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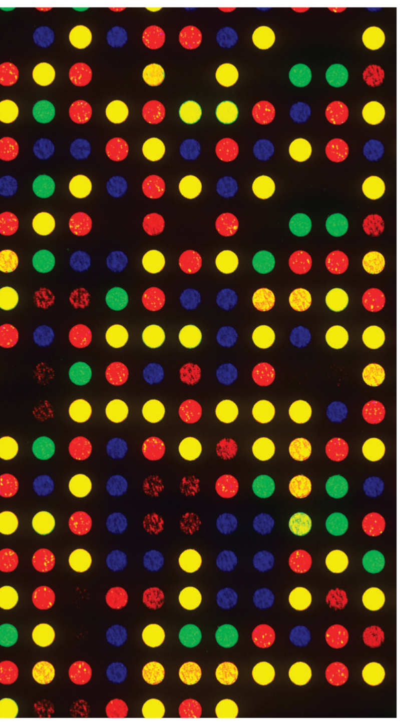
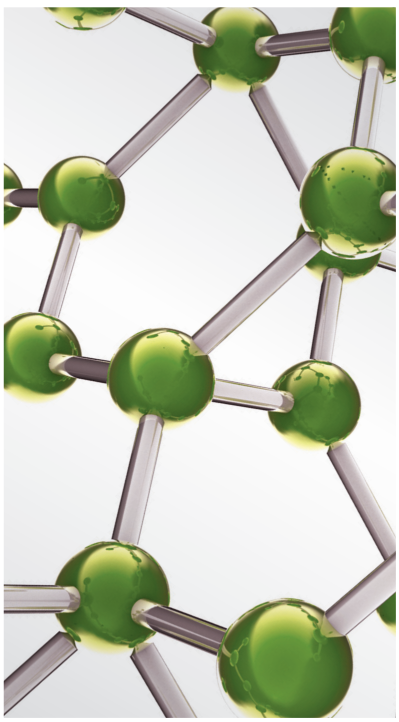
Yoga as a Therapeutic Intervention

Guest Editors: Arndt Büssing, Sat Bir S. Khalsa, Andreas Michalsen, Karen J. Sherman, and Shirley Telles



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Editorial Board

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2012, Article ID 174291, 1 page
doi:10.1155/2012/174291

Editorial

Yoga as a Therapeutic Intervention

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Received 11 September 2012; Accepted 11 September 2012

Yoga is an ancient mind/body practice, which originated in the Indian subcontinent, that promotes overall health and well-being. Yoga's ultimate goal is the achievement of a state of unified consciousness. Historically, the practice of yoga included eight steps towards spiritual emancipation and included practices involving physical postures, breathing techniques, and meditation. Today, yoga is very popular in the West amongst the general public. Numerous modern schools or styles of yoga exist (i.e., Iyengar, Ashtanga, Viniyoga, Bikram, Sivananda, Kripalu, Kundalini, Integral, among others), most of which are forms of traditional Hatha yoga, each with their own distinct priorities in terms of the balance of inclusion of spiritual and physical practices, with some styles focusing more exclusively on physical postures despite the historical focus of yoga on inner development. Research on the psychophysiological benefits of yoga and meditation practice has revealed benefits in physical, mental, and emotional self-regulation. Demonstrated improvements in stress, anxiety, mood, and physical health and well-being have proven useful for therapeutic purposes, and this has led to the popular implementation of yoga as a primary or adjunctive therapy.

Despite several clinical studies and systematic reviews on the effects of the different yoga styles, further research is required to clarify yoga's value as an intervention. With respect to yoga's value for specific indications and disorders, most studies report positive effects in favor of yoga interventions, although there are a variety of effect sizes observed. The degree of clinical benefit of yoga in any specific research trial may depend on a variety of factors including participant characteristics (age, gender, health status, etc.), diagnoses and study entry criteria, yoga intervention characteristics (e.g., yoga styles, intensities, and frequencies and durations of practice), compliance and attrition effects, and so forth. Moreover, as a relatively new field of research, most of the research trials are pilot studies, with typically small samples sizes, moderate methodological quality, and often inadequate control groups rendering the general findings tentative and in need of further research validation.

For this special issue, we have invited investigators to submit original research articles and systematic reviews/meta-analyses on the clinical effects of yoga intervention programs. The special issue starts with a summarizing overview of published literature reviews on the clinical effects of yoga interventions on physical and mental health, and it continues with a wide range of scientific contributions, addressing specific aspects of a colorful field of research. Of course we are aware of the many unanswered questions and the methodological flaws and limitations of several of these studies, yet we believe that the papers of this special issue will shed light on a fascinating and expanding field within mind-body medicine that is rich with promising findings.

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2012, Article ID 863905, 11 pages
doi:10.1155/2012/863905

Review Article

Effectiveness of Yoga for Menopausal Symptoms: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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Received 3 May 2012; Accepted 1 June 2012

Academic Editor: Arndt Büssing

Objectives. To systematically review and meta-analyze the effectiveness of yoga for menopausal symptoms. *Methods*. Medline, Scopus, the Cochrane Library, and PsycINFO were screened through April 2012. Randomized controlled trials (RCTs) were included if they assessed the effect of yoga on major menopausal symptoms, namely, (1) psychological symptoms, (2) somatic symptoms, (3) vasomotor symptoms, and/or (4) urogenital symptoms. For each outcome, standardized mean differences (SMDs) and 95% confidence intervals (CIs) were calculated. Two authors independently assessed risk of bias using the risk of bias tool recommended by the Cochrane Back Review Group. *Results*. Five RCTs with 582 participants were included in the qualitative review, and 4 RCTs with 545 participants were included in the meta-analysis. There was moderate evidence for short-term effects on psychological symptoms (SMD = −0.37; 95% CI −0.67 to −0.07; $P = 0.02$). No evidence was found for total menopausal symptoms, somatic symptoms, vasomotor symptoms, or urogenital symptoms. Yoga was not associated with serious adverse events. *Conclusion*. This systematic review found moderate evidence for short-term effectiveness of yoga for psychological symptoms in menopausal women. While more rigorous research is needed to underpin these results, yoga can be preliminarily recommended as an additional intervention for women who suffer from psychological complaints associated with menopause.

1. Introduction

Menopause is defined as the permanent cessation of ovarian function and is thereby the end of a woman's reproductive phase [1]. Menopause begins around the age of 50 years [2] and is characterized by at least 12 months of amenorrhea [3]. While it is an inevitable part of every woman's life, about 3 out of every 4 women experience complaints during menopause [4, 5]. The most common menopausal symptoms include hot flashes, night sweats, fatigue, pain, decreased libido, and mood changes [6–8]. These symptoms often persist for several years postmenopause [9]. While hormone replacement therapy can effectively reduce menopausal symptoms [10, 11], its safety has long been controversially discussed [10–12]. While the most recent research has shown relatively low risk of severe adverse events for hormone replacement within the first 10 years of menopausal onset [10, 11, 13], the long-standing uncertainty about its safety has nevertheless led to significant decreases in hormone prescriptions to menopausal women [14]. Nonhormonal pharmacologic therapies have been shown to be less effective than hormonal therapy and to be associated with their own adverse events that restrict their use for many women [15]. Therefore, many menopausal women use complementary therapies to cope with their symptoms [16–21], and yoga is among the most commonly used complementary therapies for menopausal symptoms [18–21].

An estimated 15 million American adults report having practiced yoga at least once in their lifetime, almost half of those using yoga explicitly for coping with symptoms or promoting health [22]. Deriving from ancient Indian philosophy, yoga comprises physical postures as well as advice for ethical lifestyle and spiritual practice with the ultimate goal of uniting mind, body, and spirit [23, 24]. In North America and Europe, yoga is most often associated with physical postures (asana), breathing techniques (pranayama), and meditation (dyana) [24]. A variety of yoga schools have evolved from the traditional Indian system of yoga in Western societies, which are giving different weight to physical and spiritual practice [24]. Yoga interventions have been shown to decrease anxiety [25], distress [26], blood pressure [26], pain [27, 28], and fatigue [29].

A systematic review that included studies until mid of 2008 concluded that the evidence was insufficient to recommend yoga as an intervention for menopausal symptoms [30]. In the meantime, further large studies on yoga for menopausal symptoms have been published. Therefore, the aim of this paper was to systematically assess and meta-analyze the effectiveness of yoga in women with menopausal symptoms.

2. Methods

The review was planned and conducted in accordance with PRISMA guidelines for systematic reviews and meta-analyses [31] and the recommendations of the Cochrane Collaboration [32, 33].

2.1. Literature Search. The literature search comprised the following electronic databases from their inception through April 2012: Medline (via Pubmed), Scopus, the Cochrane Library, and PsycINFO. The literature search was constructed around search terms for "yoga" and search terms for "menopause" and adapted for each database as necessary. The complete search strategy for Pubmed was as follows: *("Yoga"[Mesh] OR yog*[Title/Abstract]) AND ("Climacteric" [Mesh] OR "Menopause"[Mesh] OR "Postmenopause" [Mesh] OR "Perimenopause"[Mesh] OR "Hot Flashes" [Mesh] OR menopaus*[Title/Abstract] OR peri-menopaus* [Title/Abstract] OR perimenopaus*[Title/Abstract] OR post-menopaus*[Title/Abstract] OR post-menopaus*[Title/Abstract] OR climact*[Title/Abstract] OR hot-flash*[Title/Abstract] OR hot flash*[Title/Abstract] OR hot-flush*[Title/Abstract] OR hot flush*[Title/Abstract] OR night sweat* [Title/Abstract])*. Additionally, reference lists of identified original and review papers and the table of contents of the *International Journal of Yoga Therapy* and *Yoga Therapy Today* were searched manually.

Abstracts identified during literature search were screened, and the full articles of potentially eligible studies were read in full by 2 authors to determine whether they met the inclusion criteria.

2.2. Inclusion Criteria. To be eligible, studies had to meet the following conditions.

(1) *Types of studies*. Randomized controlled trials (RCTs) were eligible. Studies were eligible only if they were published as full paper in English, German, French, or Norwegian language.

(2) *Types of participants*. Studies of adult women who were experiencing menopausal or postmenopausal symptoms were eligible.

(3) *Types of interventions*. Studies that compared yoga interventions with no treatment or any active treatment were eligible. Studies were excluded if yoga was not the main intervention but a part of a multimodal intervention, such as mindfulness-based stress reduction. Since in North America and Europe, physical exercise is perceived as a main component of yoga [24], studies examining meditation or yogic lifestyle without physical component were also excluded. No further restrictions were made regarding yoga tradition, length, frequency or duration of the program. Cointerventions were allowed.

(4) *Types of outcome measures*. Studies were eligible if they assessed major menopausal symptoms, namely, (1) psychological symptoms (e.g., depression, anxiety, sleep disorders), (2) somatic symptoms (e.g., pain, fatigue), (3) vasomotor symptoms (e.g., hot flashes, night sweats), and/or (4) urogenital symptoms (e.g., sexual dysfunctions, bladder problems).

2.3. Data Extraction. Two reviewers independently extracted data on characteristics of participants (e.g., sample size, inclusion criteria, age), characteristics of the intervention and control (e.g., yoga tradition, program length, frequency and duration), and outcome measures and results. If necessary, discrepancies were rechecked with a third reviewer and consensus achieved by discussion.

2.3.1. Risk of Bias in Individual Studies. Risk of bias was assessed by 2 reviewers independently using the 12 criteria (rating: yes, no, unclear) recommended by the Cochrane Back Review Group [33]. These criteria assess risk of bias on the following domains: selection bias, performance bias, attrition bias, reporting bias, and detection bias. If necessary, discrepancies were rechecked with a third reviewer and consensus achieved by discussion. Studies that met at least 6 of the 12 criteria and had no serious flaw were rated as having low risk of bias. Studies that met fewer than 6 criteria or had a serious flaw were rated as having high risk of bias.

2.4. Data Analysis. Studies were analyzed separately for short- and long-term followups. For the purpose of this review, short-term followup was defined as the outcome measures taken closest to 12 weeks after randomization and long-term followup as measures taken closest to 12 months after randomization [33].

2.5. Assessment of Overall Effect Size. Meta-analyses were calculated using Review Manager 5 software (Version 5.1, The Nordic Cochrane Centre, Copenhagen) if at least 2 studies on a specific outcome were available. If studies had two or more control groups, the control groups for assessment of overall effect were selected in the following order of preference: no treatment, attention control, and active comparator. A random effects model was used because it involves the assumption of statistical heterogeneity between studies [32]. Standardized mean differences (SMD) with 95% confidence intervals (CI) were calculated as the difference in means between groups divided by the pooled standard deviation. Where no standard deviations were available, they were calculated from standard errors, confidence intervals or t values [32]; or attempts were made to obtain the missing data from the trial authors by email. The magnitude of the effect size was calculated using Cohen's categories with (1) SMD = 0.2–0.5: small; (2) SMD = 0.5–0.8: moderate; (3) SMD > 0.8: large effect sizes [34].

Levels of evidence were determined according to previously published recommendations with (1) strong evidence: consistent findings among multiple RCTs with low risk of bias; (2) moderate evidence: consistent findings among multiple high-risk RCTs and/or one low-risk RCT; (3) limited evidence: one RCT with high risk of bias; (4) conflicting evidence: inconsistent findings among multiple RCTs; (5) No evidence: no RCTs [35].

2.6. Assessment of Heterogeneity. Statistical heterogeneity between studies was quantified using the I^2 statistics, a measure of how much variance between studies can be attributed to differences between studies rather than chance. The following categories were used to calculate the magnitude of heterogeneity: $I^2 = 0$–30%: no heterogeneity; $I^2 =$ 30–49%: moderate heterogeneity, $I^2 = 50$–74%: substantial heterogeneity; $I^2 = 75$–100%: considerable heterogeneity [32]. The Chi^2 test was used to assess whether differences in results are compatible with chance alone. A P value ≤ 0.10 was regarded to indicate significant heterogeneity [32].

2.7. Subgroup and Sensitivity Analyses. Subgroup analyses were planned for type of control intervention (no treatment; attention control; active comparator). To test the robustness of significant results, sensitivity analyses were conducted for studies with high versus low risk of bias.

If statistical heterogeneity was present in the respective meta-analysis, subgroup and sensitivity analyses were also used to explore possible reasons for heterogeneity.

2.8. Risk of Bias across Studies. If at least 10 studies were included in a meta-analysis, funnel plots were generated using Review Manager 5 software. Publication bias was assessed by visual analysis with roughly symmetrical funnel plots regarded to indicate low risk and asymmetrical funnel plots regarded to indicate high risk of publication bias [36].

3. Results

3.1. Literature Search. The literature search revealed a total of 207 records. One additional record each was found in reference lists of identified review papers and the table of contents of the *International Journal of Yoga Therapy*, respectively. Seventy-one duplicates were excluded. Further 128 records were excluded since they did not meet all inclusion criteria. Ten full-text articles were assessed [37–46] and 5 articles were excluded; 1 article did not assess menopausal symptoms [37], 1 RCT was published in Korean language [38], and 3 articles reported additional outcome measures for already included studies on the same participant population [39–41]. Therefore, 5 RCTs with a total of 582 participants [42–46] were included in qualitative analysis. One RCT did not report standard deviations, nor standard errors, confidence intervals or t-values [43]. Since the missing data could not be obtained from the authors of the respective study by email, this study was excluded from quantitative analysis. Finally, 4 RCTs with overall 545 participants were included in the meta-analysis (Figure 1).

3.2. Study Characteristics. Characteristics of the sample, interventions, outcome assessment, and results are shown in Table 1. In the following, study characteristics will be presented for all trials included in qualitative synthesis.

3.2.1. Setting and Participant Characteristics. Two RCTs originated from the USA [43, 45], 1 from Brazil [42] and 2 from India [44, 46]. Studies were conducted at university medical centers [37, 38, 40] or yoga institutes [44, 46]. Patients were recruited from university medical center oncology units [43] and gynecological outpatient clinics [42, 44] or by using advertisements [42, 44–46].

Between 31.9% and 47.2% of women in each RCT were postmenopausal (median: 46.4%). One study included only women who experienced menopausal symptoms after breast cancer treatment [43]. Participants' mean age ranged from 45.6 years to 54.9 years with a median of 49.0 years. Between 0% and 82.6% of included participants were Caucasians with a median of 81.1%.

3.2.2. Intervention Characteristics. Yoga traditions were heterogeneous between studies: 1 RCT each used Iyengar yoga [45]; an integrated approach to yoga therapy [44]; yoga of awareness [43]; a combination of Yogasana and Tibetan yoga [42]; traditional Indian yoga [46], respectively. All yoga programs included yoga postures and meditation/relaxation; 4 programs also encompassed breathing techniques [42–44, 46]. Program length and intensity varied, ranging from weekly sessions over 8 weeks [43] to daily sessions over 90 days [46]. Generally, frequency of interventions was much higher in the Indian studies [44, 46] compared to the studies conducted in North or South America [42, 43, 45]. Yoga was taught by at least 1 certified and experienced yoga teacher in 2 trials [43, 45], while 3 studies did not state qualification of yoga teachers [42, 44, 46].

Two RCTs compared yoga to no treatment [43, 46]; 1 RCT compared yoga to exercise [44]; 2 3-arm RCTs compared yoga to no treatment and exercise [42, 45]. Program length, frequency, and duration of the exercise control arms were exactly matched with the yoga interventions in 2 studies [42, 44], while the yoga and exercise intervention in the third RCT were matched for total contact time [45].

3.2.3. Outcome Measures. Total menopausal symptoms were assessed in 3 studies using the Kupperman Menopausal Index [42], the Greene Climacteric Scale [45], or the Menopause Rating Scale [46]. Psychological symptoms were assessed in all 5 RCTs using either menopause-specific scales [43, 44, 46], generic questionnaires [42], or both [45]. Using menopause-specific scales, somatic symptoms were assessed by 4 RCTs [43–46]; vasomotor symptoms by 3 RCTs [43–45]; urogenital symptoms by 2 RCTs [45, 46]. Only 1 RCT reported safety data [42].

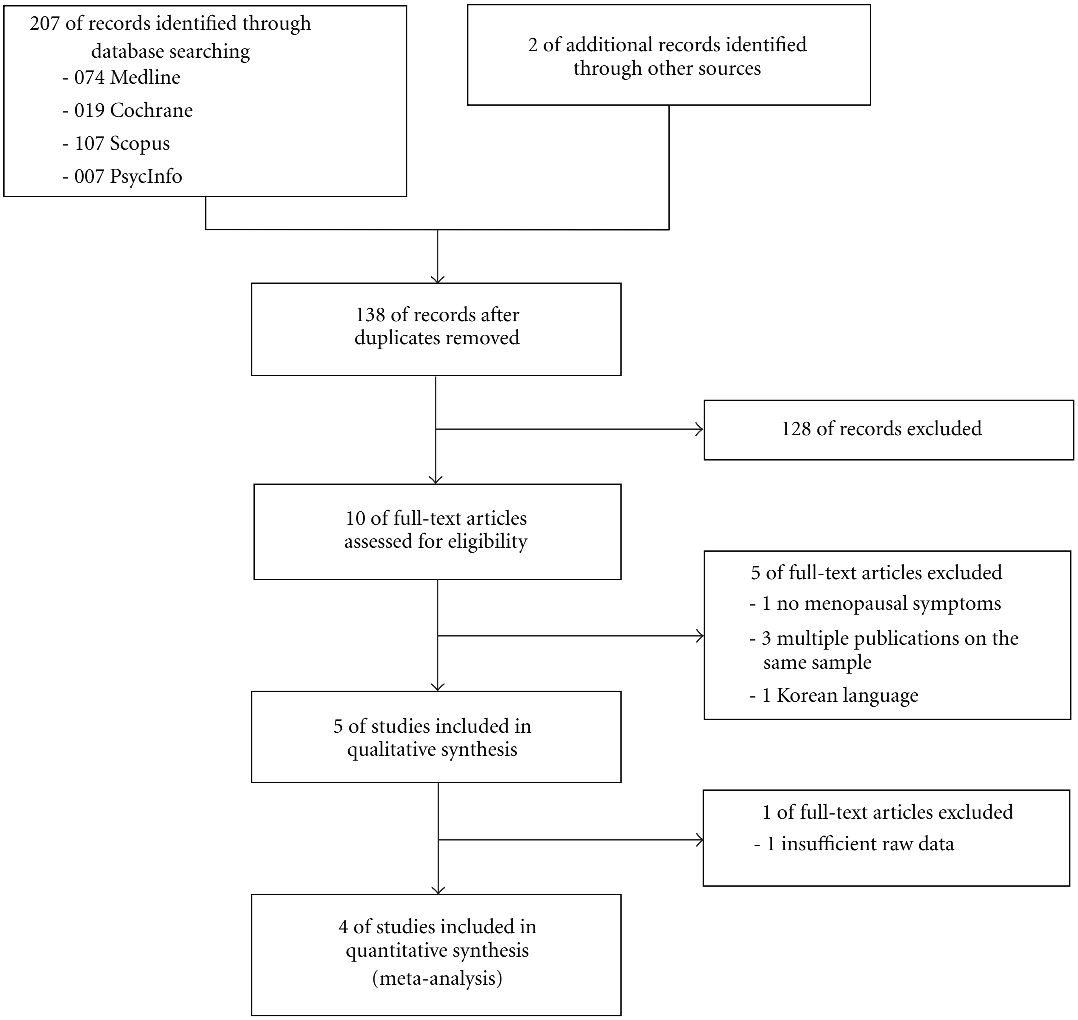


Figure 1: Flowchart of the results of the literature search.

3.2.4. Risk of Bias in Individual Studies. Two RCTs had low risk of bias [43, 46] and 3 RCTs had high risk of bias [42, 44, 45] (Table 2). Risk of selection bias mainly was low; all but 1 RCT [42] reported adequate randomization, while only 2 RCTs reported adequate allocation concealment [43, 46]. No study reported blinding of participants or providers, while 2 studies reported adequate blinding of outcome assessors [43, 45]. Only 1 study included an adequate intention-to-treat analysis [43]. Risk of selective outcome reporting was high in 2 studies that reported different outcomes from the same RCT in multiple publications without disclosing the entire study protocol [44, 45].

3.3. Analyses of Overall Effects. Meta-analyses did not reveal evidence for short-term effects on total menopausal symptoms (SMD = −0.53; 95% CI −1.19 to 0.14; $P = 0.12$; heterogeneity: $I^2 = 85\%$; $\text{Chi}^2 = 13.05$; $P < 0.01$). Moderate evidence was found for short-term effects on psychological symptoms (SMD = −0.37; 95% CI −0.67 to −0.07; $P = 0.02$; heterogeneity: $I^2 = 52\%$; $\text{Chi}^2 = 6.25$; $P = 0.10$). Based on Cohen's categories, the effects on psychological symptoms were of small size. There was no evidence for short-term effects on somatic symptoms (SMD = −0.26; 95% CI −0.76 to 0.25; $P = 0.32$; heterogeneity: $I^2 = 83\%$; $\text{Chi}^2 = 11.99$; $P < 0.01$), vasomotor symptoms (SMD = −0.04; 95% CI −0.68 to 0.60; $P = 0.90$; heterogeneity: $I^2 = 81\%$; $\text{Chi}^2 = 5.35$; $P = 0.02$), or urogenital symptoms (SMD = −0.37; 95% CI −1.14 to 0.40; $P = 0.34$; heterogeneity: $I^2 = 89\%$; $\text{Chi}^2 = 9.37$; $P < 0.01$) (Figure 2).

Only 1 RCT included a longer-term followup for yoga compared to no treatment. At 20-week followup, this study reported significant group differences for psychological, somatic, and vasomotor symptoms [43] (Table 1).

Only 1 RCT included safety data and reported that yoga was not associated with any adverse events [42].

3.3.1. Subgroup and Sensitivity Analyses. When comparing yoga to no treatment, there was no evidence for short-term effects on total menopausal symptoms, psychological symptoms, somatic symptoms, or urogenital symptoms (Table 3). When comparing yoga to exercise, there was no evidence for short-term effects on total menopausal

Table 1: Characteristics of the included studies.

Author, year	Sample size, no. of groups	Mean age ± standard deviation	Inclusion criteria	Treatment group: Intervention Program length, frequency, duration	Control group: Intervention Program length, duration, frequency	Outcome assessment (a) Short-term followup (b) Long-term followup	Outcome measures (1) Total menopausal symptoms (2) Psychological symptoms (3) Somatic symptoms (4) Vasomotor symptoms (5) Urogenital symptoms (6) Safety	Results[a] (a) Short-term followup (b) Long-term followup (1) Total menopausal symptoms (2) Psychological symptoms (3) Somatic symptoms (4) Vasomotor symptoms (5) Urogenital symptoms (6) Safety
Afonso et al., 2011 [42]	$N = 61$, 3 groups	NR	Postmenopausal women (50–65 years) Diagnosed insomnia not due to dyspnea	Yogasana and Tibetan yoga: yoga postures, breathing techniques, relaxation 4 months, twice weekly, 60 minutes	(1) Passive stretching 4 months, twice weekly, 60 minutes (2) Wait-list, no treatment 4 months	(a) month 4 (b) NA	(1) Total menopausal symptoms (KMI) (2) Anxiety (BAI), depression (BDI), insomnia (ISI) (3) NA (4) NA (5) NA (6) Safety	(a) (1) Yoga < wait-list (2) BAI: NS, BDI: NS, ISI: Yoga < wait-list (3) NA (4) NA (5) NA (b) NA (6) No adverse events
Carson et al., 2009 [43]	$N = 37$, 2 groups	Yoga: 53.9 ± 9.0 years Control: 54.9 ± 6.2 years	Breast cancer survivors ≥ 1 hot flash/day on ≥ 4 days/week No hormone replacement therapy within last 3 months No regular yoga	Yoga of awareness: yoga postures, breathing techniques, meditation, study of pertinent topics, group discussion 8 weeks, once weekly, 120 minutes	Wait-list, no treatment 8 weeks	(a) Week 6 (b) Week 20	Daily diary (numerical rating scale): (1) NA (2) Negative mood, sleep disturbances, bother (3) Joint pain, fatigue (4) Hot flashes (frequency, severity, total score), night sweats (5) NA (6) NA	(a) (1) NA (2) Negative mood: NS, sleep disturbances: Yoga < wait-list, bother: Yoga < wait-list (3) Joint pain: Yoga < wait-list, fatigue: Yoga < wait-list (4) Hot flashes frequency: Yoga < wait-list, severity: Yoga < wait-list, total score: Yoga < wait-list, night sweats: NS (5) NA (b) (1) NA (2) Negative mood: Yoga < wait-list, sleep disturbances: NA, bother: Yoga < wait-list (3) Joint pain: Yoga < wait-list, fatigue: Yoga < wait-list (4) Hot flashes frequency: Yoga < wait-list, severity: Yoga < wait-list, total score: Yoga < wait-list, night sweats: NS (5) NA (6) NA

Table 1: Continued.

Author, year	Sample size, no. of groups	Mean age ± standard deviation	Inclusion criteria	Treatment group: Intervention Program length, frequency, duration	Control group: Intervention Program length, duration, frequency	Outcome assessment (a) Short-term followup (b) Long-term followup	Outcome measures (1) Total menopausal symptoms (2) Psychological symptoms (3) Somatic symptoms (4) Vasomotor symptoms (5) Urogenital symptoms (6) Safety	Results[a] (a) Short-term followup (b) Long-term followup (1) Total menopausal symptoms (2) Psychological symptoms (3) Somatic symptoms (4) Vasomotor symptoms (5) Urogenital symptoms (6) Safety
Chattha et al., 2008 [44]	$N = 120$, 2 groups	Yoga: 49.0 ± 3.6 years Control: 48.0 ± 4.0 years	Women (45–55 years) with menopausal symptoms FSH level ≥ 15 mlU/ml No hormone replacement therapy	Integrated approach to yoga therapy: yoga postures, breathing techniques, meditation, lectures on lifestyle 8 weeks, 5 times weekly, 60 minutes	Exercise: walking, stretching, rest, lectures on lifestyle 8 weeks, 5 times weekly, 60 minutes	(a) Week 8 (b) NA	(1) NA (2) Psychological symptoms (GCS) (3) Somatic symptoms (GCS) (4) Vasomotor symptoms (GCS) (5) NA (6) NA	(a) (1) NS (2) NS (3) NS (4) Yoga < exercise (5) NS (b) NA (6) NA
Elavsky and McAuley, 2007 [45]	$N = 164$, 3 groups	Yoga: 50.0 ± 3.7 Walking: 50.5 ± 3.4 Wait-list: 48.6 ± 3.5	Women (45–55 years) with menopausal symptoms No hormone replacement therapy	Iyengar yoga: yoga postures, meditation 4 months, twice weekly, 90 minutes	(1) Walking 4 months, 3 times weekly, 60 minutes (2) wait-list, no treatment 4 months	(a) Month 4 (b) NA	(1) Total menopausal symptoms (GCS) (2) Psychological symptoms (GCS), affect (Affectometer 2), Depression (BDI) (3) Somatic symptoms (GCS) (4) Vasomotor symptoms (GCS) (5) Urogenital symptoms (GCS) (6) NA	(a) (1) NS (2) GCS: NS, Positive affect: Wait-list < yoga, BDI: NS (3) NS (4) NS (5) NS (b) NA (6) NA
Joshi et al., 2011 [46]	$N = 200$, 2 groups	Yoga: 45.6 ± 3.9 years Control: 46.3 ± 3.5 years	Women (40–55 years) with irregular cycle or postmenopausal No hormone replacement therapy No yoga practice	Yoga: yoga postures, breathing techniques, meditation 90 days, daily, 60 minutes	Wait-list, no treatment 90 days	(a) Day 90 (b) NA	(1) Total menopausal symptoms (MRS) (2) Psychological symptoms (MRS) (3) Somatovegetative symptoms (MRS) (4) NA (5) Urogenital symptoms (MRS) (6) NA	(a) (1) Yoga < wait-list (2) Yoga < wait-list (3) Yoga < wait-list (4) NA (5) Yoga < wait-list (b) NA (6) NA

Abbreviations: BAI: beck anxiety inventory; BDI: beck depression inventory; GCS: Greene climacteric scale; ISI: insomnia severity index; KMI: Kupperman menopausal index; MRS: menopause rating scale; NA: not applicable; NS: not significant.

[a] < indicates significantly lower scores.

Table 2: Risk of bias assessment of the included studies using the Cochrane Back Review Group risk of bias tool.

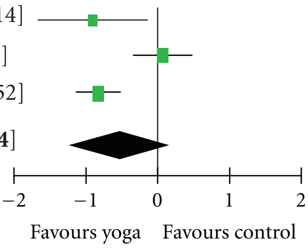
Author, year	Bias												Total: (max. 12)[a]
	Selection bias:			Performance bias:				Attrition bias:		Reporting bias:	Detection bias:		
	Adequate random sequence generation	Adequate allocation concealment	Similar baseline characteristics	Adequate partici-pant blinding	Adequate provider blinding	Similar or no co-interventions	Acceptable compliance	Acceptable and described drop-out rate	Inclusion of an intention-to-treat analysis	No selective outcome reporting	Adequate outcome assessor blinding	Similar timing of outcome assessment	
Afonso et al., 2011 [42]	Unclear	Unclear	No	Unclear	Unclear	Unclear	Unclear	No	No	Yes	Unclear	Yes	2
Carson et al., 2009 [43]	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10
Chattha et al., 2008 [44]	Yes	Unclear	Yes	No	No	Unclear	Yes	Yes	No	No	Unclear	Yes	5
Elavsky and McAuley, 2007 [45]	Yes	Unclear	No	Unclear	Unclear	Unclear	Yes	Yes	No	No	Yes	Yes	5
Joshi et al., 2011 [46]	Yes	Yes	Yes	Unclear	Unclear	Unclear	Yes	Yes	No	Yes	Unclear	Yes	7

[a] Higher scores indicate lower risk of bias.

Total menopausal symptoms

Study	Yoga Mean	Yoga SD	Yoga Total	Control Mean	Control SD	Control Total	Weight	Std. mean difference IV, random, 95% CI
Afonso et al., 2012 [42]	12.4	8.1	15	19.9	8.1	15	26.7%	−0.90 [−1.66, −0.14]
Elavsky and McAuley, 2007 [45]	12.25	8.49	61	11.71	6.56	39	35.6%	0.07[−0.33, 0.47]
Joshi et al., 2011 [46]	4.36	4.8	90	9.2	6.72	90	37.7%	−0.83 [−1.13, −0.52]
Total			**166**			**144**	**100.0%**	**−0.53** [**−1.19, 0.14**]

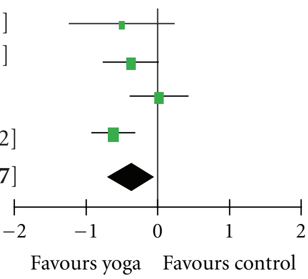
Heterogeneity: Chi^2= 13.05, df =2 ($P = 0.001$); $I^2 = 85\%$
Test for overall effect: $Z = 1.56$ ($P = 0.12$)



Psychological symptoms

Study	Yoga Mean	Yoga SD	Yoga Total	Control Mean	Control SD	Control Total	Weight	Std. mean difference IV, random, 95% CI
Afonso et al., 2012 [42]	11	7.4	15	14.8	7.4	15	12.7%	−0.50 [−1.23, 0.23]
Chattha et al., 2008 [44]	3.65	2.76	54	4.74	3.04	54	27.7%	−0.37 [−0.75, 0.01]
Elavsky and McAuley, 2007 [45]	6.88	5.58	61	6.79	4.58	39	26.3%	0.02 [−0.38, 0.42]
Joshi et al., 2011 [46]	1.85	2.73	90	3.37	3.31	90	33.3%	−0.62 [−0.92, −0.32]
Total (95% CI)			**220**			**198**	**100.0%**	**−0.37** [**−0.67, −0.07**]

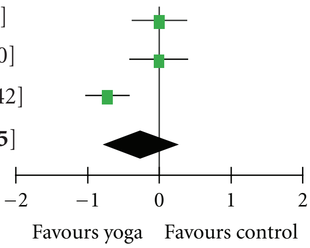
Heterogeneity: Chi^2= 6.25, df =3 ($P = 0.10$); $I^2 = 52\%$
Test for overall effect: $Z = 2.40$ ($P = 0.02$)



Somatic symptoms

Study	Yoga Mean	Yoga SD	Yoga Total	Control Mean	Control SD	Control Total	Weight	Std. mean difference IV, random, 95% CI
Chattha et al., 2008 [44]	2.16	1.74	54	2.16	2.04	54	32.8%	0.00 [−0.38, 0.38]
Elavsky and McAuley, 2007 [45]	2.75	2.4	61	2.76	2.42	39	32.0%	−0.00 [−0.41, 0.40]
Joshi et al., 2011 [46]	1.61	1.91	90	3.3	2.68	90	35.1%	−0.72 [−1.02, −0.42]
Total (95% CI)			**205**			**183**	**100.0%**	**−0.26** [**−0.76, 0.25**]

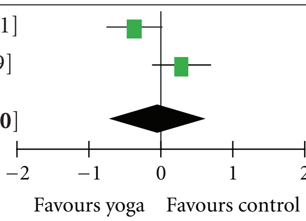
Heterogeneity: Chi^2= 11.99, df = 2 ($P = 0.002$); $I^2 = 83\%$
Test for overall effect: $Z = 0.99$ ($P = 0.32$)



Vasomotor symptoms

Study	Yoga Mean	Yoga SD	Yoga Total	Control Mean	Control SD	Control Total	Weight	Std. mean difference IV, random, 95% CI
Chattha et al., 2008 [44]	1.47	1.3	54	1.95	1.3	54	50.6%	−0.37 [−0.75, 0.01]
Elavsky and McAuley, 2007 [45]	1.72	1.6	61	1.29	1.27	39	49.4%	0.29 [−0.12, 0.69]
Total (95% CI)			**115**			**93**	**100.0%**	**−0.04** [**−0.68, 0.60**]

Heterogeneity: Chi^2= 5.35, df = 1 ($P = 0.02$); $I^2 = 81\%$
Test for overall effect: $Z = 0.13$ ($P = 0.90$)



Urogenital symptoms

Study	Yoga Mean	Yoga SD	Yoga Total	Control Mean	Control SD	Control Total	Weight	Std. mean difference IV, random, 95% CI
Elavsky and McAuley, 2007 [45]	0.9	1	61	0.87	0.93	39	48.5%	0.03 [−0.37, 0.43]
Joshi et al., 2011 [46]	0.75	1.22	90	2.17	2.35	90	51.5%	−0.76 [−1.06, −0.45]
Total (95% CI)			**151**			**129**	**100.0%**	**−0.37** [**−1.14, 0.40**]

Heterogeneity: Chi^2= 9.37, df = 1 ($P = 0.002$); $I^2 = 89\%$
Test for overall effect: $Z = 0.95$ ($P = 0.34$)

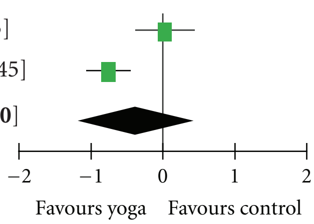


Figure 2: Forest plots of overall short-term effects of yoga on menopausal symptoms.

Table 3: Subgroup analyses: effect sizes of yoga versus controls.

Outcome	No. of studies	No. of patients (yoga)	No. of patients (control)	Standardized mean difference [95% confidence interval]	P (overall effect)	Heterogeneity I^2; Chi^2; P
Yoga versus no treatment[a]						
Total symptoms	3	166	144	−0.53 [−1.19, 0.14]	0.12	85%; 13.05; <0.01
Psychological symptoms	3	166	144	−0.36 [−0.81, 0.09]	0.12	68%; 6.23; 0.04
Somatic symptoms	2	151	129	−0.38 [−1.08, 0.33]	0.29	87%, 7.86; <0.01
Vasomotor symptoms	—	—	—	—	—	—
Urogenital symptoms	2	151	129	−0.37 [−1.14, 0.40]	0.34	89%; 9.37; <0.01
Yoga versus exercise[a]						
Total symptoms	2	76	77	0.10 [−0.37, 0.58]	0.67	38%; 1.61; 0.20
Psychological symptoms	3	130	131	0.10 [−0.43, 0.62]	0.72	75%; 7.93; 0.02
Somatic symptoms	2	115	117	0.06 [−0.20, 0.32]	0.66	0%; 0.17; 0.68
Vasomotor symptoms	2	115	117	−0.13 [−0.58, 0.33]	0.58	67%, 3.07; 0.08
Urogenital symptoms	2	151	129	−0.37 [−1.14, 0.40]	0.34	89%; 9.37; <0.01

[a] Reference [42, 45] with one control arm each.

symptoms, psychological symptoms, somatic symptoms, vasomotor symptoms, or urogenital symptoms (Table 3).

Since only 1 RCT with low risk of bias was included in the meta-analyses, no formal sensitivity analysis of the effects on psychological symptoms was possible. However, the RCT with low risk of bias [46] had higher effect size and narrower confidence intervals than the RCTs with high risk of bias [42, 44, 45] (Figure 2).

3.3.2. Risk of Bias across Studies. Since less than 10 studies were included in each meta-analysis, funnel plots were not analyzed.

