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Rapid stress reduction and anxiolysis among distressed women as a consequence of a three-month intensive yoga program

Authors' Contribution:

- A** Study Design
- B** Data Collection
- C** Statistical Analysis
- D** Data Interpretation
- E** Manuscript Preparation
- F** Literature Search
- G** Funds Collection

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Summary

Background:

Emotional distress is an increasing public health problem and Hatha yoga has been claimed to induce stress reduction and empowerment in practicing subjects. We aimed to evaluate potential effects of Iyengar Hatha yoga on perceived stress and associated psychological outcomes in mentally distressed women.

Material/Methods:

A controlled prospective non-randomized study was conducted in 24 self-referred female subjects (mean age 37.9±7.3 years) who perceived themselves as emotionally distressed. Subjects were offered participation in one of two subsequential 3-months yoga programs. Group 1 (n=16) participated in the first class, group 2 (n=8) served as a waiting list control. During the yoga course, subjects attended two-weekly 90-min Iyengar yoga classes. Outcome was assessed on entry and after 3 months by Cohen Perceived Stress Scale, State-Trait Anxiety Inventory, Profile of Mood States, CESD-Depression Scale, Bf-S/Bf-S' Well-Being Scales, Freiburg Complaint List and ratings of physical well-being. Salivary cortisol levels were measured before and after an evening yoga class in a second sample.

Results:

Compared to waiting-list, women who participated in the yoga-training demonstrated pronounced and significant improvements in perceived stress ($P<0.02$), State and Trait Anxiety ($P<0.02$ and $P<0.01$, respectively), well-being ($P<0.01$), vigor ($P<0.02$), fatigue ($P<0.02$) and depression ($P<0.05$). Physical well-being also increased ($P<0.01$), and those subjects suffering from headache or back pain reported marked pain relief. Salivary cortisol decreased significantly after participation in a yoga class ($P<0.05$).

Conclusions:

Women suffering from mental distress participating in a 3-month Iyengar yoga class show significant improvements on measures of stress and psychological outcomes. Further investigation of yoga with respect to prevention and treatment of stress-related disease and of underlying mechanism is warranted.

key words:

cortisol • distress • stress reduction • trial • yoga

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BACKGROUND

Large numbers of Americans and Europeans have recently adopted the practice of yoga for its proposed health benefits. By 1998, an estimated fifteen million, mostly female American adults, had used yoga at least once in their lifetime, and 7.4 million reported practising yoga during the previous year [1]. Featured in the lay press yoga continues to be marketed as a method to empower well-being and to reduce stress ("Power-Yoga"). Indeed, some health professionals refer their patients to Yoga teachers for help in managing a variety of stress-related ailments. Of the many styles of yoga taught in the US and Europe, Iyengar yoga is the most prevalent [2]. It is based on the teachings of the yoga master, B.K.S. Iyengar, who has applied yoga to many health problems, using a system descending from Astanga yoga [3].

A number of controlled studies exist on the effectiveness of yoga. These investigations include such conditions as osteoarthritis [4], carpal tunnel syndrome [5], multiple sclerosis [6], bronchial asthma [7], pulmonary tuberculosis [8], drug addiction [9], hypertension [10], irritable bowel syndrome [11], mild depression [12] and lower back pain [13,14]. Five of these studies evaluated Iyengar yoga and reported positive results. However, little is known about the putative impact of Iyengar yoga on emotional distress. Self-reported, frequent mental distress is increasingly prevalent among US adults, particularly among women who manifest about a 50% higher prevalence than males [15]. As recent research has emphasized the negative impact of mental distress on health, e.g. cardiovascular health, we undertook a preliminary study to examine the effects of a 12-week yoga course upon perceived stress and psychological well-being in distressed women. We expected that participation in an intensive program of Iyengar yoga would result in reduction of perceived stress, and related symptoms of anxiety and depression, as compared to on intervention (i.e. the waitlist control group), as well as increased emotional and physical well-being.

MATERIAL AND METHODS

Subjects

24 female volunteers, 26 to 51 years old (mean age 37.9 ± 7.3 yrs), were recruited by means of a local newspaper advertisement that offered women with high levels of perceived stress a three-month yoga course. All participants were requested to regularly attend two 90-minute yoga classes per week throughout the next 3 months. Further inclusion criteria included the following: (1) subjects confirmed experiencing emotional distress on more than 50% of days during the last 3 months; (2) they were not currently practicing yoga or any other form of stress reduction techniques. Subjects were excluded if they reported a current psychiatric diagnosis, were receiving treatment for any psychiatric condition, indicated any medical contraindications to exercise, were on medication for any disease, or manifested problems with alcohol or substance abuse.

