated with total Anger ($r=-0.50$, $P<0.002$) and positively correlated with Trait Anxiety ($r=0.53$, $P<0.001$), Indirect Hostility ($r=0.59$, $P<0.001$) and Months Medication ($r=0.45$, $P<0.01$).

Significant Pre–Post Reductions were Shown for HAM-D, STAI, ANGOUT, SCL, RESF-36 and LF-HRV

For the 17 completers, HAM-D at intake was 12.4 (7–18) and 6.2 (0–15) at post-intervention ($P<0.001$). All but two out of the 17 showed a decrease in HAM-D scores. For all 37 participants, using the last observation carried forward, thus no change for the 16 Outs and the four who did not complete the post-assessment, the mean reduction in HAM-D scores was still significant ($P<0.001$). For the 17 completers, significant pre-post reductions ($P<0.05$) were shown for STAI, ANGOUT, SCL, RESF36 and LF-HRV (Table 1).

Table 1. Pre–post yoga intervention changes (completers, $n=17$); means

Variable	Pre	Post	*P*
HAM-D	12.4	6.2	0.001
QIDS	11.9	9.4	NS
SCL	1.0	0.7	0.04
STAI	53.0	47.4	0.005
ANGERIN	19.9	18.1	NS
ANGEROUT	15.2	12.5	0.05
MC	15.5	16.0	NS
RESF36	23.1	51.3	0.02
SLEEP	10.2	9.1	NS
HR (bpm)	72.2	71.8	NS
SBP (mmHg)	134.0	132.5	NS
LF-HRV	6.81	6.51	0.05
HF-HRV	5.53	5.40	NS
LFHF-HRV	1.23	1.22	NS
LFTOT-HRV	0.36	0.36	NS
HFTOT-HRV	0.30	0.30	NS
BRS (ms/mmHg)	6.32	6.39	NS

REMISS Participants were Less Educated and Exercised More Often Than NON-REMISS Participants, and the Two Groups also Differed on HR, BRS and HR Variability at Intake

Eleven participants (65%) ended the study at remission levels (REMISS, <7 on HAM-D); for the remaining six participants, one showed a sizable reduction (14–9) and the other five small changes. With respect to intake (pre) measures, REMISS participants differed significantly (Ps <0.05) from NON-REMISS participants on intake data as follows: less education, more habitual exercise; lower HR, higher levels of HF-HRV, lower levels of LFHF-HRV, higher levels of HFTOT-HRV, lower levels of LFTOT-HRV and higher BRS (Table 2). Given the activity-oriented intervention, we examined the relationship between the intake measure of habitual exercise and the physiological measures for all participants. The various high-frequency HRV measures (vagally mediated) were positively correlated with hours of exercise (rs 0.35 to 0.40), and the low-frequency HRV measures were negatively correlated with exercise (rs -0.25 to -0.35).

REMISS Participants showed Greater Improvement in Depressed Mood, Neurotic Symptoms and Middle Insomnia compared with NON-REMISS Participants, and the Two Groups also Differed on Changes in HR Variability Pre- to Post-intervention

Differences between pre- and post-intervention assessment measures were examined as a function of whether

Table 2. Significant differences between REMISS ($n=11$) and NON-REMISS ($n=6$) participants at intake (means)

Variable	REMISS	NON-REMISS	*P*
Education (years)	15.9	18.2	0.01
Exercise (h/week)	9.9	0.8	0.02
Heart rate (bpm)	68.7	78.4	0.04
HF-HRV	6.01	4.90	0.02
HFTOT-HRV	0.31	0.27	0.01
LFTOT-HRV	0.35	0.38	0.03
LFHF-HRV	1.14	1.38	0.01
BRS (ms/mmHg)	7.88	4.58	0.02

Table 3. Significant differences between REMISS ($n=11$) and NON-REMISS ($n=6$) participants pre- and post-yoga (means)

Variable	REMISS		NON-REMISS		
	Pre	Post	Pre	Post	*P*
HAM-D	11.8	3.3	13.3	11.7	0.001
QIDS	13.8	6.9	9.5	12.7	0.01
SCL	1.1	0.7	0.8	0.8	0.04
HF-HRV	5.96	5.53	4.89	5.20	0.01
LFHF-HRV	1.16	1.19	1.38	1.26	0.02
HFTOT-HRV	0.32	0.30	0.28	0.29	0.002

participants achieved remission or not, using HAM-D <7 for stratification. REMISS participants showed greater reductions in their QIDS and SCL scores. In addition, they also showed several physiological effects: a reduction in HF-HRV and HFTOT-HRV compared with increases in the NON-REMISS group and a small increase in LFHF-HRV compared with a small decrease in the NON-REMISS participants (Table 3).