3.4. Discussion. This systematic review found moderate evidence for short-term improvements of psychological symptoms in menopausal women after yoga interventions. However, no evidence was found for improvements regarding somatic, vasomotor, urogenital, or total menopausal symptoms. Further, no group difference was found when comparing yoga to exercise. The available safety data suggest that yoga is not associated with serious adverse events. However, future RCTs should ensure more rigorous reporting of adverse events and reasons for dropouts.

The conclusions of the present review are not in line with a recent qualitative systematic review on mind-body interventions, which concluded that there was moderate evidence that yoga might relief common menopausal symptoms including vasomotor and psychological symptoms [47]. On the other hand, the finding of a small significant reduction of psychological symptoms in the present review is also not in line with another systematic review that concluded that yoga is ineffective in relieving any menopausal symptoms including psychological symptoms [30]. Differences in inclusion criteria such as the inclusion of nonrandomized studies in both aforementioned reviews as well as new evidence that is now available [42, 43, 46] might at least partly explain the differences in results. Therefore, the latter review included much less RCTs and participants than the present one; for example, 2 RCTs and 232 participants in the meta-analysis on psychological symptoms [30], compared to 4 RCTs and 418 participants in the present review. The results of the present review are, however, in line with those of a Cochrane review that found no differences between yoga and exercise in vasomotor symptom relief [48].

3.4.1. External and Internal Validity. Patients in the included studies were recruited from inpatient clinics, outpatient clinics, and yoga centers and by advertisements in North America, South America, and Asia. Patients' age ranged from their mid-forties to their mid-fifties and members of different ethnic groups were included. Most studies included peri- or postmenopausal women that were healthy besides their menopausal symptoms; however, 1 study specifically included only breast cancer survivors [43]. The results of this review are therefore applicable to the vast majority of women with menopausal symptoms in clinical practice. External validity is however limited by the high frequency of yoga sessions especially in the 2 Indian studies [44, 46]. Yoga programs that require daily meetings over several weeks might be hard to establish in Western societies.

Three out of 5 studies had high risk of bias [42, 44, 45]. One of the 2 studies with low risk of bias [43, 46] could not be included in the meta-analysis [43]. Adequate allocation concealment was reported in only 2 studies, [43, 46], and only 2 studies reported adequate blinding of outcome assessors [43, 45]. Blinding patients or care providers in yoga studies might not be possible at all [27]. No study that was included in the meta-analysis applied adequate intention-to-treat analysis. While no formal sensitivity analysis was possible, the only RCT with low risk of bias that could be included in the meta-analysis for psychological symptoms [46] had higher effect size and narrower confidence interval than the RCTs with high risk of bias. While the effects of yoga on psychological symptoms therefore seem to be robust against bias, definite judgments on internal validity of the results cannot be drawn.

3.4.2. Strengths and Weaknesses. This review is the first meta-analysis available on menopausal symptoms that included only randomized controlled trials. Moreover, in contrast to the only other available meta-analysis on yoga for menopausal symptoms [30], subgroup analyses for different types of control interventions were possible for almost all prespecified outcome measures, and the levels of evidence were determined according to established recommendations [35].

The primary limitation of this paper is the small total number of eligible RCTs. Moreover, since only 1 study included a longer-term followup, no formal meta-analysis on long-term effects of yoga for menopausal symptoms was possible. The overall high risk of bias further restricts the interpretation of the results. Substantial statistical heterogeneity was present in the significant meta-analysis on psychological symptoms and subgroup analysis could not provide reasons for heterogeneity. Further limitations include the restriction of eligible publication languages, and the use of compound scores for psychological symptoms in most of the included studies. Therefore, the specific variables that were improved by the yoga interventions, for example, depression, anxiety, or sleep, could not be evaluated.

3.4.3. Implications for Further Research. Given the popularity of yoga among patients with menopausal symptoms, further studies are warranted. These studies should ensure rigorous methodology and reporting, mainly adequate randomization, allocation concealment, intention-to-treat analysis, and blinding of at least outcome assessors [49]. Comparisons of yoga to adequately matched active control interventions are equally needed as comparisons of different yoga styles. Dismantling studies that separately evaluate the effects of different components of yoga such as physical postures, breathing techniques, or meditation would further improve knowledge of the underlying mechanisms of yoga in menopausal symptom relief.

4. Conclusion

This systematic review found moderate evidence for short-term effectiveness of yoga for psychological symptom relief in menopausal women. Since many menopausal women request complementary therapies either instead of hormone replacement therapy or in addition to it, yoga can be preliminarily recommended as an adjunct intervention for women who suffer from psychological complaints associated with menopause. However, more rigorous research is needed to underpin these results.

Acknowledgment

This review was supported by a grant from the Rut- and Klaus-Bahlsen-Foundation.

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2012, Article ID 143271, 16 pages
doi:10.1155/2012/143271

Review Article

Guidelines for Developing Yoga Interventions for Randomized Trials

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Received 3 May 2012; Accepted 5 July 2012

Academic Editor: Shirley Telles

Little guidance is available to assist researchers in developing treatment protocols for research on yoga for health concerns. Because yoga is a complex multifactorial mind-body discipline historically developed for nonmedical purposes, numerous decisions must be made in order to thoughtfully develop such protocols. In this paper, a systematic approach is proposed to assist researchers in selecting an intervention that is appropriate for the condition under consideration and explicitly developed. Researchers need to consider the type or "style" of yoga, the components to include (e.g., breathing exercises, postures) as well as the specific protocol for each component, the dose to be delivered (frequency, duration of practice, and the total duration of practice), and issues related to selection of instructors and monitoring the fidelity to the intervention. Each of these domains and the key issues for the development of protocols is discussed. Finally, some areas for further research related to protocol development are recommended.

1. Introduction

One of the most unexplored aspects of designing clinical studies of complementary and alternative (CAM) therapies is the thoughtful, systematic development of treatment protocols. Such protocols can be challenging to develop because of the tension between the desire for reproducible protocols in a scientific setting and the fluid and adaptable nature of CAM therapies such as yoga, wherein a plethora of treatment elements and variations exist and adaptation to the individual is common. Yet, protocols are critical because they comprise the intervention that is tested in a clinical trial. Every effort should be made to ensure that such protocols are well designed, suitable for the population under study, and would be recognized by other yoga experts as being reasonable treatments for the condition under study.

Even though little guidance assists researchers in developing protocols for most CAM therapies, a striking exception has been acupuncture, where there has been considerable work on developing treatment protocols [1–3] and even an extension of the CONSORT statement [4] for reporting appropriate details of such protocols [5]. From a researcher's perspective, acupuncture has many broad features in common with yoga. These include a multiplicity of "styles," different elements of treatment, a wide variety of prescriptions for specific conditions, tendency to customize treatments to individuals, and differences between practitioners' training and focus. In this paper, a systematic approach for developing treatment protocols for studies of yoga is adapted and extended from previous work on acupuncture protocols. While the approach is focused on yoga studies conducted in the Western world, it could be appropriately adapted for studies in India and other non-Western countries as well.

2. Methods and Results

2.1. A Therapeutic Perspective on Selecting Yoga Treatments. The origins of yoga are rooted in antiquity as a spiritual discipline for self-development. Of note, the only yoga posture described in the Yoga Sutras, the first text on yoga, was sitting. Traditionally, even hatha yoga, the physical aspect of yoga practice, was described as a spiritual discipline [6]. However, contemporary research on yoga in the Western world is primarily focused on potential physical and mental health benefits and thus, the discussion about the development of treatment protocols is oriented to this goal. Current clinical research on yoga focuses primarily on efficacy studies of yoga evaluating the therapeutic value under optimal circumstances. These presently serve as "proof-of-concept" studies. A second class of studies, focused on effectiveness (i.e., the therapeutic value of yoga as it is actually practiced in the community), would allow a much broader treatment protocol.

We propose that each of the following domains needs to be addressed when developing an appropriate and robust yoga protocol for efficacy trials.

(1) Style of yoga.
(2) Dose and delivery of yoga.
(3) Components of the yoga intervention.
(4) Specific class sequences.
(5) Dealing with modifications.
(6) Selection of instructors.
(7) Facilitation of home practice.
(8) Measurement of intervention fidelity over time.

Some of these domains are the clear purview of experts in teaching yoga for therapeutic purposes, but researchers should be aware that they will need to work with such experts to ensure that the proposed intervention meets the needs of rigorous science as well as therapeutic soundness.

While each of these elements is important, specific decisions made in developing a specific protocol will depend on the condition or disease under study, the study population, likely comorbidities, and the availability of suitable instructors.

To help the reader understand the state of discussion regarding protocol development, we have included pertinent information about several of these domains using data from relatively recent clinical trials of yoga for cardiovascular risk factors and disease [7–19], symptoms related to cancer or its treatment [20–31], back pain [32–41],and other types of pain [42–49]. We selected these conditions because they represent a range of reasons for which yoga has been studied and often include a broad range of outcomes that yoga is postulated to influence.

2.1.1. Style of Yoga. Yoga has traditionally been practiced in the context of a lineage, with different variations passed down from teacher to student. In the West particularly, this results in a number of different "styles" of yoga, each of which has slightly different emphases. These vary in physical intensity from gentle to vigorous, in performance of the posture from adapting the pose to fit the body type to precise alignment of the body, in how much they include an explicit emphasis on the "spiritual," in how long postures might be held, and whether they "flow" from one to another. Some styles focus on special breathing techniques while in the postures. Numerous other differences exist as well. The term "hatha yoga" would refer to the general practice of physically focused yoga, without reference to another style. Whether these stylistic differences are important from a therapeutic perspective, or they are simply various variations on a theme that each has its own internal coherence, is unknown and should be explicitly examined in future studies.

Although yoga lineages from many parts of India are now taught in the West, T Krishnamacharya, an Indian yoga expert from Mysore, had an extraordinary influence on yoga in the West because he trained several well-known hatha yoga teachers including BKS Iyengar and Pattabhi Jois (who developed his style of "Ashtanga Yoga"). More recently, Westerners have been adapting and sometimes blending different yoga lineages to create a variety of new styles.

When selecting a particular style for research on health, a major consideration is the need to use a style that is safe and appropriate for the patient population. Even then, there are likely to be multiple styles that may be appropriate. Several considerations can be used to narrow the choice further. It could be that among the most appropriate styles, some may appeal more to specific populations than others. For example, when creating a yoga intervention for stress reduction among adolescents, a vigorous style would be more appropriate than when creating such an intervention for elderly caregivers. For individuals with multiple health problems, simple and safe postures would likely be ideal. For persons who travel extensively, yoga requiring lots of props would not be desirable. Some styles have specific therapeutic principles for dealing with specific health conditions, while others use more general principles and believe that all yoga is health producing. Some special yoga programs have already been developed as a package and used in nonstudy settings.

When reviewing the recent yoga literature describing studies for back pain ($n = 10$) [32–41], other pain ($n = 8$) [42–49], cardiovascular disease ($n = 13$) [7–19], and cancer ($n = 12$) [20–31] (Table 1), studies from the West were more likely to describe yoga in terms of specific styles (68%) than those conducted in India (7%). Among those, Iyengar yoga was the most commonly studied (36%), while another 21% specifically mentioned hatha yoga.

The depth and degree of teacher training is a major consideration both for a study and for ensuring that any positive treatment results could be successfully disseminated. Yoga teacher training is highly variable across styles and the quality of instructors is similarly variable. A style with modest training standards might be less desirable than one with more intensive standards because, if the intervention was effective, it would be easier to disseminate to the general public with higher quality standards in place. Moreover, from a practical perspective, instructors versed in all traditions may not be available in all locations. Another consideration is whether the style of yoga in the study could be easily adapted for dissemination to patients if the study was successful. A rarely used style that could not be adapted by other teachers would not be of general interest. A style with an explicit emphasis on safety is critical for therapeutic use.

2.1.2. Dose of Yoga. For studies, an appropriate dose must be established to optimize the potential value of a yoga protocol. Specifically, the critical questions are how much yoga needs to be practiced each week (frequency per week and minutes

Table 1: Styles of Yoga.

	West [USA, Europe, Australia, Brazil, and Turkey]					
Yoga style	Back pain	Other pain	CVD	Cancer	Total	Percentage
Ashtanga Vinyasa			Cade 2010		1	4%
Classical				Ulger 2010	1	4%
Hatha	Galantino 2004 Saper 2009		Pullen 2008 Pullen 2010 van Montfrans 1990	Moadal 2007	6	21%
Iyengar	Jacobs 2004 Williams 2005 Williams 2009	Evans 2011 (IBS) Evans 2011 (rheumatoid arthritis) Garfinkel 1998 (carpal tunnel) Kuttner 2007 (IBS)		Banasik 2011	8	29%
Iyengar-inspired				Culos-Reed 2006 Galantino 2012	2	7%
Multiple perspectives	Cox 2010 Tilbrook 2011				2	7%
Not stated		da Silva 2007 (fibromyalgia)	Cheema 2011		2	7%
Tibetan				Cohen 2004	1	4%
Viniyoga	Sherman 2005 Sherman 2011				2	7%
Yoga in daily life				Kovacic 2011	1	4%
Yoga of awareness (Kripalu influenced)		Carson 2011 (fibromyalgia)		Carson 2009	2	7%

Table 1: Continued.

Yoga style	Back pain	Other pain	CVD	Cancer	Total	Percentage
Asia [India, Thailand]						
Comprehensive, no "stylistic details"	Tekur 2008	John 2007 (migraine)		Banerjee 2007 Raghavendra 2007 Rao 2008 Vadiraja 2009	6	40%
Kriya			Agte 2011		1	7%
Not stated		Telles 2009 (musculoskeletal hand discomfort)	Datey 1969 McCaffrey 2005 Murthy 2011 Pal 2011 Patel 1976 Selvamurthy 1998 Yogendra 2004		8	53%
				Sum	15	100%

* Specific styles of yoga or specific programs.

per session) and for how long (total number of weeks) in order to see therapeutic change and to promote longer term practice for chronic conditions, where individuals might need to practice yoga on a regular basis for an extended period of time to achieve optimal benefits. Inherent in this question is how much of the yoga should be practiced with an instructor and how much, if any, at home? Part of the answer to this question would deal with the quality and consistency of the practice. For example, is there some level of practice that is so substandard that no benefit would be expected? If so, the intervention should be long enough that the quality of the practice exceeds this threshold. How much exposure to an instructor is necessary to main adequate practice at home?

Typically, yoga is taught in a class format in the West. However, therapeutically oriented yoga was originally customized to the needs of specific individuals and taught individually. Depending on the condition and the goals of the study, different formats could be used. But, it is likely that most clinical trials will use a class format.

In the absence of published studies on optimal dosing, new studies should review the literature for their condition (or related conditions). Table 2 (and Table 4) illustrates the variations in the dose of yoga used in studies of pain, cancer, and cardiovascular disease. Intervention length was typically short (median of 8 weeks, with slightly longer for back pain). Most Western studies have included weekly or twice weekly classes, lasting between 60 and 90 minutes. Total class hours varied between a single class followed by a home intervention to a week long retreat (the latter in India), with a median of 16 hours. Most studies encouraged home practice. While some Asian studies have also been short in duration, they have included more classes per week and some were missing the information needed to determine the total exposure to yoga.

Because there is little information regarding the choice of dose, more work needs to be done to establish optimal treatment parameters, including exposure to yoga in a formal class, at home and whether other contact with instructors between formal classes should be facilitated. Because yoga is a skill, it may be appropriate for many people to practice at home once the safety issues are addressed and the components are learned properly.

2.1.3. Components of the Yoga Intervention. Yoga as a spiritual discipline includes specific attitudes and behaviors (known as the "Yamas" and "Niyamas"), physical postures (known as "Asanas"), breathing exercises (known as "pranayama"), interiorization of the mind (Pratyahara), and progressively deeper states of concentration (Dharana) and meditation (Dhyana) leading to Oneness (Samadhi). In this context, all are considered valuable and practiced as a holistic package. Conceivably, all these elements could have therapeutic benefits for physical and mental health as well, so it is important to decide which of these (i.e., attitudes and behaviors, postures, breathing exercises, interiorization, and concentration/meditation) should be included in a yoga protocol for a particular condition. In order to promote the proper attitude for the safe practice of the intervention and to distinguish yoga from other therapies, the principles of yama and niyama should form a framework from which the instructor teaches the entire class. The components of a class might well differ from condition to condition. For example, therapy for back pain might focus on the practice of asana, with coordinated breathing, while therapy for hypertension might focus on meditation and therapy for complex conditions might include all of them.

A variety of techniques might be used in order to decide which elements should be included: consideration of the population (e.g., children may be unwilling to meditate), reviews of the treatment literature, consensus across a variety of more comprehensive styles using senior teachers, a formal Delphi process with senior instructors, and a consideration of yoga theory. However, formal studies testing the value of various techniques for specific populations would be desirable as well.

Table 3 indicates that most yoga classes include postures, breathing exercises, and relaxation in both Asia and the West. Meditation is more commonly taught in Asia than in the West. Other components, including philosophy, visualization, and Yoga Nidra, were less commonly mentioned. Conceivably, classes could contain more components than mentioned in the description.

2.1.4. Specific Class Sequences. Yoga interventions are rarely described in detail in the biomedical literature. In some extant reports, there are apparently standardized sequences developed, while in others instructors select from a menu of asanas and/or pranayamas. Standardized sequences are more reproducible, but raise the question of whether multiple sequences would be appropriate for a study? If so, should the sequences be progressively more difficult (appropriate, for example, for rehabilitation from injury) or simply different but of comparable difficulty to keep the participants interested (e.g., for stress reduction)? In addition, would a prespecified sequence unduly constrains instructors from providing the best possible protocol, given the variability in abilities that might exist within different groups of participants?

When specifying sequences in detail, there is a need to consider variability due to physical limitations of the condition (e.g., not all back pain patients will be equally impaired), the presence of common comorbidities for some individuals (e.g., neck pain may be more common among back pain patients), and other important contextual factors (e.g., fitness). Finally, there is a question of whether sequences should be specifically designed for the condition of interest or should be focused on general health, reflecting the belief that yoga is of general salubrious benefits?

In general, the proposed sequences should be reviewed by expert nonstudy instructors familiar with this population. A reasonable exception might be when the class sequences are developed or approved by a very senior teacher in the style of interest or if the protocol is in widespread usage. After refinement of the protocol based on those comments, it is critical to pilot test the new intervention with some patients similar to those in the proposed study. The intention of this pilot test is to ensure that the teachers can deliver the intervention in the intended time frame, to discover any

Table 2

(a) Dosing of yoga: summary of studies from the Western World*

	West [USA, Europe, Australia, Brazil, and Turkey]			
	Back pain	Other pain	CVD	Cancer
Durations (weeks)				
N	9	6	5	8
Range	6–24 weeks	4–8 weeks	8–20 weeks	1–12 weeks
Median	12 weeks	7 weeks	9 weeks	7.5 weeks
Mode	12 weeks	8 weeks	8 weeks	none
Classes/week				
N	9	6	5	8
Range	1-2 classes/week	only 1 class-2/wk	1–3 classes/week	1–7 classes/week
Median	1 class/week	2 class/week	2 class/week	1 class/week
Mode	1 class/week	2 class/week	2 class/week	1 class/week
Length of single class (min.)				
N	9	6	5	7
Range	60–90 minutes	50–120 minutes	50–70 minutes	45–120 minutes
Median	75 minutes	60–90 minutes	60 minutes	75 minutes
Mode	75 minutes	90 minutes	60 minutes	90 minutes
Total hours of classes				
N	9	6	5	7
Range	12–72 hours	1–18 hours	8–26 hours	7–24 hours
Median	15 hours	16 hours	19 hours	16 hours
Mode	15 hours	18 hours	none	none
Home practice (any recommended)				
N	9	6	5	8
%Yes	100%	67%	60%	50%

*Further details are provided in Table 4(a).

(b) Dosing of yoga: summary of studies from Asia*

	Asia [India, Thailand]			
	Back pain	Other pain	CVD	Cancer
Durations (weeks)				
N	1	2	8	3
Range	1 week	8, 12 weeks	3–52 weeks	6 weeks
Median	1 week	na**	8 weeks	6 weeks
Mode	1 week	na	3 weeks	6 weeks
Classes/week				
N	1	2	5	2
Range	7 classes	5 classes	3–7 classes	3, 7 classes
Median	na	5 classes	4 classes	na
Mode	na	5 classes	3 classes	na

(b) Continued.

	Asia [India, Thailand]			
	Back pain	Other pain	CVD	Cancer
Length of single class (min.)				
N	1	2	6	4
Range	Retreat, 9 hrs/day	60 minutes	30–63 minutes	60–90 minutes
Median	na	60 minutes	30 minutes	60 minutes
Mode	na	60 minutes	30 minutes	60 minutes
Total hours of classes				
N	1	2	4	2
Range	56 hours	40, 60 hours	10.5–80 hours	18+, 25 hours
Median	na	na	13.5 hours	na
Mode	na	na	na	na
Home practice (any recommended)				
N	1	2	8	4
%Yes	0%	50%	25%	75%

* Further details are provided in Table 4(b).
** Not applicable.

Table 3: Components of Yoga.

	Back pain	Other pain	CVD	Cancer	Total	Percentage
West [USA, Europe, Australia, Brazil, and Turkey]						
Postures	9 (Galantino 04, Jacobs 04, Williams 05, Sherman 05, Williams 09, Saper 09, Cox 10, Tilbrook 11, and Sherman 11)	6 (Carson 2011 (fibromyalgia), da Silva 2007 (fibromyalgia), Evans 2011 (IBS), Evans 2011 (rheumatoid arthritis), Garfinkel 1998 (carpal tunnel syndrome), and Kuttner 2007 (IBS))	5 (Cade 2010, Cheema 2011, Pullen 2008, Pullen 2010, and van Montfrans 1990)	7 (Banasik 2011, Carson 2009, Cohen 2004, Culos-Reed 2006, Galantino 2012, Moadal 2007, and Ulger 2010)	27	96%
Breathing	6 (Galantino 04, Sherman 05, Saper 09, Cox 10, Tilbrook 11, and Sherman 11)	3 (Carson 2011 (fibromyalgia), da Silva 2007 (fibromyalgia), and Kuttner 2007 (IBS))	5 (Cade 2010, Cheema 2011, Pullen 2008, Pullen 2010, and van Montfrans 1990)	7 (Carson 2009, Cohen 2004, Culos-Reed 2006, Galantino 2012, Kovacic 2011, Moadal 2007, and Ulger 2010)	21	75%
Relaxation	7 (Galantino 04, Jacobs 04, Sherman 05, Saper 09, Cox 10, Tilbrook 11, and Sherman 11)	2 (da Silva 2007 (fibromyalgia), Garfinkel 1998 (carpal tunnel syndrome))	4 (Cade 2010, Pullen 2008, Pullen 2010, and van Montfrans 1990)	4 (Culos-Reed 2006, Galantino 2012, Kovacic 2011, and Ulger 2010)	17	61%
Meditation	1 (Galantino 04)	1 (Carson 2011 (fibromyalgia))	4 (Cheema 2011, Pullen 2008, Pullen 2010, van Montfrans 1990)	3 (Carson 2009, Moadal 2007, Ulger 2010)	9	32%
Mental focus	1 (Tilbrook 11)		1 (Cade 2010)	1 (Kovacic 2011)	3	11%
Visualization				1 (Cohen 2004)	1	4%
Philosophy/ lifestyle	1 (Tilbrook 11)	2 (Carson 2011 (fibromyalgia), da Silva 2007 (fibromyalgia))			3	11%
Yoga Nidra				1 (Kovacic 2011)	1	4%
Asia [India, Thailand]						
Postures	1 (Tekur 2008)	2 (John 2007 (migraine), Telles 2009 (musculoskeletal hand discomfort))	6 (Agte 2011, McCaffrey 2005, Murthy 2011, Pal 2011, Selvamurthy 1998, Yogendra 2004)	4 (Banerjee 2007, Raghavendra 2007, Rao 2008, Vadiraja 2009)	13	87%
Breathing	1 (Tekur 2008)	2 (John 2007 (migraine), Telles 2009 (musculoskeletal hand discomfort))	5 (Agte 2011, McCaffrey 2005, Murthy 2011, Pal 2011, Patel 1976)	4 (Banerjee 2007, Raghavendra 2007, Rao 2008, Vadiraja 2009)	12	80%
Relaxation	1 (Tekur 2008)	2 (John 2007 (migraine), Telles 2009 (musculoskeletal hand discomfort))	6 (Datey 1969, McCaffrey 2005, Murthy 2011, Pal 2011, Patel 1976, Yogendra 2004)	3 (Raghavendra 2007, Rao 2008, Vadiraja 2009)	12	80%
Meditation	1 (Tekur 2008)	1 (John 2007 (migraine))	2 (Agte 2011, Patel 1976)	4 (Banerjee 2007, Raghavendra 2007, Rao 2008, Vadiraja 2009)	8	53%
Chanting	1 (Tekur 2008)		1 (Pal 2011)	3 (Banerjee 2007, Raghavendra 2007, and Vadiraja 2009)	4	27%

Table 3: Continued.

	Back pain	Other pain	CVD	Cancer	Total	Percentage
Mental Focus			2 (Datey 1969, Patel 1976)		2	13%
Visualization		1 (Telles 2009 (musculoskeletal hand discomfort))		3 (Banerjee 2007, Raghavendra 2007, and Rao 2008)	4	27%
Philosophy/ lifestyle	1 (Tekur 2008)		2 (Agte 2011, Yogendra 2004)		3	20%
Yoga Nidra				1 (Banerjee 2007)	1	7%

difficulties the participants might have in performing the postures and breathing exercises, or other components of the intervention. Such intervention development testing should be performed before any official studies are undertaken to ensure that the intervention can be delivered and practiced in a reproducible manner.

2.1.5. Dealing with Modifications. If sequences are specifically detailed, some freedom is essential to adapt the postures to individual needs because of physical limitations or other conditions. In previous studies, our research group [40, 50, 51] has typically offered a clear alternative if a posture would be suitable for only a fraction of the participants. We have also provided the most common modifications (e.g., a chair variation).

2.1.6. Instructors. Deciding on the qualifications of the instructors is clearly critical for the outcome of the study. Because yoga is not a licensed profession, it can be difficult to assure competency. From that perspective, establishing the minimum level of training and experience is critical but selection of instructors after having observed them teaching is also recommended. Even with well-trained and experienced instructors, it is important to train them on the protocol. For protocols that are intricate or challenging in any way, detailed training with practice teaching to promote consistency is recommended.

For some conditions and settings, it could be appropriate to require additional qualifications apart from yoga training (e.g., certification as a nurse or a physical therapist). Instructors should have a personal yoga practice that includes all elements of the yoga protocol.

2.1.7. Home Practice. If home practice is believed to be an important part of the intervention, then aids to facilitate practice are recommended. These may include a home practice book with a description of the practice, a CD or DVD or internet materials to be used on the computer or a mobile phone. The options for aids to home practice are likely to increase in the future. A realistic perspective is necessary on the appropriate amount of home practice so that participants are actually likely to comply. In back pain studies, 20 to 30 minutes of home practice is recommended. If informal practice is desired (e.g., body awareness in daily activity), aids to facilitate this are recommended as well.

2.1.8. Measurement of Intervention Fidelity over Time. Intervention fidelity, or the concept that core features of the intervention should be delivered as intended, is an area that has received increasing attention among behavioral medicine researchers [52]. Yet, little work in this area has been done for yoga. At the very least, a fraction of classes should be observed to ensure that instructors are delivering the interventions as designed. Checklists should be developed that specify the critical and minimum components of the intervention. For example, in a protocol with prespecified sequences, all elements of the sequence should be performed. Safety issues should be addressed by instructors for any postures or other elements that require special attention to reduce risk of injury. Other important aspects of instruction (e.g., the principle of truthfulness as applied to the practice of postures so that the practitioners are only doing what their body can actually do at that moment) should be included in the checklist as well. Evaluating these less tangible elements of yoga will be challenging, but critical, to ensure that the yoga actually reflects enough of the Indian roots that it can be recognized by seasoned practitioners as reflecting a practice designed to enhance awareness rather than simply exercise or mechanical breathing exercises.

3. Discussion

In this paper, a systematic yet flexible framework for developing treatment protocols for yoga trials is recommended. The proposed approach starts from the perspective of yoga as it is currently practiced (with variations in styles and components of the intervention) and recommends adaptations to the needs of each study.

We currently lack the necessary empirical data for establishing robust treatment protocols of yoga. Therefore, a number of alternative methods were suggested for assisting in this process, including consideration of yoga theory, literature reviews, consensus among senior teachers, the use of a formal Delphi process, and practical considerations. All of these methods rely to some degree on opinion rather than structured observations. As such, the biases of the participants cannot always be explicated and issues of loyalty to lineage or the potential of commercial profit from positive studies cannot always be excluded. Nonetheless, each of them also has certain strengths as well as weaknesses. For example, some aspects of yoga theory are classically based,

Table 4: Dosing of yoga: (a) studies from the Western World. (b) Studies from Asia.

(a)

	West [U.S., Europe, Australia, Brazil, Turkey]					
	Back pain	Other pain	CVD	Cancer		
Durations (weeks)					Total	Percentage
1				1 (Kovacic 2011)	1	4%
4		1 (Kuttner 2007—IBS)		1 (Ulger 2010)	2	7%
6	1 (Galantino 04)	2 (Evans 2011—IBS, Evans 2011—rheumatoid arthritis)			3	11%
7				2 (Cohen 2004, Culos-Reed 2006)	2	7%
8		3 (Carson 2011—fibromyalgia, da Silva 2007—fibromyalgia, and Garfinkel 1998—carpal tunnel)	2 (Pullen 2008, van Montfrans 1990)	2 (Banasik 2011, Carson 2009)	7	25%
8–10			1 (Pullen 2010)		1	4%
10			1 (Cheema 2011)		1	4%
12	6 (Jacobs 04, Sherman 05, Saper 09, Cox 10, Tilbrook 11, and Sherman 11)			2 (Galantino 2012, Moadal 2007)	8	29%
16	1 (Williams 05)				1	4%
20			1 (Cade 2010)		1	4%
24	1 (Williams 09)				1	4%
Classes/week					Total	Percentage
1 hour total, then at home		1 (Kuttner 2007—IBS)			1	4%
1	5 (Sherman 05, Saper 09, Cox 10, Tilbrook 11, andSherman 11)	2 (Carson 2011—fibromyalgia, da Silva 2007—fibromyalgia)	1 (van Montfrans 1990)	4 (Carson 2009, Cohen 2004, Culos-Reed 2006, and Moadal 2007)	12	43%
2	4 (Galantino 04, Jacobs 04, Williams 05, Williams 09)	3 (Evans 2011—IBS, Evans 2011—rheumatoid arthritis, and Garfinkel 1998—carpal tunnel)	2 (Pullen 2008, Pullen 2010)	2 (Banasik 2011, Ulger 2010)	11	39%
2-3			1 (Cade 2010)		1	4%
3			1 (Cheema 2011)		1	4%
7				1 (Kovacic 2011)	1	4%
Varies				1 (Galantino 2012)	1	4%
Length of single class (min.)					Total	Percentage
45				1 (Kovacic 2011)	1	4%
50		1 (da Silva 2007—fibromyalgia)	1 (Cheema 2011)		2	7%
60	1 (Galantino 04)	1 (Kuttner 2007—IBS)	3 (Cade 2010, Pullen 2010, van Montfrans 1990)	1 (Ulger 2010)	6	21%

(a) Continued.

	Back pain	Other pain	CVD	Cancer		
60–90		1 (Garfinkel 1998—carpal tunnel)			1	4%
70			1 (Pullen 2008)		1	4%
71				1 (Galantino 2012)	1	4%
75	5 (Sherman 05, Saper 09, Cox 10, Tilbrook 11, and Sherman 11)			1 (Culos-Reed 2006)	6	21%
90	3 (Jacobs 04, Williams 05, and Williams 09)	2 (Evans 2011—IBS, Evans 2011—rheumatoid arthritis)		2 (Banasik 2011, Moadal 2007)	7	25%
120		1 (Carson 2011—fibromyalgia)		1 (Carson 2009)	2	7%
Not stated				1 (Cohen 2004)	1	4%
Total hours of classes					Total	Percentage
1		1 (Kuttner 2007—IBS)			1	4%
6.67		1 (da Silva 2007—fibromyalgia)			1	4%
7				1 (Kovacic 2011)	1	4%
8			1 (van Montfrans 1990)	1 (Ulger 2010)	2	7%
8.75				1 (Culos-Reed 2006)	1	4%
12	1 (Galantino 04)				1	4%
15	5 (Sherman 05, Saper 09, Cox 10, Tilbrook 11, and Sherman 11)				5	18%
16		1 (Carson 2011—fibromyalgia)	1 (Pullen 2010)	1 (Carson 2009)	3	11%
16–18		1 (Garfinkel 1998—carpal tunnel)			1	4%
18		2 (Evans 2011—IBS, Evans 2011—rheumatoid arthritis)		1 (Moadal 2007)	3	11%
18.67			1 (Pullen 2008)		1	4%
21.3				1 (Galantino 2012)	1	4%
24				1 (Banasik 2011)	1	4%
25			1 (Cheema 2011)		1	4%
26	1 (Jacobs 04)				1	4%
40–60			1 (Cade 2010)		1	4%
48	1 (Williams 05)				1	4%
72	1 (Williams 09)				1	4%
Not stated				1 (Cohen 2004)	1	4%
Home practice (any recommended)					Total	Percentage
Yes	9 (Galantino 04, Jacobs 04, Williams 05, Sherman 04, Williams 09, Saper 09, Cox 10, Tilbrook 11, and Sherman 11)	4 (Carson 2011—fibromyalgia, Evans 2011—IBS, Evans 2011—rheumatoid arthritis, and Kuttner 2007—IBS)	3 (Cade 2010, Pullen 2010, and van Montfrans 1990)	4 (Carson 2009, Cohen 2004, Galantino 2012, and Kovacic 2011)	20	71%

(a) Continued.

	Back pain	Other pain	CVD	Cancer		
No		2 (da Silva 2007—fibromyalgia, Garfinkel 1998—carpal tunnel)	2 (Cheema 2011, Pullen 2008)	4 (Banasik 2011, Culos-Reed 2006, Moadal 2007, and Ulger 2010)	8	29%

(b)

	Asia [India, Thailand]					
	Back pain	Other pain	CVD	Cancer		
Durations (weeks)					Total	Percentage
1	1 (Tekur 2008)				1	7%
3			3 (Datey 1969, Murthy 2011, and Selvamurthy 1998)		3	20%
6				2 (Banerjee 2007, Vadiraja 2009)	2	13%
6+				1 (Rao 2008)	1	7%
8		1 (Telles 2009—musculoskeletal hand discomfort)	2 (Agte 2011, McCaffrey 2005)		3	20%
9			1 (Patel 1976)		1	7%
12		1 (John 2007—migraine)			1	7%
24			1 (Pal 2011)		1	7%
52 (1 year)			1 (Yogendra 2004)		1	7%
Varies				1 (Raghavendra 2007)	1	7%
Classes/week					Total	Percentage
3			2 (McCaffrey 2005, Patel 1976)	1 (Vadiraja 2009)	3	20%
5		2 (Telles 2009—musculoskeletal hand discomfort), John 2007 (migraine))	1 (Pal 2011)		3	20%
7	1 (Tekur 2008)		1 (Selvamurthy 1998)	1 (Raghavendra 2007)	3	20%
Varies			1 (Yogendra 2004)	1 (Rao 2008)	2	13%
Not stated			3 (Agte 2011, Datey 1969, and Murthy 2011)	1 (Banerjee 2007)	4	27%
Length of each class (min.)					Total	Percentage
30			4 (Datey 1969, Murthy 2011, Patel 1976, and Selvamurthy 1998)		4	27%
35–40			1 (Pal 2011)		1	7%
60		2 (John 2007—migraine, Telles 2009—musculoskeletal hand discomfort)		3 (Raghavendra 2007, Rao 2008, and Vadiraja 2009)	5	33%
63			1 (McCaffrey 2005)		1	7%
90				1 (Banerjee 2007)	1	7%
Not stated	1 (Tekur 2008) —retreat with 9 hours of yoga/day		2 (Agte 2011, Yogendra 2004)		3	20%

(b) Continued.

	Back pain	Other pain	CVD	Cancer		
Total hours of classes					Total	Percentage
10.5			1 (Selvamurthy 1998)		1	7%
13.5			1 (Patel 1976)		1	7%
18				1 (Vadiraja 2009)	1	7%
18+				1 (Rao 2008)	1	7%
25.2			1 (McCaffrey 2005)		1	7%
40		1 (Telles 2009—musculoskeletal hand discomfort)			1	7%
56	1 (Tekur 2008)				1	7%
60		1 (John 2007—migraine)			1	7%
70–80			1 (Pal 2011)		1	7%
Not stated			4 (Agte 2011, Datey 1969, Murthy 2011, and Yogendra 2004)	2 (Banerjee 2007, Raghavendra 2007)	6	40%
Home practice					Total	Percentage
Yes		1 (John 2007—migraine)	2 (Agte 2011, Yogendra 2004)	3 (Raghavendra 2007, Rao 2008, and Vadiraja 2009)	6	40%
No	1 (Tekur 2008)	1 (Telles 2009—musculoskeletal hand discomfort)	6 (Datey 1969, McCaffrey 2005, Murthy 2011, Patel 1976, Pal 2011, and Selvamurthy 1998)	1 (Banerjee 2007)	9	60%

transcend lineage, and define the discipline, such as universal compassion and attention to awareness. Other components, such as the theory of sequencing of postures, fit more clearly into specific styles of yoga. Reviews of the literature, even if comprehensive, can only include previously published studies. Because most studies do not report on the basis for their interventions, it is difficult to know whether these were carefully thought out and comprehensive in their development or relied on local instructors to come up with programs. Consensus among senior teachers is likely easier if they are selected from a single style or related styles. If the instructors are familiar with the condition, such an approach may be useful in coming up with protocols that have some chance for success. However, if the patient population is somehow different from those of the various instructors, their input may not be as valuable. The Delphi process can be cumbersome and time consuming and thus may not be attractive to the most knowledgeable instructors. In addition to appropriate attention to practical concerns, use of multiple methods is recommended at this point to minimize the weaknesses of each of them.

One caveat regarding the evaluation of yoga for medical concerns is the question of what precisely is yoga. Although developed as a holistic and multicomponent discipline, a lot of yoga practice in the West has been changed from its traditional roots. In fact, even many teachers lack a clear understanding of what makes yoga unique. Thus, it could be that many "therapeutic yoga interventions" are actually "therapeutic mind-body interventions inspired by yoga." Nonetheless, they may offer useful benefits to persons with a variety of health conditions.

Much work needs to be done in developing further recommendations for treatment protocols. Paramount among those is development of a better understanding of optimal dosing. In addition to hours of class time, dosing is likely to include consideration of home practice and time allotted to specific elements of yoga (e.g., meditation, postures).