After signing informed consent and collection of baseline data, subjects could choose from one of two sequential 3 month-courses, with a maximum class size of 18 subjects. 16 subjects preferred participation in the first class; eight subjects first served as waiting list control and subsequent-

ly participated in the second yoga course. The study protocol was reviewed and approved by the Institutional Review Board of the University Clinic Essen.

Measurements

A battery of standardized and validated self-report measures was administered at pre- and post-course or waiting list period: (1) The German version of the Spielberger State-Trait Anxiety Inventory (STAI), which consists of 20 items relating to state anxiety and 20 items relating to trait anxiety (16); (2) the German version of the Cohen Perceived Stress Scale (CPSS), which consists of 14 items about current levels of experienced and perceived stress (17); (3) the German version of the Profile of Mood States (POMS), which is a 34 items instrument that measures four domains of mood disturbance including vigor, fatigue, depression-anxiety and anger [18]; (4) the German version (ADL-S) of the Center for Epidemiological Studies Depression Scale (CES-D), which consists of 20 items about general depression symptoms and behaviour [19], and (5) the Zerssen Bf-S/Bf-S' well-being scales, which measure momentary emotional well-being and consist of two 28-item instruments, using three answer categories with higher scores indicating lower well-being [20]. The Bf-S/Bf-S' is sensitive to clinically relevant, short-term changes in general well-being and overall health-related symptoms and its salutogenetic dimensions of health can serve as an indicator for changes in quality-of-life [20].

In addition, we measured symptoms and severity of headache and back pain, general physical well-being and quality of sleep, using 10-point Likert scales for each category, with a reference period of the preceding week. Finally, general and specific physical complaints were measured with the well-validated, 70-item Freiburg Complaint List, that inventories subjective evaluation of physical complaints across the major physiological functional domains [21]. Resting heart rate and blood pressure were measured after 5 minutes of rest while subjects were seated. In a second study sample yoga-practicing subjects provided a saliva sample for cortisol before and after a yoga session which was held from 8:00 PM to 9:30 PM. Salivary cortisol was measured by radioimmunoassay (Laboratory for Stress-Monitoring, University of Göttingen).

Yoga and control intervention

Subjects in the yoga class attended two 1.5 hour yoga classes each week for 12 consecutive weeks. Subjects were taught the Iyengar approach to yoga by a certified Iyengar yoga instructor. The yoga instructor had trained in the method for over 15 years, and had experience teaching persons with mental distress. The classes emphasized postures, that, according to the Iyengar yoga instructions, are supposed to alleviate stress, particularly back bends, standing poses, forward bends and inversions. Throughout the program, subjects were encouraged to continue yoga practice at home. Subjects in the control group were asked to maintain their routine activities and not begin any other exercise or stress reduction program during the following 3 months.

Statistical analysis

Outcomes were analysed on an intention-to-treat basis by univariate analyses of covariance (ANCOVA) which includ-

Table 1. Demographic, medical and psychological characteristics of study participants. Mean ±SD if not indicated otherwise.

Characteristic	Yoga group (n=16)	Control group (n=8)	P-value
Mean age, y	36.7±6.7	40.4±8.2	0.084
Heart rate, bpm	74±11	70±7	0.653
Diastolic blood pressure, mmHg	71±9	76±13	0.107
Systolic blood pressure, mmHg	109±14	121±21	0.034
Smokers, n (%)	4 (25)	3 (37.5)	0.646
Weight, kg	62.1±9.4	66.5±11.5	0.174
Depression Score, CES-D	24.3±10.2	19.3±8.3	0.685
State Anxiety, S-STAI	52±9.1	44.9±12.4	0.105
Trait anxiety, T-STAI	49.1±8.5	47.3±13.3	0.956
Stress Score, CPSS	34.2±5.7	30.8±9.2	0.701
Sleep disturbances, n (%)	8 (50)	5 (63)	0.306

CES-D – Center for Epidemiological Studies Depression Scale; S-STAI – State-Anxiety; T-STAI – Trait-Anxiety; CPSS – Cohen Perceived Stress Scale.