We also examined each of the 17 items in the HAM-D to specify which symptom factors in the HAM-D were most responsive to treatment. The effects indicate greater improvement in depressed mood ($P<0.005$) and middle insomnia ($P<0.005$) for REMISS compared with NON-REMISS participants.

Significant Immediate Changes Seen in Mood After Each Class

For the 17 completers, all 20 moods showed significant immediate changes from before to after each class (all P values <0.0001): negative moods decreased, positive moods increased, energy/arousal moods increased (less tired, more energetic, etc.) (Table 4). Moods did not change significantly over the course of the sessions with one exception: average levels of 'happy' (pre- and post-class ratings) increased over the course of the sessions ($P<0.03$) and the increases in 'happy' from before to after each class became greater over the course of sessions ($P<0.03$).

Table 4. Mood ratings pre- and post-yoga classes

Mood	Pre	Post
Positive		
Happy	2.9	3.5
Relaxed	2.6	3.8
Optimistic	2.8	3.3
Confident	2.8	3.4
Content	2.6	3.4
Negative		
Stressed	2.7	1.5
Sad	2.6	2.0
Frustrated	2.8	1.9
Irritated	2.6	1.7
Depressed	2.4	1.7
Anxious	2.4	1.5
Blue	2.4	1.7
Angry	2.1	1.6
Pessimistic	2.5	2.0
Energy/Arousal		
Attentive	3.1	3.5
Fatigued	3.2	2.4
Alert	3.0	3.6
Tired	3.3	2.6
Energetic	2.4	3.4
Sleepy	3.0	2.3

All pre–post differences, $P<0.001$.

The average level of mood ratings over all the classes differed between REMISS and NON-REMISS participants as follows: REMISS rated themselves higher on happy, relaxed, optimistic, confident, and content, and they rated themselves lower on frustrated, pessimistic, depressed, anxious and blue (Ps <0.025). The differences between REMISS and NON-REMISS participants for energy/arousal related moods were not significant.

Comparing the REMISS and NON-REMISS groups, in five moods, the change in rating from beginning to the end of class differed significantly. For three negative moods (frustrated, pessimistic, anxious), the decrease was greater for the NON-REMISS group, reflecting higher initial values for this group (Ps <0.05). In fact, at the end of class, the REMISS participants remained lower. For two energy-related moods (tired, energetic), the same pattern was shown, less tired and more energetic for NON-REMISS participants (Ps <0.05). In these cases, the two groups had similar levels at the end of classes.

Discussion

Our findings extend prior work examining the therapeutic effects of yoga on emotional state. First, we found that beneficial effects not only address the biomedically defined symptoms of unipolar major depression, but yield improvements in a more broadly defined set of reports of mood state experience. Second, these effects are present at a session-by-session level as well as accruing over time. Third, pre-intervention autonomic differences were found between subjects who entered symptomatic remission with the yoga augmentation and those who did not, suggesting that it may be possible to consider prospectively which individuals with depression may benefit most from complementary yoga augmentation of anti-depressant medication.

The findings of the benefits of yoga for depressed patients in partial remission are consistent with previous studies of depressed patients (5,6) using interventions that emphasize rhythmic breathing aspects of yoga. The Iyengar approach in the present study focused mainly on more active asanas and included only brief periods of relaxation and breathing exercises. Future studies will be needed to explore the relative importance of the various components of yoga practices (e.g. physical activity, attentional focus, specific postures) and the mechanisms by which they produce clinical benefits (44). Iyengar yoga practice places a great deal of emphasis on 'opening the chest' as in the case of certain poses such as backbends, which may have direct effects on the circulation that may elevate mood and psychological well-being (8).

A limitation of this study is the single-group outcome design with no placebo or other controls. As with many unblinded interventional studies, it is possible that the observed benefits in the present study may be related to other factors unrelated to our intervention, such as participation in a therapeutic program and expectations of benefit; of note, we found that the participants' expectations assessed at intake were not correlated with symptomatic outcome. Regular participation in a social group is another such non-specific factor. No limitations were placed on socializing either immediately before or after each session or at other times. Future studies may incorporate explicit controls for this factor and should gather data on how much socializing took place and how it affects outcome. It is noteworthy that studies employing Iyengar yoga interventions for other conditions (cancer survivors, self-reported emotional distress) found beneficial effects for depression and mood as well as anxiety and physical well-being (45–47). These studies included control conditions.

Our remission rate of 65% compares favorably with other CAM intervention studies: 43% using SAMe as an augmenter to anti-depressants (48); 20% using omega-3 fatty acid (49); 19% using folinic acid (50). Coppen and Bailey (51) added folic acid or placebo to fluoxetine, and found that 65% (folate) versus 48% (placebo) met 'recovery' criteria using a more liberal standard for remission (HAM ≤ 9) than in the present study. Using their criterion, the remission rate in our study is 77%. In a study of the effects of aerobic exercise as a monotherapy for depression, Dunn and colleagues (52) found a 25% remission rate.