Currently, a variety of interventions fall under the rubric of yoga and their heterogeneity makes it difficult to summarize the evidence regarding yoga's therapeutic efficacy. However, developing a more scientifically rigorous understanding of some of the elements of yoga (postures, breathing exercises, relaxation, and meditation) and their physiological correlates might permit the development of future protocols based more directly on optimization of the underlying physiological parameters. By searching for common factors across styles (e.g., enhancing parasympathetic tone), such protocols might circumvent the need to look at the benefits of a variety of styles of yoga.

Because therapeutic yoga is traditionally individualized, it is conceivable that more standardized protocols will not provide optimum benefits for participants. There are several ways to test this hypothesis. One is to directly compare a standardized versus individualized protocol as separate arms of a clinical trial. Another is to try a standardized protocol and see if those who fail to improve on such a protocol do better with an individualized protocol. Such studies would be important in assisting both the research and the yoga community in understanding whether and by how much standardized research protocols are likely to underestimate the effects of various yoga interventions.

Other studies could investigate the value of other parts of the protocol, such as home practice in improving treatment outcomes. By empirical testing of these recommendations for developing yoga protocols, guidance on their relative value will be better refined. This, in turn, will allow more rigorous evaluation of the value of yoga for addressing chronic pain, various symptoms related to cancer and its treatment, cardiovascular health, and a variety of quality of life-related aspects of chronic disease.

Although empirical studies comparing various aspects of yoga protocols could well be valuable, researchers need to understand that the differences in effectiveness between such protocols are likely to be small. As a consequence, very large sample sizes would be needed to detect statistically significant differences. For example, in a study of yoga for back pain, 60% of those receiving yoga had improved by at least 50% at the end of treatment [34]. If we had compared this treatment with a more "optimal yoga" and expected 70% to improve this amount, the sample size would be over 450 persons per group. Another way to approach this challenge is to ask whether there are clinically important benefits between the two protocols. If only clinically unimportant differences were found when comparing various types of protocols (e.g., different styles of yoga) for a number of distinctly different conditions (e.g., symptoms such as pain or fatigue, mental health concerns, and physiologically based diseases), this would be reassuring for the public, who might not be able to find classes teaching the precise contents of the yoga intervention.

In the context of describing randomized trials, more detailed descriptions of yoga interventions will enhance the ability of researchers to judge the quality of a trial, to clearly understand what was done, and to replicate key clinical studies. By including additional elements for nonpharmacological clinical trials in the CONSORT statement [53], as now required by many journals for such trials, the routine reporting of yoga trials will be improved. For example, such elements as a description of the different components of the interventions, standardization of key features, and how the intervention was tailored to individuals will be routinely included. However, this does not unambiguously enumerate all principal domains that clearly describe yoga protocols and does not specify the level of detail that will be reported. Therefore, yoga researchers will benefit from creating a consensus document to specify the critical elements for fully reporting protocols of yoga interventions in clinical trials.

Acknowledgments

The author would like to thank Lilia Peng for assistance with the preparation of the tables. This publication was made possible by cooperative agreement no. U01 AT003208 from the National Center for Complementary and Alternative Medicine (NCCAM) at the National Institutes of Health. The contents are solely the responsibility of the author and do not necessarily represent the official views of NCCAM.

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2012, Article ID 408727, 9 pages
doi:10.1155/2012/408727

Research Article

Iyengar Yoga for Distressed Women: A 3-Armed Randomized Controlled Trial

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Received 25 May 2012; Revised 7 August 2012; Accepted 9 August 2012

Academic Editor: Shirley Telles

Distress is an increasing public health problem. We aimed to investigate the effects of an Iyengar yoga program on perceived stress and psychological outcomes in distressed women and evaluated a potential dose-effect relationship. Seventy-two female distressed subjects were included into a 3-armed randomized controlled trial and allocated to yoga group 1 ($n = 24$) with twelve 90 min sessions over 3 months, yoga group 2 ($n = 24$) with 24 sessions over 3 months, or a waiting list control group ($n = 24$). The primary outcome was stress perception, measured by Cohen Stress Scale; secondary outcomes included state trait anxiety, depression, psychological and physical quality of life (QOL), profile of Mood States, well being, and bodily complaints. After three months, women in the yoga groups showed significant improvements in perceived stress ($P = 0.003$), state trait anxiety ($P = 0.021$ and $P = 0.003$), depression ($P = 0.008$), psychological QOL ($P = 0.012$), mood states being ($P = 0.007$), and bodily complaints well($P = 0.012$) when compared to controls. Both yoga programs were similarly effective for these outcomes; however, compliance was better in the group with fewer sessions (yoga group 1). Dose effects were seen only in the analysis of group-independent effects for back pain, anxiety, and depression. These findings suggest that Iyengar yoga effectively reduces distress and improves related psychological and physical outcomes. Furthermore, attending twice-weekly yoga classes was not superior to once-weekly classes, as a result of limited compliance in the twice-weekly group.

1. Background

Several recent studies indicate there is an increasing number of people of Western societies that suffer from distress and stress-related disease. For example, a recent survey of a large German health insurance company found that up to 80% of the general population feel distressed frequently, and 30% feel distressed most of the time [1]. Other studies have reported that up to 50–60% of all physician consultations may be due to stress-related complaints or disease [2–4]. Experimental and epidemiological studies have shown that stress considerably contributes to cardiovascular disease, degenerative neurological disease, chronic pain syndromes, delayed wound healing, depression, and cancer [5–8]. Data from the INTERHEART study indicate that 30% of myocardial infarctions might be caused by stress in the recent past [9]. Experimental research has further shown that psychosocial stress can increase cellular oxidative stress, activate signal transduction, and modify gene expression [5]. Others have shown that objective stress (e.g., years of care giving) and perceived life stress were both related to shorter telomere length, indicating replicative senescence and thus bodily aging [10].

Yoga is an increasingly used self-care and health-promoting technique in the US and Europe. An estimated 30 million persons, mostly women (72%), had practiced yoga in the US according to a recent survey [11]. Iyengar yoga is one of the most prevalent styles taught in the US and Europe (44%) [12]. It is based on the teachings of the yoga master Iyengar who has applied yoga specifically to health problems [13]. Yoga intervention studies have shown promising findings, including enhanced emotional well being and resilience to stress in the workplace [14], improved inflammatory and endocrine responses [15], enhanced mindfulness [16], improvements both in physical/emotional well being [17, 18] and in anxiety and health status [19].

Despite its potential benefits and popularity among distressed people, the effectiveness of yoga in relieving perceived stress has been addressed only in a few randomized controlled trials. One systematic review describes the effects of yoga on stress-associated symptoms; here Chong et al. [20] identified 8 controlled trials, 4 of which were randomized and fulfilled the authors' selection criteria. The results indicated a positive effect of yoga in reducing stress levels or stress symptoms; however in their conclusions, the authors underlined the need for further trials. In a previous controlled nonrandomized pilot study we found a pronounced stress-relieving effect of a 3 month-Iyengar Yoga intervention in distressed women [21]. We conducted the present randomized controlled trial to evaluate the effectiveness of Iyengar yoga, including different "doses" (levels) of yoga practice, on perceived stress and related physical and psychological well being. We hypothesized that yoga practice would reduce stress perception and related symptoms as compared to a waiting list control group. A secondary aim of the study was to evaluate a potential dose-effect relationship in yoga practice. We hypothesized that a yoga class twice a week would lead to greater improvements than a yoga class once a week.

2. Methods

2.1. Design. A 3-armed randomized controlled trial was conducted in which female distressed individuals were randomized to three groups: (1) once-weekly yoga classes (12 sessions of 90 min in three months), (2) twice-weekly yoga classes (24 sessions of 90 min in three months), and (3) waiting list control.

2.2. Subjects. The study is based on the results of a previous pilot study [21]. Screening revealed that among distressed subjects more than 90% of call-ins were women; therefore, we decided to include only women for this study to ensure a homogeneous sample. Community-dwelling female volunteers were recruited from local newspaper advertisements and flyers that offered women with high levels of perceived stress a cost-free three-month yoga course. Subjects were included if they (1) were female in the age 20–60 years, (2) had current distress with a sum score > 18 on the CPSS, (3) were experiencing at least 3 of 8 of the following self-reported known stress-related symptoms: insomnia, disturbed appetite, back or neck pain, tension-type headache, decreasing daytime alertness, digestive problems, frequent cold hands/feet, and (4) were not currently practicing yoga or any related form of stress reduction. They were excluded if they (1) reported a current psychiatric diagnosis, (2) indicated any medical contraindications to physical exercise, (3) were on current medication for any disease, (4) had manifest problems with alcohol or substance abuse and (5) were pregnant.

After signing an informed consent and collection of baseline data, subjects were randomized to moderate yoga (group 1 = once weekly 90 min yoga class for 3 months; $n = 24$), intensified yoga (group 2 = twice weekly 90 min yoga class for 3 months; $n = 24$), or the waiting list control group ($n = 24$). Subjects in the waiting list control group had the option of participating in yoga classes after termination of the study. The study protocol was approved by the Institutional Review Board of the Essen University Hospital and all study participants gave their informed consent.

3. Outcomes and Measurements

3.1. Primary Outcome. All subjects were asked to complete standardized questionnaires at the outset of the study (baseline), and after 3 months. The primary outcome was change of the mean score of the Cohen Perceived Stress Scale (CPSS) asking for subjective stress within the last week. The CPSS consists of 14 items about current levels of experienced and perceived stress [22].

3.2. Secondary Outcomes. Secondary outcomes included the following:

(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 [23];

(2) the German translation of the Profile of Mood States (POMS) [24], which is a 35-item instrument that measures four domains of mood disturbance including vigor, fatigue, depression anxiety, and anger [25];

(3) the German version of the Brief Symptom Inventory (BSI), which includes 53 items and provides scores for 9 psychological symptom scales and a general severity index (GSI) [26];

(4) the German version of the Center for Epidemiological Studies Depression Inventory (CES-D), a 20-item scale designed for the general population [27, 28]. The long German version of the CES-D is the "Allgemeine Depressionsskala" (ADS-L);

(5) quality of life (QOL) was measured by the German version of the Medical Outcomes Study 36-Item-Short Form (SF-36) with its 8 dimensions of health:

physical functioning (10 items), social functioning (2 items), role limitations due to physical problems (4 items), role limitations due to emotional problems (3 items), mental health (5 items), energy/vitality (4 items), pain (2 items), and general health perception (5 items) and the physical and mental sum score;

(6) the Bf-S Zerssen well being scale measures momentary emotional well being and consists of three answer categories, with higher scores indicating lower well being [29]. The 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 [29].

In addition, we measured general physical well being and symptoms and severity of headache, neck, and back pain, using 10-point Likert scales for each category, with a reference period of the past week. Finally, general and specific physical complaints were measured with the well-validated, 70-item Freiburg Somatic Complaints (FBL) Questionnaire, that inventories subjective evaluation of physical complaints across the major physiological functional domains [30].

3.3. Interventions. Participants in the yoga groups were asked to participate in once- or twice-weekly 90 min yoga classes according to the Iyengar style [31] in a fully equipped yoga studio for 3 months. Subjects were taught by a certified Iyengar yoga instructor who had been trained in the method for over 15 years. The classes emphasized postures that, according to the Iyengar yoga teachings, are supposed to alleviate stress, particularly back bends, standing poses, and forward bends and inversions (list of poses, see Table S5 in Supplementary Material available online at doi:10.1155/2012/408727). Each Yoga class was finished by 15 min of meditation in Shavasana. No explicit breathing techniques were used. 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 to begin any other exercise or stress reduction program during the following 3 months.

3.4. Randomization. Patients were randomly allocated to a treatment group by a nonstratified block randomization with varying block lengths and by prepared sealed, sequentially numbered opaque envelopes containing the treatment assignments. Randomization was based on the “RANUNI” pseudo-random number generator of the SAS/Base statistical software (SAS Inc., Cary, NC, USA), and the envelopes were prepared by the study biostatistician. When a patient fulfilled all enrolment criteria, the study physician opened the lowest numbered envelope to reveal that patient’s assignment.

3.5. Sample Size and Statistical Analysis. Sample size calculation was based on the results of the pilot study [21]. To detect a difference of 0.85 standard deviations of the Cohen Perceived Stress score between the yoga and the wait-list group with a power of 80% by means of a two-sided level $\alpha = 5\%$ t-test a sample size of $n = 46$ (23 per group) was calculated. Accordingly, this yields a sample size of $n = 23$ per group within a three-group comparison when using a hierarchical test procedure on a level of $\alpha = 5\%$ (total sample $n = 69$). Here, the power to detect a difference between the moderate and intensified yoga group amounts to 26.4% on the basis of between-group difference of 0.4 standard deviations. The number of dropouts was rather small (<5%) in the pilot study [21]. We therefore decided to include a sample of $n = 72$ patients into the trial with $n = 24$ in each of the three groups.

Outcomes were analysed on an intention-to-treat (ITT) basis by univariate analyses of covariance (ANCOVA) which included group and baseline values as well as outcome expectation as covariates. From these models we estimated baseline-adjusted treatment effects and their 95% confidence intervals (CI). ANCOVA was also used for ordinal data derived from the Likert scales. All reported P values are based on a two-sided test, and a P value <0.05 was considered significant. Missing data of case record forms were multi-imputed, that is, multiple copies of the original data set were generated, hereby replacing missing values by randomly gene-rated values.

The primary analysis compared the outcomes between the 3 groups. Due to the compromised adherence in the yoga classes, we conducted secondary analyses in which the yoga groups were pooled and outcomes were analysed according to yoga class adherence. Here, participants were stratified according to the number of visits of yoga classes: 1–6 ($n = 7$), 7–12 ($n = 18$), and 13–24 ($n = 15$). ANCOVA was applied, respectively. All statistical analyses were done with the statistical analysis package SAS (version 9.2).

4. Results

238 subjects responded to the advertisement. About 25 individuals declined participation, citing unavailability because of scheduling problems, time demands, travel requirements, or unspecified reasons. A total of 72 subjects fulfilled all entry criteria and were enrolled into the study. Subjects were recruited between March 2006 and January 2008 and were randomly allocated to the yoga group 1 ($n = 24$) with 12 scheduled sessions, the yoga group 2 ($n = 24$) with 24 sessions, or the waiting list control group ($n = 24$) and included in the ITT analysis (see Figure 1).

Two participants in the control group and 4 subjects in each yoga group dropped out due to causes not related to the study intervention, for example, unwillingness to stay in the study or return to the study center, lack of time, and minor medical problems (common cold).

4.1. Baseline Characteristics. Subjects’ ages ranged from 19 to 52 years (mean age 39.6 ± 8.3 years) (Table 1). Baseline characteristics were balanced between groups with exception of significantly less smokers in the yoga group 1 ($P = 0.046$) and significantly less persons practicing exercise on a regular basis in group 2 ($P = 0.028$). Few persons practiced relaxation techniques before study entry (control group: 1;

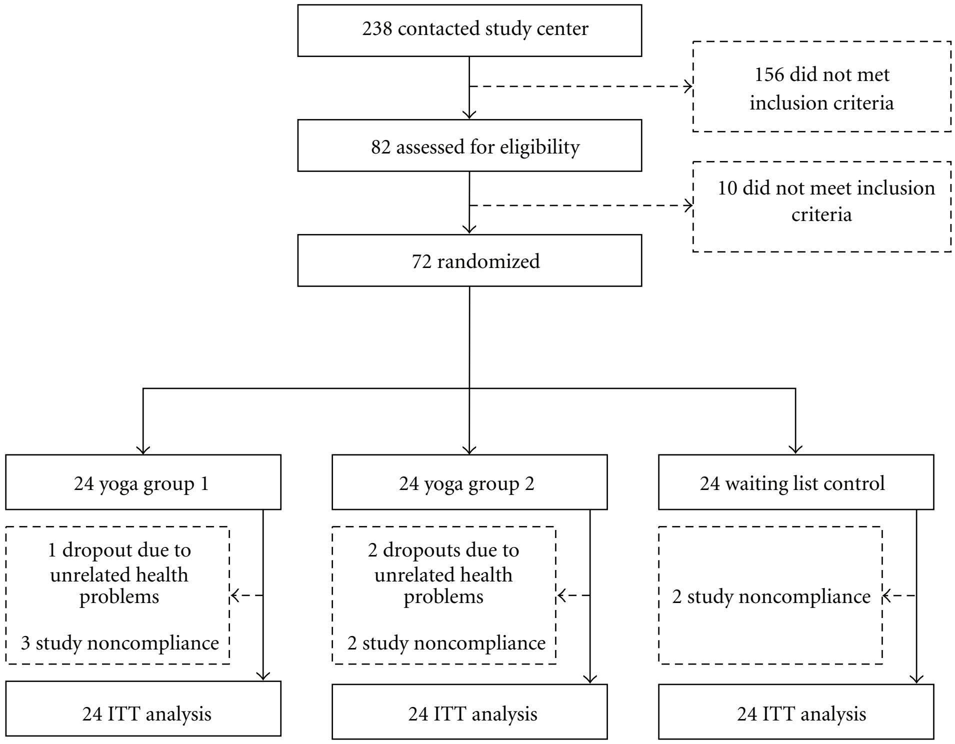

Figure 1: Trial flow chart.

Table 1: Baseline characteristics. Mean ± SD if not indicated otherwise.

Characteristic	Yoga group 1 (n = 24)	Yoga group 2 (n = 24)	Control group (n = 24)	P value
Mean age, y	39.5 ± 7.8	40.0 ± 8	39.3 ± 9.2	0.991
BMI (kg/m^2)	25.61 ± 3.7	25.7 ± 6	24.7 ± 6	0.357
Smokers, n (%)	2 (8.3)	9 (37.5)	8 (33.3)	0.046
Weight, kg	74.4 ± 13.7	70.4 ± 18.5	70.8 ± 18.2	0.139
Exercise practice n (%)	15 (62.5)	7 (29.2)	15 (62.5)	0.028
Insomnia, n (%)	19 (79.2)	18 (75)	21 (87.5)	0.813
CPSS score	34.0 ± 8.0	35.8 ± 6.3	31.2 ± 6.8	0.067
CES-D score	22.3 ± 8.4	23.0 ± 8.1	21.0 ± 8.8	0.598
S-STAI	45.5 ± 10.6	49.0 ± 9.3	43.5 ± 11.0	0.169
T-STAI	53.6 ± 10.7	53.7 ± 9.1	50.2 ± 8.6	0.51
Bf-S	24.9 ± 14.1	23.8 ± 13.8	23.5 ± 14.0	0.948
GSI-score	67.6 ± 9.8	67.9 ± 7.2	67.4 ± 9.0	0.991
POMS vigor	2.2 ± 0.8	2.2 ± 1.1	2.8 ± 1.3	0.194
POMS fatigue	2.8 ± 1.5	2.5 ± 1.3	2.7 ± 1.4	0.613
POMS depression	1.6 ± 1.5	1.1 ± 0.8	1.5 ± 1.2	0.649
POMS anger	1.5 ± 1.6	1.0 ± 1.2	1.4 ± 1.3	0.418
QOL mental health	−0.8 ± 0.8	−0.6 ± 0.8	−0.7 ± 0.9	0.575
QOL physical score	0.0 ± 0.8	−0.1 ± 0.7	−0.3 ± 0.8	0.542
QOL mental score	−1.7 ± 0.9	−2.0 ± 0.7	−1.6 ± 0.8	0.143
Freiburg complaint list	2.7 ± 0.5	2.7 ± 0.5	2.6 ± 0.6	0.578

CPSS: Cohen Perceived Stress Scale; CES-D: Center for Epidemiological Studies Depression Scale; S-STAI: State Anxiety; T-STAI: Trait Anxiety; Bf-S: Zerssen well being scale; GSI: General Severity Index; POMS: Profile of Mood States; QOL: short form-36 Quality of Life.

Table 2: Between-group differences of treatment effects on perceived stress and psychological outcomes, mean (95% CI).

	Yoga group 1 versus control		Yoga group 2 versus control		Yoga group 1 + 2 versus control	
	Change	P value	Change	P value	Change	P value
CPSS	−6.7 (−10.9; −2.5)	0.002	−4.7 (−9.2; −0.3)	0.036	−5.7 (−9.5; −2.0)	0.003
CES-D	−4.2 (−7.9; −0.5)	0.028	−4.6 (−8.5; −0.7)	0.02	−4.4 (−7.6; −1.2)	0.008
S-STAI	−5.2 (−10.6; 0.1)	0.056	−6.0 (−11.6; −0.4)	0.037	−5.6 (−10.4; −0.9)	0.021
T-STAI	−5.8 (−10.1; −1.6)	0.007	−5.3 (−9.5; −1.1)	0.014	−5.6 (−9.2; −1.9)	0.003
GSI-score	−7.5 (−12.9; −2.2)	0.006	−8.2 (−13.5; −3.0)	0.002	−7.9 (−12.5; −3.3)	0.001
Bf-S	−7.0 (−14.2; 0.2)	0.057	−6.2 (−13.3; 0.9)	0.087	−6.6 (−12.8; −0.4)	0.036
POMS vigor	0.8 (0.1; 1.4)	0.022	0.6 (0.0; 1.3)	0.06	0.7 (0.1; 1.3)	0.017
POMS fatigue	−1.3 (−2.1; −0.6)	0.001	−1.0 (−1.8; −0.3)	0.009	−1.2 (−1.8; −0.5)	0.001
POMS depression	−0.4 (−1.0; 0.2)	0.20	−0.3 (−0.9; 0.2)	0.239	−0.4 (−0.9; 0.1)	0.154
POMS anger	−0.8 (−1.3; −0.2)	0.007	−0.5 (−1.1; 0.1)	0.084	−0.6 (−1.1; −0.1)	0.012
QOL mental health	0.8 (0.3; 1.3)	0.002	0.6 (0.1; 1.1)	0.022	0.7 (0.2; 1.1)	0.002
QOL physical sum score	0.1 (−0.3; 0.4)	0.72	−0.2 (−0.6; 0.2)	0.269	−0.1 (−0.4; 0.2)	0.653
QOL mental sum score	0.6 (0.1; 1.2)	0.024	0.6 (0.0; 1.1)	0.044	0.6 (0.1; 1.1)	0.012

CPSS: Cohen Perceived Stress Scale; CES-D: Center for Epidemiological Studies Depression Scale; S-STAI: State Anxiety; T-STAI: Trait Anxiety; Bf-S: Zerssen well being scale; GSI: General Severity Index; POMS: Profile of Mood States; QOL: short form-36 Quality of Life.

yoga group 1: 2; yoga group 3: 2). The baseline CPSS scores were 34.0 ± 8.0 for yoga group 1, 35.8 ± 6.3 for group 2, and 31.2 ± 6.8 for the control group ($P = 0.067$). Baseline scores of the strees, depression (CES-D) and anxiety (STAI) scores were in a range that is commonly regarded to indicate relevant distress.

4.2. Adherence. Adherence to the yoga classes was moderate, with participants of yoga group 1 visiting 71 ± 29% and participants of yoga group 2 visiting 63 ± 36% of offered classes. Half of the subjects in both yoga classes visited more than 80% of offered classes, 17% of women in yoga group 1 and 25% of women in yoga group 2 visited less than 20% of offered classes.

4.3. Primary Outcome. Both yoga programs were beneficial with regard to the course of perceived stress while the control group showed no relevant changes (Figure 2). The CPSS score was reduced from 34.0 ± 8.0 at baseline to 24.9 ± 7.1 after the intervention for yoga group 1, and from 35.8 ± 6.3 to 28.1 ± 6.9 for yoga group 2. After intervention, the mean group difference in CPSS score between yoga group 1 and the control group was −6.7 (95% CI: −10.9, −2.5; $P = 0.002$) and the mean group difference between yoga group 2 and the control group was −4.7 (−9.2, −0.3; $P = 0.036$). If the CPSS scores of the 2 yoga groups were pooled, the difference between the pooled yoga group CPSS scores compared to the CPSS score of the control group was −5.7 (−9.5, −2.0; $P = 0.003$) after intervention (Table 2).

4.4. Secondary Outcomes. Both yoga intensities were similarly effective for most predefined secondary outcomes.

4.5. Psychological Outcomes. Results on psychological outcomes are summarized in Table 2. Regarding quality of life, the mental sum score and the mental health subscale of the SF-36 showed significant group differences for each yoga group compared to controls, while other subscales of the SF-36 showed no significant between group differences (data not shown).

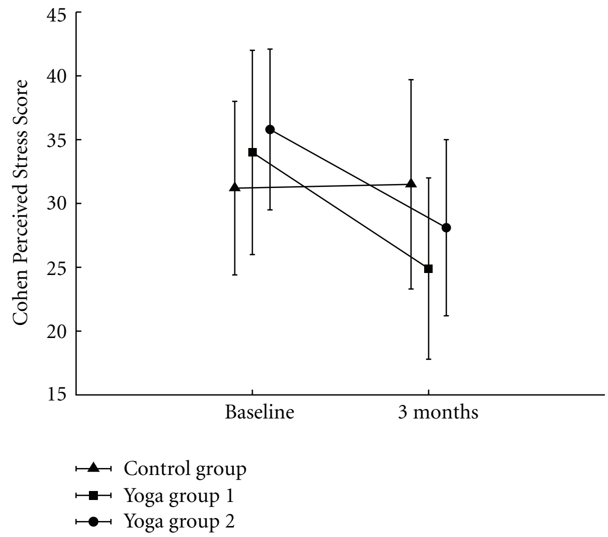

Figure 2: Perceived stress. Mean (±SD) CPSS score on study entry and at three months in the yoga and control groups. Significant between-group treatment effect of −6.7 (−10.9; −2.5) (adj., 95% CI), $P = 0.002$ in yoga group 1 (versus control) and −4.7 (−9.2; −0.3), $P = 0.036$ (Table 2) in yoga group 2 (versus control). The pooled group difference reached −5.7 (−9.5; −2.0), $P = 0.003$ (versus control).

Comparing both pooled yoga interventions to controls, the psychological outcomes as state and trait anxiety, the GSI-score, the CES-D depression score, well being, and three dimensions of the POMS (vigor, fatigue, and anger) were better with yoga.

4.6. Physical Complaints and Physical Well Being. Mean changes in self-rated values of severity of general physical well being, neck and back pain (all Likert scaled), and the summarized complaint list score of the FBL are given in Table 3. Both yoga intensities were similarly effective for all physical outcomes and showed significant improvement compared to controls. Pooled analysis of both yoga groups showed significant improvements compared to controls.

Also, outcomes for the pooled yoga groups on the 6 subscales of the FBL showed significant improvements compared to controls (data not shown in tables): tenseness ($P = 0.009$), pain ($P = 0.035$), motor activity ($P = 0.005$), emotional reactivity ($P = 0.005$), and sensory ($P = 0.013$).

4.7. Dose Effects of Yoga Unrelated to Group Allocation. As comparison between both yoga groups revealed no relevant group differences while adherence was better in yoga group 1 compared to yoga group 2, we conducted a further analysis to identify potential dose effects of yoga practice independent of group allocation.

Here, we found group-independent dose effects for back pain severity, the GSI-Score, the CES-D depression score, and state-trait anxiety (Table 4). None of the other significant parameters showed group-independent dose effects.

4.8. Safety. There were no clinically relevant adverse effects associated with yoga practice for all subjects.

5. Discussion

We conducted this 3-armed randomized controlled trial with distressed women to investigate the effects of 2 different intensities of Iyengar yoga practice for 3 months on perceived stress and related psychological and physical outcomes. Compared to controls, women who participated in the yoga practice groups demonstrated pronounced and significant improvements in perceived stress and most related psychological and physical outcome measures. In contrast to our hypothesis, yoga classes twice a week were no more effective than a yoga class visit once a week; however, lower compliance in the intensified yoga group reduced the difference in yoga intensity between the two yoga groups. Nevertheless, in a separate analysis of the impact of yoga intensity independent of group allocation some dose effects were found for back pain, the GSI-Score, depression, and anxiety.

Baseline scores of perceived stress and depression and anxiety scores indicated the studied population having clinically relevant distress on study entry. Despite randomization of subjects, there were a number of significantly different baseline characteristics, including smoking and exercise habits. These differences were adjusted in the data analysis.

This trial adds further evidence for the use of Iyengar yoga as an effective stress reduction tool. We replicated the findings of our previous nonrandomized controlled pilot study [21], in which subjects ($n = 16$) attended two weekly 90 min Iyengar yoga classes. In this pilot study we found even larger treatment effects for the psychological and physical outcome parameters. Compliance with the twice-weekly yoga classes was better in this pilot study than in the present randomized trial, which may account for the larger effects seen in the pilot study.

A recent systematic review has looked at the ability of yoga to reduce stress levels in healthy adult populations and was based on eight trials that indicated a positive effect of yoga in reducing stress levels or stress symptoms [20]; however, the quality and design of the included studies revealed stronger methodological weaknesses. The results of our randomized clinical trial parallel previous studies that demonstrated beneficial effects of yoga in stress reduction, mood enhancement, and improvements in depression and anxiety in patients with depressive syndromes and with musculoskeletal pain [21, 32, 33]. Other studies suggest that even a short program of yoga might be effective for enhancing emotional well being and resilience to stress in the workplace [34] and for improving stress, anxiety, and health status in subjects with mild to moderate levels of stress [19]. Furthermore, our findings are consistent with those of other studies, that demonstrated the effectiveness of yoga in the treatment of chronic low back pain [35–40], a physical symptom frequently associated with distress.

Our current study had multiple strengths including the use of recommended and validated assessment tools and outcome measures, the high-quality yoga teaching, well-defined inclusion and exclusion criteria, an observation period of 3 months, and the comparison of two yoga intensities.

Nevertheless, the study has limitations, including modest sample sizes and no long-term followup. Furthermore, as with all studies with self-applied nonpharmacological interventions, it was impossible to blind treatments. We cannot estimate the extent to which the observed yoga effects were nonspecific due to the influence of setting, the attention of yoga teachers, the participants' beliefs about the health-related effects of yoga and meaning responses [41] and social interaction within the groups. The benefits are not attributable to differences in covariates as prognostic factors for which the analyses were statistically adjusted. We further conducted an analysis adjusting for outcome expectation, which did not change the overall results. Furthermore, our analysis included baseline values as covariates, thus regression to the mean effects can be ruled out as an explanation for the results.

A final possible limitation of this study relates to recruitment of self-described distressed women for a study in which the primary purpose was to evaluate the effects of B.K.S. Iyengar yoga on stress reduction. Admittedly, enrollment of subjects who rated themselves as "distressed," but otherwise healthy, was subjective. Yet, this limitation is arguable, as baseline data from multiple validated instruments for stress assessment indicated that the women enrolled were, indeed, distressed.

Adherence to the yoga classes was worse than anticipated, especially in the group that was offered yoga twice weekly. The reduction of adherence started within the first weeks of the offered yoga classes. One may speculate that for the

Table 3: Between-group differences of treatment effects on physical symptoms and complaints (when present), mean (95% CI).

	Yoga group 1 versus control		Yoga group 2 versus control		Yoga group 1 + 2 versus control	
	Change	*P* value	Change	*P* value	Change	*P* value
Physical well being	−2.3 (−3.4; −1.0)	0.001	−0.7 (−2.0; 0.5)	0.256	−1.5 (−2.5; −0.4)	0.007
Back pain	−1.7 (−3.1; −0.2)	0.025	−2.5 (−4.2; −0.8)	0.004	−2.1 (−3.5; −0.7)	0.004
Neck pain	−2.2 (−3.6; −0.7)	0.003	−1.4 (−2.9; 0.1)	0.06	−1.8 (−3.1; −0.5)	0.005
Freiburg complaint list, sum score	−0.3 (−0.5; −0.1)	0.006	−0.2 (−0.4; 0.0)	0.115	−0.2 (−0.4; 0.0)	0.012

Table 4: Group differences for group-independent effects of yoga according to frequency of visited yoga classes compared to controls, mean (95% CI).

	7–12 versus 0 yoga classes		13–24 versus 0 yoga classes*	
	Change	*P* value	Change	*P* value
Back pain	−2.3 (−3.7; −1.0)	0.001	−3.5 (−5.5; −1.5)	0.001
GSI-Score	−8.5 (−13.9; −3.0)	0.003	−10.2 (−15.9; −4.4)	0.001
CES-D	−4.5 (−8.3; −0.6)	0.049	−5.9 (−10.5; −1.3)	0.011
S-STAI	−6.5 (−12.0; −1.0)	0.02	−7.4 (−13.4; −1.4)	0.015
T-STAI	−6.1 (−10.5; −1.7)	0.006	−6.5 (−11.2; −1.8)	0.007

GSI: General Severity Index; CES-D: Center for Epidemiological Studies Depression Scale; S-STAI: state anxiety; T-STAI: Trait Anxiety.
*Group differences between 7–12 and 13–24 classes not significant.

addressed study population with high demands in work and family life practicing yoga twice weekly for 90 min in distant centers might be not feasible in daily life. As our results indicate that once-weekly participation in yoga led to pronounced and clinically relevant improvements in outcomes, adhering to a more rigorous yoga practice schedule may be not necessary for stress-symptom improvement. On the other hand, the actual difference between the 2 yoga groups was one 90 min yoga session per week. Thus, we do not know if a more intensive yoga practice with 3 or 4 weekly classes would lead to more beneficial effects.

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 their vigorous postures, and participants may have experienced increasing feelings of mastery over time, as they were challenged to learn difficult postures. In addition, the commitment of an extra amount of time to concentrated practice might induce beneficial effects on self-control and foster self-efficacy. The practice of Iyengar yoga comprises physical movements with isometric muscle strengthening, stretching, and flexibility, combined with a mental focus and an emphasis on mindfulness of body movements and consideration of breathing patterns [31]. Thus, the practice of yoga might enhance both toning of muscles and release of muscle tension. Recent research has also shown that stretching is associated with increased vagal tone and consequent relaxation [42, 43]. This induced relaxation response may further reduce stress-related muscle tension. A final consideration is that regular aerobic exercise has been shown to be an effective treatment for depression [44]. The beneficial effect of Iyengar yoga could, therefore, also be due to the physical effort it entailed.

6. Conclusion

In conclusion, this study suggests that Iyengar yoga is an effective treatment for women in reducing mental distress and concomitant psychological and physical symptoms. Offering twice-weekly yoga classes is not superior to weekly classes. To better evaluate the impact of yoga on prevention and treatment of stress and stress-related disease, further studies are needed, which include longer-term followup, men, larger sample sizes, and control groups engaged in activity.

Conflict of Interests

The authors do not have any conflict of interests with the content of the paper.

Acknowledgment

The study was supported by the Karl and Veronica Carstens Foundation, Essen.

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2012, Article ID 165410, 7 pages
doi:10.1155/2012/165410

Review Article

Effects of Yoga on Mental and Physical Health: A Short Summary of Reviews

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Received 4 May 2012; Revised 4 July 2012; Accepted 18 July 2012

Academic Editor: Vernon A. Barnes

This report summarizes the current evidence on the effects of yoga interventions on various components of mental and physical health, by focussing on the evidence described in review articles. Collectively, these reviews suggest a number of areas where yoga may well be beneficial, but more research is required for virtually all of them to firmly establish such benefits. The heterogeneity among interventions and conditions studied has hampered the use of meta-analysis as an appropriate tool for summarizing the current literature. Nevertheless, there are some meta-analyses which indicate beneficial effects of yoga interventions, and there are several randomized clinical trials (RCT's) of relatively high quality indicating beneficial effects of yoga for pain-associated disability and mental health. Yoga may well be effective as a supportive adjunct to mitigate some medical conditions, but not yet a proven stand-alone, curative treatment. Larger-scale and more rigorous research with higher methodological quality and adequate control interventions is highly encouraged because yoga may have potential to be implemented as a beneficial supportive/adjunct treatment that is relatively cost-effective, may be practiced at least in part as a self-care behavioral treatment, provides a life-long behavioural skill, enhances self-efficacy and self-confidence and is often associated with additional positive side effects.

1. Introduction

The conceptual background of yoga has its origins in ancient Indian philosophy. There are numerous modern schools or types of yoga (i.e., Iyengar, Viniyoga, Sivananda, etc.), each having its own distinct emphasis regarding the relative content of physical postures and exercises (*asanas*), breathing techniques (*pranayama*), deep relaxation, and meditation practices that cultivate awareness and ultimately more profound states of consciousness. The application of yoga as a therapeutic intervention, which began early in the twentieth century, takes advantage of the various psychophysiological benefits of the component practices. The physical exercises (*asanas*) may increase patient's physical flexibility, coordination, and strength, while the breathing practices and meditation may calm and focus the mind to develop greater awareness and diminish anxiety [1], and thus result in higher quality of life. Other beneficial effects might involve a reduction of distress, blood pressure, and improvements in resilience, mood, and metabolic regulation [2].

Khalsa stated that a majority of the research on yoga as a therapeutic intervention was conducted in India and a significant fraction of these were published in Indian journals, some of which are difficult to acquire for Western clinicians and researchers [3]. In their bibliometric analysis from 2004, they found that 48% of the enrolled studies were uncontrolled, while 40% were randomized clinical trials (RCT), and 12% non-RCT (N-RCT). Main categories which were addressed were psychiatric, cardiovascular, and respiratory disorders [3].

Despite a growing body of clinical research studies and some systematic reviews on the therapeutic effects of yoga, there is still a lack of solid evidence regarding its clinical relevance for many symptoms and medical conditions. For many specific indications and conditions, there is inconsistent evidence with several studies reporting positive effects of the yoga interventions, but other studies are less conclusive. In some instances, these discrepancies may result from differences between the study populations (e.g., age, gender, and health status), the details of the yoga interventions, and follow-up rates.

In this paper, we summarize the current evidence on the clinical effects of yoga interventions on various components of mental and physical health. In general, the respective reviews (Table 1) and an Agency for Healthcare Research and Quality Report (AHRQ) evidence report on "Meditation Practices for Health," which cites also studies on yoga [30], include a heterogeneous set of studies with varying effect sizes, heterogeneous diagnoses and outcome variables, often limited methodological quality, small sample sizes, varying control interventions, different yoga styles, and strongly divergent duration of interventions.

2. Yoga and Mental Health

2.1. Depression. We found four relevant publications, including two reviews on the effects of yoga on depression [4, 5], a description of studies on yogic breathing [6] for depression, and one "summary" [8]. The reviewing authors have reported that the studies reviewed showed a large variety of diagnoses ranging from "major depression or some other type of diagnosed depression" to "elevated depressive symptoms" [5]. Although several randomized controlled trials (RCTs) reported beneficial effects of yoga interventions for treating depressive symptoms, the quality and quantity of the data from these studies appear insufficient to conclude whether there is substantial clinical justification to consider yoga as a treatment of depression. Compared to passive controls, the yoga interventions seem to be effective; when compared with active controls, not surprisingly, the effects are less conclusive [5]. The study results are so far not sufficient in quantity and quality to determine whether studies with a focus on the *asanas* are more effective as compared to studies with meditation-focussed or *pranayama*-focussed styles. Thus, there is a strong need to conduct more conclusive studies with high methodological quality and larger patient samples. Whether motivation of depressed patients could be a problem or not remains to be clarified. There has been an attempt to explore mechanisms of action and to understand the complete picture of the effects of yoga in depression looking at electrophysiological markers of attention, and neurotransmitters which were found to change with yoga [7, 31].