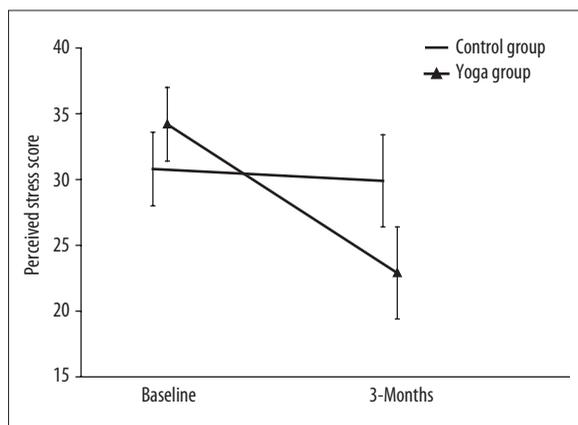


Figure 1. Mean (±SD) Perceived Stress Score on study entry and at three months in the yoga and control groups. Significant between-group treatment effect of -7.9 (95%CI -13.9 to -1.8 ; $P=0.018$), significant reduction of perceived stress within the yoga group ($P<0.0001$) but not in the control group ($P=0.80$).

ed group and baseline values as covariates. From these models we estimated baseline adjusted treatment effects and their 95% confidence intervals (CI). All reported P -values are based on two-sided tests, and a P -value <0.05 was considered significant. Changes in cortisol levels were tested with Wilcoxon test. Standardized effect sizes of psychological outcomes were calculated by dividing the treatment effects by the pooled standard deviations at baseline. As all data were complete there was no need to impute any missing value.

RESULTS

Of 60 candidates who called in, 25 met the inclusion criteria and agreed to enroll. One participant in the control group dropped out early due to acute illness necessitating an operation and was excluded from analysis. Baseline

characteristics are presented in Table 1 and were statistically balanced between groups with exception of non-significantly older age ($p=0.083$) and higher systolic blood pressure ($p=0.034$) in the control group. Adherence to the yoga classes was good, with all participants visiting $>90\%$ of offered classes. Blood pressure, resting heart rate, weight and smoking status remained unchanged in the yoga and control groups after three months.

Perceived stress and psychological outcomes

After the yoga intervention perceived stress significantly decreased compared to the waiting list (Figure 1). Among the psychological parameters, State and Trait anxiety, three dimensions of the POMS (vigor, fatigue, depression-anxiety) and the well-being scores improved significantly in the yoga group compared to the control. Depressive symptoms in the CES-D tended to be reduced through the yoga intervention. As the small sample size of the control group may reduce the power of between group effect estimates we also provided data for within-group effects which depicted large improvement of the yoga participants over all psychological parameters. Summarized results on psychological outcomes are given in Table 2. The respective effect sizes of Trait-anxiety, perceived stress, emotional well-being, vigor and fatigue were all above one (Figure 2), thus suggesting large effects of yoga (22). Baseline scores of stress (CPSS), depression (CES-D) and anxiety (STAI) scores indicated the yoga group having clinically relevant distress on study entry. The yoga-induced improvement of depression and anxiety scores amounted to 50% and 30%, respectively, well-being improved by 65%, together indicating a substantial effect of the yoga class on psychological outcome.

Physical complaints and physical well-being

At study entry 15 out of 16 patients in the yoga group (94%) and 6 out of 8 controls (75%) reported having frequent lower back pain. After the yoga intervention back pain resolved completely in 5 yoga participants and in none of the con-



Table 2. Effects on perceived stress and psychological outcomes.

	Yoga group			Control group			Treatment effect	P-value
	Baseline	3-months	P-value**	Baseline	3-months	P-value**		
State anxiety	52.0±9.1	38.2±7.5	<0.0001	44.9±12.4	44.6±10.9	0.94	-9.2 (-16.3;-2.1)	0.019
Trait anxiety	49.1±8.5	38.9±6.9	<0.0001	47.3±13.3	49.1±8.7	0.47	-11.3 (-15.6;-6.9)	<0.001
Depression (CESD)	24.3±10.2	12.6±7.9	0.0011	19.3±8.3	18.1±8.7	0.74	-6.6 (-13.7;0.5)	0.082
Well-being Bf-S*	29.6±11.8	11.6±7.0	<0.0001	20.3±12.0	18.0±9.8	0.55	-8.6 (-15.6;-1.5)	0.026
Well-being Bf-S'*	27.9±12.2	10.2±6.9	0.0012	20.4±10.5	22.3±9.7	0.59	-13.1 (-20.2;-6.1)	0.001
POMS								
Vigor	17.3±5.5	24.3±7.4	0.0018	20.9±6.2	18.1±8.7	0.30	8.4 (2.1;14.8)	0.016
Fatigue	25.5±7.4	11.7±7.4	<0.0001	16.8±10.4	19.4±9.1	0.57	-10.3 (-18.1;-2.6)	0.016
Depression/Anxiety	22.9±16.8	8.0±9.6	<0.0001	14.6±10.3	13.4±10.9	0.74	-8.3 (-16.0;-0.6)	0.046
Anger	14.1±9.6	5.6±5.7	<0.0001	7.8±9.2	7.9±3.9	0.97	-3.5 (-8.0;1.1)	0.152