The attrition rate of 19% is lower than that occurs in exercise programs. Pollock (53) reported that 50% of non-depressed individuals drop out of exercise programs within 6 months. In the report by Dunn *et al.* (52), 62% of the control condition using flexibility exercises dropped out. Only one of the many demographic, psychological and biological intake measures in the present study discriminated those who attended six or more classes from those who did not. Most of the latter stopped attending after one or two sessions; 6 out of the 37 who enrolled in the study attended no sessions at all. Reasons given for non-attendance were difficulties with transportation, location of the venue, parking and traffic congestion, even though all who were enrolled agreed to participate after they were informed in detail about the arrangements.

For all who completed the study, aside from clinical symptoms of depression, reductions were also observed in measures of anxiety, expression of anger, neurotic symptoms, limitations on usual role activities because of emotional difficulties, and LF-HRV. Thus, participation in yoga did not in effect target depression only but also affected psychological and biological processes indicative of improved mental health in general and more effective social behavior. LF-HRV reflects both sympathetic and parasympathetic innervation of the heart and is an indication of inadequate cardiac parasympathetic modulation (54). The reduction in LF-HRV, however, was not coupled with an increase in HF-HRV, suggesting inadequate cardiac parasympathetic modulation. From these findings, we may speculate that yoga practice was beneficial in reducing stress responsivity, an effect which is generally associated with sympathetic nervous system activation. The pattern of HRV findings for those who achieved remission versus those who did not may seem counterintuitive in that it decreased in the former and increased in the latter. Those who achieved remission had higher levels of HRV at intake, and the observed opposite effect may reflect the phenomenon of regression to the mean.

We may speculate further on the reduction in HF-HRV observed in the patients who remitted. The capacity to suppress vagal influence appears to mediate attentional and emotional processes that allow an organism to optimally engage or cope with environment challenges (15,55). Resting vagal influence and the capacity to suppress this influence have been found to be strongly related, but the precise distinction between these