2.2. Fatigue. We found one systematic review/meta-analysis evaluating the effects of yoga on fatigue in a variety of medical conditions. The review included 19 RCTs and included healthy persons as well as patients with cancer, multiple sclerosis, dialysis, chronic pancreatitis, fibromyalgia, and asthma [9]. Overall, a small positive effect with an SMD of 0.28 [0.24–0.33] was found. This standardized mean difference (SMD) describes the difference in the group mean values divided by the respective standard deviation; a value between 0.3 and 0.5 can be regarded as small, SMD between 0.5 and 0.8 as moderate, and SMD >0.8 as large. For those studies that included cancer patients ($n = 10$), the treatment effect of yoga was 0.20 (0.15–0.24); for all other studies that did not include cancer patients ($n = 9$), the effect was 0.46 (0.24–0.67) [9]. Nevertheless, there are some studies on cancer-related fatigue which indicate that treatment effects of yoga could be improved in well-designed future studies.

Table 1: Systematic reviews for the different domains discussed.

Indications	Studies on yoga interventions
Depression	2 reviews [4, 5], 1 description of studies on yogic breathing [6, 7], 1 summary [8]
Fatigue	1 systematic review [9]
Anxiety and anxiety disorders	1 systematic review [1], 1 Cochrane review on meditation therapy [10], 1 description of studies on yogic breathing [6, 7], 1 summary [8]
Stress	1 systematic review [11]
Posttraumatic stress disorder	1 review article [12]
Physical fitness	1 critical review [13]
Sympathetic/parasympathetic activation	1 systematic review [14]
Cardiovascular endurance	1 review [15]
Blood pressure and hypertension	1 systematic review [14]
Pulmonary function	1 review [15]
Glucose regulation	3 systematic reviews [14, 16, 17]
Menopausal symptoms	1 review [18], 1 systematic review [19]
Musculoskeletal functioning and pain	3 systematic reviews [20–22], 2 reviews [23, 24]
Cancer	2 reviews [25, 26], 2 meta-analyses [27, 28]
Epilepsy	1 Cochrane review [29]

2.3. Anxiety and Anxiety Disorders. There is one systematic review examining the effects of yoga on anxiety and anxiety disorders [1], a Cochrane review on meditation therapy for anxiety disorders [10] (citing one yoga study [32]), a description of studies on yogic breathing (which are also addressed in the systematic review) [6], and one summary [8].

Most studies described beneficial effects in favour of the yoga interventions, particularly when compared with passive controls (i.e., examination anxiety), but also compared with active controls such as relaxation response or compared to standard drugs. However, there are currently no meta-analyses available which would clearly differentiate this important issue. At least the AHRQ report stated that "yoga was no better than Mindfulness-based Stress Reduction at reducing anxiety in patients with cardiovascular diseases" [30].

2.4. Stress. One systematic review describes the effects of yoga on stress-associated symptoms. Chong et al. identified 8 controlled trials, 4 of which were randomized, which fulfilled their selection criteria [11]. Most studies described beneficial effects of yoga interventions. Although not all studies used adequate and/or consistent instruments to measure stress, they nevertheless indicate that yoga may reduce perceived stress as effective as other active control interventions such as relaxation, cognitive behavioural therapy, or dance.

Also the AHRQ report stated that "yoga helped reduce stress" [30]. Here, the two included studies showed a significant reduction of stress scores in favour of the yoga group (SMD = −1.10 [CI: −1.61 to −0.58].

Posttraumatic Stress Disorder. A single review article looked at the existing research on yoga for posttraumatic stress disorder (PTSD) [12]. Seven articles were reviewed which included 8 studies on PTSD following exposure to natural disasters such as a tsunami and a hurricane (1 RCT, 1 N-RCT, 3 group study, 2 single-arm studies, 1 cross-sectional study) and 2 studies on PTSD due to combat and terrorism (1 RCT, 1 single-arm study). After a natural disaster, yoga practice was reported to significantly reduce symptoms of PTSD, self-rated symptoms of stress (fear, anxiety, disturbed sleep, and sadness) and respiration rate. Similarly, yoga interventions were able to improve the symptoms of PTSD in persons with PTSD after exposure to combat and terrorism. The interventions varied in duration from one week (when interventions were given on the site) to six months. The review suggested a possible role of yoga in managing PTSD, though long-term studies conducted with greater rigor are needed [12].

3. Yoga and Physical Fitness

3.1. Physical Fitness. There was one critical review which evaluated whether yoga can engender fitness in older adults [13]. Ten studies with 544 participants (mean age 69.9 ± 6.3) were included; 5 of these studies were RCTs, and 5 studies had a single-arm pre/post-design. With respect to physical fitness and function, the studies reported moderate effect sizes for gait, balance, body flexibility, body strength, and weight loss [13]. However, there is still a need for additional research trials with adequate control interventions (active and specific) to verify these promising findings.

One may expect that retaining physical fitness and improving physical functioning can have a positive effect on functional abilities and self-autonomy in older adults. Further studies should address whether or not individuals' self-esteem and self-confidence will increase during the courses, and whether or not regular classes may also improve social competence and involvement. A problem with studies enrolling elderly subjects can be compliance with the study protocol leading to low levels of study completion and long-term follow-up data. Future studies should investigate the most appropriate duration of yoga intervention and the most suitable postures and yoga style for the elderly.

3.2. Sympathetic/Parasympathetic Activation. There were 42 studies on the yoga effects on sympathetic/parasympathetic activation and cardiovagal function [14], that is, 9 RCTs, 16 non-RCTs, 15 uncontrolled trials, and 2 cross-sectional trials. Most studies offered "some evidence that yoga promotes a reduction in sympathetic activation, enhancement of cardiovagal function, and a shift in autonomic nervous system balance from primarily sympathetic to parasympathetic" [14]. However, some of the studies included in the review showed less clear-cut or even contrasting, effects. Because most of these effects are short-term phenomena, more rigorous work is needed.

Another lacuna is that there are very few studies which have studied plasma catecholamine levels and most of them are early studies [33, 34].

3.3. Cardiovascular Endurance. Raub's literature review, which included 7 controlled studies, reported "significant improvements in overall cardiovascular endurance of young subjects who were given varying periods of yoga training (months to years)" [15]. Outcome measures included oxygen consumption, work output, anaerobic threshold, and blood lactate during exercise testing. As expected, physical fitness increased in adolescents or young adults (athletes and untrained individuals) compared to other forms of exercise, with a longer duration of yoga practice resulted in better cardiopulmonary endurance.

4. Yoga and Cardiopulmonary Conditions

4.1. Blood Pressure and Hypertension. Innes et al. reported on 37 studies investigating the effects of yoga on blood pressure and hypertension, among them 12 RCTs, 12 nonrandomized clinical trials, 11 uncontrolled studies, 1 cross-sectional study, and 1 single yoga session examination. Most reported a reduction of systolic and/or diastolic pressure. However, there were several noted potential biases in the studies reviewed (i.e., confounding by lifestyle or other factors) and limitations in several of the studies which makes it "difficult to detect an effect specific to yoga" [14].

Ospina et al.'s AHRQ cites two studies which found small, insignificant improvements of systolic (weighted mean difference = −8.10; 95% CI, −16.94 to 0.74) and diastolic blood pressure (weighted mean difference = −6.09; 95% CI, −16.83 to 4.64) in favour of yoga when compared to no treatment [30]. When compared to health education, yoga interventions resulted only in small and insignificant improvements of systolic blood pressure (weighted mean difference = −15.32; 95% CI, −38.77 to 8.14) and diastolic blood pressure (weighted mean difference = −11.35; 95% CI, −30.17 to 7.47) [30].

4.2. Pulmonary Function. In his descriptive literature review, Raub also examined studies evaluating yoga's effects on lung function in healthy volunteers and patients with chronic bronchitis and asthma [15]. In healthy volunteers practicing yoga, there are reported improvements of various parameters of lung function with breathing control techniques, specific postures, and/or relaxation techniques [15]. However, these improvements were "not consistent and depended upon the length of yoga training, the type of yoga practice used (e.g., breathing exercises and yoga postures), and the type of subject" [15]. Raub also cited some studies on patients with asthma describing improvements in peak expiratory flow rate, medication use and asthma attack frequency. In a double-blinded RCT with placebo-control, [35] there were only a few small and insignificant improvements in lung function variables. Thus, more rigorous trials are needed to clarify the value of yoga breathing practices for patients with asthma.

5. Yoga and Metabolic/Endocrine Conditions

5.1. Glucose Regulation. Three systematic reviews examined the effects of yoga on risk indices associated with insulin resistance syndrome [14], risk profiles in adults with type 2 diabetes mellitus [16], and the management of type 2 diabetes mellitus [17]. Innes et al. [14] identified several studies on the effects of yoga on insulin resistance syndrome-associated variables, that is, 2 RCTs, 2 non-RCTs, and 8 uncontrolled clinical trials. These studies reported postintervention improvement in various indices in adults. However, the results varied by population (healthy adults, adults at cardiovascular disease risk, adults with type 2 diabetes, etc.) and study design.

Another systematic review by Aljasir et al. [17] addressed the management of type 2 diabetes mellitus and concluded that the reviewed trials "suggest favourable effects of yoga on short-term parameters related to diabetes but not necessarily for the long-term outcomes." However, the duration of treatment in the reviewed studies was variable (ranging from 20 min. session per day to three to five 90 min. sessions in the review of Aljasir et al. [17]; 3-4 h per day for 8 days, 2 sessions per day (25–35 min) for 3 months to 40 min per day for 6 months, and 72 4 h sessions during 12 months in the review by Innes and Vincent [16]).

The AHRQ cites two studies comparing yoga versus medication which reported a large and significant reduction of fasting glucose in individuals with type 2 diabetes in one study, and a smaller but still significant improvement in the other study [30]. The authors discussed differences in the study populations, and interventions as possible explanation for the observed heterogeneity of results.

5.2. Menopausal Symptoms. A single review addressed menopausal symptoms and analyzed 3 RCT, 1 N-RCT, and 3 uncontrolled clinical trials [18]. Although some studies reported beneficial effects, "the evidence was insufficient to suggest that yoga is an effective intervention for menopause" [18].

A recent systematic review included 5 RCTs, which addressed effects of yoga on menopausal symptoms, particularly psychological symptoms, somatic symptoms, vasomotor symptoms, and/or urogenital symptoms [19]. However, yoga was associated with small effects on psychological symptoms (SMD = -0.37; 95% CI -0.67 to -0.07; $P = 0.02$), but no effects on "total menopausal symptoms, somatic symptoms, vasomotor symptoms, or urogenital symptoms" [19].

6. Yoga and Musculoskeletal Conditions

6.1. Musculoskeletal Functioning and Pain. There were 3 systematic reviews [20–22] and 2 other reviews on the effects of yoga on musculoskeletal function, chronic pain conditions, and pain-associated disability [23, 24]. Two reviews specifically addressed low back pain [22, 24] or arthritis [23], while the other reviews summarized studies on various chronic pain conditions, most with a focus on musculoskeletal conditions and associated disability.

Posadzki et al. [21] included 11 RCTs with variable methodological quality and found that 10 of 11 studies reported significantly greater effects in favor of yoga when compared to "standard care, self care, therapeutic exercises, relaxing yoga, touch and manipulation, or no intervention." A recent meta-analysis on pain intensity/frequency, and pain-related disability included 5 RCTs with single blinding, 7 RCTs without blinding, and 4 non-RCTs [20]. Reviewed studies included yoga for the treatment of back pain (6 studies), rheumatoid arthritis (2 studies), headache/migraine (2 studies), and other indications (i.e., hemodialysis, irritable bowel syndrome, labor pain, etc.). All of these studies reported positive effects in favor of the yoga interventions. There were moderate treatment effects with respect to 5 pain (SMD = -0.74 [CI: -0.97 to -0.52], $P < 0.0001$), and pain-related disability (SMD = -0.79 [CI: -1.02 to -0.56], $P < 0.0001$). Despite some study limitations, there was evidence that yoga may be useful for several pain-associated disorders. Thus, well-designed larger scale studies with adequate controls for confounding factors and more thorough statistical analyses are needed to verify these promising findings.

With respect to chronic back pain, the studies indicate that yoga was more effective than the control interventions (including usual care or conventional therapeutic exercises), albeit some studies showed no between group difference [22]. Two recent and properly powered trials of yoga for back pain were published and reported clinically meaningful benefits for yoga over usual medical care from 6- to 12-months postrandomization [36, 37], but not over an intensive stretching intervention [36].

7. Yoga and Specific Diseases

7.1. Cancer. With respect to cancer, there are 2 reviews [25, 26] and 2 meta-analyses (one with 10 studies [27], and one "letter to the editor" with 6 studies [28]). According to the findings of the more comprehensive meta-analysis of Lin et al., the yoga groups showed improvements in psychological health when compared to waitlist or supportive therapy groups, that is, anxiety (8 studies: SMD = −0.76 [−1.34 to −0.19], $P = 0.009$), depression (8 studies: SMD = −0.95 [−1.55 to −0.36], $P = 0.002$), distress (2 studies: SMD = −0.4 [−0.67 to −0.14], $P = 0.003$), and stress (5 studies; SMD = −0.95 [−1.63 to −0.27], $P < 0.006$) [27]. With respect to overall quality of life, there was just a trend towards improvement (SMD = −0.29 [−0.58 to 0.001], $P = 0.06$). To explain the positive outcomes, Smith and Pukall suggested that complex pathways which may involve relaxation, coping strategies, acceptance, and self-efficacy [26]. Although Lin et al. stated that the “findings are preliminary and limited and should be confirmed through higher-quality, randomized controlled trials,” they nevertheless attested “potential benefit of yoga for people with cancer in improvements of psychological health” [27]. However, the outcome parameters described in these cancer reviews were also addressed in the symptom-specific reviews described above.

7.2. Epilepsy. To assess the potential effects of yoga in the treatment of epilepsy, 1 Cochrane review analyzed 1 RCT and 1 N-RCT [29]. However, the authors were not able to draw “reliable conclusions” whether yoga may be effective or not.

8. Discussion

These reviews suggest a number of areas where yoga may be beneficial, but more research is required for virtually all of them to more definitively establish benefits. However, this is not surprising given that research studies on yoga as a therapeutic intervention have been conducted only over the past 4 decades and are relatively few in number. Typically, individual studies on yoga for various conditions are small, poor-quality trials with multiple instances for bias. In addition, there is substantial heterogeneity in the populations studied, yoga interventions, duration and frequency of yoga practice, comparison groups, and outcome measures for many conditions (e.g., depression and pain). Disentangling the effects of this heterogeneity to better understand the value of yoga interventions under various circumstances is challenging. For many conditions, heterogeneity and poor quality of the original trials indicated that meta-analyses could not be appropriately conducted. Nevertheless, some RCTs of better quality found beneficial effects of yoga on mental health (see Uebelacker et al.’s critical review [5]). Further investigations in this area are recommended, particularly because of the plausibility of the underlying psychophysiological rationale (including the efficacy of frequent physical exercises, deep breathing practices, mental and physical relaxation, healthy diet, etc.).

While it is not surprising that physical fitness can be improved by training, using either yoga or conventional exercises, it is of interest that in individuals with pain yoga may have beneficial effects with overall moderate effects sizes. However, these effects were strong particularly in healthy individuals, but much weaker in patients with chronic pain conditions. The beneficial effects might be explained by an increased physical flexibility, by calming and focusing the mind to develop greater awareness and diminish anxiety, reduction of distress, improvement of mood, and so forth. Because patients may recognize that they are able to be physically active, even despite of persisting pain symptoms, they may therefore experience higher self-competence and self-awareness, which contributes to higher quality of life.

Conceivably, *asanas* particularly have a positive effect on fitness and physical flexibility with a secondary effect on the mental state, while the *pranayama* practices and relaxation/meditation techniques may result in greater awareness, less stress, and higher well-being and quality of life. However, this remains to be shown in well-performed future studies.

Because patients are engaged in the yoga practices as a self-care behavioural treatment, yoga interventions might well increase self-confidence and self-efficacy. On the other hand, patients with psychological burdens and/or low motivation (i.e., depression, anxiety, fatigue, etc.) might be less willing to participate fully in intensive yoga interventions. Some of these studies found relatively low participation and high dropout rates in some of the analysed studies. Patient compliance may be higher with the social support within group interventions, while private regular practices at home might be more difficult to perform consistently. These factors need to be addressed in further studies. Innes et al. [14] argued that most studies were from India where “yoga is an integral part of a longstanding cultural and spiritual tradition.” It is thus unclear whether adherence in Western patients might be the same. Many of the Indian clinical trials, which have been conducted in residential settings, not typically found outside India, include yoga class interventions 5 to 7 days per week, whereas such compliance would not be possible with patient populations outside India. However, such practices are unlikely to be continued, at least at such intensity. If as believed by some yoga practitioners, the intensity of the practice should be greater at the beginning of therapy, such programs would be an excellent way to begin yoga treatment. In India, there is a gradual shift in the attitude towards yoga with most urban Indians under the age of 35 believing yoga is a way to keep fit rather than attaching the same cultural importance to it, which earlier generations did. For these reasons, cross-cultural studies (which are lacking) using an identical intervention given to a population in India and parallel conducted elsewhere would be very useful.

Motivation might be a crucial point. To overcome this, shorter time interventions might be an option for some specific indications (i.e., pain and depressive symptoms), while the cardiovascular and fitness effects might require long-term practices. In fact, some pain studies suggest that short-term interventions might be more effective than longer durations of practice [20]. This would indicate a putative lack of motivation to be physically active. Indeed, a couple of reviews noted that data on subject treatment compliance was not routinely reported in most studies [4, 30].

Clearly yoga intervention programs require an active participation of the individuals as do all behavioral interventions, and thus adherence might be a crucial point that limits potentially beneficial effects of yoga. It is apparent in many life style diseases, that patients must change attitudes and behaviour in order to successfully treat these diseases. A positive feature of yoga interventions is that they may in fact

Table 2: Level of action and observed effects of yoga interventions.

	Specific effects	Unspecific effects
Cognition	Contemplative states; Mindfulness; Self-identity; Self-efficacy; Beliefs; Expectations	Control of attentional networks
Emotions	Emotional control/regulation	Quality of Life
Physiology	Vagal afferent activity; Heart rate/Respiratory; Relaxation response/Stress reduction	Social contacts
Physical body	Physical flexibility, Fitness/Endurance	Healthy life style

Specific and unspecific effects are often interconnected.

be very supportive for the execution and maintenance of such lifestyle changes due to the experience of well-being from the practices which can support regular practice, and from the changes in mind/body awareness that occur over time with continued yoga practice, which will in turn support a desire to adopt and maintain healthy behaviours.

Thus, further studies should identify which patients may benefit from the interventions, and which aspects of the yoga interventions (i.e., physical activity and/or meditation and subsequent life style modification) or which specific yoga styles were more effective than others. Larger-scale and more rigorous research is highly encouraged because yoga may have potential to be implemented as a safe and beneficial supportive/adjunct treatment that is relatively cost-effective, may be practiced at least in part as a self-care behavioral treatment, provides a life-long behavioural skill, enhances self-efficacy and self-confidence, and is often associated with additional positive side effects (Table 2).

The degree to which yoga interventions are curative treatments remains to be determined; currently it is safe to suggest that yoga can be a beneficial supportive add-on or adjunct treatment. Jayasinghe stated that one may "conclude that yoga can be beneficial in the primary and secondary prevention of cardiovascular disease and that it can play a primary or a complementary role in this regard" [38]. Because of yoga's low risk for side effects, when selecting appropriate postures for the population, and potential for actual positive side effects, it might be a promising candidate particularly for cardiac rehabilitation, depending on the patients' abilities and willingness to adopt yoga practices with regularity. However, the meditative and self-reflective (cognitive) aspects of yoga could be problematic especially for patients with psychotic or personality disorders. Nevertheless, there is currently insufficient data on contraindications or side effects related to yoga practices in patients with psychological disorders.

Taken together, while several reviews suggest positive benefits of yoga, various methodological limitations (including small sample sizes, heterogeneity of controls and interventions) limit the generalizability of these promising study findings. It is quite likely that yoga may help to improve patient self-efficacy, self-competence, physical fitness, and group support, and may well be effective as a supportive adjunct to mitigate medical conditions, but not yet as a proven stand-alone, curative treatment. Confirmatory studies with higher methodological quality and adequate control interventions are needed.

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2012, Article ID 758641, 15 pages
doi:10.1155/2012/758641

Review Article

The Evolution of Mindfulness-Based Physical Interventions in Breast Cancer Survivors

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Received 8 May 2012; Accepted 27 June 2012

Academic Editor: Andreas Michalsen

Survivors of breast cancer are faced with a multitude of medical and psychological impairments during and after treatment and throughout their lifespan. Physical exercise has been shown to improve survival and recurrence in this population. Mind-body interventions combine a light-moderate intensity physical exercise with mindfulness, thus having the potential to improve both physical and psychological sequelae of breast cancer treatments. We conducted a review of mindfulness-based physical exercise interventions which included yoga, tai chi chuan, Pilates, and qigong, in breast cancer survivors. Among the mindfulness-based interventions, yoga was significantly more studied in this population as compared to tai chi chuan, Pilates, and qigong. The participants and the outcomes of the majority of the studies reviewed were heterogeneous, and the population included was generally not selected for symptoms. Yoga was shown to improve fatigue in a few methodologically strong studies, providing reasonable evidence for benefit in this population. Improvements were also seen in sleep, anxiety, depression, distress, quality of life, and postchemotherapy nausea and vomiting in the yoga studies. Tai chi chuan, Pilates, and qigong were not studied sufficiently in breast cancer survivors in order to be implemented in clinical practice.

1. Introduction

Cancer survivorship, as a distinct and complex phase of the cancer journey, has gained strong support by both survivors of breast cancer and their clinicians. Breast cancer survivors account for 2.4 million of the 10 million cancer survivors in the United States [1].

Survivors of breast cancer are faced with a multitude of medical and psychological impairments during and after treatment and throughout their lifespan. One intervention shown convincingly to improve some of the long-term toxicities and late effects of therapy is physical exercise [2, 3]. Moderate physical exercise has also been associated with reducing breast cancer risk among postmenopausal women [4]. Aerobic training has also been shown to increase recurrence-free and overall survival in this population [5]. Such conventional exercise regimens however can be challenging for women who have undergone surgery, chemotherapy, and/or radiation treatment who are also experiencing the additional burden of anxiety and stress about the possibility of recurrence.

Thus, it is not surprising that breast cancer survivors are increasingly exploring interventions that combine mind and body components, herein referred to as "mindful exercise." Mindful exercise includes yoga, tai chi chuan, Pilates, and qigong. These exercise interventions address both physical and psychological needs simultaneously and may be particularly appealing to breast cancer survivors [6]. A growing number of research studies in breast cancer survivors have demonstrated beneficial effects such as improving quality of life (QOL) and fitness levels while reducing fatigue and depression [7–10].

Published reviews of mindful exercise interventions lack the comprehensive inclusiveness that is part of the mindful-based exercise modalities (yoga, tai chi chuan, Pilates, and qigong) but instead focus on only one method. These interventions are similar in their philosophy of affecting both the mind and the body, and they target similar outcomes of QOL, mood, and fatigue. In this paper, we provide a comprehensive review of the scientific evidence on the effect of all mindful exercise interventions in breast cancer survivors.

2. Background

Heightened awareness of cancer survivorship issues in the late 1990s, coupled with evidence that most cancer survivors use one or more forms of complementary and alternative medicine (CAM) [11], led to an increased recognition of the need for rigorous research in this arena. The Office of Cancer Complementary and Alternative Medicine and the National Center for Complementary and Alternative Medicine, created within the National Cancer Institute, encourage and support the scientific scrutiny of CAM therapies for treatment of cancer and cancer sequelae. This growing body of research has led to a renaissance in how both patients and physicians address the wellness of the whole person, including the physical, psychological, and spiritual needs.

A high proportion of breast cancer survivors use one or more types of CAM, the most popular categories being the "natural products" and "mind-body practices" [6, 12, 13]. Mind-body practices target the "interaction between brain, mind, body, and behavior, with the intent to use the mind to affect the physical function and promote health" [14]. These practices include meditation, guided imagery, deep-breathing exercises, progressive relaxation, hypnotherapy, yoga, tai chi chuan, qigong, and acupuncture. Some of these methods are mostly meditative, while others such as yoga, tai chi chuan, and qigong include a significant physical component which qualifies them as distinct fitness methods. Another fitness method that is part of the "movement" category of CAM therapies is the Pilates method [14].

In the general population, yoga and Pilates are the fastest growing fitness methods [15]. These interventions are greatly advertised to breast cancer survivors as effective methods of rehabilitation, despite limited scientific evidence of their benefit on QOL and other psychological parameters. It has been claimed that the mindfulness component connects the body, mind, spirit, thus having beneficial effects on depression, anxiety, fatigue, and pain [16–18]. However, the majority of the research on mind-body interventions involves studies that are small and lack a proper comparison group [19–21].

Given the importance of physical activity in improving sequelae of breast cancer treatment and decreasing the recurrence and mortality rates, it is prudent that clinicians and researchers understand if physical exercise with a mindful component has similar effects. The purpose of our paper is to provide an overview of the scientific evidence of the effect of all mindful exercise interventions among breast cancer survivors.

3. Yoga

The most studied of the mindful exercise interventions, yoga, has origins in the Buddhist tradition about 5000 years ago. There are 13 types of yoga, some more meditative (Kundalini) and others more physical (Hatha and the styles derived from it: Iyengar, Ashtanga, and Vinyasa) [22], but they all involve the union between mind, body, and spirit.

The most practiced in the Western world today is Hatha yoga and its derivations. A survey conducted in 2007 by the National Center for Complementary and Alternative Medicine on the use of CAM by Americans demonstrated that more than 13 million adults had used yoga in the previous year and that the use of yoga among adults increased by 3 million people between 2002 and 2007. According to this survey, the most common reasons people use yoga for are its beneficial effects on anxiety, stress, asthma, high blood pressure, and depression, but yoga is also used as part of a general health regimen for physical fitness and relaxation [23].

Hatha yoga includes a vast array of asanas (postures done with awareness) and pranayama (regulated breathing through the nostrils), with the purpose of relaxing the body and quieting the thoughts [18, 19]. Iyengar yoga focuses on alignment and holding poses, while the Ashtanga yoga features poses that flow together [22]. Scientific inquiries of yoga benefits started to occur in the early 1970s with reports of benefits in medical ailments such as hypertension, anxiety, depression, and back pain, to name a few. Over the last decade, the number of studies addressing Hatha yoga in cancer survivors has surged and their methodologic quality is improving.

4. Tai Chi Chuan (TCC)

Tai chi chuan is a multicomponent intervention that has its origins in China, as a martial art. It combines meditation, graceful movement, deep breathing, and relaxation to move vital energy throughout the body [49]. Over the past 20 years, TCC has been found to be successful at reducing falls and improving sleep in the elderly [50, 51], improving QOL and increasing exercise tolerance in heart failure patients [49, 52], improving physical functioning in patients with rheumatoid arthritis [53], improving blood pressure and cholesterol in hypertensive patients [8], and improving bone mineral density [54]. Recent methodologically stronger studies have brought TCC to the attention of the medical community by demonstrating significant improvements in symptoms and QOL in patients with fibromyalgia [55] and in the balance, functional capacity, and falls risk of patients with Parkinson's disease [56]. In cancer populations, tai chi chuan was studied mostly in breast cancer survivors.

5. Pilates

The Pilates method was developed by the German trainer Joseph Pilates in the 1930s. It combines exercises inspired from yoga, karate, Zen meditation, and the ancient Greek and Roman philosophies of achieving physical and mental perfection [57, 58]. Pilates strengthens the core muscles which subsequently can lead to improvement in spine flexibility and posture [59]. Initially popular with professional dancers and later adopted by professional athletes, Pilates has become extremely popular in the general population. The practice of Pilates has increased by 450% since 2000, with 8.6 million participants in 2009 [15]. The medical field also followed suit, with more than fifty peer-reviewed publications reporting beneficial effects from Pilates in health-related conditions such as back pain, orthopedic rehabilitation, fibromyalgia, and QOL in the elderly [60–63].

Pilates exercises are practiced on a floor mat, on a special Pilates chair, or with the help of a spring machine (the Pilates reformer). While performing the exercises, the awareness is on breathing and muscle control. Positive claims associated with Pilates include increased flexibility, range of motion (ROM), muscle endurance, cardiorespiratory fitness, mood level, motivation, energy level, and coordination. However, many of these claims are poorly supported with evidence-based studies [64].

6. Qigong

This is a form of Chinese health exercise and is an important part of Chinese traditional medicine, consisting of a combination of slow movements, self-massage, slow breathing, healing posture, and meditation [7, 18]. It is the most commonly practiced form of mindful exercise used worldwide, having been practiced for over 3,000 years. Qigong has been studied intensively in medical conditions including depression, hypertension, cardiovascular disease, and anxiety. Studies of qigong in cancer survivors ($N = 15$ studies) have reported benefits in QOL, mood, fatigue, and inflammation [72].

7. Methods

Two independent reviewers performed a literature search of the Ovid databases (EMBASE and MEDLINE) from inception until February 2012 (in the title area) and the PubMed database (in the title/abstract area) for the following terms: "yoga AND breast cancer," "tai chi chuan AND breast cancer," "Pilates AND breast cancer," "qigong AND breast cancer", and "mindful exercise AND breast cancer." Included in this analysis were the following types of human studies: randomized controlled (RCT), nonrandomized controlled (CCT), one-arm pilot studies, and surveys. Excluded from the analysis were reviews (systematic and nonsystematic), case reports, case series, and conference abstracts.

One investigator (DLS) then assessed the results and excluded studies in which the mindful exercise intervention was not specifically targeted to cancer survivors and those that were obvious duplicates. The reference list of the studies included was evaluated for missed publications and then these were included in the study. Studies for which the outcomes were reported as two to four separate publications were combined in a single entry.

The articles that met the inclusion criteria were reviewed independently by two investigators and the relevant data were abstracted.

8. Results

Yoga. The search "yoga AND breast cancer" identified 42 publications, of which 25 met the inclusion criteria. These included 17 RCTs, 1 survey, and 7 one-arm pilot studies. Table 1 describes the study design, type of yoga studied, outcome measured, and results of these studies.

Tai Chi Chuan. The search "tai chi chuan AND breast cancer"identified 11 studies of TCC in breast cancer survivors, and 5 qualified for inclusion: 4 RCTs and 1 one-arm pilot study, as described in Table 2.

Pilates. The search "Pilates AND breast cancer" identified 3 studies addressing the effect of the Pilates exercises in breast cancer survivors. Two were included in this review (1 RCT and 1 one-arm pilot). These studies are described in Table 3.

Qigong. The search "qigong AND breast cancer" identified 5 studies of qigong in breast cancer survivors and 4 were included in the analysis: 1 RCT, 2 CCTs, and 1 one-arm pilot, as listed in Table 4.

9. Discussion

This comprehensive review reveals that yoga is the most studied of the mindful exercise interventions in breast cancer survivors, whereas TCC, Pilates, and qigong are less well represented.

Yoga. Historically, the first publication of the effects of yoga in breast cancer survivors appeared in 2003 [75]. In this study, yoga was part of a more comprehensive intervention named "Mindfulness-Based Stress Reduction" (MBSR) in a sample of breast cancer ($N = 59$) and prostate cancer ($N = 10$) survivors. There was evidence of increased QOL and sleep quality and decreased stress after the intervention, but without a control group, the findings are limited.

It was not until 2006, when a survey of 2022 survivors of any cancer in the Nurses Health Study [6] showed that 62% of this population used one or more CAM methods, that the interest in yoga use in cancer survivorship increased. In this study, yoga was the only CAM intervention that increased the QOL compared to the nonusers of CAM. In fact, users of CAM methods other than yoga had a lower QOL compared to the nonusers in this study, a finding also seen in a previous study of general cancer survivors [76].

We identified 24 studies of yoga in breast cancer survivors. The outcomes assessed in these studies are heterogeneous, although some of them are a recurrent theme, such as fatigue (9 trials, 6 showing significantly favorable results), QOL (8 trials, all positive), anxiety (8 studies, all positive), and depression (9 studies, 8 positive). Other less common outcomes assessed were sleep (5 studies, 2 positive), stress, mood, mental health, affect, spirituality, vitality, distress, pain, physical fitness, cognition, chemo-induced nausea, and vomiting. Statistical significant or trends toward improvements were shown for all of these outcomes in the majority of the studies reviewed here. Notable negative results were found for weight, BMI, and hip circumference in a study of postmenopausal obese or overweight breast cancer survivors [28]. In this study, despite a slight weight gain, there was a significant decrease in the waist circumference of -3.1 cm in the yoga versus control population.

The population selected for these studies was relatively heterogeneous with respect to stage of disease and time since breast cancer diagnosis. In addition, the participants were

Table 1: Summary of studies involving yoga interventions in breast cancer survivors (in order of the publication date).

Reference	Intervention (type/duration)	Study design	N and characteristics	Main outcomes	Results/comments (group by time interactions reported for the controlled studies and time effects for noncontrolled studies)
Galantino et al. [24], 2012	Hatha yoga 10 weeks, 90′ sessions, 2x/week	One-arm qualitative, exploratory design	10 Aromatase inhibitors associated arthralgias	Performance accomplishment Structured experience Verbal support Physical feedback	Themes discovered: (i) empowerment (importance of camaraderie, community, and sharing) (ii) pain relief (iii) increased physical fitness (energy, flexibility, and function); relieved stress/anxiety (iv) transferability of yoga through breathing
Bower et al. [17], 2011	Iyengar yoga versus health education 12 weeks, 90′ sessions, 2x/week	RCT	31 Persistent fatigue Stages I-II Postmenopausal	Fatigue (FSI) Vigor (MFSI) Depression (BDI-II) Sleep (PSQI)	**Decreased fatigue*** **Increased vitality*** **Increased vigor*** **More confident on managing fatigue*** **Decreased depressive symptoms*** No difference in sleep
Galantino et al. [9], 2011	8 weeks, twice a week	One arm	10 Postmenopausal with AIs-induced arthralgias	Balance (Functional reach) Flexibility (Sit and Reach) Pain (BPI) Function (PSFS) QOL (FACT-B)	**Improvements in balance, flexibility, function, pain severity, and QOL** Trend towards reduced pain interference 80% adherence to the home program
Banasik et al. [25], 2011	Iyengar yoga versus wait list 8 weeks, 90′ sessions, 2x/week	RCT	18 Stage II-IV	QOL (FACT-B) Fatigue Likert scale Salivary cortisol	No difference in QOL **Decreased fatigue*** No difference in the slope of cortisol
T. Kovačič and M. Kovačič [26, 27], 2011	Yoga in daily life system + PT versus PT 4 weeks	RCT	32 Immediately after surgery	Self-esteem (RSES) General health (GHQ-12) Symptoms (RSCL) Stress (PSS)	**Improved self-esteem*** **Less distress during hospitalization and afterwards***
Littman et al. [28], 2011	Viniyoga (at home or classes) versus wait list 5x/week for 6 months	RCT	63 Obese and overweight women (BMI $\geq$ 24)	Feasibility (time to recruit, retention, adherence) QOL (FACT-G, FACT-B) Fatigue (FACIT-F) Weight and height Waist and hip circumference	12 months to recruit Attendance was 20 classes and 56 at home practices in 6 months 51% were satisfied the program Trend towards improved QOL and fatigue **Decreased waist circumference by −3.1cm*** No change in weight, BMI, and hip circumference
Bower et al. [29], 2011	Iyengar yoga 12 weeks, 90′ sessions, twice weekly	One arm	12 Persistent fatigue	Fatigue (FSI) Depression (BDI-II) Sleep (PSQI) Pain (BCPTSS) QOL (SF-36) Physical function (8-foot walk test, chair stands) Program Evaluation	**Decreased fatigue and number of days with fatigue/week*** **Improved vitality, depression, and general health*** No difference in sleep Trend towards decreased pain **All improvements persisted at 3 months after intervention*** **Improvement in physical function*** High satisfaction with the program

Table 1: Continued.

Reference	Intervention (type/duration)	Study design	*N* and characteristics	Main outcomes	Results/comments (group by time interactions reported for the controlled studies and time effects for noncontrolled studies)
Desai et al. [30], 2010	Any type of yoga	Survey of yoga use	300 Users of AIs	Sociodemographics of yoga users	17.7% breast cancer survivors used versus 6% in general population **Yoga use associated with white race, lower BMI, higher education, higher socioeconomic status, part-time employment, stage II cancer,previous chemotherapy, and previous radiotherapy*** **In multivariate analysis, yoga use was associated with higher education and lower BMI***
Speed-Andrews et al. [31], 2010	Iyengar yoga 12 week classes	One arm	24	QOL (SF-36, FACT-B) Fatigue (FSI) Stress (PSS) Anxiety (STAI) Depression (CESSDS) Body image (brief body image scale) Self-esteem (Rosenberg Self-Esteem Scale) Happiness (the happiness measure) Motivational outcomes Program evaluation	**Improved generic QOL (mental health, vitality, pain, and roleemotional)*** Trend of improvement in breast specific-QOL Trend of improvement on stress, depression, body image, and self-esteem Strong motivational response Very high satisfaction with the program, very high perceived benefit
Ülger and Yağli [32], 2010	8 yoga sessions	One arm	20	QOL (NHP) Stress (STAI-I, STAI-II) Satisfaction with the program	**Improved QOL*** **Decreased anxiety*** High satisfaction with yoga program
Chandwani et al. [33], 2010	yoga versus wait list 6 weeks 2x/week	RCT	61 Undergoing radiotherapy	QOL Fatigue Meaning finding Intrusive thoughts Sleep Depression/anxiety	**Improved health perception, physical functioning scores, more intrusive thoughts, and greater meaning finding*** No difference in fatigue, depression, sleep
Vadiraja et al. [34], 2009	Integrated yoga program (18–24, 60′ sessions) plus brief supportive therapy (every 10 days) versus brief supportive therapy (every 10 days)	RCT	88 Stage II-III Undergoing radiotherapy	QOL (EORTCQOL C30) functional scales Affect (PANAS)	**Improved positive affect*** **Improved emotional function*** **Improved cognitive function*** **Decrease in negative affect*** **Positive correlation between positive affect and physical, emotional, cognitive, and social function and global QOL***
Carson et al. [35], 2009	Yoga of awareness versus wait list 8 weeks	RCT	37 Stage I-II Vasomotor symptoms	Hot flashes before, after, and at 3 months after intervention	**Decreased hot flash frequency, severity, and total score*** **Improved joint pain, fatigue, sleep, bother, vigor, negative mood* (maintained at 3 months)** **More time practicing positively correlated with less fatigue, less bother, and more acceptance***

Table 1: Continued.