* Well being scales inversely rated with higher values indicating reduced well-being. POMS – Profile of Mood States. Mean ±SD and mean (95%CI) for treatment effects.

** P-value for within-group differences.

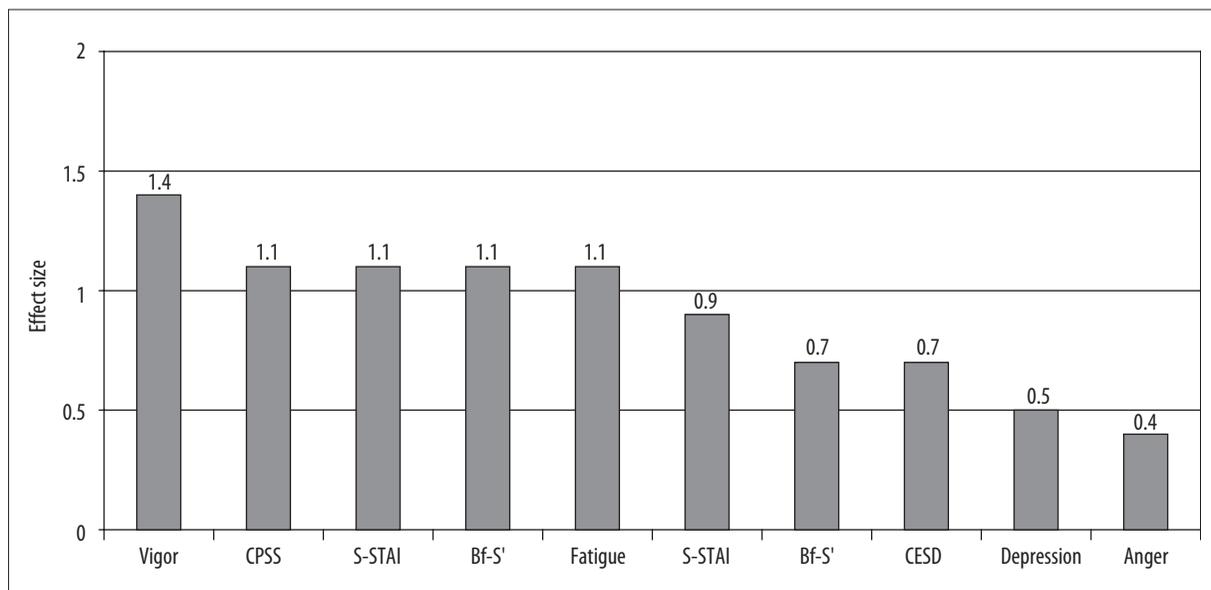


Figure 2. Effect sizes of measured psychological outcomes. CPSS, Cohen Perceived Stress Scale; T-STAI, Trait-Anxiety; S-STAI, State-Anxiety Bf-S/S', von Zerssen Well-Being Scales; CES-D, Center for Epidemiological Studies Depression Scale; Vigor, Fatigue, Depression and Anger represent the four dimensions of the German version of the Profile of Mood States.

trols. Frequent headache was present in 11 subjects of the yoga group (69%) and in 4 controls (50%) at study entry. After the Yoga intervention headache completely resolved in 5 yoga participants and in none of the controls. Mean self-rated values of severity of headache, back pain, general physical well-being (all Likert scaled) and the summarized complaint list score and the score of the pain subscale of the

FBL are given in Table 3. Sleep disturbances were present in 8 yoga participants (50%) and 5 controls (63%) and resolved in 3 and 1 subjects respectively.

There were no adverse effects associated with yoga practice for all subjects. 13 of the 16 yoga class participants aimed to continue with the yoga class. Asking for the barriers that

Table 3. Effects on physical symptoms and complaints (when present).