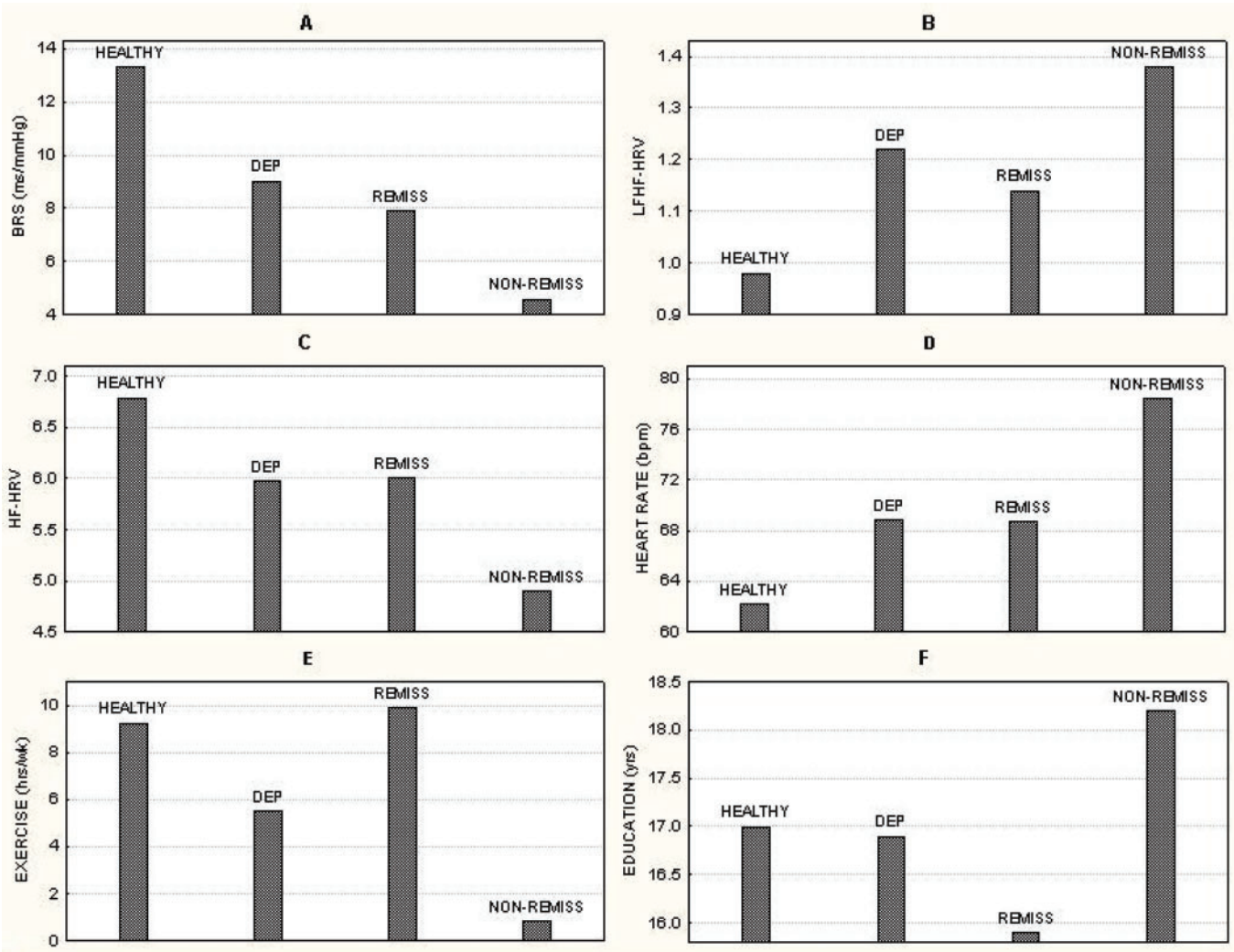

Figure 1. Differences between REMISS and NON-REMISS Participants compared with data on 28 depressed and 28 matched healthy individuals (means).

mechanisms and their concomitant behavioral processes is not yet clearly understood. This suggests the possibility that after yoga treatment, some patients with higher intake resting vagal tone became actively engaged in coping with their depression and improving their mental health. For the patients with initial lower resting vagal tone (non-remitters), yoga treatment may not increase vagal tone to a level needed sufficient to improve their condition. In these patients, it is possible that a longer period of treatment would be beneficial, and future experiments may explore this possibility.

We cannot exclude the possibility that a subject's breathing pattern may be affected by the specific yoga practices in this intervention and that such effects may be related to the HRV findings. Both rate and depth of respiration affect HRV (56) and may have a general effect on the autonomic nervous system or an effect related to voluntary exercise efforts and that may be independent of vagal control of the heart. The latter may determine phasic respiration- but not tonic vagus-related changes in HF-HRV. One might see reductions in respiration rate associated with the focus on breathing in yoga practice, which would likely show up in increased HF-HRV, which was not the case for remitters. Further investigation is warranted on the effects of respiration and of other physiological pathways of yoga on mood and clinical condition.

The participants who remitted differed at intake in several ways from those who did not. They had less formal education, spent many more hours a week in regular exercise, and had higher levels of HF-HRV, lower levels of LF-HRV and higher BRS. The significance of the exercise and physiological effects is understandable and suggests that remitters were already disposed to an activity-based treatment and that from the standpoint of autonomic nervous system functioning they had a greater capacity for emotional regulation. Habitual exercise and physical activity appear

to be beneficial for mood, depression and mental health in general and may facilitate remission in the treatment of depression (57,58). The finding of less education for remitters may be in line with a greater disposition toward an activity-based rather than an educational or verbal therapy. In future studies, it may be advantageous to combine meditation or other mental approaches with the methods used in this study.

For further understanding of the differences between remitters and non-remitters, see Fig. 1 which plots the means for six of the eight effects in Table 2 and compares them with the means of the same measures obtained in 28 depressed and 28 matched healthy controls (30, discussed earlier). For these six measures, the calculations were exactly the same and directly comparable. It can be seen that for Education (Panel F) the NON-REMISS group had higher levels and the REMISS group lower levels compared with the 'norms' for depressed and healthy people. For exercise (Panel E), the NON-REMISS group stands out with many fewer hours of regular exercise. As to the measures of autonomic regulation (Panels A–D), it is apparent that the NON-REMISS participants differed most from the healthy group in all respects with lower BRS, higher LF/HF, lower HF-HRV and higher HR. It appears that exercise and education may have only additive or secondary influences on the differences between REMISS and NON-REMISS participants in baseline autonomic activity. In general, these comparisons support the conclusion that the non-remitters had reduced capacity for emotional regulation.

The mood data indicate that remitters tended to be in a better mood throughout the study, more positive and less negative. All participants felt better from before to after each yoga class: more positive, less negative, and more energetic; in fact, the non-remitters showed a greater improvement than the remitters as their initial and overall moods were less positive to begin with. Thus, mood improvements associated with yoga practice appear to be universal. How they affect depression in any one person must depend on other individual characteristics.

In conclusion, yoga appears to be a promising intervention for depression. It is cost-effective and easy to implement. Most importantly, yoga produces many beneficial emotional, psychological, behavioral and biological effects, as supported by observations in this study. The physiological methods are especially useful as they provide objective markers of the processes and effectiveness of the intervention. The methods and observations in this report may help guide further clinical research on the application of yoga in depression, with appropriate placebo control and comparison conditions, and in other mental health disorders, and in future research on the processes and mechanisms involved.

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