Reference	Intervention (type/duration)	Study design	*N* and characteristics	Main outcomes	Results/comments (group by time interactions reported for the controlled studies and time effects for noncontrolled studies)
Vadiraja et al. [36], 2009	Integrated yoga program (18–24, 60′ sessions) plus brief supportive therapy (every 10 days) versus brief supportive therapy (every 10 days)	RCT	88 Stage II-III Undergoing radiotherapy	6 AM salivary cortisol level before and after radiotherapy Self-rated anxiety, depression, and stress before and after radiation therapy	**Significant decreased anxiety, depression, perceived stress, and salivary cortisol*** **Cortisol level positively correlates with anxiety and depression***
Vadiraja et al. [37], 2009	Integrated yoga program (18–24, 60′ sessions) plus brief supportive therapy (every 10 days) versus brief supportive therapy (every 10 days)	RCT	88 Stage II-III Undergoing radiotherapy Mastectomy	Symptoms (RSCL) QOL (EORTCQOL C30) symptom scale	**Decreased fatigue*** **Decreased insomnia*** **Decreased appetite loss*** **Decreased psychological distress*** No change in physical distress No change inactivity level **Distress positively correlated with fatigue, nausea, vomiting, pain, dyspnea, insomnia, appetite loss, and constipation**
Danhauer et al. [38], 2009	Restorative yoga versus wait list Weekly 75′ sessions × 10 weeks	RCT	44 34% in active treatment	Physical Health (SF-12) QOL (FACT-B) Fatigue (FACT-Fatigue) Spiritual well-being (FACIT-Sp) Depression (CES-D) Sleep (PSQI) Affect (PANAS) Feasibility Program Evaluation	**Improved mental health, depression, positive affect, and spirituality*** **Greatest benefit on participants with higher negative affect and lower emotional well-being at baseline*** Trend towards decreased sleep latency and increased QOL Recruitment 19%, adherence 58%- higher in women with higher baseline physical health and QOL High satisfaction with class, no adverse events
Rao et al. [39], 2009	Integrated yoga program (1–7 weekly 60′ sessions for 24 weeks) plus 3-4 brief supportive therapy every 10 days versus brief supportive therapy every 10 days	RCT	98 Stage II-III Radiotherapy Chemotherapy	Anxiety (STAI) Symptom checklist	**Decreased anxiety andsymptom severity*** **Anxiety states positively correlate with symptoms severity and distress***
Rao et al. [40, 41], 2008	Integrated yoga program versus supportive therapy + exercise rehabilitation 4 weeks	RCT	98 Stage II-III Immediately at diagnosis	Anxiety (STAI) Depression (BDI) QOL (FLIC) Symptom checklist Lymphocytes, Immunoglobulins Cytokines Hospital stay Drain retention Time to suture removal Postoperative complications	**Decreased anxiety, depression, and treatment-related symptoms after surgery*** **Increased QOL after surgeryLess decrease in CD56% after surgery*** **Decrease in IgA levels after surgery*** **Significant decrease in hospital stay, drain retention, days to suture removal*** **Decreased TNFαafter surgery***

Table 1: Continued.

Reference	Intervention (type/duration)	Study design	N and characteristics	Main outcomes	Results/comments (group by time interactions reported for the controlled studies and time effects for noncontrolled studies)
Danhauer et al. [42], 2008	Restorative yoga Weekly 75′ sessions × 10 weeks	One-arm pilot	51 Breast and ovarian cancer (N = 14 with breast cancer)	Physical Health (SF-12) QOL (FACT-G) Spiritual well-being (FACIT-Sp) Fatigue (FACT-Fatigue) Depression (CES-D) Anxiety (STAI) Affect (PANAS) Feasibility Program evaluation	**Improvedmental health, QOL, fatigue, depression, state anxiety, and negative effect*** No change in positive affect and spiritual well-being Better adherence was associated with better physical health High satisfaction with the program (88% positive)
Rao et al. [43], 2008	Integrated yoga versus brief supportive therapy	RCT	37 Stage II-III Active cancer treatments	NK cell % after surgery, radiation, and chemo	**NK cell% was higher after chemo*** No difference in NK percentage after surgery and after chemo
Raghavendra et al. [44], 2007	Integrated yoga by instructor (at chemo and every 10 days and at home 60′ daily) versus supportive therapy (30–60′ at chemo and every 10 days)	RCT	62 Stage II-III Postmastectomy Post radiation Undergoing chemotherapy	Nausea and emesis (MANE) Anxiety (STAI) Depression (BDI) QOL (FLIC) Symptom check list Treatment-related toxicity and side-effects (WHO Toxicity criteria)	**Reduced frequency and intensity of chemo-associated nausea*** Trend towards reduced frequency and intensity of chemo-associated vomiting* **Reduced intensity and frequency of anticipatory nausea and vomiting*** **Nausea and vomiting (both anticipatory and after chemo), positively correlated with anxiety, depression, distress, and chemo-related toxicity and negatively with QOL*** **Decreased anxiety, depression, and distress*** **Increased QOL*** **Decreased treatment toxicity*** *
Moadel et al. [45], 2007	Hatha yoga versus wait list 12 weekly −90′ sessions	RCT	128 Ethnically diverse	QOL (FACT-B, FACT-G) Fatigue (FACIT-F) Spirituality (FACIT-Sp) Depressed mood Index mood (POMS) Adherence Program evaluation	**Less decrease in social well-being*** Subgroup analysis for nonchemo patients: **improved QOL, emotional, social, and spiritual well-being, distressed mood, anxiety, and irritability*** **Adherence was positively associated with physical well-being and negatively associated with fatigue and distressed mood*** Breathing and meditation components were rated higher than the social connection
Banerjee et al. [46], 2007	Integrated yoga versus supportive counseling plus light exercise 90′ sessions for 6 weeks, frequency not specified	RCT	68 Radiation therapy	Anxiety/depression (HADS) Stress (PSS) DNA damage assay	**Decreased anxiety, depression perceived stress, and DNA damage***

Table 1: Continued.

Reference	Intervention (type/duration)	Study design	*N* and characteristics	Main outcomes	Results/comments (group by time interactions reported for the controlled studies and time effects for noncontrolled studies)
Carson et al. [47], 2007	Yoga of awareness Weekly sessions for 8 weeks	One arm	21 Metastatic disease	Daily measures of pain, fatigue, distress, invigoration, acceptance, and relaxation Focus group feedback Focus Group Questionnaire	**Increase in daily invigoration and acceptance*** Trend towards improvements in pain and relaxation **Greater yoga practice positively associated with decreased pain, increased invigoration, and acceptance*** **Greater yoga practice positively associated with decreased next-day pain and fatigue and increased invigoration, relaxation, and acceptance*** Program was considered overall very helpful
Culos-Reed et al. [48], 2006	Modified Hatha yoga versus wait list 7 weeks of weekly 75′ sessions	RCT	38	Mood (POMS) Response to stress (SOSI) QOL (EORTC QLQ-C30) Physical activity (LSI) Fitness (CPA-FLA)	**Improvements in QOL, emotional functioning, and diarrhea*** tTrend toward improved emotional irritability, gastrointestinal symptoms, cognitive disorganization, mood, tension, depression, and confusion No difference in physical activity and fitness

AIs: Aromatase Inhibitors; BCPTSS: Breast Cancer Symptom Scale; BDS: Beck Depression Scale; BDI: Beck Depression Inventory; BPI: Brief Pain Inventory; CAM: Complementary and Alternative Medicine; CES-D: Center for Epidemiologic Studies-Depression Scale; CPA-FLA: Canadian Physical Activity, Fitness and Lifestyle Appraisal; EORTC QLQ-C30: European Organization for Research and Treatment Core Quality of Life Questionnaire-C30; FACT-B: Functional Assessment of Cancer Therapies-Breast; FACT-G: Functional Assessment of Cancer Therapies-General; FACIT-F: Functional Assessment of Chronic Illness Therapy-Fatigue; FACIT-Sp: Functional Assessment of Chronic Illness Therapy-Spirituality; FLIC: Functional Living Index for Cancer; FSI: Fatigue Symptom Inventory; GHQ-12: General Health Questionnaire-12; HADS: Hospital Anxiety and Depression Scale; IL-2R: Interleukin 2 Receptor; INF: Interferon; LOT-R: Life Orientation Test-Revised; LSI: Leisure Score Index; MANE: Morrow Assessment of Nausea and Emesis; MFSI: Multidimensional Fatigue Symptom Inventory; NHP: Nottingham Health Profile; PANAS: Positive and Negative Affect Schedule; POMS: Profile of Mood States; PSFS: Patient-Specific Functional Scale; PSQI: Pittsburgh Sleep Quality Inventory; PSS: Perceived Stress Scale; RCT: randomized controlled study (yoga versus control group); QOL: Quality of Life; RSCL: Rotterdam Symptom Checklist; RSES: Rosenberg; Self-Esteem Scale; SF-12: Short Form-12 Health Survey; SF-36: Medical Outcome Studies Short Form; SOSI: Symptoms of Stress Inventory; STAI: State Trait Anxiety Inventory; TNF: Tumor Necrosis Factor; bold text with*: statistically significant ($P < 0.05$).

Table 2: Studies involving tai chi chuan in breast cancer survivors.

Reference	Intervention (type/duration)	Study design	N	Main outcomes	Comments/results (group by time interactions reported for the controlled studies and time effects for non-controlled studies)
Reid-Arndt et al. [65], 2012	Yang style tai chi chuan 10 weeks, 60′ sessions, 2x/week	One arm	23 (16 with breast cancer) At least 12 months from chemotherapy	Neuropsychological tests (memory, executive function, language, and attention) Self-reported cognitive functioning (MASQ) Distress (IES-R) Mood (POMS-SF) Fatigue (POMS-SF) Balance	**Improvements in immediate and delayed memory, verbal fluency, attention, executive functioning, and self-reported cognitive functioning*** **Improvements in stress*** Trend toward improved vigor No changes in fatigue **Improved balance***
Sprod et al. [66], 2012	Yang style tai chi chuan versus standard support therapy 12 weeks, 60′ sessions, 3x/week	RCT	35	HRQOL (MOS SF-36) IL-6, IL-8 Glucose Cortisol Insulin, IGF-1; IGFBP-1; IGFBP-3	**Improved physical functioning and general mental health*** Trends towards improved social functioning and lack of increase in insulin levels
Janelsins et al. [67], 2011	Yang style tai chi chuan versus psychosocial support therapy 12 weeks, 60′ sessions, 3x/week	RCT	19	Insulin, IGF-I, IGFBP Body composition (weight, bmi, fat mass, fat-free mass) Cytokine levels (IL-6, IL-2 and IFN-γ	**Lack on increase in insulin levels*** No change in IGF-1,IGFBP or cytokines **Decreased BMI***
Peppone et al. [68], 2010	Yang style tai chi chuan versus psychosocial support therapy 12 weeks, 60′ sessions, 3x/week	RCT	16	Bone formation (serum BSAP) Bone resorption (serum NTx) Bone remodeling index IGF-1, IGFBP1,3 Cytokines (IL-2, 6, 8, IFN-γ2)	Trend towards an increase in bone formation and a decrease in bone resorption **Improvement in bone remodeling index***
Mustian et al. [69–71], 2008, 2006, 2004	Yang style tai chi chuan versus psychosocial support therapy 12 weeks, 60′ sessions, 3x/week	RCT	21	Functional capacity (aerobic capacity, muscle strength, and flexibility) QOL (FACIT-Fatigue) Body composition Self-esteem (RSE)	Trend toward improvement in aerobic capacity and flexibility **Improved muscle strength and QOL at 12 weeks*** No difference in body composition **Improved self-esteem*** **Self-esteem positively correlated with QOL***

BSAP: Bone-Specific Alkaline Phosphatase; FACIT-Fatigue: Functional Assessment of Chronic Illness Therapy-Fatigue; HRQOL: health-Related Quality of Life; IGFBP: Insulin-like Growth Factor Binding Protein; IL: Interleukin; IGF: Insulin-like Growth Factor; MASQ: Multiple Abilities Self-Report Questionnaire; NTx: N-Telopeptides of Type I Collagen; IES-R: Impact of Event Scale-Revised; POMS-SF: Profile of Mood States-Short Form; RSE: Rosenberg Self-Esteem Scale; bold text with*: statistically significant ($P < 0.05$).

generally not selected for a medical condition or symptom. Barton and Pachman [80] recommended that trials of mind-body interventions should include symptomatic patients in order for an effect size attributable to the intervention to be measurable. This might explain the heterogeneity of effect sizes observed in a systematic review of the effect of yoga on psychological outcomes in cancer survivors (mostly breast cancer) [81]. This review concluded that, although evidence for benefits exists, these should be interpreted with caution given the methodological flaws of the studies.

One notable exception is a study by Bower et al. [17] that selected a homogeneous population of fatigued (scores of ≤50 on the SF-36 vitality scale) stage 0-II breast cancer survivors. There was significant improvement in the fatigue level in yoga versus control wait-list intervention with a large effect size ($d = 1.5$), superior to other behavioral interventions is managing fatigue in cancer patients [82].

Fatigue is one of the most commonly assessed outcomes in the studies reviewed. Indeed, one-third of patients with cancer report persistent fatigue at five to ten years from diagnosis [83] and no interventions were clearly shown to improve or decrease the duration of this symptom. Yoga seems to be promising in this regard. A recent systematic review [84] addressing the effects of a yoga intervention on

Table 3: Studies involving Pilates method in breast cancer survivors.

Reference	Intervention (type/duration)	Study design	N	Main outcomes	Comments/results (group by time interactions reported for the controlled studies and time effects for non-controlled studies)
Stan et al. [73], 2012	Mat Pilates 12 weeks, 45′ sessions, 3–5x/week Postmastectomy	One arm	15 All had mastectomy	Shoulder ROM Spine flexibility Height Arm volumes QOL (FACT-B) Mood (POMS) Body image (MBSRQ)	**Improved shoulder abduction and internal rotation*** **Improved neck flexion and rotation towards the unaffected side*** No difference in spine flexibility and height **Increased arm volume of the affected compared to the unaffected side (subclinical lymphedema in 6 patients)*** **Improved QOL and certain scales of mood and body image***
Eyigor et al. [74], 2010	Mat Pilates plus home exercise (walking, stretching, and ROM) versus home exercises 8 weeks, 60′ sessions, 3x/week	RCT	52 All had mastectomy	Aerobic capacity (6MWT) Flexibility (modified sit and reach test) Fatigue (BFI) Depression (BDI) QOL (EORTC-QLQ-C30 and B23)	**Improved aerobic capacity*** No difference in the other outcomes

6MWT: 6-Minute Walk Test; BFI: Brief fatigue Inventory; BDI: Beck Depression Index; BPI: Brief Pain Inventory; EORTC-QLQ-C30: European Organization for Research and Treatment Cancer-Quality of Life; FACT-B: Functional Assessment of Cancer Therapies-Breast; MBSRQ: Multidimensional Body-Self-Relations Questionnaire; POMS: Profile of Mood States-Short Form; UE: Upper Extremity; bold text with*: statistically significant ($P < 0.05$).

fatigue in breast cancer survivors showed improvement in fatigue scores (SMD = 0.33, CI 0.01–0.65, $P = 0.04$). In fatigued patients, a low-moderate intensity physical exercise such as yoga might be more appealing and feasible than the regular aerobic exercises. Indeed, in the study by Bower et al. [17] the adherence to the intervention was excellent (80%), much higher compared to aerobic exercise intervention studies [2]. Furthermore, the program evaluation was excellent in all the studies assessing this outcome, suggesting that yoga is a popular intervention in breast cancer patients.

The lack of an active control group further impacts the methodology of these studies. Only 3 out of 18 RCTs had an active control group of physical activity intervention, whereas 15 were controlled with brief supportive therapy or wait list. Without a control group undergoing a nonmindfulness exercise intervention, it is very challenging to differentiate whether the benefits observed are specific to the yoga intervention or could be attributed to any exercise method or simply to the attention bias (for the studies with a wait-list design). Indeed, a recent systematic review comparing mindfulness-based exercise versus nonmindfulness exercise methods in people with depression has shown benefits from both categories of exercise in reducing the depression level and depression symptoms. A comparison between the two methods was not feasible, given the limitation of designs [18]. This suggests that specifically designed studies that are rigorously conducted need to be performed comparing a mindfulness based versus standard exercise intervention to be able to discern the true and significant benefits of the mindfulness component of an intervention such as yoga.

Another limitation of studies of yoga in breast cancer survivors is their almost exclusive appeal to the high-income, white population. The only study to include an ethnically and economically diverse population [45] reported on the effect of yoga versus usual care wait list in a multiethnic sample of 128 breast cancer survivors. There was no difference in QOL except for less decrease in social well-being in the yoga group. However, in a secondary analysis of the participants not receiving chemotherapy, significant improvements were seen in the overall QOL, emotional well-being, social and spiritual well-being, and less distressed mood in the yoga group compared to the control, wait-list group.

Overall, yoga intervention seems to be beneficial in this population, especially in fatigued patients. However, the results of these studies should be interpreted with caution, given the small sizes and the heterogeneity of the population, outcomes and yoga intervention (duration, frequency, and type of yoga program), and methodological limitations of the studies. Similar conclusions were drawn by a systematic review of the effects of yoga on psychological outcomes in cancer survivors [81] and by a review of integrative therapies in cancer survivors [80].

More rigorous studies of yoga have recently been conducted capturing the attention of the scientific community. A recent clinical trial by Mustian et al. focused on yoga versus usual care in 410 cancer survivors (75% with breast cancer) with sleep disturbances. This study showed significant improvement in sleep (22% versus 12%) and fatigue (42% versus 12%) and a significant decrease in the use of sleep medications in the yoga group compared with the

Table 4: Studies involving qigong in breast cancer survivors.

Reference	Intervention (type/duration)	Study design	N	Main outcomes	Comments/results (group by time interactions reported for the controlled studies and time effects for non-controlled studies)
Cohen et al. [77], 2010	External qigong (applied by qigong master) daily (2–5′) for 5 consecutive days	One arm	9 Untreated cancer Tumor size ≤ 3 cm	Tumor size by breast imaging QOL (FACT-B) Distress (BSI) Cancer-related symptoms (MIDAS)	No difference in tumor size No difference in QOL, distress, and symptoms
Oh et al. [7], 2010	Medical qigong versus usual care 10 weeks, 90′ sessions 2x/week Home practice 30′ daily	RCT	162 Only 34% were breast cancer survivors	QOL (FACT-G) Fatigue (FACT-Fatigue) Mood (POMS) Inflammation (CRP)	**Improvements in all domains of QOL*** **Improvement in fatigue*** **Improvement in overall mood and all subscales of mood, except for anger-hostility and confusion subscaleImprovement in CRP level***
Yeh et al. [78], 2006	Chan-Chuang qigong versus no intervention 21 days	CCT	67 Undergoing chemotherapy	CBC (on days 0, 8, 15, and 22 days of chemotherapy)	No change in WBC, platelets, and hemoglobin **Better rebound of WBC after 21 days***
Lee et al. [79], 2006	Chan-Chuang qigong versus no intervention 21 days	CCT	67 Undergoing chemotherapy	Symptom distress (SDS) Psychological distress (SCL-90-R) (on days 0, 8, 15, and 22 days of chemotherapy)	**Improved overall symptom score at day 22*** **Less numbness and heartburn on day 8, less pain and numbness on day 15, less pain, numbness, heartburn, and dizziness on day 22*** No difference in overall psychological score **Less hopelessness about the future on day 8, less unwillingness to live on day 22***

BSI: Brief Symptom Inventory; CRP: C-Reactive Protein; CBC: Complete Blood Count; FACT-B: Functional Assessment of Cancer Therapies-Breast; FACT-F: Functional Assessment of Cancer Therapies-Fatigue; POMSs: Profile of Mood States; MDASI: MD Anderson Symptom Inventory; SCL-90-R: Symptom Checklist-Revised; SDS: Symptom Distress Scale; bold text with*: statistically significant ($P < 0.05$).

usual care group [85]. In an abstract presented at the annual meeting of the American Society of Clinical Oncology in 2011, Cohen et al. reported on a study of yoga versus stretching versus control wait-list group on 163 breast cancer survivors undergoing radiotherapy. Yoga and stretching were superior to the control group in improving fatigue and physical functioning. Yoga was superior to the other groups in improving QOL, benefit finding, cortisol slope, and heart rate variability [86]. From these studies and the increasing interest in yoga for cancer survivors and medical institutions, it appears that yoga is establishing itself into the mainstream management and treatment of cancer survivors.

Tai Chi Chuan. The studies of TCC in breast cancer are few, generally small ($N = 16–21$), poorly controlled, and have heterogeneous outcomes. Benefits were shown in improvements in QOL, fat mass, bone formation, aerobic capacity, shoulder ROM, and self-esteem. However, a recent systematic review of this intervention failed to show any benefits attributable to TCC in the four RCTs included in the review [87]. The three, small nonrandomized, controlled clinical trials included in this review did show favorable effects in psychological and physical outcomes, although the risk of bias was high.

Future studies of TCC that include a symptomatic group of breast cancer survivors and compare TCC to other forms of low-impact aerobic exercise may be useful to help understand if the effects seen from TCC are unique to this form of exercise. With the increasing recognition of the importance of metabolic abnormalities such as hyperinsulinemia [88] in the prognosis of breast cancer, and of the prevalence of long-term sequelae such as metabolic bone disease [89] in this population, rigorous studies of tai chi chuan, a low-impact exercise intervention shown to improve these outcomes in noncancer patients, should be conducted.

Pilates. The study of the Pilates method in breast cancer survivors is underrepresented (only three studies exist addressing this method, one being a case series [73, 74, 90]), in contrast to the intense advertising of this method in the rehabilitation of breast cancer survivors. The evidence from these studies showed improvements in aerobic capacity, QOL, mood, body image after mastectomy, and improved shoulder ROM, as well as potential concerns of lymphedema. These findings are also limited by the small size and the limited research performed in this area. No studies of Pilates in survivors of types of cancer other than breast were conducted. Strong evidence to support Pilates as an effective rehabilitation method after breast cancer treatment is lacking at this time.

Qigong. The four studies of qigong in breast cancer survivors all have different outcomes. A small ($N = 9$) non-controlled study reported on the effects of externally applied qigong, by a qigong master, to the cancerous mass, failing to reveal a change in size or a change in psychological outcomes. The other three studies report on the effects of qigong practiced by the participants. The largest of these studies ($N = 162$) and with the strongest methodology did show significant improvements in QOL, fatigue, mood, and CRP levels [7], but only 34% of the participants in this study had breast cancer. A recent systematic review of qigong in cancer survivors has shown a significant improvement in the immune function, but no conclusion could be drawn towards psychological outcomes, due to the heterogeneity of the outcomes and the methodological flaws [91]. At this time, not enough evidence exists to recommend the use of qigong for breast cancer patients.

10. Conclusion

Our review has found that studies of mindful exercise interventions in breast cancer survivors are generally small, poorly controlled, and the outcomes are heterogeneous. With the exception of evidence that yoga improves fatigue in breast cancer survivors, no other strong conclusions can be derived, given the methodological limitations of the studies.

The significant interest by both patients and health care providers to integrate CAM therapies into the management of breast cancer survivors should hopefully lead to more effort and attention given to incorporating evidence-based CAM knowledge into clinical care. In this age of evidence-based medicine, CAM researchers will be expected to conduct RCTs that are adequately powered, well designed, and controlled, and with scrupulous attention paid to eliminating sources of bias. A multidisciplinary approach, in combination with personalized programs, has now become the state-of-the-art management of breast cancer. It is prudent that CAM researchers conducting clinical trials prioritize the need to assess safety, efficacy, and long-term benefits, while attempting to define the position of CAM in this complex therapeutic approach. With supporting evidence, health care providers are in a better position to educate survivors of breast cancer, help them make evidence-based decisions, and recommend CAM therapies that are demonstrated to improve QOL of their patients.

Acknowledgments

The authors gratefully acknowledge the invaluable guidance in the writing of this paper from Brent Bauer, MD and Mrs. Gladys Hebl, from Mayo Clinic Grant and Publication Support Services, who helped with the preparation and submission of the manuscript.

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2012, Article ID 124703, 9 pages
doi:10.1155/2012/124703

Review Article

Effects of Yoga Interventions on Fatigue: A Meta-Analysis

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Received 5 June 2012; Revised 25 July 2012; Accepted 26 July 2012

Academic Editor: Andreas Michalsen

Background. Researchers aimed at systematically reviewing and meta-analyzing the effectiveness of yoga interventions for fatigue. *Methods*. PubMed/Medline was searched until January 2012 for controlled clinical studies. Two reviewers independently extracted the data. The methodological quality of the studies was assessed. A meta-analysis was performed. *Results*. Nineteen clinical studies (total $n = 948$) were included in this review. Investigated yoga styles included Hatha, Iyengar, Asanas, Patanjali, Sahaja, and Tibetan yoga. Participants were suffering from cancer, multiple sclerosis, dialysis, chronic pancreatitis, fibromyalgia, asthma, or were healthy. Yoga had a small positive effect on fatigue (SMD = 0.27, 59% CI = 0.23–0.31). Seven studies received 4 points on the Jadad score. There were baseline differences in at least 5 studies. *Conclusion*. Overall, the effects of yoga interventions on fatigue were only small, particularly in cancer patients. Although yoga is generally a safe therapeutic intervention and effective to attenuate other health-related symptoms, this meta-analysis was not able to define the powerful effect of yoga on patients suffering from fatigue. Treatment effects of yoga could be improved in well-designed future studies. According to the GRADE recommendations assessing the overall quality of evidence, there is a moderate effect of the confidence placed in the estimates of the effects discussed here.

1. Introduction

Prolonged fatigue is defined as self-reported, persistent fatigue lasting 1 month or longer. In the United States it is reported that 24% of the general adult population has had fatigue lasting 2 weeks or longer; 59% to 64% of these persons reported that their fatigue has no defined medical cause [1, 2]. When fatigue cannot be specifically explained by a medical condition such as anemia or hypothyroidism, it may represent a chronic fatigue syndrome. Chronic fatigue syndrome is an illness characterized by profound disabling fatigue lasting at least 6 months (persistent or relapsing) and accompanied by numerous rheumatological, infectious, and/or neuropsychiatric symptoms [3]. The presence of chronic fatigue requires clinical evaluation to identify any conditions underlying or contributing which may require treatment. Further diagnosis cannot be made without such an evaluation.

Risk factors for fatigue are cancer and its treatment, pain, nausea, depressive symptoms, and other psychological dysfunctions or burdens. All models that try to explain the cause and development of fatigue assume that there are complex, multicausal processes that create the disability. Suggested pathophysiological factors include a dysregulation of inflammatory cytokines, interruption of the regulatory circuits of the hypothalamus, changes in the serotonin system of the central nervous system, and interruption of the circadian secretion of melatonin and of the circadian rhythm [4–15].

Among the various treatment strategies, that is, exercise, psychosocial support, stress management, nutrition, sleep regulation, and restorative therapy [34], physical activity was identified as important particularly for patients with advanced stages of cancer to attenuate anxiety, depression, stress, and fatigue [35]. Also, meditation programs were shown to improve mood and sleep quality and to reduce stress and fatigue in cancer patients [36]. Yoga, one of the best known and frequently used mind-body interventions, combines physical exercises and meditation [37] and might thus also be effective to attenuate fatigue.

Yoga's conceptual background originates in Indian philosophy, and there are numerous schools or types of yoga (i.e., Iyengar, Viniyoga, Sivananda, etc.) with distinct priorities in terms of spiritual and physical practices [37]. A typical yoga session with a specific sequence of postures (*asanas* of Hatha Yoga), breathing techniques (*pranayama*), and mental concentration/meditation (*dhyana*) lasts between 1 and 2 hours.

Presumed benefits of yoga include increased muscular strength, flexibility, range of motion, energy, relaxation, and sense of well-being, decreased pain, improved sleep quality, stress reduction, and control over physiological parameters [26, 38–41].

So far, in one RCT it has been demonstrated that the practice of yoga improves fatigue levels in psychiatric inpatients following at least one yoga session [42]. Furthermore, it was shown in a 4-month RCT that yoga could reduce fatigue scores in asthma patients [25] and a 12-week intervention with an RCT design also reduced fatigue scores in patients with chronic pancreatitis [43]. This range of health conditions shows that yoga is being used as a therapy for patients with numerous conditions, some of which involve fatigue.

Thus, yoga could in fact be a beneficial supportive intervention to attenuate fatigue, but there is currently lack of an adequate meta-analysis to assess its effectiveness with respect to fatigue symptoms. To assess its putative relevance in the treatment of patients with fatigue caused by various conditions, we performed a meta-analysis of the current literature focusing on fatigue and fatigue-associated disability.

2. Materials and Methods

2.1. Literature Search Strategy. We searched the electronic literature database PubMed/Medline until January 2012 for clinical studies focusing on yoga interventions and fatigue. English language search terms were "yoga * fatigue." To increase the chance to find all relevant publications describing the effects of yoga interventions on fatigue, there were no limitations in the initial search in terms of language, year, status, or design. Reference lists of reviews on yoga for fatigue were scanned for further trials. Finally, experts were contacted for gray literature not listed in the databases mentioned above, and reference lists of relevant articles and authors were checked.

2.2. Selection Criteria. All potentially eligible studies were retrieved and the full-text articles were reviewed to determine whether they met the inclusion criteria.

Inclusion criteria were controlled clinical studies (randomized or nonrandomized) addressing the effects of yoga interventions on fatigue symptoms. The findings were analyzed with respect to fatigue scores on various outcome measures. We excluded case series, case reports, studies lacking a control group, expert statements, and theoretical reflections. We also excluded studies with complex interventions such as mindful-based stress reduction (MBSR) programs (which include yoga practices), because the contributing effects of the relevant elements cannot be distinguished.

2.3. Data Extraction. Review authors (S. M. and A. B.) assessed studies for inclusion in the review. They took part in the extraction of data and independent assessment of methodological quality (S. M. and K. B.). Disagreements were resolved by consensus. We extracted study data on the following topics: general study design (prospective, multicenter, etc.), treatment allocation (randomization, matched pairs, etc.), treatment concealment and blinding, treatments (yoga style and practices, duration and frequency, type of control intervention), patient characteristics (mean age, gender distribution), diagnosis, adherence to therapy (compliance, drop-outs, etc.), and outcome assessments, that is, fatigue scores pre-post.

To assess the methodological quality of the respective studies, we adopted the Jadad score which refers to randomization (0 to 2 points), blinding of the assessor (statistician, physician, assessor, or researcher, as cited in the original publications; 0 to 1 points), and dropout reporting (0 or 1 point) as indicators of methodological quality of a study [44]. Because it is impossible to blind also patients (double blind) in yoga studies, the maximum achievable Jadad score was 4 in our review. However, while it is clear what blinding of a "statistician" means, it is not very clear what blinding of "researcher" (as it was stated in some studies) may mean; we assumed that this term refers to the outcome assessor.

Allocation concealment was assessed in accordance with the Cochrane guidelines [45]: *A* means adequate (telephone randomization or using consecutively numbered, sealed, opaque envelopes); *B* means uncertainty about the concealment (method of concealment is not known); *C* means inadequate (e.g., alternate days, odd/even date of birth, hospital number).

2.4. Statistical Analysis. All relevant outcome data were extracted as they were given in the publication. They were converted into standardized mean differences (SMD) and their standard errors (SE) using standard formulas [45]. An SMD 0.2 indicates a small effect, 0.5 a moderate, and 0.8 a large effect [46].

Overall estimates of the treatment effect were obtained from random effects meta-analysis [47]. We performed various subgroup analyses with respect to condition, methodological quality, and duration of treatment. Heterogeneity between studies was assessed by standard χ^2-tests and the I^2 coefficient which measures the percentage of total variation across studies due to true heterogeneity rather than chance [48]. I^2 coefficients 25% would indicate low, 30–60% moderate, and >75% high heterogeneity.

Heterogeneity was formed by study quality (high: Jadad score = 4 and allocation concealment = *A*), moderate quality (scores 2-3), low quality (score 0-1), and type of control group (waiting list: routine care only; active treatment: any other intervention given additionally to routine care). Funnel plot asymmetry was assessed by Egger's test [31].

Finally, we carried out a grading of recommendations assessment, development, and evaluation (GRADE) in order to being able make judgments about evidence and recommendations in this field of yoga for fatigue. The GRADE system judges and rates the quality of the evidence underlying the recommendation made in a meta-analysis [50]. During this process factors that affect the strength of a recommendation include the quality of evidence, the uncertainty about

TABLE 1: Overview of identified studies.

First Author [Study-ID]	Year	Fatigue condition	N (analyzed)	Yoga style	Control intervention(s)	Duration of treatment	Methodological quality*	Instrument	SMD	SD
Bower et al. [4]	2011	Breast cancer	31	Iyengar	Health education class	12 weeks	4	FSI	0.95	0.14
Carson et al. [16]	2009	Breast cancer	30	Yoga awareness	Waiting list	8 weeks	4	Diary	0.93	0.09
Chandwani et al. [17]	2010	Breast cancer	61	Patanjali	Waiting list	6 weeks	3	BFI	0.66	0.07
Littman et al. [18]	2011	Breast cancer	63	Hatha	Waiting list	24 weeks	3	FACT-F	−0.01	0.06
Vadiraja et al. [19]	2009	Breast cancer	75	Asanas, Pranayama	Supportive counseling	6 weeks	3	EORTC	0.74	0.24
Banasik et al. [20]	2011	Breast cancer	14	Iyengar	Waiting list	8 weeks	2	Cella's FACT-B	1.62	0.24
Danhauer et al. [21]	2009	Breast cancer	27	Asanas, Pranayama	Waiting list	10 weeks	2	FACT-F	0.51	0.14
Moadel et al. [22]	2007	Breast cancer	128	Hatha	Waiting list	12 weeks	2	FACT-F	0.05	0.03
Carson et al. [23]	2010	Fibromyalgia	50	Yoga awareness	Waiting list	8 weeks	4	FIQ-R	0.26	0.08
Cohen [24]	2004	Lymphoma	39	Tibetan	Waiting list	7 weeks	4	BFI	0.00	0.10
Manocha et al. [25]	2002	Asthma	59	Sahaja	Relaxation, group discussion, CBT	16 weeks	4	POMS		
Oken et al. [26]	2004	Multiple sclerosis	57	Iyengar	Waiting list/Exercise class + stationary bike	24 weeks	4	MFI	0.63	0.31
Oken et al. [27]	2006	Healthy	135	Hatha	Waiting list/Exercise class + walking	24 weeks	4	MFI	0.03	0.21
Speca et al. [28]	2000	Different types of cancer	90	Yoga stretches	Waiting list	7 weeks	3	POMS	0.38	0.21
Yurtkuran et al. [29]	2007	Dialysis	40	Asanas	Standard therapy	12 weeks	3	VAS	0.01	0.07
Khalsa et al. [30]	2011	Healthy	121	Yoga education class	Physical education class	11 weeks	2	POMS	0.48	0.11
Sareen et al. [31]	2007	Chronic pancreatitis	52	Iyengar	Standard therapy	12 weeks	2	SF-36	1.36	0.30
Berger et al. [32]	1992	Healthy	50	Hatha	Swimming	14 weeks	1	POMS	0.93	0.09
Velikonja et al. [33]	2010	Multiple sclerosis	nr	Hatha	Sports climbing	10 weeks	1	MFI	0.29	0.14

*Jadad score.

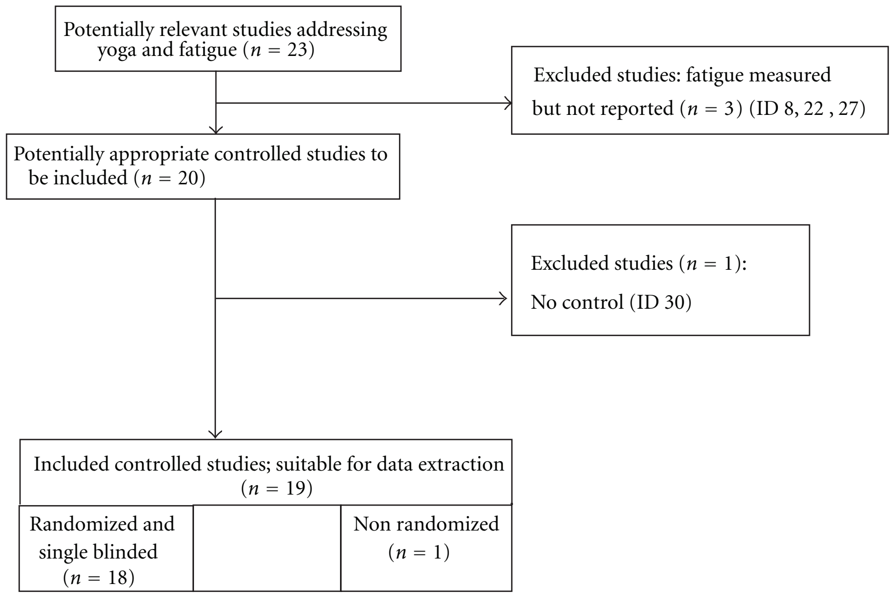

Figure 1: Flow chart.

the balance between beneficial and harmful consequences, the uncertainty or variability in values and preferences, and the uncertainty about whether the intervention represents a wise use of resources [51]. The quality assessment includes factors such as the design of the study, rating the level of quality and its limitations, rating the consistency across included studies, and the directedness of outcome measures [52].

3. Results

3.1. Literature Search Results. We found 23 potentially relevant studies addressing the effects of yoga on fatigue [16–23, 27–30, 32, 33, 49, 53–59]. Among them, four studies were excluded because either they delivered no baseline data, had no control group, or measured but did not report pre-post fatigue scores. Nineteen controlled studies with a total of 948 patients were considered eligible for inclusion (Figure 1).

3.2. Participant Characteristics. The type of patients included breast cancer patients ($n = 8$ studies), different types of cancer ($n = 1$), lymphoma ($n = 1$), patients with multiple sclerosis ($n = 2$), dialysis ($n = 1$), chronic pancreatitis ($n = 1$), fibromyalgia ($n = 1$), asthma ($n = 1$), and also healthy participants ($n = 3$). The number of individuals analyzed varied considerably from 14 to 135 (mean ± SD: 62 ± 35) (Table 1).

3.3. Study Designs and Methodological Quality. According to specifications in the articles, all 19 studies had a prospective design. Eighteen studies were randomized, whereas one study was not randomized. Seven studies were single blinded (i.e., statistician, physician, assessor, or researcher, as stated in the respective studies) and randomized and thus had a higher methodological quality (JADAD score 4). Ten studies were randomized (without blinding) and displayed a moderate methodological quality (scores 2-3). One study was randomized but with a low quality (Jadad score 1) (Table 1).

Eleven studies applied a waiting-list control group design of which 2 others also had a third active control group either attending an exercise class using a stationary bike or a walking exercise class. Two further studies applied a design where one control group received standard care and one of these 2 trials also had an active control group which received supportive counseling. Other active controls were a health education and a physical education class, sports climbing, swimming, relaxation, and cognitive behavioral therapy.

The methodological quality of the studies ranged from very low to medium. Two clinical trials only received one point on the Jadad score, five studies received 2 points, 5 studies received 3 points, and 7 further studies received the maximum of 4 points. Ten studies were assuring blinding of the outcome assessor, which means that in the interpretation of the remaining studies a detection bias should be taken into account. Only 7 studies addressed incomplete outcome data, meaning that rest of the trials is under the influence of attrition bias. Twelve studies analyzed their data based on intention to treat. Apart from 2 trials all others described the dropout rate and how the data were dealt with.