	Yoga group		Control group		Treatment effect	P-value
	Baseline	3-months	Baseline	3-months		
Physical well-being	6.1±2.1	3.8±1.7	5.9±1.8	6.3±1.4	-2.5 (-3.8;-1.2)	<0.01
Headache	5.0±3.6	1.3±1.9	2.3±2.9	3.1±4.2	-5.3 (-8.6;-2.0)	0.008
Back pain	6.1±2.3	2.8±2.4	3.6±3.9	3.5±3.7	-2.7 (-5.3;-0.1)	0.055
Freiburg complaint list, sum score	192±37	167±30	167±27	162±33	-14.4 (-30.4;1.5)	0.093
Freiburg pain score	24.9±7.8	18.3±4.1	19.6±8.4	19.1±8.2	-3.7 (-7.2;-0.2)	0.053

Mean ±SD and mean (95%CI) for treatment effect.

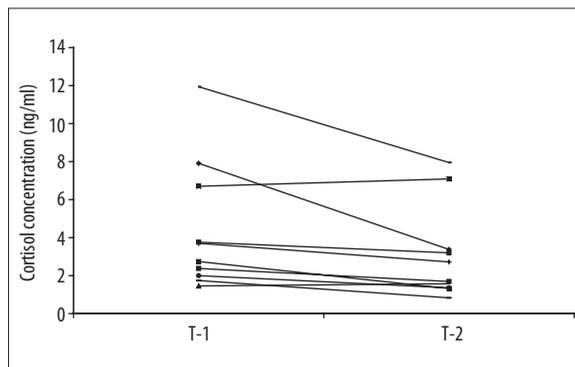


Figure 3. Salivary cortisol concentration before and after a 90 minute Iyengar class in 11 subjects. Decrease of mean cortisol concentration from 4.28 ± 3.06 to 3.20 ± 2.39 ng/ml (decrease in 9 out of 11 subjects, $P=0.029$).

might oppose their yoga practice in the future, the need of time and the participation fee (55€/month) ranked highest. Of note, the majority of yoga participants reported a pronounced stress-reducing effect occurring immediately after each yoga class. To further reveal potential mechanisms of the observed yoga-induced stress reduction and anxiolysis we measured salivary cortisol concentrations immediately before and after a yoga class in another study sample, consisting of 11 female subjects (mean age 38.2 ± 7.1 years) practicing yoga since more than 3 months under the supervision of the same yoga teacher. Analysis showed a decrease of mean cortisol levels from 4.28 ± 3.06 to 3.20 ± 2.9 ng/ml (9 out of 11 subjects, Figure 3); $p=0.029$.

DISCUSSION

In this controlled, non-randomized study we examined how participating in a 3 month- intensified Iyengar yoga course affects perceived stress, stress-related psychological outcomes and physical complaints in distressed women. Strong changes among a broad range of psychological and health variables associated with the intervention indicate that this form of yoga may markedly alleviate perceived stress and related symptoms. Although pain was not an inclusion criteria in this study, the majority of our enrolled patients reported having frequently back pain and headache, which, in addition, was improved by yoga intervention. Accordingly, a recent randomized trial has found Iyengar yoga to be beneficial in patients with chronic lower back pain [14].

The demonstrated marked reduction in perceived stress and related anxiety/depression symptoms in our yoga practising participants appears to be of clinical importance. The prevalence of self-reported stress increases in industrialized nations [15], and, there is growing evidence that perceived stress has a major impact on the initiation and progression of disease, i.e. cardiovascular disease and chronic pain syndromes [23,24]. Our findings are in accordance with a recent pilot study on patients with mild depression, which found an eight-week program of Iyengar yoga to be beneficial on psychological outcomes in these patients [12]. Also, a recent uncontrolled study in psychiatric inpatients found mood as assessed by POMS to be beneficially affected following participation in a yoga class [25]. A controlled study in healthy students evaluated the immediate effect of a single 90 min Hatha yoga class and found a reduction of perceived stress and negative mood after the yoga practice [26]. Further studies on yoga have focused on evaluation of stress reduction, however, all these studies concentrated on yogic meditation and breathing techniques but not on the use of strict postures [27]. In view of its safety and low costs, further research should evaluate the value of Iyengar yoga for the prevention and treatment of stress-related disease, especially in women.