3.4. Intervention Characteristics: Duration of Intervention. Researchers in those included studies applied Hatha, Iyengar, Asanas, Patanjali, Sahaja, and Tibetan yoga. The whole duration of taught yoga classes lasted between 5 and 24 weeks with the majority of studies lasting more than 8 weeks.

3.5. Outcome Measures. Most of these studies measured more symptom outcomes than merely fatigue, for instance, anxiety, depression, and sleep disturbance. Instruments to

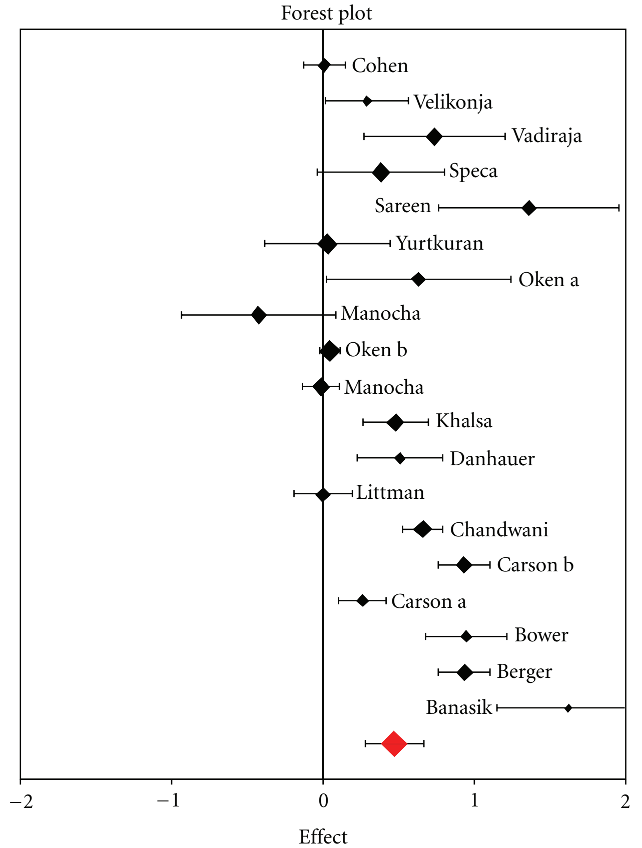

Figure 2: Forest plot with effect sizes for included studies, SMD = 0.27 [0.23–0.31], $I^2 = 94.4\%$.

measure fatigue symptoms were MFI, POMS, SF-36, FACT-F, EORTC, BFI, diaries, and visual analogue scales (VAS).

3.6. Effect Sizes Fatigue. As shown in Table 1, most studies reported positive effects in favor of the yoga interventions. With respect to fatigue, a random effect meta-analysis estimated the overall treatment effect at SMD = 0.27 [0.23; 0.31] ranging from -0.43 ± 0.26 to 1.62 ± 0.24 (Figure 2). Overall heterogeneity of study results was high ($I^2 = 94.4\%$).

3.7. Subgroup Analyses. Subgroup analysis (Table 2) enrolling only those studies with comparable means at baseline showed effect sizes ranging from -0.4 ± 0.23 to 1.6 ± 0.24. Those studies with a high methodological quality showed less of an effect of the yoga intervention on fatigue (SMD = 0.24 [0.18; 0.29]) than those with high quality (SMD = 0.46 [0.37; 0.55]).

Trials with a waiting list control group also showed less of an effect (SMD = 0.22 [0.18; 0.27]) than those that used other controls such as, for instance, health education class, relaxation, swimming, or exercise (SMD = 0.47 [0.38–0.55]) (Table 2).

Interestingly, studies enrolling (breast) cancer patients had lower effects in favor of yoga than those studies with other conditions (including healthy individuals) (Tables 1 and 2).

3.8. Nonrandomized Study. One study was included that was non-randomised. Velikonja et al. [33] carried out a clinical controlled trial with 50 healthy participants who chose either to take part in a Hatha yoga class or to attend a swimming class for a 14-day treatment period. Changes in fatigue were assessed with the POMS and there was a positive effect of the yoga over the swimming (SMD = 0.93 (SD = 0.09)).

4. Discussion

The findings of this meta-analysis, enrolling 18 RCT, with single-blinding and 1 N-RCT, indicate small effects of yoga interventions on fatigue, particularly in patients with cancer.

The overall treatment effects were weak, while the heterogeneity was high. Subgroup analyses did not provide further explanations (i.e., studies with passive control had smaller effects that those with an active control; studies with higher quality had better effects than those with low quality). In fact, among 7 studies with a high quality (Jadad score 4), 4 studies had high treatment effects, 1 study a weak effect, and 2 studies no effect. The highest effects were observed in studies with low quality (Jadad score 1-2), but the lowest, too. This may be attributed to the fact that generally adequate sample sizes in the high-quality studies permitted a greater statistical power to detect any beneficial

Table 2: Subgroup analyses.

Subgroup	Enrolled studies (ID numbers)	SMD	95% CI	I^2
Overall	1, 2, 4, 5, 7, 11, 12, 14, 16, 17, 19, 21, 24, 25, 28, 29, 31, 32, 33	0.27	0.23–0.31	94.4%
Jadad score				
High	4, 5, 16, 17, 25, 29, 32	0.46	0.37; 0.55	93.3%
Intermediate	7, 12, 19, 24, 28	0.23	0.15; 0.30	94.3%
Low	1, 2, 11, 14, 21, 31, 33	0.24	0.18; 0.29	96.0%
Control group*				
Waiting list	1, 4, 5, 7, 12, 14, 25, 28, 31	0.22	0.18; 0.27	95.8%
Other controls	2, 11, 19, 21, 24, 29, 32, 33	0.47	0.38; 0.55	93.7%
Condition				
Cancer	1, 4, 7, 12, 14, 19, 25, 28, 29, 31	0.20	0.15; 0.24	94.3%
Noncancer	2, 5, 11, 16, 17, 21, 24, 32, 33	0.46	0.24; 0.67	76.6%

* Excluded from analysis since more than 1 control (Oken et al. [27], Oken et al. [49]).

Table 3: GRADE recommendation: Fatigue (assessed with: various fatigue subscales).

Quality assessment							No of patients (yoga: control)	Effect SMD (95% CI)	Quality
No. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations			
19	RCT	No serious risk of bias	Serious[1]	No serious indirectness	No serious imprecision	None	458 : 490	SMD = 0.27, 95% CI = 0.23–0.31, I^2 = 94.4%	Moderate

[1] Baseline differences between groups in at least 5 studies.

effects of the treatments. Possibly, further sub-group analyses could provide an indication of confounding variables which were not taken into consideration in this meta-analysis.

It was striking that studies enrolling patients with cancer had lower effects than those with other conditions. One may conclude that the effectiveness of yoga interventions to attenuate cancer-related fatigue is limited. Nevertheless, at least four of these studies had strong effects in favor of the yoga interventions, while two studies (and one study enrolling lymphoma patients) showed no beneficial effects compared to the control group. Most of these studies had a passive control, and thus one may expect effects in favor of the yoga group. Moreover, among these studies one may find those with both higher and lower quality, different types of yoga styles, and differences in the duration of treatments (7 to 24 weeks)—and thus one cannot easily attribute the effects to differences in quality of the studies. Because of these less clear-cut data with respect to cancer-related fatigue, more convincing high-quality studies with active controls and circumscribed duration of treatment (i.e., 12 weeks) are highly encouraged to draw valid conclusions.

With respect to other indications, yoga had weak effects on fatigue in patients with fibromyalgia (SMD 0.26), while in two studies with multiple sclerosis the effects ranged from SMD 0.29 to 0.63. The effects were much better in a study with weak methodology enrolling patients with chronic pancreatitis (SMD 1.36). There were no relevant effects in patients with dialysis and lymphoma. However, three studies addressed fatigue symptoms in healthy individuals; two studies with weak methodology reported positive effects (SMD ranging from 0.48 to 0.93), while one study with higher quality showed no effect in favor of yoga (SMD 0.03). Thus, the evidence that yoga might be effective to treat fatigue symptoms in noncancer diseases is so far rather weak. Although the summarized treatment effects in the cancer studies were weak, there are at least some promising studies which indicate that the treatment effects could be improved. It was of interest that the best results in cancer patients were yielded in those studies with shorter duration of treatment which could indicate that motivation of cancer patients might be a crucial factor too.

Certainly, this meta-analysis has its limitations. For example, the pooled estimates were based on heterogeneous data, with respect to indications, control groups, duration of treatment, yoga style, and methodological quality of these studies. The time intervals of measuring pre/post-fatigue were different across all studies. Furthermore, one non-randomized study was included in the meta-analysis (Velikonja et al., [33])—albeit discussed separately. A general problem in this field of research also seems to be the variety of outcome measures used for the given endpoint—in this case fatigue symptoms. For instance, the "vitality" subscale on the SF-36 does not adequately capture fatigue since the used items do not capture the full burden of chronic fatigue, which is reflected by the developing research team who defines minimum vitality as "feeling tired and not as fatigued." With respect to the GRADE criteria (Table 3), there were neither serious risks of bias nor serious inconsistency, indirectness, nor imprecision. Overall, the estimated treatment effect of the papers was moderate, but the studies' outcome effects were not associated with their methodological quality.

Future studies should also address patients' motivation, impacts not only the number of drop-outs, but also the (intrinsic) intensity of practice ("inner congruence"). These studies have to identify which patients may benefit from the interventions [60] and which aspects of the yoga interventions (i.e., physical activity and/or meditation and subsequent life style modification) or which specific yoga styles were more effective than others.

5. Conclusion

Although yoga is in general a safe therapeutic intervention and effective to attenuate several other health-related symptoms, this meta-analysis is not able to define relevant effects of yoga on patients suffering from fatigue. According to the GRADE recommendations assessing the overall quality of evidence, there is a moderate confidence effect of the confidence placed in the estimates of the effects discussed here (Table 3). Nevertheless, there are some studies on cancer-related fatigue which indicate that treatment effects of yoga could be improved in well-designed future studies.

Acknowledgment

The authors would like to thank Professor G. B. Marks for the supply of some missing values.

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2012, Article ID 971896, 11 pages
doi:10.1155/2012/971896

Research Article

The Physical Demands of the Tree (Vriksasana) and One-Leg Balance (Utthita Hasta Padangusthasana) Poses Performed by Seniors: A Biomechanical Examination

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Received 3 May 2012; Accepted 23 July 2012

Academic Editor: Andreas Michalsen

Yoga is considered especially suitable for seniors because poses can be modified to accommodate practitioners' capabilities and limitations. In this study, biomechanical assessments on healthy seniors ($n = 20$; 70.1 ± 3.8 yr) were used to quantify the physical demands, (net joint moments of force [JMOFs] and muscular activation in the lower extremities) associated with the performance of 3 variations (introductory, intermediate, advanced) of 2 classical Hatha yoga poses – Tree and One-Leg Balance (OLB). ANOVA and Cohen's-d were used to contrast the postural variations statistically. The advanced (single-limb, without additional support) versions were hypothesized to generate the greatest demands, followed by the intermediate (single-limb [Tree] and bilateral-limb [OLB] with support) and introductory (bilateral-limb) versions. Our findings, however, suggest that common, long-held conceptions about pose modifications can be counter-intuitive. There was no difference between the intermediate and advanced Tree variations regarding hip and knee JMOFs in both the sagittal and frontal planes ($P = 0.13$–0.98). Similarly, OLB introductory and intermediate variations induced sagittal JMOFs that were in the opposite direction of the classic advanced pose version at the hip and knee ($P < .001$; $d = 0.98$–2.36). These biomechanical insights provide evidence that may be used by instructors, clinicians and therapists when selecting pose modifications for their yoga participants.

1. Introduction

Yoga is a popular exercise activity for older adults, with senior participation in the US estimated at greater than 900,000 participants—an increase of 90% between years 2007 to 2010 [1]. Likely contributing to this rise in participation are anecdotal and lay-journal reports that yoga increases joint range of motion, strength, and balance, improves emotional and spiritual wellness, and that it is relatively safe. Moreover, yoga appears to be especially suited for seniors because programs and individual postures can be modified and tailored to accommodate a variety of participant physical capabilities and limitations [2–4]. Unfortunately, well-designed, randomized controlled trials examining yoga in seniors are rare, and little is known regarding the physical demands, program efficacy, and safety of programs designed for older adult participants. Moreover, seniors have diminished strength and balance, reduced joint range of motion, and a greater prevalence of spinal-canal stenosis, osteoarthritis, and hyperkyphosis [5–7]; therefore, yoga programs designed without using evidenced-based prescription may place elders at risk for musculoskeletal and neurological pain and injury (e.g., strains, sprains, and impingements).

In the present study, we provide some of this evidence by characterizing the physical demands associated with the performance of 3 common variations (we termed these introductory, intermediate, and advanced) of 2 classical Hatha poses, Tree (Vriksasana) and One-Leg Balance (Utthita Hasta Padangusthasana; OLB). The physical demands of yoga can be quantified by estimating the net joint moments of force (JMOFs) and muscular activation patterns generated during performance of the individual poses and their modifications. While performing a pose, external reaction forces (e.g., ground reaction forces; GRFs) acting on body segments produce external JMOFs about the joints. Acting in the opposite direction, these external JMOFs must be met by internal JMOFs generated via muscular and ligamentous constraints in order to maintain the position of the body's center of mass and/or prevent collapse of the limbs. Although increased muscle loading due to JMOFs may stimulate beneficial adaptational responses (e.g., strength and endurance), excessively high JMOFs may lead to the detrimental loading of articular, ligamentous, and capsular structures and exacerbate existing joint pathology (e.g., osteoarthritis; OA) [8, 9]. For example, a pose that induces a high medial (abductor) JMOF at the knee is likely to increase the stress on the medial collateral ligament and raise the joint reaction forces across the lateral condyles. Conversely, high lateral knee (adductor) JMOFs, produced during functional activities (e.g., walking), have been shown to predict OA progression [10, 11].

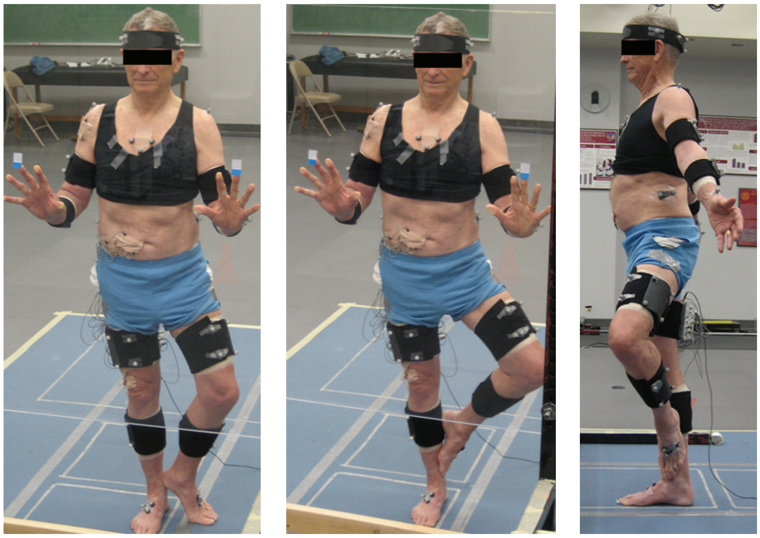
Information regarding the JMOFs and muscle activation patterns associated with yoga poses may be used by instructors, clinicians, and therapists to select the most appropriate pose versions, targeted at each participant's experience, physical capabilities, and injury history. This information may also be used to determine when it is appropriate to "advance" participants by prescribing the more demanding pose variations. For the present investigation, we hypothesized that for, both the Tree and OLB poses, the "introductory" versions (with bilateral-limb and wall support (Tree); bilateral-limb and block support (OLB)) would generate the smallest physical demands, the "intermediate" versions (with single-limb and wall support (Tree) and bilateral-limb and chair support (OLB)) would generate intermediate demands, and the most "advanced" versions (with unilateral-limb support alone (Tree and OLB)) would generate the greatest physical demands across all lower extremity (LE) joints and planes of motion. Our *a priori* hypotheses are based on the accumulative experience of the research team, which included a geriatrician, biomechanist, yoga instructor with extensive clinical-trial and senior-student training experience, and a physical therapist [12].

2. Subjects and Methods

2.1. Subjects. Participants in this study were part of the Yoga Empowers Senior Study (YESS) [12]. The YESS study sample consisted of 6 men and 14 women, aged 70.7 years (±3.8 years). Mailing lists, physician referrals, flyers, and newspaper advertisements were used to recruit the participants. Initial eligibility (e.g., age) was evaluated by phone, and then additional inclusion and exclusion criteria were assessed in person. The following were exclusions: active angina; uncontrolled hypertension (SBP > 160 or/and DBP > 90); high resting heart rate (greater than 90) or respiratory rate (greater than 24); unstable asthma or exacerbated chronic obstructive pulmonary disease; cervical spine instability or other significant neck injury; rheumatoid arthritis; unstable ankle, knee, hip, shoulder, elbow, or wrist joints; hemiparesis or paraparesis; movement disorders; peripheral neuropathy; stroke with residual deficit; severe vision or hearing problems; walker or wheelchair use; not able to attend in-person classes; has not had checkup by regular provider within 12 months (if not taking any prescription medications) or in the past 6 months (if any regular medicines taken). Participants also had to execute the following safety tests stably and independently: transition from standing to recumbent on the floor and reverse; lift both arms to shoulder level; stand with feet side-by-side for 30 seconds; stand with feet hip-width apart for 60 seconds.

2.2. Study Design. The YESS study was a single armed pre-post intervention study of 2 specified series of Hatha yoga postures, conducted in ambulatory, community-dwelling adults aged 65 years or greater. The Yoga intervention was delivered 2 days per week, 1 hour per session, for 32 weeks. We used Hatha yoga, which teaches *asanas* (postures) and *pranayama* (breathing). The intervention consisted of 2 sets of postures, Series I and Series II, designed to be progressive (i.e., to advance in difficulty) and to train major muscle groups that are integral to conducting activities of daily living. These included the shoulder/upper extremity (necessary for reaching and for carrying light loads); trunk stabilizers (for balance); hip/lower extremity (for static and dynamic balance, locomotion, and transfers (e.g., sit to stand)). We used modified versions of standard *asanas*, tailored in a manner that we believed to be suitable for independent, ambulatory seniors. Specific postures were selected by the research team based upon our combined knowledge of yoga, biomechanics, physical therapy, and movement science. Reproducibility was also a specific goal; we therefore modeled the YESS program after the Ashtanga School, which uses a standard set of opening and closing postures, and a variable middle series which progresses in difficulty. Similarly, YESS used opening and closing sequences and 2 ordered, progressive middle sequences, termed Series I (first half of the study) and Series II (second half of the study). Using this standardized approach makes the intervention transparent to both the research and the teaching communities.

This paper focuses on the biomechanical analysis of 2 poses, Tree (Vriksasana) and OLB (Utthita Hasta Padangusthasana) (see the following for description of biomechanical data collection and analysis). Three versions of each of these poses were instructed across the 2 series of the YESS intervention. The poses were "progressed" in difficulty by reducing the limb support from a bilateral stance (introductory versions) to single-limb stance (advanced versions) and by reducing or removing additional supporting structures (wall, chair, blocks). By the end of the study, the participants were practiced at performing all 3 versions of each pose. The object of the current analysis was to examine the biomechanics of the 3 progressive versions of each pose; therefore, we used biomechanical data from the



(a) (b) (c)

Figure 1: The variations of Tree pose, performed while the participant is instrumented for biomechanical analysis. (a) TreeWF: Tree pose with hands on wall and contralateral foot on the ground; (b) TreeW: Tree pose with hands on wall; (c) Tree: free-standing, single-support Tree pose.

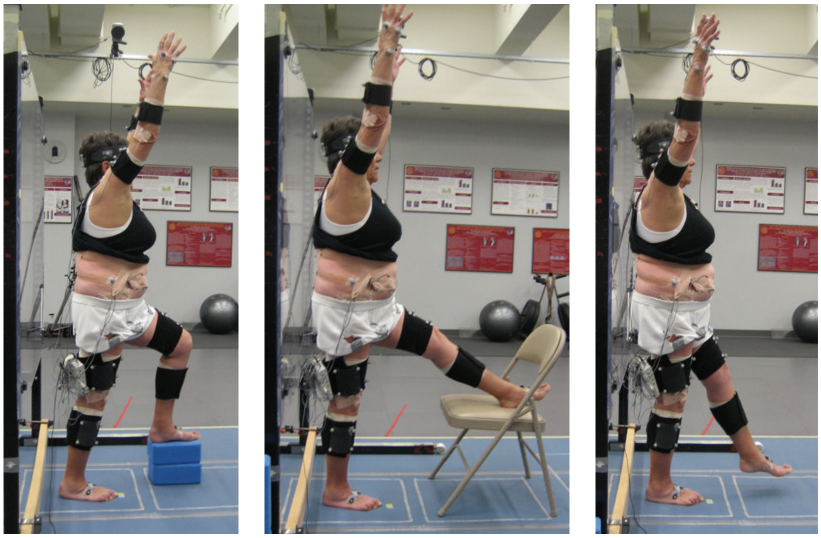
final biomechanics study visit, during which biomechanics data on all 3 versions of each pose were obtained.

The introductory version of Tree pose consisted of standing on the dominant limb (the limb with which one would kick a ball; we refer to this as the *stance* limb) and placing the contralateral foot on the floor, with toes and forefoot in contact with the floor and the heel resting just above the contralateral ankle. The participant's hands lightly touched a wall (TreeWF, Figure 1(a)). In the intermediate version of Tree, participants placed their contralateral foot on the medial aspect of the support-limb shank, just above the ankle (Figure 1(b)) and again used the wall for support (TreeW). The advanced version of Tree approached the classic posture; it was the same as version 2, but the wall support was not used (in the classical version of Tree, the contralateral foot is placed on the mid-to upper thigh) (Tree, Figure 1(c)).

OLB was also a single-limb-stance pose in which the participants stood on their dominant limb. The introductory OLB variation included the use of 2 or 3 standard yoga blocks (OLBb; block height = 20 or 30 cm depending on participant height). Here the subjects placed their contralateral foot on the blocks with their knee flexed to 90° (Figure 2(a)). The intermediate version of OLB included the use of a chair (OLBc). Here, the participants flexed their contralateral hip and rested their extended limb on the seat of a standard folding chair (seat height = 44.5 cm; Figure 2(b)). The advanced version of OLB was a free standing pose with the contralateral limb lifted anteriorly with a flexed hip (OLB). They also lifted their arms above their head by flexing their shoulders to approximately 180° (Figure 2(c)).

2.3. Biomechanical Assessments. Biomechanical analysis was performed at the USC Musculoskeletal Biomechanics Research Laboratory using standard techniques [13]. Whole-body kinematic data were collected using an eleven-camera motion capture system at 60 Hz (Qualisys Tracking System with Oqus 5 cameras; Qualisys, Gothenburg, Sweden). Reflective markers were placed on a head band and over the following anatomical landmarks of the lower and upper extremities bilaterally: first and fifth metatarsal heads, malleoli, femoral epicondyles, greater trochanters, acromions, greater tubercles, humeral epicondyles, radial and ulnar styloid processes, and third metacarpal heads. Markers were also attached to the spinous process of the 7th cervical vertebrae (C7), jugular notch, L5/S1, bilateral iliac crests, and bilateral posterior superior iliac spines, in order to define the trunk and pelvis. Based on these markers, a total of 15 body segments were modeled, including the upper arms, forearms, hands, head, trunk, pelvis, thighs, shanks, and feet. Noncollinear tracking marker plates were placed on each of these segments to track segmental position during the poses, using previously documented procedures [14, 15].

Once instrumented, the subjects performed the pose sequences, while guided by their instructor. The sequence of the poses was the same as when it was carried out in the regular yoga classes. A firm but portable clear plexiglass wall, which permitted capture of the markers, was positioned for wall support in the lab visits. For each pose, the participant was instructed to begin in a starting position, move smoothly into the pose, hold the pose while taking one full breath, and then return back to the original position. Simultaneously, the instructor also performed each pose in order to provide visual cueing. Once the participant had moved into the pose position, the instructor provided a verbal cue to the research associate to initiate the 3-second data collection. Two successful trials of each pose version were collected, and all 3 seconds of each pose were used for the analyses.



(a) (b) (c)

Figure 2: The variations of One-Leg Balance (OLB) pose, performed while the participant is instrumented for biomechanical analysis. (a) OLBb: double-support OLB pose with contralateral foot on the yoga blocks and knee flexed; (b) OLBc: double-support OLB pose with contralateral foot on a chair and knee extended; (c) OLB: free-standing, single-support OLB pose.

The subjects also completed 2 successful walking trials at their self-selected "comfortable speed." The walking trials provided a reference condition [16–18]. That is, walking is a well-studied, stereotypical activity and the JMOFs measured during comfortable-pace walking could be compared to the JMOF's generated by the 2 yoga poses.

GRFs were measured from a force platform at 1560 Hz (AMTI, Watertown, MA). Qualisys Track Manager Software (Qualisys, Gothenburg, Sweden) and Visual 3D (C-motion, Rockville, MD) were used to process the raw coordinate data and compute segmental kinematics and kinetics. Trajectory data was filtered with a fourth-order zero lag Butterworth 12 Hz low-pass filter. In Visual 3D, the head was modeled as a sphere, the torso and pelvis as cylinders, and the upper and lower extremity segments as frusta of cones. The local coordinate systems of body segments were derived from the standing calibration trial. Joint kinematics were computed based upon Euler angles with the following order of rotations: flexion/extension, abduction/adduction, internal/external rotation. The principle moments of inertia were determined from the subject's total body weight, segment geometry, and anthropometric data. Using standard inverse dynamics techniques, along with the International Society of Biomechanics recommended coordinate systems, net JMOFs in the sagittal and frontal planes, for the ankle, knee, and hip, were calculated from the inertial properties, segmental kinematics, and GRFs [19, 20]. JMOFs were normalized to each subject's bodyweight in kg. Additionally, a support moment, calculated as the sum of the ankle, knee, and hip sagittal plane JMOFs, was determined for each pose [17, 21].These instrumentation and data-processing techniques have previously been used in our laboratory to assess exercise performance with high reliability (Cronbach's alpha = 0.98; [22]).

Surface electromyographic (EMG) signals of the lower gluteus medius, hamstrings, vastus lateralis, and gastrocnemius muscles were collected on the subjects' dominant limb at 1560 Hz using active surface electrodes (Motion Lab Systems, Baton Rouge, LA). Standard procedures, including preparation of the skin and electrode placement, were employed [23]. The obtained EMG signals were amplified (×1000), notch filtered at 60 Hz, and band-pass filtered at 20–500 Hz. A root mean square smoothing algorithm [24] with a 75 ms constant window was used to smooth the EMG data over the 3-second data collection period corresponding to the epoch of kinematic and kinetic data. EMG processing and smoothing were performed using MATLAB (MathWorks, Natick, MA). The study protocol was approved by the Institutional Review Boards at the University of Southern California (USC) and University of California at Los Angeles (UCLA), and all subjects provided their written consent to participate.

2.4. Statistical Analysis. The JMOFs of the stance limb ankle, knee, and hip joints, in the sagittal and frontal plane, were the primary dependent variables. These were averaged over the collected period and both repetitions. Secondary dependent variables included the EMG activity, which was also averaged across the 2 trials. Repeated measures ANOVA (1 group × 3 tasks) were used as omnibus tests to identify significant differences in the JMOFs and EMG results for each dependent variable within each pose group (Tree and OLB). Tukey's post hoc tests were used to examine the pairwise comparisons between tasks in each group when the ANOVA tests were significant. Additionally, Cohen's d effect sizes (small $d = 0.2$; medium $d = 0.5$; large $d = 0.8$) are reported for all statistically significant post hoc comparisons [25]. Statistical analysis was conducted via PASW Statistics

Table 1: Lower extremity peak net joint moments of force during the stance phase of gait at a self-selected walking speed.

Moments (Nm/kg)	Hip	Knee	Ankle
Sagittal plane			
Extensor	0.81 ± 0.06	0.63 ± 0.04	1.33 ± 0.04[‡]
Flexor	0.54 ± 0.03	0.30 ± 0.03	0.29 ± 0.06[†]
Frontal plane			
Abductor	0.87 ± 0.04	0.38 ± 0.03	0.09 ± 0.01
Adductor	0.08 ± 0.01	0.09 ± 0.01	0.19 ± 0.02

Mean ± standard error.
[‡]Plantar flexor moment.
[†]Dorsiflexor moment.

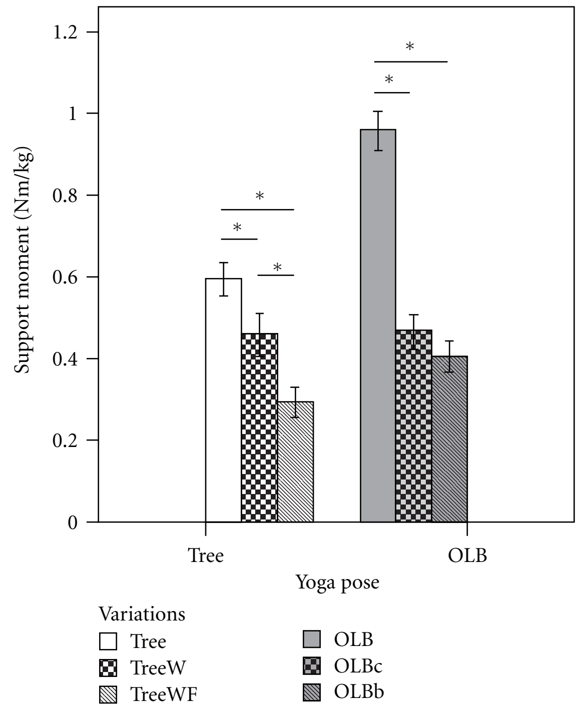


Figure 3: Magnitude of support JMOF during variations of Tree and OLB. The whiskers represent standard errors (*$P < 0.05$).

18 (IBM SPSS Statistics, Armonk, NY), and significance level was set at $P < 0.05$.

3. Results

3.1. Self-Selected Walking JMOFs. The average peak JMOFs across the self-selected walking trials are presented in Table 1. These JMOFs generated during walking provide a metric against which the pose JMOFs can be compared.

3.2. Tree Support JMOF. The repeated measures ANOVA test identified a significant difference in the support JMOF among the 3 Tree variations ($F_{2,38} = 36.12$; $P < 0.001$). Pairwise comparisons (post hoc analysis) revealed that the support JMOF during the classical Tree pose (the advanced version) was 30% ($P = 0.001$, $d = 0.65$) greater than Tree with wall support (TreeW, the intermediate version) and 103% greater than Tree with toes touching the floor and wall support (TreeWF, the introductory version) ($P < 0.001$, $d = 1.76$; Figure 3). Additionally, the TreeW support JMOF was 57% greater than TreeWF ($P < 0.001$, $d = 0.83$).

3.2.1. Tree Sagittal Plane JMOFs and EMG. Figure 4 illustrates comparisons of the JMOF at the hip, knee, and ankle in the sagittal plane across Tree variations. Repeated measures ANOVA identified significant differences in hip flexor and ankle plantar flexor JMOFs ($F_{2,38} = 13.36$ and 29.40, resp.; $P < 0.001$), but not the *knee extensor* JMOF ($F_{2,38} = 0.795$; $P = 0.46$). Pairwise comparisons revealed that the average hip flexor JMOF generated during TreeWF was 188% greater than classical Tree ($P < 0.001$, $d = 0.70$) and 268% greater than TreeW ($P < 0.001$, $d = 0.83$). There was not a statistically significant difference between the 2 single-support Tree versions (Tree and TreeW; $P = 0.88$). Regarding the ankle plantar flexor JMOF, the pairwise comparison demonstrated that the traditional Tree induced a JMOF that was 31% greater than TreeW ($P < 0.001$, $d = 0.92$) and 66% greater than TreeWF ($P < 0.001$, $d = 1.77$); while TreeW was 27% greater than the introductory TreeWF ($P = 0.01$, $d = 0.75$).

Surface EMG signals from the gastrocnemius muscles were used to support the sagittal-plane JMOFs at the ankle (Table 2). Significant differences were identified across the Tree versions in gastrocnemius activation level ($F_{2,38} = 68.29$; $P < 0.001$). Average gastrocnemius activation during the classical Tree was 123% greater than Tree with wall support (TreeW; $P < 0.001$, $d = 1.29$) and 324% greater than Tree with toes touching the floor and wall support (TreeWF; $P < 0.001$, $d = 1.94$). Gastrocnemius activation during TreeW was 90% greater than that during TreeWF ($P = 0.052$, $d = 0.91$).

3.2.2. Tree Frontal Plane JMOFs and EMG. In the frontal plane, the overall statistical analyses identified significant differences across the 3 Tree variations at each LE joint ($F_{2,38} = 50.05$, 36.44, and 19.03 for, hip, knee, and ankle, resp.; $P < 0.001$). Pairwise comparisons revealed that the 2 single-support Tree poses (Tree and TreeW) engendered similar hip abductor JMOFs ($P = 0.98$) which were approximately 55% greater than the JMOF engendered during the introductory version TreeWF ($P < 0.001$, $d = 1.90$). Complementing the frontal-plane JMOF findings, the classical Tree and TreeW poses generated higher average gluteus medius EMG signals (85% and 54%, resp.) than TreeWF. However, statistical significance in the EMG level was only found in the difference between the classical Tree and TreeWF ($P = 0.007$, $d = 0.60$), and only a trend was identified between TreeW and TreeWF ($P = 0.12$). Gluteus medius activation also did not differ between the traditional Tree and TreeW ($P = 0.46$). Similar to findings related to the hip joint, the classical Tree and TreeW produced knee abductor JMOFs which were 54% and 71% greater than the JMOF generated by the TreeWF, respectively ($P < 0.001$,

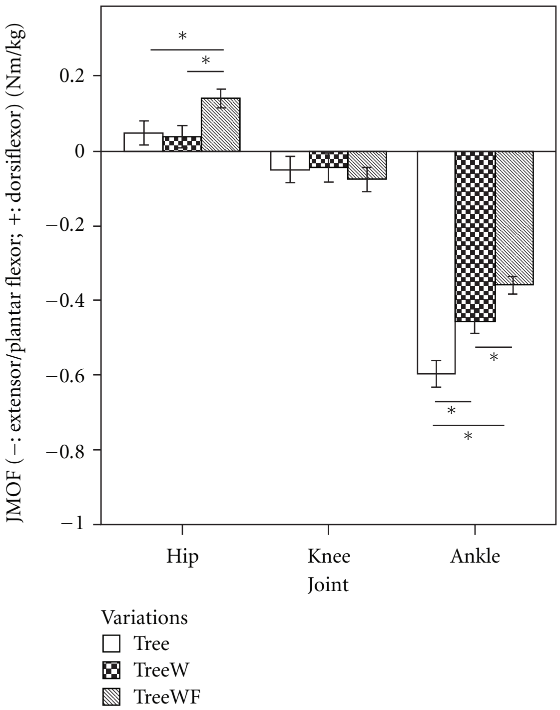


Figure 4: Mean JMOFs in the sagittal plane during Tree variations. The whiskers represent standard errors (*$P < 0.05$).

d = 1.12 and 1.43; Figure 5). All 3 Tree variations produced ankle invertor JMOFs. The classical Tree ankle invertor JMOF was 40% greater than that generated during TreeW ($P = 0.006$, $d = 0.39$) and 118% greater than that generated during the introductory version, TreeWF ($P < 0.001$, $d = 0.87$).

3.3. OLB Support JMOF. Similar to the Tree findings, the repeated measures ANOVA test identified that the support JMOF differed statistically among the 3 OLB variations ($F_{2,38} = 97.00$; $P < 0.001$). Pairwise comparisons revealed that the support JMOF during the classical OLB pose (the advanced version) was 106% greater than OLB with foot on a chair (OLBc, the intermediate version; $P < 0.001$, $d = 2.48$) and 137% greater than OLB with foot on blocks (OLBb, the introductory version; $P < 0.001$, $d = 2.90$). There was not a significant difference in support JMOF between OLBc and OLBb ($P = 0.36$).

3.3.1. OLB Sagittal Plane JMOFs and EMG. Comparisons of JMOFs at the hip, knee, and ankle in the sagittal plane are illustrated in Figure 6, and EMG data for the OLB versions are presented in Table 3. Repeated measures ANOVAs identified statistical differences among OLB variations in sagittal plane JMOFs at all 3 LE joints ($F_{2,38}$ = 92.55, 36.10, and 54.69 for hip, knee, and ankle, resp.; $P < 0.001$). At the hip, an extensor JMOF was generated during the traditional OLB; whereas a flexor JMOF was generated during the OLBb which was 135% greater than the flexor JMOF generated during the OLBc ($P = 0.02$, $d = 0.72$). At the knee,

Table 2: Average EMG activity of lower extremity muscle groups during Tree poses.

EMG (mV)	TreeWF	TreeW	Tree
Gluteus Medius	17.35 ± 3.26	26.64 ± 4.46	32.15 ± 7.13
Hamstrings	11.96 ± 2.63	24.70 ± 7.36	48.05 ± 10.60
Vastus lateralis	62.22 ± 15.02	77.37 ± 20.46	101.47 ± 23.71
Gastrocnemius	24.33 ± 3.75	46.21 ± 6.63	103.12 ± 12.31

Mean ± standard error.

Table 3: Average EMG activity of lower extremity muscle groups during OLB poses.

EMG (mV)	OLBb	OLBc	OLB
Gluteus medius	19.34 ± 2.95	30.95 ± 4.67	44.28 ± 6.38
Hamstrings	21.49 ± 8.29	29.47 ± 6.95	94.78 ± 13.55
Vastus lateralis	78.20 ± 15.03	106.89 ± 20.40	86.92 ± 12.50
Gastrocnemius	41.37 ± 6.32	49.48 ± 5.16	117.72 ± 12.33

Mean ± standard error.

the classical OLB generated a flexor JMOF, whereas similar extensor JMOFs were generated with the 2 double-support OLB variations (OLBb and OLBc) ($P = 0.74$). At the ankle, pairwise comparisons revealed that the plantar flexor JMOF associated with the traditional OLB was 85% greater than OLBb ($P < 0.001$; $d = 2.17$) and 91% greater than OLBc ($P < 0.001$; $d = 2.34$). The plantar flexor JMOF did not differ between OLBb and OLBc variations ($P = 0.94$). These ankle plantar-flexor results were supported by the gastrocnemius EMG data. The classical OLB pose induced significantly greater gastrocnemius muscle activation than the intermediate version of OLB with foot on a chair (OLBc; 138%; $P < 0.001$, $d = 1.61$) and the introductory version of OLB with foot on blocks (OLBb; 185%; $P < 0.001$, $d = 1.74$). No significant EMG difference was found between the OLBc and OLBb ($P = 0.605$).