Various aspects of the yoga intervention could account for the observed beneficial effects on stress, mood and well-being. The yoga classes were activating through its vigorous postures and participants may have experienced enhanced feelings of mastery, as they were challenged to learn difficult postures (asanas). Also the commitment of three hours a week to concentrated practice might induce beneficial effects on self-control and foster self-efficacy. Of note, also regular aerobic exercise has been shown to be an effective treatment for depression [28]. The beneficial effect of Iyengar yoga could, therefore, also be due to the physical effort it entailed.

Stress, in general may lead to anxiety and depression, involving chronic sympathetic activation and activation of HPA axis [29]. Yoga practice induces an immediate decrease in salivary cortisol concentrations as demonstrated in our second study sample, thus pointing to a direct effect on HPA axis. Furthermore, preliminary studies have found improved indices of cardiac autonomic function after comprehensive yoga practice [30].

With respect to signaling molecules, nitric oxide may also be involved in the pathophysiology of stress, anxiety and de-

pression [29,31] and, conversely, in the mechanism of stress-reducing treatments [32,33]. Of note, through its vigorous postures with repeated functional peripheral vessel occlusion and subsequent hyperemia yoga may also modulate blood flow and alter endothelial function. Hence, an alteration of endothelial function may be a likely effect of yoga, and, nitric oxide is constantly produced and released throughout the endothelium. Therefore, we surmise a dominant role of nitric oxide in the stress-reducing effects of Iyengar yoga. In addition, yoga may also induce the relaxation response, for which a decrease in cortisol levels and sympathetic nervous system responsiveness has been demonstrated [34,35]. Also, the involvement of different signaling molecules (including nitric oxide, opiates and endocannabinoids) in related regulatory pathways has been proved [36].

Additionally to the relaxation response, stretching is another component of Hatha (Iyengar) yoga. In a recent study that investigated the effects of 15 min of daily stretching exercise a significant increase of heart rate variability and a marked decrease of heart rate was found after the four-week intervention, and, the increase in flexibility was correlated to improvement of cardiac autonomic function [37]. As Iyengar yoga has an intensive stretching component itself, it might be that the increased flexibility also contributes to stress reduction by means of improved autonomic function. However, heart rate and blood pressure were unchanged in our study, but we did not record more elaborated parameters of autonomic function, i.e. heart rate variability and baroreceptor sensitivity.

Some limitations relate to our study. First, we used a non-randomized study design in order to achieve maximum adherence with the treatment. Non-randomized studies may introduce a bias by indication and by different levels of motivation between the groups. However, baseline values of psychological measures showed yoga participants as being only slightly more affected by distress. Moreover, all baseline differences of psychological measures were statistically nonsignificant, thus making selection bias an unlikely explanation for the pronounced yoga effect. Furthermore, our analysis included baseline values as covariates, thus regression-to-the mean effects can be ruled out as an explanation for the results. Second, our study population was of limited size. Smaller study populations hold the risk of non-detection of moderate treatment effects, however, if effects are found the clinical relevance of the intervention is emphasized.

A further possible limitation stems from the subjective definition of stress in our study, with subjects rating themselves as "stressed" used for recruitment and inclusion of the otherwise healthy participants. However, the primary purpose of this study was to evaluate the effects of Iyengar yoga on one of the greatly featured benefits in the public, namely stress reduction and empowerment. Measurement of stress is complex and difficult. Yet, the baseline values for perceived stress, anxiety and depression (CES-D) in our participants were all above one standard deviation of the population-based mean [38–40], thus confirming that our population studied was in fact distressed.

Because emotional distress and even mild elevations of depressive symptoms have been associated with adverse out-

comes [41], our findings raise the possibility that the health benefits of Iyengar yoga might be clinically meaningful. Of note, a construct of measuring stress by few or even a single-item question was used in the INTERHEART and Göteborg Studies [24,42]. These studies found a strong association between cardiovascular risk and the assessed self-perceived stress. Thus, it seems likely, that our participants were affected by a health-affecting level of stress, and that yoga induced-stress reduction might translate into relevant risk reduction.

CONCLUSIONS

Iyengar yoga seems to offer considerable promise for women who suffer from mental distress and merits further research with respect to prevention and treatment of stress-related disease. Our results suggest that the selected outcome measures are sensitive instruments to track modification of distress in future studies. In addition, further investigation of the underlying mechanisms is necessary. These studies should search for yoga-induced modulations of putative regulatory pathways, e.g. HPA axis, sympathetic nervous system, nitric oxide release/endothelial function and endogenous endocannabinoids and opiates.

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