3.3.2. OLB Frontal Plane JMOFs and EMG. In the frontal plane, the JMOFs generated at each LE joint differed statistically among the 3 OLB variations ($F_{2,38}$ = 80.66, 21.92, and 11.94 for hip, knee, and ankle, resp.; $P < 0.001$). The traditional OLB induced a hip abductor JMOF which was 17% greater than that induced during the intermediate version, OLBc ($P < 0.001$, $d = 0.82$), and 53% greater than that produced by the introductory version, OLBb ($P < 0.001$, $d = 2.24$) (Figure 7). A higher gluteus medius activation was also induced by the traditional, single-support OLB pose compared to OLBc (43%, $P = 0.003$, $d = 0.53$) and OLBb (129%, $P < 0.001$, $d = 1.12$). Complementing the significant differences (31%) found in the hip abductor JMOF between the 2 double-support OLB variations (OLBc and OLBb; $P < 0.001$, $d = 1.22$), gluteus medius activation during OLBc was 60% greater than that during OLBb ($P = 0.009$, $d = 0.66$). At the knee, the pairwise comparison revealed that the advanced OLB and intermediate OLBc poses produced abductor JMOFs which were 76% ($d = 0.91$) and 55% ($d = 0.75$) greater than that produced during the introductory

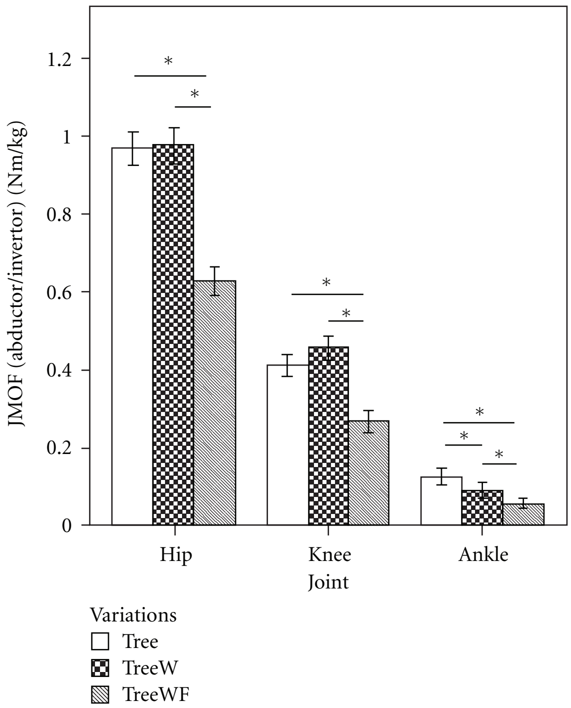


Figure 5: Mean JMOFs in the frontal plane during Tree variations. The whiskers represent standard errors (*$P < 0.05$).

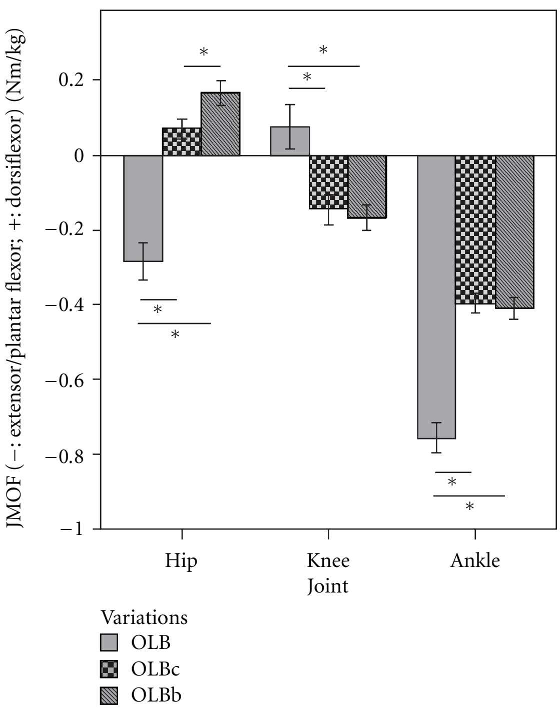


Figure 6: Mean JMOFs in the sagittal plane during OLB variations. The whiskers represent standard errors (*$P < 0.05$).

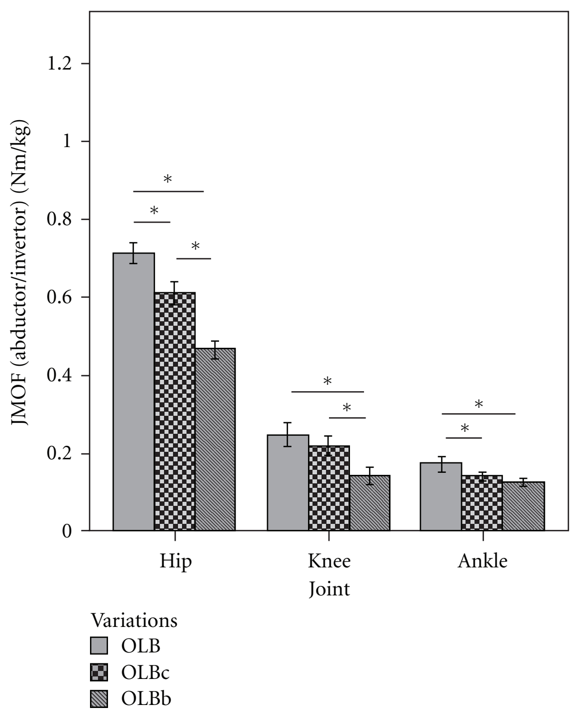


Figure 7: Mean JMOFs in the frontal plane during OLB variations. The whiskers represent standard errors (*$P < 0.05$).

version, OLBb ($P < 0.001$). There was not a difference in knee abductor JMOF between traditional OLB and OLBc ($P = 0.21$). At the ankle, the invertor JMOF produced during the traditional OLB pose was 23% greater than that produced during OLBc ($P = 0.007$, $d = 0.46$) and 38% greater than that produced during OLBb ($P < 0.001$, $d = 0.68$). No difference was observed between OLBb and OLBc ($P = 0.27$).

4. Discussion

In this study, we quantified the JMOFs and average EMG activity associated with 3 versions of yoga poses that are traditionally done standing on one leg: Tree and One-Leg Balance. The 3 versions of each pose progressively increased the difficulty level of performing each version from introductory, through intermediate, to advanced. By conducting biomechanical tests during the performance of each version of Tree and One-Leg Balance, we formally evaluated whether the poses were indeed becoming more physically demanding as hypothesized.

Our findings, which were not always intuitive, demonstrated that, within each pose, the different variations engendered significantly different JMOFs and EMG activity, in some but not all joints, planes of motion, and muscle groups. Thus, our general hypothesis that the introductory poses would generate the smallest physical demands, the intermediate versions would generate intermediate demands, and the most advanced versions would generate the greatest physical demands, in a uniform fashion that is across all LE joints and planes of motion, was not upheld. Moreover, we were surprised to find that within a given pose type (e.g., One-Leg Balance) some pose variations generated JMOFs in opposite directions (i.e., hip flexor versus hip extensor) and thus were likely to target antagonistic muscle groups and opposing articular structures. In the following sections, we discuss the meaning and implications of the biomechanical findings for the Tree and One-Leg Balance poses, in turn.

4.1. Tree. For the support moment, our findings supported our hypothesis that the classical Tree would generate the greatest support moment, followed by Tree with wall support and then Tree with toes on floor and wall support (i.e., Tree > TreeW > TreeWF). The support moment is calculated as the sum of the individual extensor moments at the hip, knee, and ankle; consequently, this comprehensive measure is considered a good indicator of the *overall* demand on the lower extremity [16, 21, 26, 27]. Our findings demonstrated that there is a nonlinear relationship across the 3 variations with a large increase (57%) from TreeWF to TreeW and only a moderate increase (30%) from TreeW to Tree. Therefore, based on these analyses, the degree of difficulty change between the introductory and intermediate versions is much greater than the increment in difficulty between the intermediate and advanced versions. These results suggest that more time may be needed practicing the introductory version (TreeWF) before transitioning to the intermediate version (TreeW); whereas less time may be needed in the progression from the intermediate version to the advanced, classical Tree version.

In contrast to the support moment and ankle JMOF findings, our Tree pose findings were not intuitive for the hip and knee JMOFs—in other words, the hypothesized relations that the classical Tree would generate the greatest JMOFs, followed by Tree with wall support, and then Tree with toes on floor and wall support did not hold. For example, in the frontal plane the Tree and TreeW produced almost identical hip abductor JMOFs which were approximately 55% greater than TreeWF (a large effect size) and 12% greater than the average peak JMOF produced during the walking trials. The EMG findings for the gluteus medius (a primary hip abductor) were consistent with the JMOF results.

Hip abductor strength is important because it is associated with balance performance [28–30] and fall risk [31] in seniors. Consequently, exercise programs designed to improve balance and reduce fall risk should include activities which target the hip abductors. We had hypothesized that using a wall for balance support (i.e., TreeW) would reduce the frontal-plane demands and gluteus medius activity associated with the advanced pose (Tree) by allowing the participants to shift their center of mass location closer to their hip joint center. This, however, was not supported by the biomechanical evidence. Clinically, these findings are important and imply that instructors can increase the demands to the hip abductors early in a yoga program, even in participants that have relatively poor balance capabilities and need to use a wall for support.

In the sagittal plane at the hip, surprisingly, it was the introductory TreeWF variation that generated the greatest flexor JMOF (a modest-to-large effect size), whereas no difference was found between Tree and TreeW. Hip flexor performance is positively associated with stride length and walking speed in seniors [16, 32, 33], and DiBenedetto and colleagues [34] reported that both of these parameters increased in older adults following an 8-week Iyengar Hatha yoga program. Clinically, our findings suggest that the hip flexors (e.g., psoas major and iliacus) can be targeted early in a yoga intervention program using the introductory TreeWF pose, even when participants with limited balance capabilities need to use a wall and their contralateral limb for support.

At the knee, all 3 Tree poses produced a similar extensor JMOF in the sagittal plane. This JMOF, however, was small and only 8.8% of the average peak extensor moment generated during self-selected walking. These findings are not surprising because the extended knee position associated with all 3 versions of the Tree results in a GRF projection which is close to the knee joint axis of rotation. Contrastingly, when the knee is flexed during the loading phase of gait, the GRF moves progressively posterior to the knee joint and an appreciable knee extensor JMOF is generated. Thus, none of the Tree versions examined, in and of themselves, is likely to improve knee extensor strength or endurance.

In the frontal plane, Tree and TreeW produced similar knee abductor JMOFs which were 54–71% greater than that generated during TreeWF and were greater (8–20%) than the average peak knee abductor JMOF produced during walking at self-selected speed. These findings have important implications for participants with knee pathology because high and/or sustained knee abductor JMOFs will increase the loading of the MCL and compressional loading across the lateral condyles and lateral patellofemoral surfaces. These loading characteristics are associated with OA [10, 11, 35], and joint pain [36, 37]; thus, the intermediate and advanced tree poses could exacerbate preexisting conditions. Importantly, and in contrast to commonly-held conceptions, the use of a wall for support during Tree posing will not diminish the frontal plane JMOF or offer protection for the knee joint.

4.2. OLB. Similar to the Tree results, most of the OLB JMOF findings were in contrast to our stated hypotheses that the traditional One-Leg Balance pose (OLB) would induce greater JMOFs than the intermediate One-Leg Balance pose with chair (OLBc), which would induce a JMOF which was greater than the One-Leg Balance pose with blocks (OLBb) (i.e., OLB > OLBc > OLBb). For example, the support moment generated during the advanced OLB pose was 106–137% greater than OLBc and OLBb (a large effect size); however, the average support moment did not differ between OLBb and OLBc. These findings suggest that, in terms of overall LE demand, a considerable increase in effort will be required as participants advance from the introductory and intermediate OLB poses to the advanced OLB pose.

At the hip, the abductor JMOF results were the only OLB findings that supported our stated hypothesis. The hip abductor JMOF for the OLB was 17% greater than OLBc and 53% greater than OLBb (large effect sizes). Thus, there appears to be a nearly linear progression in demand across the 3 OLB variations, suggesting that a similar amount of practice is likely to be necessary in order to progress a participant from OLBb to OLBc and from OLBc to OLB. In relation to the JMOF produced during self-selected walking, OLB produced a sustained hip abductor JMOF that was 82% of the average peak JMOF generated during the walking trials. Thus, the OLB pose sequence, like the Tree pose sequence, may be a good addition to yoga programs designed to increase hip abductor strength, improve balance, and reduce fall risk in seniors.

In the sagittal plane, the hip JMOF results were quite interesting. While the classical OLB generated a hip *extensor* JMOF that was 35% of the average peak extensor JMOF generated during gait, OLBc and OLBb generated hip *flexor* JMOFs which were 13% and 31% of the average peak *flexor* JMOF generated during gait. Thus, these 3 variations target antagonistic muscle groups and opposing joint articular structures. Nonetheless, because these JMOFs (both flexor and extensor) were well below those generated during self-selected walking, their inclusion in yoga programs designed to increase walking performance via improvements in hip flexor/extensor strength is not supported.

Similar results were found in the sagittal plane JMOFs at the knee. Whereas the classical OLB pose generated a knee *flexor* JMOF, the intermediate OLBc and the introductory OLBb poses generated similar *extensor* JMOFs. Both extensor and flexor JMOFs, however, were well below those generated during the gait trials—76% and 74% less, respectively. Like the Tree pose variations, the small sagittal plane JMOFs at the knee are likely the result of an almost vertical alignment of the thigh and shank, and small knee flexion/extension angles which position the projection of the GRF close to the knee joint center. Consequently, these poses are not likely to have a large influence on knee extensor/flexor strength or endurance. Interestingly, hamstring EMG activity increased dramatically when subject performed the classic OLB pose, in concert with the knee flexor JMOF; however, the EMG activity level of the vastus lateralis only decreased slightly between the intermediate to advanced versions. Thus it appears that the participants used a cocontraction strategy at the knee during performance of the advanced, classic, OLB pose, potentially stiffening the joint and increasing stability. This cocontraction strategy, however, will increase the loading across the tibiofemoral condyles and thus, could exacerbate existing OA symptoms (e.g., pain).

In the frontal plane at the knee, OLB and OLBc generated JMOFs which were 76% and 55% greater than that of OLBb, respectively. Both of these differences demonstrated large effect sizes; however, all 3 variations engendered knee abductor JMOFs that were appreciably less than the average peak JMOF engendered during gait. Thus, these pose variations are not likely to be riskier than walking programs in aggravating preexisting knee pathologies.

A note of caution, however, when comparing the JMOFs generated during yoga poses with those generated during walking, it is important to consider that walking is a cyclic activity in which the JMOFs increase and decrease during a gait cycle. Thus, we calculated and recorded the *peak* JMOFs, across the hip, knee, and ankle, which were produced during the walking trials. Contrastingly, during yoga practice the participants statically held their poses "for a full breath" before returning to a starting position, and we calculated the average JMOFs engendered during the middle 3 seconds of each pose. Thus, a fair comparison between the JMOFs engendered during yoga and walking should take into consideration that the peak JMOFs reported during walking only occur for an instant in time, whereas the average JMOFs produced during each yoga pose persist for 5-6 seconds. Consequently, although the peak JMOFs produced during dynamic activities such as walking may be greater than those generated during the yoga poses, the overall muscular stimulation and extended joint loading, that occurs during yoga posing, may be greater than that produced during walking or other dynamic activities (e.g., resistance exercise).

At the ankle, OLB generated an ankle plantar flexor JMOF that was approximately 88% greater than the JMOF generated during OLBb and OLBc (large effect size) and 57% of the average peak JMOF generated during gait. Plantar flexor strength and performance are associated with balance and postural control [38, 39], walking performance [40], and fall risk [41–43] in seniors. Our findings suggest, however, that it is not until participants are able to safely perform the advanced version of the OLB pose, that they will appreciably load their plantar flexor muscles. This is also supported by the results of muscle activity level in ankle plantar flexor. EMG level of gastrocnemius induced by the advanced version was approximately 123% greater than that induced by the other two versions.

In the frontal plane at the ankle, OLB produced an invertor JMOF that was approximately 30% greater than the JMOF generated during OLBb and OLBc (small to modest effect size) and similar to the average peak JMOF generated during gait. Ankle invertor strength is important for balance and safe ambulation, and it is correlated with performance in the timed up-and-go test in seniors [38]. Because this test requires a combination of strength, balance, and agility, it is often considered a “comprehensive” measure of ambulatory proficiency [44–46]. Our findings suggest that performance of the classical OLB pose will target the ankle invertors (e.g., tibialis anterior and posterior) and thus may ultimately improve dynamic balance and ambulation proficiency.

5. Conclusions

This is the first study to quantify the physical demands of yoga pose variations, using biomechanical methodologies. This paper is informative and provides evidence that can be used by instructors, clinicians, and therapists to help select pose variations which are appropriately tailored to the experience, physical capabilities, and injury history of participants. Although we only examined 2 poses and 3 variations of each, our biomechanical analysis was comprehensive and included the kinetic examination of 3 LE joints across 2 planes of motion, and the study of 4 functionally important muscle groups. Future studies are needed to examine additional poses which are prevalent in older-adult yoga programs and their common variations.

Importantly, our findings were not always intuitive and suggest that common, long-held, conceptions about the demands placed on the body by poses should be investigated experimentally. For example, pose variations which have long been considered introductory may actually induce approximate or even higher demands at some joints and planes of motion, than pose variations considered advanced. Similarly, we were surprised to find that some pose variations (e.g., OLBb and OLBc) induced JMOFs which were in the opposite direction of those generated during the classical variation (OLB). Finally, we demonstrated that the use of props, such as a wall, to reduce contraindicated joint loading (e.g., knee frontal plane JMOF) may have little or no effect. While these findings are informative, evidenced-based yoga programs designed using this type of biomechanical information will ultimately have to be tested experimentally, within randomized controlled trials, to determine their influence on program safety, participant retention, physical-performance efficacy, and quality of life in seniors.

Acknowledgments

The authors thank the participants who volunteered for the YESS project. Research reported in this publication was supported by the National Center for Complementary and Alternative Medicine of the National Institutes of Health under Award no. R01AT004869-01. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2012, Article ID 983258, 10 pages
doi:10.1155/2012/983258

Research Article

Frequency of Yoga Practice Predicts Health: Results of a National Survey of Yoga Practitioners

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Received 22 April 2012; Accepted 20 June 2012

Academic Editor: Sat Bir S. Khalsa

Background. Yoga shows promise as a therapeutic intervention, but relationships between yoga practice and health are underexplored. *Purpose*. To examine the relationship between yoga practice and health (subjective well-being, diet, BMI, smoking, alcohol/caffeine consumption, sleep, fatigue, social support, mindfulness, and physical activity). *Methods*. Cross-sectional, anonymous internet surveys distributed to 4307 randomly selected from 18,160 individuals at 15 US Iyengar yoga studios; 1045 (24.3%) surveys completed. *Results*. Mean age 51.7 (±11.7) years; 84.2% female. Frequency of home practice favorably predicted ($P < .001$): mindfulness, subjective well-being, BMI, fruit and vegetable consumption, vegetarian status, sleep, and fatigue. Each component of yoga practice (different categories of physical poses, breath work, meditation, philosophy study) predicted at least 1 health outcome ($P < .05$). *Conclusions*. Home practice of yoga predicted health better than years of practice or class frequency. Different physical poses and yoga techniques may have unique health benefits.

1. Introduction

Three out of every four dollars in health care are spent on treatment of chronic, lifestyle-related health conditions including obesity, type 2 diabetes, cardiovascular disease (CVD), and cancer [1]. These conditions are associated with a number of modifiable health behaviors including diet [2, 3], physical activity [4–6], cigarette smoking [7, 8], and excessive alcohol consumption [9, 10]. Poor mental health [11], low social support [12, 13], and poor sleep [14] are also factors that contribute to morbidity and mortality.

Making even small, positive changes in health behaviors significantly improves mortality rates [15], and simultaneously changing multiple health behaviors results in further reductions in morbidity and mortality [16, 17]. While the answer to America's health crisis appears clear, permanently improving health behaviors has proven to be elusive.

Yoga, an ancient discipline that uses a combination of practices including physical poses, breath work, and meditation, is defined by Patanjali in the second yoga sutra as "the stilling of the changing states of the mind [18]." It has recently shown promise as an intervention targeting a number of outcomes associated with lifestyle-related health conditions including cardiovascular disease [19], metabolic syndrome [20], diabetes [21], and cancer [22]. While aerobic exercise long has been a valuable tool in combating these health conditions, a review of clinical trials comparing exercise to yoga found yoga to be equal or superior to aerobic exercise in improving a number of outcomes associated with chronic health conditions [23].

One mechanism that would explain the effectiveness of yoga interventions compared with exercise interventions is that, in addition to the benefits of increased physical activity associated with the physical practice of yoga poses, yoga appears to downregulate the Hypothalamic-Pituitary-Adrenal (HPA) axis and the Sympathetic Nervous System (SNS) response to stress, possibly via direct vagal stimulation [20]. Repeated firing of the HPA axis and SNS can lead to dysregulation of the system and ultimately diseases such as obesity, diabetes, autoimmune disorders, depression, substance abuse, and cardiovascular disease [24, 25]. Numerous studies have shown yoga to have an immediate download effect on both the SNS/HPA axis response to stress by decreasing cortisol [26, 27] and blood glucose [28, 29], as well as norepinephrine and epinephrine levels [30]. Yoga significantly decreases heart rate, systolic and diastolic blood pressure [30–32], and inflammation [33], and yoga increases levels of Immunoglobulin A [34] and Natural Killer Cells [35]. In addition to the immediate SNS and HPA-axis effects, yoga improves outcomes associated with chronic SNS/HPA-axis activation: blood cholesterol [36–38]; body composition including: BMI [39], body weight [36, 37, 40], and waist circumference [29]; fatigue [41, 42]; and sleep in healthy and diseased populations [43].

While this evidence is promising, the relationship between yoga practice and positive changes in health behaviors remains unclear. Only three studies were found examining relationships between yoga practice and aspects of health in individuals who practice yoga [40, 44, 45]. These studies contributed valuable evidence that there may be a favorable relationship between regular yoga practice and BMI [44, 45], diet [45], and weight maintenance [40]. However, these studies looked only at yoga practice in general and did not examine the relative contributions of the different aspects of yoga practice.

This also appears to be the case in many clinical trials involving yoga, as studies frequently focus either exclusively on interventions using only physical poses or breath work, or they utilize a combination of different aspects of yoga practice (including vigorous physical poses, gentle restorative poses, breath work, and meditation) without examining the relative contributions of the individual aspects. This creates two problems when interpreting the results. First, when yoga is taught according to classical texts such as the Yoga Sutras [18], it consists of eight components; only one of the eight components focuses on the physical practice of poses. The remaining components consist of breath work, control of the mind and senses, meditation, and ethical practices that guide one's behaviors such as how to interact with others and how to treat oneself [18]. A second reason for examining the relative contributions of the different aspects of yoga practice is that the different physical poses (standing poses, vigorous poses such as arm balances and back bends, inversions such as head stand and should stand) and yoga practices such as breath work and meditation are believed to have different physiological and psychological effects [46]. No studies were found in peer-reviewed journals that examine the relative contributions of the various aspects of yoga. Therefore, the clinical value of the individual components remains unclear.

The objective of this study is to better understand the interrelationship between yoga practice and health. Specifically, the study addressed the contributions of yoga practice in general (years of practice, classes per month, and/or days per month of home practice) and practice of specific components of yoga practice (physical poses, breath work, meditation, and/or philosophy study) to these aspects of health. It is important to study the unique contributions of the individual components of yoga practice because some aspects of yoga practice may be more effective than others in improving specific health outcomes such as body weight, sleep, and mental health.

2. Methods

The study utilized a cross-sectional design with an anonymous online survey to examine yoga practice and its relationship to aspects of health including physical activity, fruit and vegetable consumption, sleep disturbance, fatigue, social support, mindfulness, and subjective well-being.

2.1. Participants and Randomization. Approval for the study was obtained from the Institutional Review Board at the University of Maryland, Baltimore. Individuals included (1) were at least 18 years of age, (2) practiced yoga (either taking classes or practicing at home) at least weekly for a minimum of two months within the past 6 months, and (3) had Internet access and ability to complete an online survey. The length and amount of yoga practice required to be included in the study was chosen based upon the expert opinion of Senior Iyengar yoga instructors as to the minimum required to be considered an individual who practices yoga.

The researchers worked with the Iyengar Yoga National Association U.S. (IYNAUS) in selecting study participants. Iyengar yoga studios were chosen because they have (1) a large national organization (representing over 900 teachers and 100+ studios) and (2) strict standardization of teaching that would likely contribute to consistent instruction.

There are over 900 certified Iyengar Yoga Teachers within IYNAUS, representing over 100 yoga studios. The investigators worked with IYNAUS to target studios in the major geographic regions (Northeast, Southeast, Midwest, Southwest, and West), taking steps to ensure all the regions were represented in proportion to the number and size of studios in their region. Based on an a priori power analysis, 15 studios with e-mail list serves of 18,160 were selected to participate in the survey. Random sampling software (SPSS version 19) was used to draw a random sample (approximately 25%) of e-mail addresses from each studio. Using this sampling strategy, 4307 potential subjects were randomly selected from the 15 yoga studios to receive a secure link to the survey, which was sent by the studio owners. Of the 1164 individuals (27%) who responded to the survey, 1045 (89.8%) completed the survey in its entirety and met inclusion criteria. Data were collected from June to September of 2011.

2.2. Measurement. Following strategies suggested by Dillman et al. [47] to develop and implement the survey, the researchers used SurveyMonkey to create a 65-item questionnaire that asked detailed questions about yoga practice and health. Health outcomes were aspects of health that are associated with increased risk of morbidity and mortality. The survey utilized preexisting measures except for demographic characteristics, descriptors of yoga practice, and a few individual health items including smoking, alcohol consumption, and vegetarian status.

2.2.1. Yoga Practice. Questions regarding yoga practice were divided into questions about general yoga practice (years of practice and frequency of home practice and yoga classes) and specific components of yoga practice (physical poses, breath work, meditation, and philosophy study). Physical poses were divided into four categories: standing poses; vigorous poses such as sun salutations, backbends, and arm balances; inversions such as head and shoulder stands; gentle and/or restorative poses. Frequency of physical poses was defined as days per month of practice at home and in class, with the exception of gentle poses, which was defined as ≤30 or >30 minutes per week. Frequency of breath work and meditation were defined as ≤ or > once per week. The study of yogic philosophical texts, primarily the Yoga Sutras of Patanjali, is considered one of the ethical requirements of yoga study [18]. The amount of time spent on the study of yoga philosophy (yoga sutras) was defined as the frequency with which one attends classes or lectures (including recordings or webcasts) or reads classical yoga texts such as the Yoga Sutras, Bagavad Gita, or the Upanishads.

2.2.2. Demographics. Demographic data were collected from each subject including information regarding: age, gender, race, height, weight, education, marital status, and job status. Body mass index (BMI) was calculated using the following formula: [Weight (pounds)/height (inches) 2] × 703 [48].

2.2.3. Sleep Disturbance, Fatigue, and Social Support. Sleep disturbance (4-items), fatigue (4-items), and social support (8-items) were measured using short forms from the Patient-Reported Outcomes Measurement Information System (PROMIS) (sleep disturbance and fatigue) and the National Institutes of Health (NIH) Toolbox (social support). PROMIS and the NIH Toolbox are initiatives of the NIH designed to provide the public with a free national item bank of valid and reliable measures of commonly used patient-reported outcomes measures [49, 50]. All item banks have high reliability [51] and compare favorably with legacy measures [52]. Each item is assessed on a 5-point Likert scale, ranging from 1 ("not at all") to 5 ("very much") to measure perceptions of the amounts of social support (during past month), as well as sleep disturbance and fatigue (during past 7 days), with higher scores indicating of higher levels of the concepts. In the present study, Cronbach's alpha was .83 for sleep disturbance, .90 for fatigue, and .96 for social support.

2.2.4. Subjective Well-Being (Happiness). Subjective well-being is a multidimensional construct of mental health involving emotional, psychological, and social well-being, often referred to as "happiness [53]." Subjective well-being was measured using the 14-item Mental Health Continuum-short form (MHC-SF) that asked subjects to report how frequently they experienced symptoms of positive mental health in the past month. Answers range from "never" to "every day" and scores range from 14 to 70, with higher scores indicating higher levels of subjective well-being. Cronbach's alpha for the total scale was .91 in the present study.

2.2.5. Fruit and Vegetable Consumption. The number of servings per day of fruits and vegetables was obtained using 7 items from the National Cancer Institute's Multifactor Screener, a self-report, food frequency questionnaire. The Multifactor Screener asked subjects how often they ate fruits and vegetables during the past month. Responses ranged from never to several times per day, from which pyramid servings of fruits and vegetables per day were calculated. This questionnaire was validated in a number of large studies including NCI's Observing Protein and Energy (OPEN) study and Eating at America's Table Study (EATS), with correlations with true consumption ranging from 0.5 to 0.8 [54].

2.2.6. Physical Activity. Information regarding physical activity was gathered using the 7-item International Physical Activity Questionnaire (Short form) (IPAQ). Subjects were instructed to report average number of days per week and minutes per day of physical activity, not including yoga classes or practice, during the past month. Results were used to calculate the total number of metabolic-equivalent minutes (MET-min) of exercise per week and levels of physical activity [55]. The IPAQ was extensively studied in 12 countries and was found to be valid and reliable in 18 to 65-year-old adults in a variety of settings [56, 57].

2.2.7. Freiberg Mindfulness Inventory—Short Form. Mindfulness was measured using the Freiberg Mindfulness Inventory—Short Form (FMI-SF), an 8-item version of the original 30-item Freiberg Mindfulness Inventory [58, 59] that uses a 4-point Likert scale to assess how frequently subjects experience certain situations or mind states. Scores range from 8 to 32, with higher scores indicating higher levels of mindfulness. Cronbach's alpha was .87 in the present study.

2.2.8. Other Health Information. Single items were used to assess current smoking status (yes/no), vegetarian status (defined as no consumption of meat, fish, or poultry), and alcohol consumption (alcoholic drinks per week).

2.3. Statistical Analysis. Data cleaning techniques using SPSS 19.0 were used to identify miscoded data, outliers, and missing data. Because the survey required participants to answer every question, less than 5% of the data were missing. Incomplete cases were excluded from future analyses. Independent t tests were used to examine differences between those cases with and without missing data as well as incomplete versus complete cases; no significant differences were noted. Three variables (gentle poses, meditation, and breath work) were badly skewed and could not be normalized. These three variables were dichotomized using the median as a cut point. Descriptive statistics (frequencies, percentages, measures of central tendency, and standard deviations) were obtained to describe the demographic data, yoga practice habits, and aspects of health. According to Gellman and Hill [60], analysis adjustment for multiple analyses is not necessary in an exploratory model building context. Thus, the researchers used a .05 level of significance for all analyses.

Research questions examining relationships of predictors with outcomes were analyzed using linear or logistic regression, depending upon the level of measurement of the outcome. Regression analyses were conducted using the following steps. First, bivariate relationships of yoga practice and demographic variables with aspects of health were investigated by computing Pearson r correlations. Next, any yoga practice variable or demographic variable that had at least a small ($r = .10$) and significant relationship to the health variable of interest was included in appropriate regression analyses (linear or logistic) to examine the independent effects of all correlated variables [61]. Variables that were significant at $P = .05$ were placed into subsequent regressions to examine interaction effects. Interactions that were not significant at $P = .05$ were removed, one at a time, until the final model was determined.

Research questions examining differences in means between those with high and low practice frequency were analyzed using independent t tests. Cut off points for determining high and low yoga practice groups were selected using the highest and lowest quartiles. A priori power analyses showed the 1045 cases were sufficient to achieve 80% power with alpha .05 with a medium effect size for all analyses.

Table 1: Demographic characteristics of study sample ($N = 1045$).

Variables	M (SD)	Range
Age ($n = 1043$)	51.7 (11.7)	19–87
	Frequency	Percent
Gender		
Female	880	84.2
Race		
White	932	89.2
Other[a]	113	10.8
Marital status		
Married/lives with partner	730	69.8
Single[b]/widowed/separated/divorced	308	29.5
Other	7	0.7
Employment		
Full time	532	50.9
Part time	277	26.5
Not employed	236	22.6
Education		
High school/GED/trade/vocational school/Other	31	3.0
Some college	100	9.6
College graduate	386	36.9
Master's degree	387	37.0
Doctoral degree	141	13.5

[a]Multiracial ($n = 38$; 3.6%), Asian ($n = 28$; 2.7%), African American ($n = 18$; 1.7%), American Indian/Alaskan/Hawaiian/Pacific Islander (6; 0.6%), other ($n = 23$; 2.2%).
[b]Never married.

3. Results

Demographic characteristics of the study sample are included in Table 1. The age of participants ranged from 19 to 87 years ($M = 51.7 \pm 11.7$). The large majority of subjects was female (84.2%) and white (89.2%). Most of the subjects were married (61.3%) and employed full time (50.9%). They were highly educated, with almost 90% having either an undergraduate (36.9%), master's (37%), or a doctoral (13.5%) degree. Subjects reported practicing yoga for less than one to more than 25 years ($M = 11.4 \pm 7.5$). They reported taking between zero and 28 classes per month ($M = 6.1 \pm 5.1$) and practicing yoga outside of class up to 28 days per month ($M = 12.2 \pm 9.7$).

In the final models examining general yoga practice, frequency of home practice was the practice variable that most often predicted aspects of health (Table 2). Specifically practice frequency ($\beta = .106$, $P < .001$) and years of practice ($\beta = .039$, $P < .05$) were independent predictors of mindfulness. For every extra day per week of yoga home practice, mindfulness scores increased .42 of a point (.10 of a SD). After controlling for gender and age, practice frequency was a significant independent predictor of subjective well-being ($\beta = .183$, $P < .001$) and BMI ($\beta = -.043$, $P < .001$). Every additional day per week of home practice was associated with a decrease of .17 of a point (.04 of SD) in BMI. After controlling for gender and age, practice frequency predicted fruit and vegetable servings per day ($\beta = .031$, $P < .001$). Practice frequency was the only variable negatively related to sleep disturbance ($\beta = -.052$, $P < .001$), and individuals who practiced more frequently had higher odds of being a vegetarian than those who practiced less often (OR = 1.057, $P < .001$). For every additional day per week of yoga practice, sleep improved by .21 of a point (.07 of an SD) and the odds of being vegetarian increased 22.8%. After controlling for the effects of practice frequency ($\beta = -.171$, $P < .01$) and age ($\beta = -.072$, $P < .01$), there was a significant interaction effect between practice frequency and age on fatigue ($\beta = .002$, $P < .01$). Older individuals had lower levels of fatigue regardless of practice frequency, but younger individuals with a higher frequency of home practice exhibited lower levels of fatigue than those who practiced less often (see Figure 1). At the highest levels of practice, older and younger individuals experienced similar fatigue levels.

Because practice frequency was such an important predictor of health, the authors explored differences in yoga practice between intense practitioners (those who practice at home ≥5 days per week) and less intense practitioners (those with a home practice of ≤1 day/week). Intense practitioners reported significantly more years of yoga practice ($M = 15.1 \pm 6.7$ years versus 8.6 ± 7.2 years) than those who were

Table 2: Summary of results of final linear and logistic regression models predicting health outcomes from general patterns of yoga practice in combination with influential demographic predictors ($N = 1045$).

Health outcome	Final predictors[a]	Parameter statistics *B*	SE	*t*
Mindfulness	Practice frequency[b]	.106	.014	7.53**
	Years of practice	.039	.018	2.17*
Subjective well-being	Practice frequency[b]	.183	.034	5.31**
	Gender[c]	3.39	.915	3.72**
BMI ($n = 1034$)	Practice frequency[b]	−.043	.012	−3.26**
	Gender[c]	−2.013	.321	−6.28**
Fruit and vegetables/Day ($n = 1043$)	Practice frequency[b]	.031	.006	5.59**
	Age	.013	.005	2.92**
	Gender[c]	−.583	.147	−3.97**
Sleep disturbance	Practice frequency[b]	−.052	.009	−5.58**
Fatigue	Practice frequency[b]	−.171	.042	−4.02**
	Age	−.072	.011	−6.36**
	Practice frequency[b] x Age	.002	.001	2.91**
				Wald/OR
Vegetarian status	Practice frequency[b]	.056	.011	25.78*/1.057*

[a]Each final model includes all predictors included in the final model. Demographic covariates were included if they had at least a small ($r = .1$) and significant ($P < .05$) correlation with the health variable. No demographic covariate met these criteria that was not included in the final model. [b]Days per month of home yoga practice. [c]Gender coded males "0," females "1." Abbreviations—*B*: unstandardized beta weight. SE: standard error. *t*: *t* score for linear regressions. x: interaction effect. Wald: Wald statistic for logistic regressions. OR: odds ratio. BMI: body mass index. Note: for all measures, higher scores indicate more of the concept measured. *$P < 0.05$ level (2-tailed). **$P < 0.01$ (2-tailed).

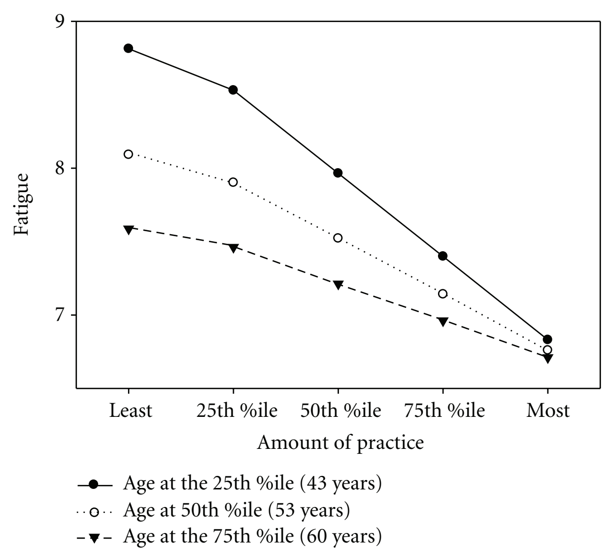

Figure 1: Interaction effect between frequency of home yoga practice and age ($n = 1043$). Note: Percentiles for frequency of home yoga practice: least = 0 days/month, 25th = 4 days/month, 50th = 12 days/month, 75th = 20 days/month, most = 28 days/month.

less experienced ($t = -12.038$, $df = 480$; $P < .001$). Intense practitioners practiced more standing poses ($M = 17.8 \pm 7.6$ days per month versus $M = 7.2 \pm 5.4$ days per month; $t = -21.587$, $df = 700$; $P < .001$), more vigorous poses ($M = 14.6 \pm 8.5$ days per month versus $M = 4.3 \pm 4.6$ days per month; $t = -19.755$, $df = 482.31$; $P < .001$), and more inversions ($M = 18.04 \pm 9.0$ days per month versus $M = 4.51 \pm 4.6$ days per month; $t = -24.508$, $df = 468.71$; $P < .001$) than less intense practitioners. Those with high practice frequency report studying philosophy about once per month, compared to those with low practice frequency who study yoga philosophy only about 3 or 4 times per year ($P < .001$). Intense practitioners had nine times the odds of regularly practicing gentle poses, twice the odds of

Table 3: Results of final linear and logistic regression models predicting health outcomes from specific types of yoga practice[a] in combination with influential demographic predictors ($N = 1045$).

Health outcome	Final predictors[b]	*B*	S.E.	*t*
Mindfulness	Breath work[c]	1.60	.29	5.51*
	Meditation[c]	1.05	.28	3.71*
	Philosophy study	.31	.08	4.09*
Subjective well-being	Meditation[c]	2.80	.71	3.95*
	Philosophy study	.76	.20	3.87*
	Gender[d]	3.40	.91	3.73*
BMI ($n = 1034$)	Vigorous poses[e]	−.05	.02	−3.27*
	Philosophy study	−.16	.07	−2.22**
	Gender[d]	−2.03	.32	−6.34*
Fruit and vegetables/day ($n = 1043$)	Standing poses[e]	.024	.01	3.31*
	Gentle poses[f]	.36	.11	3.16*
	Gender[d]	−.59	.15	−4.03*
	Age	.01	.01	3.17*
Sleep disturbance	Vigorous poses[e]	−.07	.14	−5.50*
Fatigue	Inversions[e]	−.05	.01	−4.62*
	Meditation[c]	−.52	.18	−2.83*
	Age	−.05	.01	–6.53*
				Wald/OR
Vegetarian status[g]	Gentle poses[f]	.73	.24	9.05*/2.07*
	Philosophy study	.24	.06	15.84*/1.27*
Alcohol consumption[h]	Gentle poses[f]	−.48	.13	14.37*/.621*
	Race[i]	.92	.22	17.56*/.53*

[a]Specific yoga practices: physical poses (standing, vigorous, inversions, and gentle), breath work, meditation, and yoga philosophy study. [b]Each final model includes all predictors included in the final model. Demographic covariates were included if they had at least a small ($r = .1$) and significant ($P < .05$) correlation with the health variable. No demographic variable met these criteria that was not included in the final model. [c] ≤ or > once per week. [d]Gender coded "0" = male "1" = female. [e]Days per month. [f]≤ or ≥ 30 minutes per week. [g]Vegetarian status coded no = "0", yes = "1". [h]Alcohol consumption (number of drinks one consumes on a typical day when one drinks) coded ≤2 drinks per day = "0", >2 drinks per day. [i]Race coded "0" = other, "1" = white. Abbreviations—*B*: unstandardized beta weight. SE: standard error. *t*: *t* score for linear regressions. Wald: Wald statistic for logistic regressions. OR: odds ratio. BMI: body mass index. Note: For all measures, higher scores indicate more of the concept measured. *$P < 0.05$ level (2-tailed). **$P < 0.01$ (2-tailed).

meditating at least weekly, and nearly three times the odds of practicing breath work at least weekly than those who reported low practice frequency ($P < .001$).

In the final models examining specific components of yoga practice, all of the specific components predicted at least one aspect of health (Table 3). Notably, frequency of philosophy study was the yoga practice variable that most often predicted health. Frequency of philosophy study ($\beta = .310$, $P < .001$), along with breath work ($\beta = .290$, $P < .001$) and meditation ($\beta = .282$, $P < .001$), positively predicted mindfulness. Frequency of philosophy study ($\beta = .756$, $P < .001$), in addition to meditation ($\beta = 2.80$, $P < .001$) and female gender ($\beta = 3.39$, $P < .001$), also positively predicted subjective well-being. More frequent philosophy study also contributed to a lower BMI ($\beta = -.158$, $P < .05$) and higher odds of being a vegetarian ($\beta = .242$, $P < .001$).

After controlling for gender, vigorous poses remained an independent predictor of BMI ($\beta = -.053$, $P < .05$). Vigorous poses also predicted sleep disturbance ($\beta = -.065$, $P < .05$). For every additional day per week of vigorous pose practice, BMI decreased .21 of a point (.05 of a SD) and sleep disturbance improved .26 of a point (.087 of an SD). Frequency of gentle poses ($\beta = .360$, $P < .001$), along with standing poses ($\beta = .024$, $P < .01$), remained positive predictors of fruit and vegetables consumption, even when controlling for the effects of age and gender. Those individuals who practiced gentle poses 30 minutes or more per week had 7% higher odds of being vegetarian (OR = 2.073, $P < .01$) and about 50% lower odds of consuming alcohol (OR = .621, $P < .001$) than those who practiced gentle poses for 30 minutes or less per week.

4. Discussion

In general, frequency of yoga practice outside of class, as opposed to years of yoga practice or class participation, was repeatedly a predictor of aspects of health including mindfulness, subjective well-being, BMI, fruit and vegetable consumption, and sleep disturbance. It did not appear to matter how long an individual had practiced yoga. Rather, it appeared to matter how often they practiced. While class participation may be important in learning to do yoga, it did not predict any aspects of health. Perhaps time spent in class counts as additional practice time, and it is not unique unto itself.

While the individual effects of frequency of home practice are small, accounting for less than 7% of the variance in the health variables, they are cumulative. For instance, for an individual who did not previously have a home practice of yoga, practicing one day per week is associated with consuming an extra tenth of a serving of fruits and vegetables per day or almost one extra serving per week. If that same individual were to practice five days per week, that would be associated with an increase of over one half a serving of fruits and vegetables per day or nearly four and a half extra servings per week.

Individuals who were intense practitioners (5+ days per week of home practice) tended to practice all aspects of yoga including all of the physical poses, breath work, meditation, and philosophy study more often than those who did not practice as often. Intense practitioners attended class at the same rate as less intense practitioners. This possibly explains why class frequency did not predict any aspects of health. Because frequency of home practice was an important predictor of many aspects of health, and intense practitioners tended to practice all aspects of yoga, it is logical to assume that a practice that includes all aspects of yoga may be more beneficial to health than practice that includes only one or two aspects of yoga (such as only breath work or vigorous poses).

The interaction effect of practice frequency with age on fatigue showed that older individuals, regardless of their practice frequency, had significantly lower levels of fatigue than younger yoga practitioners; younger individuals who had a more frequent home practice had less fatigue than younger practitioners who did not practice as often. Perhaps older individuals experience benefits from just a little bit of yoga practice, while younger individuals need more to experience benefits on fatigue. This finding is encouraging for older individuals beginning the practice of yoga, as problems with sleep and fatigue are common in the elderly [62, 63].

While no single category of physical pose (standing poses, vigorous poses, inversions, and/or gentle poses) was related to all aspects of health, each category of physical pose was related significantly to at least one aspect of health. The physical poses, often referred to as the "external" or physical practice in yoga texts [64], were most commonly related to the physical aspects of health (sleep, diet, BMI). In contrast, the higher level practices of breath work and meditation, typically defined in yoga texts as tools for controlling a distracted, fluctuating mind [64], were associated with mindfulness and subjective well-being. It is possible that physical poses, particularly active poses (such as standing poses) and vigorous poses (such as sun salutations, backbends, and arm balances), have effects similar to those of exercise. These findings support previous evidence that exercise is related to diet [65], energy levels [65], and BMI [66]. Levels of physical activity in this population predicted fruit and vegetable consumption and levels of fatigue, although the effects (standardized betas) of physical activity were smaller than those of yoga home practice. Likewise, because breath work and meditation appear to influence mindfulness and well-being, they may be particularly useful in treating conditions such as depression and anxiety.

More frequent practice of gentle poses, including supine restorative poses and relaxation pose (Savasana), were associated with three aspects of health that deal with feeding behaviors or cravings: higher fruit and vegetable consumption, higher rates of vegetarianism, and lower alcohol consumption. It has been postulated that yoga impacts the Hypothalamic-Pituitary-Adrenal (HPA) axis and the Sympathetic Nervous System (SNS) response to stress [23], possibly via direct vagal stimulation [20]. Evidence suggests that stress is associated with unhealthy changes in food seeking behavior including increased consumption of foods high in sugar and fat [67, 68], as well as increased alcohol consumption [69, 70]. Of all types of physical poses, gentle poses would likely exert the most profound relaxation response. Perhaps an effective weight loss intervention would include a combination of active physical poses for their exercise benefits, as well as gentle poses for their possible effects on the HPA axis response to stress, particularly as it relates to self-medicating with food and alcohol. While combination approaches have resulted in weight loss in past studies [36–38], none looked specifically at the combination of active and gentle poses.

Compared to other components of yoga practice, frequency of philosophy study most often predicted aspects of health. It is doubtful that reading yoga philosophy texts will lead to lower BMI or more happiness. Rather, because individuals who were intense practitioners ($\geq$5 days per week of yoga practice) studied philosophy significantly more often than those who practiced less than once per week, it is likely that frequency of philosophy study served as a "proxy variable" for intense practice. In addition, these same intense practitioners tended to practice all aspects of yoga, with more days of practice per month of all of the physical poses, breath work, and meditation. Thus, any relationship between philosophy study and health may reflect the relationship of frequency and intensity of yoga practice to health. This provides more evidence that an intense practice involving all aspects of yoga practice may be more beneficial to health than a less intense practice that includes only one or two aspects of yoga practice, such as just practicing the physical poses or breath work.

A number of limitations existed in this study. The findings of this study are generalizable only to Iyengar yoga practitioners in the USA. Second, anonymous online surveys have the potential for denial, deception, and recall and/or response bias. Thus, answers for measures such as height and weight might not be accurate. The response rate of 27% was low, which could potentially result in bias. Because subjects were predominantly white, female, and highly educated, it is not known if a lack of diversity may have limited the ability to control for these demographics in the models. Finally, the cross-sectional nature of the study allows one to draw inferences, but do not allow one to conclude that yoga actually impacts health. It should be noted that the use of the word "predicted" when describing the relationship between yoga practice and health is the appropriate term when interpreting linear regressions, but it does not imply causality. Despite these limitations, this study makes an important contribution to understanding of the practice of yoga and its potential contribution to practitioners' health.

5. Conclusion

In conclusion, yoga may be a useful intervention for improving health behaviors or life-style-related health conditions. Frequency of home practice appears to be very important—more important than how long an individual has been practicing or how many classes one takes. This emphasizes a simple fact: it is not enough simply to learn how to do healthy behaviors. Rather, healthy behaviors must be incorporated into one's daily life. While these findings suggest that individuals will only glean benefits from yoga practice that are proportional to the energy they are willing to invest in making it a part of their lives, the findings also suggest that they do not have to practice for years in order to reap the rewards.

What one practices, be it the different types of physical poses, breath work, or meditation, is important because the different aspects of yoga practice may well have different health benefits. Randomized clinical trials are needed to examine causal relationships between the different aspects of yoga practice and aspects of health. For instance, does an intervention focusing on gentle poses positively affect feeding behaviors? Does an intervention focusing on vigorous poses effect sleep better than an intervention focusing on gentle poses?

While this study focused exclusively on Iyengar yoga, it is important to note that styles of yoga differ in what components of yoga practice are emphasized. Thus, some styles of yoga may be better suited for certain individuals, depending upon the aspects of health they are seeking to improve, as well as their temperament and physical condition. For this reason, future research should examine the comparative effectiveness of different styles of yoga on a variety of health outcomes.

Acknowledgment

The authors wish to thank the Iyengar Yoga National Association U.S. and all the participating yoga studios for their assistance in this research study. The authors extend a special note of appreciation to Kathleen Pringle and John Schumacher for their expert guidance in developing and implementing the survey.

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2012, Article ID 715942, 13 pages
doi:10.1155/2012/715942

Review Article

Systematic Review of Yoga for Pregnant Women: Current Status and Future Directions

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Received 20 April 2012; Accepted 8 June 2012

Academic Editor: Karen J. Sherman

Objectives. Yoga is used for a variety of immunological, neuromuscular, psychological, and pain conditions. Recent studies indicate that it may be effective in improving pregnancy, labour, and birth outcomes. The purpose of this paper is to evaluate the existing literature on yoga for pregnancy. *Methods*. Six databases were searched using the terms "yoga AND pregnancy" and "yoga AND [post-natal OR post-partum]". Trials were considered if they were controlled and evaluated a yoga intervention. All studies were evaluated for methodological quality according to the Jadad scale and the Delphi List. *Results*. Six trials were identified: three were randomized controlled trials (RCTs) and three were controlled trials (CTs). The methodological quality and reporting ranged from 0–5 on the Jadad scale and from 3–6 on the Delphi List. Findings from the RCT studies indicate that yoga may produce improvements in stress levels, quality of life, aspects of interpersonal relating, autonomic nervous system functioning, and labour parameters such as comfort, pain, and duration. *Conclusions*. The findings suggest that yoga is well indicated for pregnant women and leads to improvements on a variety of pregnancy, labour, and birth outcomes. However, RCTs are needed to provide more information regarding the utility of yoga interventions for pregnancy.

1. Introduction

Yoga is an ancient mind-body practice that originated in India and is becoming increasingly recognized and used in developed nations as a health practice for a variety of immunological, neuromuscular, psychological, and pain conditions [1, 2]. The word yoga comes from the Sanskrit term "yug" and directly translates as "to unite"; more broadly, it means to work towards a unified experience of the self and improved health [3]. Most recognized for its potential to create balance along emotional, mental, physical, and spiritual dimensions, yoga is a comprehensive system that uses physical postures (*asana*), breathing exercises (*pranayama*), concentration and meditation (*dharana* and *dhyana*), and contemplative practice. Although there are a plethora of lineages and schools of yoga that are offered in modern society, practices typically include at least the physical postures and breathing exercises. Yoga is thought to alter nervous system regulation and physiological system functioning (e.g., immune, endocrine, neurotransmitter, and cardiovascular) and improve psychological well being (e.g., frequency of positive mood states and optimism) and physical fitness (e.g., strength, flexibility, and endurance) [2].

Pregnancy is a condition in which women undergo distinct physiological changes and stress and is accompanied by unique physical and psychological demands. There is a need to manage the various physical, emotional, mental, and pain states that arise throughout the stages of pregnancy and labour. The well being and quality of life of the mother is critical for optimal pregnancy outcomes; self-soothing techniques, psychoeducation, and relaxation are particularly important in this transitional and meaningful time [4]. Maternal stress and anxiety during pregnancy is associated with a host of negative consequences for the fetus and subsequent development. For instance, fetal exposure to maternal stress and stress-related peptides is a risk factor for adverse outcomes on the programming of the nervous system and brain morphology of fetuses, infants, and children. Early gestational stress exposure is associated with negative outcomes at different developmental stages, slowed maturation and behavioural response patterns in fetuses, alterations in neonatal stress regulation and behavioural reactions to stress, blunted cognitive functions and emotional and behavioural problems in infants and toddlers, and reduced brain volume in areas associated with cognitive function in children [5]. In addition, prenatal maternal stress and anxiety may be risk factors for potential negative consequences for children later in life, such as the development of attention deficit hyperactivity disorder or lowered performance on aspects of executive function [6, 7]. It is hypothesized that maternal stress may affect the intrauterine environment and alter fetal development during critical periods, through either activation of the placental stress system, causing the release and circulation of corticotropin releasing hormone, or through diminished blood flow and oxygen to the uterus [8]. Therefore, it is important to regulate maternal stress and provide expecting mothers with coping strategies for the inevitable stresses and changes that occur during pregnancy to increase quality of life and to maximize infant health and development.

Physical exercise can be helpful in the management of stress and other associated conditions or symptoms accompanying pregnancy, such as edema, gestational hypertension or diabetes, mood instability, musculoskeletal discomfort, aches, and weight gain [9]. Engaging in physical exercise during pregnancy was once regarded as a risky behaviour, although it is increasingly recognized as safe and is encouraged in routine prenatal care. Melzer et al. [9] concluded that regular physical exercise has maternal and fetal advantages that outweigh risks and recommend at least 30 minutes of exercise, most days of the week for the prevention and treatment of conditions associated with inactivity, such as gestational diabetes and hypertension.

Mind-body practices that cultivate general health, diminish distress, and increase self awareness, such as tai chi or yoga, maybe be particularly effective in addressing both the physical and psychoemotional aspects of pregnancy and labour [4]. Other related practices, including biofeedback, meditation, and imagery, have been found to reduce anxiety and endocrine measures, such as cortisol, in women during labour [10, 11]. Relaxation therapies for pain management in labour have also become popular as women are seeking alternatives to traditional treatment approaches, including analgesics and anesthesia, which can be invasive and are sometimes associated with negative side effects for both the mother and infant [12].

Labour pain is a subjective and multidimensional experience that varies according to each woman's individual perceptions of and reactions to nociceptive information during labour and is influenced by psychosocial, cognitive, and physiological factors [13]. It is suggested that practitioners use a multidisciplinary approach to pain management in labour and incorporate both pharmacological and nonpharmacological approaches that can be tailored to individual preferences and needs [14]. Confidence, self-efficacy, and coping ability are considered important for a positive labour experience, and maternal prenatal anxiety is negatively associated with prelabour self-efficacy for childbirth and labour pain [15]. Other psychological factors, such as pain catastrophizing, have been associated with greater lumbopelvic pain during pregnancy and with decreased postpartum physical ability [16] and can also predict the request for pain relief during labour [17].

Yoga may be effective in the reduction of negative symptoms associated with pregnancy and birth. Given that 35% of women aged 28–33 years already practice yoga, it is important to evaluate its effects on the maternal experience of stress, anxiety, pain, discomfort, and other variables as well as on labour and birth outcomes [18]. A recent review of yoga for pregnancy related outcomes concluded that yoga is positively indicated for use in pregnancy but the findings are not definitive since some of the trials included in that review were uncontrolled and others demonstrated poor methodological quality for different reasons [19]. The primary purpose of the present paper is to systematically evaluate the evidence for the use of yoga during pregnancy and labour and to make recommendations for the direction of future research.

2. Materials and Methods

Literature searches were conducted to identify all controlled clinical trials of yoga and pregnancy. The following databases were used: EBSCOHost Web: CINAHL, Pubmed, Medline, Proquest, PsychoInfo and "Evidence Based Medicine Reviews: Cochrane DSR, ACP Journal Club, DARE, and CCTR". The two terms "yoga" and "pregnancy" were linked together using the Boolean operator "AND" in order to search articles containing both terms. In addition, a search containing the terms "yoga AND [post-natal OR post-partum]" was conducted. The reference lists of located articles were also searched for possible publications. Only articles in English were included.

Yoga was defined as a mind-body practice that included traditional physical postures and may incorporate other components, such as breathing exercises and meditation. Only studies that used yoga postures explicitly as an intervention were included; interventions that employed other aspects of yoga, such as yogic breath, yogic philosophy, ayurvedic herbs, or mindfulness as the primary intervention, were not included, as the effects of asana or integrated yoga programs were of primary interest. Information on trial design, randomization, blinding, drop out rate, inclusion and exclusion criteria, details about treatment and control conditions, main outcome measures, and main results were extracted, as has been done in previous reviews of yoga for certain conditions [20].

Studies were evaluated independently by two reviewers (K. Curtis and J. Katz) according to the five-item Jadad scale [21] and the nine-item Delphi List [22]; any differences were resolved through discussion until a consensus was reached. The Jadad scale evaluates studies according to a five-item rating scale, with each item awarded one point for a "yes" answer and zero points for a "no" answer. By selecting a commonly used rating scale, the findings of the present paper are more easily compared with review articles that evaluate related interventions. The items include the following questions: (1) was the study randomized, (2) was randomization explained and appropriate, (3) was the study double blinded, (4) was the process of double

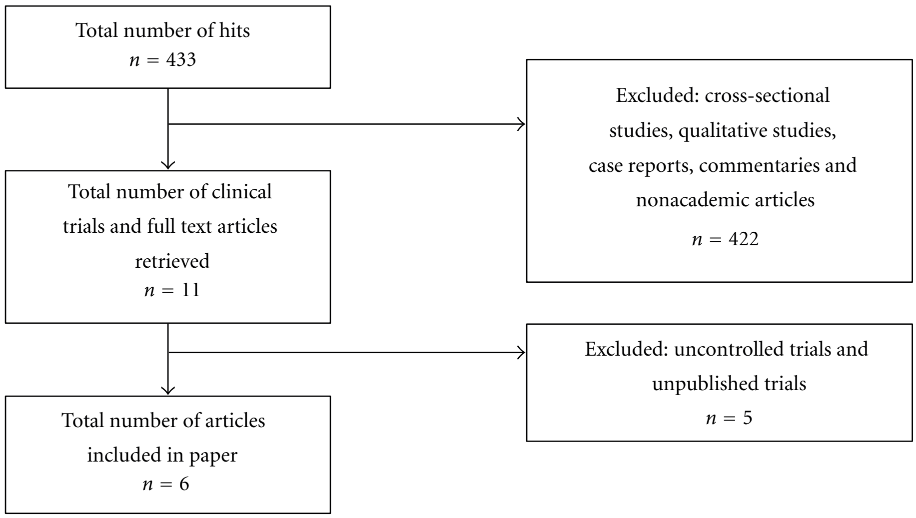

Figure 1: Flow diagram of articles.

blinding explained and appropriate, and (5) was information provided on the number and reasons for participant drop out or withdrawal. Points are deducted if randomization or blinding is inappropriate. Double-blinding is intrinsically challenging in trials involving a yoga intervention, so a modified approach to questions 3 and 4 was used, in which a point was awarded to studies that used a single blind approach, and a second point was awarded if the authors explained how the assessor/statistician was blinded.

The Delphi List more specifically addresses the issue of blinding and also includes items concerning other important aspects of clinical trials. It contains two separate items for care provider blinding and patient blinding, making it amenable to evaluating trials in which participant blinding is impossible. This nine item scale includes a series of questions which are rated according to yes/no/don't know, with one point awarded for ratings of "yes" answers and zero points awarded for "no" or "don't know". The items include: (1) treatment allocation: (a) was a method of randomization performed and (b) was the treatment allocation concealed, (2) were the groups similar at baseline regarding the most important prognostic indicators, (3) were the eligibility criteria specified, (4) was the outcome assessor blinded, (5) was the care provider blinded, (6) was the patient blinded, (7) were point estimates and measures of variability presented for the primary outcome measures and (8) did the analysis include an intention-to-treat analysis. Finally, given the limited number of studies published on yoga for pregnancy, in addition to the varying designs methodology of the studies, a meta-analysis was not performed and the studies are presented descriptively.

3. Results

The search strategy, "yoga AND pregnancy" and "yoga AND [post-natal OR post-partum]", generated 433 initial results (Figure 1), including nonacademic results (EBSCO-Host Web; 72, Pubmed; 49, Medline; 41, Proquest; 251, PsychInfo; 17, Cochrane; 3). We excluded cross-sectional surveys, case reports, qualitative studies, and commentaries. Of the remaining articles, a total of 11 clinical trials were retrieved for further evaluation including three unpublished studies (a presentation at a conference and two doctoral dissertations). Of these 11 trials, we excluded five on the basis that they were pilot studies and did not have a control group (three used the data from the same intervention) [23–27]. Five controlled studies, resulting in six publications, involving 689 participants were eligible and are included in the present paper (Table 1) [28–33].

The six studies originated in India [29–32], Taiwan [28], and Thailand [33]. All studies had participants who were either (1) primigravida [28, 33], (2) primigravida or multigravida with one living child [31, 32], or (3) primigravida or multigravida [29, 30]. Three of the six studies were randomized [31–33] and three were not [28–30]. Exclusion criteria included a variety of medical conditions and complications such as: diabetes, hypertension, obesity, multiple pregnancy, history of previous pregnancy loss due to known single gene defects, chromosomal disorders, intrauterine infections, in vitro fertilization pregnancy, previous history of intra uterine growth retardation, preeclampsia, maternal structural abnormalities, fetal abnormality on ultrasound scanning, multigravida with no living children, psychiatric problems, being younger than 18, abnormal extremities (unable to do activities), unable to speak the native language, previous exposure to yoga, and regular exercise for one year. Furthermore, one study excluded women if they were admitted to hospital during active labour and if they received epidural anesthesia or a caesarean section, in accordance with the methodology for data collection of that study [28].

The various components of a yoga practice that were included in the reviewed trials included postures (*asana*), breathing practices (*pranayama*), concentration/meditation (*dharana/dhyana*), deep relaxation or yoga sleep (yoga *nidra*), lectures/counseling sessions on lifestyle change, and information on anatomy and chanting (Table 2). Typically,

Table 1: Controlled studies of yoga for pregnancy.

First author, year	Study design	Participants (pregnant women)	Experimental intervention	Control intervention	Outcome measures	Main results
Rakhshani, 2010 [31]	Prospective, two-armed RCT	18th–20th week of gestation, 20–35 yrs of age, PG or MG with at least one living child ($N = 111$, $n = 102$)	Integrated yoga, 20th–36th week of gestation. First month of yoga was done with instructor, following months done at home (1 hour, 3 times a week). Refresher classes were provided at each antenatal visit.	Standard antenatal exercises, 20th–36th week gestation, same format as the yoga intervention.	WHOQOL-100, FIRO-B	Significant improvements in the yoga condition for physical, psychological, environmental, and social domains of the WHOQOL-100 and on expressed inclusion and wanted control of the FIRO-B when compared to the control group.
Satyapriya, 2009 [32]	Prospective, two-armed RCT	18th–20th week of gestation, 20–35 years of age, PG or MG with at least one living child ($N = 122$, $n = 90$)	Integrated yoga and yogic relaxation, 20th–36th week of gestation (until delivery). First month of yoga was done with instructor (2 hours, 3 times a week), following months done at home with cassette (1 hour, 3 times a week). Refresher classes were provided 1 time a month until week 28 and 2 times a month until week 36.	Standard prenatal exercises, 20th–36th week gestation, same format as the yoga intervention.	PSS, HRV	The yoga group's stress scores decreased, while the control group's stress scores increased. Improved autonomic response in both yoga and control group.
Chuntharapat, 2008 [33]	RCT	26th–28th weeks of gestation, ≥18 years of age, PG ($n = 74$)	6 × 1 hour yoga classes on weeks 26th–28th, 30th, 32nd, 34th, 36th, and 37th week of gestation as well as 1 hour practice at home, at least 3 times a week after the first class for 10–12 weeks.	Routine nursing care, including casual conversations for 20–30 min, during hospital visits.	STAI pretrial, VASTC, MCQ, VAPS, PBOS, Apgar scores, length of labor, birth augmentation, use of pethidine	Experimental group demonstrated significantly higher levels of comfort, lower levels of self-reported, and experimenter observed pain throughout labour and shorter duration of labour than the control group.
Sun, 2010 [28]	Nonrandomized controlled trial	26th–28th weeks of gestation, ≥18 years, PG ($N = 96$, $n = 88$)	Initial yoga class was taught by investigator, followed by home practice video of 30 min, 3 times a week for 12–14 weeks.	Standard hospital care.	DoPQ, CBSEI	Decreased pregnancy discomfort and increased childbirth self-efficacy in the yoga group when compared to standard care.

Table 1: Continued.

First author, year	Study design	Participants (pregnant women)	Experimental intervention	Control intervention	Outcome measures	Main results
Narendran, 2005 [30]	Prospective, matched, and observational study	18th–20th weeks of gestation, 18–35 years of age, PG or MG (n = 335)	Yoga practice 1 hour daily until delivery, taught in the first week and refresher classes every 3-4 weeks.	Walking 30 min, twice daily from enrollment until delivery.	Birth weight, gestational age at delivery, PIH, IUGR, PIH with IUGR, duration of labor, mode of delivery, preterm delivery, IUD.	The number of infants weighing ≥2500 g was greater in the yoga group. The yoga intervention group presented with lower duration of labor and lower incidence of IUGR and PIH with IUGR than the control group.
Narendran, 2005 [29]	Prospective, matched, and observational study	18th–20th weeks of gestation, 18–35 years of age, PG or MG, women who had abnormal Doppler readings of umbilical and uterine arteries (n = 121)	Yoga practice 1 hour daily until delivery, taught in the first week and reviewed every 3-4 weeks with instructor.	Walking 30 min, twice daily from enrollment until delivery.	Birth weight, gestational age at delivery, PIH, IUGR, PIH with IUGR, duration of labor, mode of delivery, preterm delivery, IUD.	Greater number of infants weighing ≥2500 g was higher in the yoga group.

WG: weeks of gestation, PG: primigravida, MG: multigravida, WHOQOL-100: World Health Organization Quality of Life Inventory-100, FIRO-B: fundamental interpersonal relationships orientation-B, PSS: perceived stress scale, HRV: heart rate variability, STAI: state-trait anxiety inventory, VASTC: visual analogue scale of total comfort, MCQ: maternal comfort questionnaire, VAPS: visual analogue pain scale, PBOS: pain behavioural observation scale, DoPQ: discomforts of childbirth questionnaire, CBSEI: childbirth self-efficacy inventory, PIH: pregnancy-induced hypertension, IUGR: intrauterine growth retardation, IUD: intrauterine death.

Table 2: Components of yoga intervention for each study.

Author (year)	Postures (*asana*)	Breathing exercises (*pranayama*)	Concentration/meditation (*dharana*/*dhyana*)	Deep relaxation/yoga sleep (*nidra*)	Lecture/ counseling	Anatomy	Chanting
Rakhshani et al. (2010) [31]	×	×	×	×	×		
Satyapriya et al. (2009) [32]	×	×	×	×	×		×
Sun et al. (2010) [28]	×		×				
Chuntharapat et al. (2008) [33]	×	×	×	×		×	×
Narendran et al. (2005) [30]	×	×	×	×			
Narendran et al. (2005) [29]	×	×	×	×			

yoga programs that assimilate multiple aspects of yoga, such as physical postures, breathing practices, and lectures on yogic philosophy, are considered "integrated" yoga programs. Some interventions incorporated teachings from ancient yogic texts, such as Patanjali's yoga sutras [32, 33], while another had a greater emphasis on yoga as exercise [28]. The yoga programs commenced either on week 18–20 of gestation, resulting in a 16–20 week-long intervention [29–32] or at week 26–28 of gestation, resulting in an 10–14 week-long intervention [28, 33]. Yoga interventions consisted of weekly practice of thirty minutes to one hour, three times a week [28, 31–33], or one hour daily [29, 30]. Control interventions included a walking group [29, 30], standard prenatal exercises [31, 32], and routine nursing care [28, 33].

All studies except one [33] provided a list of the postures used in the yoga interventions and four of the studies tailored the interventions to differ across trimester, according to the evolving needs of the pregnant women [29–32]. The two studies that included standard antenatal exercises as a control intervention used the same set of exercises, as approved by the Executive Council of the Society of Obstetrician and Gynecologists of Canada and by the Board of Directors of the Canadian Society for Exercise Physiology and provided them in table format [31, 32]. The standard antenatal exercise condition consisted of lectures (e.g., physiology of pregnancy, modern science concepts of a healthy lifestyle, and management of stress), a series of stretches (e.g., hamstring, thigh, and calf), strengthening exercises (e.g., squatting, push ups, and seated rowing), walking, and supine rest.

All studies provided participants with materials with which to practice at home, including cassettes, booklets, and videos. Three of the studies monitored participant adherence to home practice with diaries and phone calls [28, 31–33], one study used only phone calls [28] and two did not report that they monitored participant home practice [29, 30]. Most studies used valid and reliable measures of the dependent variables [28, 31–33], two also used researcher modified measures or measures developed for the particular trial [28, 33] and three used primarily quantitative information that was documented at birth or extracted from hospital records [29, 30, 33]. Statistical analysis was overly liberal in terms of the Type I error rate in most studies; the use of a 2-way repeated measures ANOVA with groups (yoga, control) and time (baseline and posttreatment) would have been more appropriate than conducting both independent and paired t-tests given the study designs used [28–31]. On the other hand, one study [32] used t-tests to evaluate pre- and postdifferences both within and between groups but verified some findings by means of an ANOVA and another study employed a repeated measures ANOVA with Bonferroni-corrected comparisons, appropriate to the study design [33]. Primary outcome measures included maternal-related variables at various time points throughout pregnancy, during labour, and immediately after birth as well as infant-related variables at birth.

Scores on each item of the Jadad scale and Delphi List are illustrated in Tables 3 and 4, respectively. Overall, Jadad scores ranged from zero to five; two studies were of high quality, scoring a five on the scale and four were of low quality, scoring a zero, one, or two on the scale. The more detailed Delphi List resulted in slightly greater variability in scores, which ranged 3–6 out of 9 possible points. Not one study was awarded points for care provider or participant blinding.

4. Description of RCTs and Controlled Studies Evaluating Yoga for Pregnancy

Rakhshani et al. [31] evaluated the effects of integrated yoga on the quality of life and interpersonal relationships of 102 healthy pregnant women when compared to standard antenatal exercises, using an RCT design. The 16-week-long integrated yoga program went from the 20th to 36th weeks of gestation and included lectures, breathing exercises (*pranayama*), physical postures (*asana*), meditation (*dhyana*), and a deep relaxation technique. The yoga group showed significantly greater improvements than the control group on the physical, psychological, environmental, and social domains of the World Health Organization Quality of Life Inventory (WHOQOL-100) as well as on the Expressed

Table 3: Score breakdown on the Jadad scale for each study.

Author (year)	Randomization and explanation	Single blinding and explanation	Description of participant withdrawal/dropout	Total score
Rakhshani et al. (2010) [31]	2	2	1	5
Satyapriya et al. (2009) [32]	2	2	1	5
Sun et al. (2010) [28]	0	0*	1	1
Chuntharapat et al. (2008) [33]	2	0	0	2
Narendran et al. (2005) [30]	0	0	0	0
Narendran et al. (2005) [29]	0	0	0	0

* Study authors state that the methodology was double blind, but in light of other information provided, it is clear that it was not.

Table 4: Score breakdown on the Delphi List for each study.

Author (year)	Randomized	Treatment allocation concealed	Similar baseline characteristics	Eligibility criteria specified	Outcome assessor blinded	Treatment provider blinded	Patient blinded	Point estimates/ variability	Intention-to-treat analysis	Total
Rakhshani et al. (2010) [31]	1	0	1*	1	1	0	0	1	0	5
Satyapriya et al. (2009) [32]	1	1	1*	1	1	0	0	1	0	6
Sun et al. (2010) [28]	0	0	1	1	0	0	0	1	0	3
Chuntharapat et al. (2008) [33]	1	0	1	1	0	0	0	1	0	4
Narendran et al. (2005) [30]	0	0	1	1	0	0	0	0	1	3
Narendran et al. (2005) [29]	0	0	1	1	0	0	0	1	1	4

* All baseline characteristics were matched except for professional status.

Inclusion and Wanted Control facets of the Fundamental Interpersonal Relationships Orientation (FIRO-B) questionnaire. Strengths of the study include an RCT design and a large sample size. The authors suggest that yoga is a noninvasive and cost-effective way of improving quality of life and interpersonal relationships during pregnancy.

Satyapriya et al. [32] used an RCT design to compare the effects of a similar 16–18-week-long integrated yoga program (plus a chanting component) with a control group that received standard prenatal exercises on maternal stress during pregnancy. Women who participated in the program were recruited between the 18th and 20th week of pregnancy and participated until their 36th week. The self-report perceived stress scale (PSS) and objective measures of heart rate variability (HRV) were used to measure stress. Heart rate was measured continuously before, during and after a deep relaxation technique (DRT) period in the yoga condition and of a corresponding supine rest (SR) period in the control condition. Three measures of heart rate were collected for analysis of continuous heart rate recording: low frequency (LF: related to sympathetic modulation), high frequency (HF: related to efferent vagal activity), and the ratio of low frequency to high frequency (LF/HF: related to sympathovagal balance).

Pre- to postintervention comparisons within each group showed that PSS scores decreased significantly in the yoga group and increased significantly in the control group so that by the end of the intervention PSS scores were significantly lower in the yoga group compared with the control group. Significant decreases in LF heart rate and the LF/HF ratio and significant increases in HF heart rate were observed from before to during the DRT and SR periods of the yoga and control conditions at the 20th and 36th weeks of gestation. At the 36th week, LF heart rate decreased from before to after in only the DRT (yoga) practice, whereas a significant before-to-after increase on HF and decrease on LF/HF ratio were observed in both groups. The results suggest that the DRT of the yoga condition may be a more powerful modulator of the sympathetic nervous system or the "fight or flight" response than the SR component of the exercise condition. Strengths of this study include an RCT design, a large sample size, an objective physiological measure, and information on the reliability of the PSS for an Indian population.

In addition to evaluating the effects of yoga on maternal experiences throughout pregnancy, Sun et al. [28] also examined the effects of a 12–14 week yoga program during weeks 26th–28th to 38th–40th weeks on pregnancy-related discomfort as measured by the Discomforts of Pregnancy Questionnaire (DoPQ) and maternal childbirth self-efficacy during labour/delivery, when compared to standard hospital care using a nonrandomized, controlled trial design. Although there were no differences between the two groups in discomfort between the 26th and 28th week of gestation, the yoga group reported significantly less discomfort in the 38–40th week of gestation period. Furthermore, women in the yoga condition had significantly higher self-efficacy expectancy and outcome expectancy in both the active and second stages of labour than the women in the control group, as measured by the Childbirth Self-Efficacy Inventory (CBSEI).

The majority of women (77.8%) in the yoga group did not experience any contractions while practicing yoga, very few (4.4%) experienced a contraction once every 10 minutes, and about a fifth (17.8%) experienced a contraction once every 30 minutes. The authors conclude that a prenatal yoga program is safe for pregnant women and can reduce the discomforts of pregnancy and increase maternal self-efficacy and self-confidence, but an RCT design is needed to confirm these findings.

Although Sun et al. [28] state that the study was double blind, the absence of information on who was blinded and during what phase of the intervention raise questions about how double blinding was possible. Other methodological problems include a nonrandom method of allocating participants to treatment groups and the use of a nonvalidated questionnaire (DoPQ) developed by study investigators to measure discomfort during pregnancy. Furthermore, the principal investigator, who was not a certified yoga teacher, taught the yoga intervention to participants at the initial practice session, which may have compromised the quality of the yoga program and may also have introduced experimenter bias. However, assets of this study are that it employs a highly reliable measure with unidimensional subscales (CBSEI) and includes reports on adverse effects.

The effects of a 10–12 week prenatal yoga program during weeks 26th–28th to 37th-38th of gestation on labour outcomes were also evaluated by Chuntharapat et al. [33]. Labour variables such as maternal comfort, self-reported and experimenter-observed pain, length of labour, augmentation, and use of medication as well as birth outcomes, such as Apgar scores, were assessed in an RCT comparing an integrated yoga program to routine nursing care. It was found that the yoga program resulted in significantly higher maternal comfort at three different assessment points during labour as well as at a 2 hr assessment point postlabour. Both self-reported and observed labour pain scores were significantly lower in the experimental group than in the control group, although, not surprisingly, pain scores did increase over time in both groups. Furthermore, results demonstrated that the first stage of labour and the total duration of labour were significantly shorter in women who had received the yoga intervention. Significant between group differences were not found in the number of participants in whom labor was induced, the use of pethidine or in the newborns' Apgar scores. Strengths include clear and detailed charts depicting the results and the use of a variety of instruments to evaluate pain. A potential limitation is that participants were allowed to practice more than three times a week and so the dose-dependent relationship between amount of time practicing yoga and the observed effects is unclear. The study researchers did provide information on internal consistency for some measures (VASTC, MCQ, and VASPS) and a reliability coefficient for the PBOS but did not include external reports of validity.

In a nonrandomized, controlled trial, Narendran, Nagarathna, Narendran, Gunasheela, and Nagendra [30] compared the effects of an ∼20-week-long integrated yoga condition to a walking condition during weeks 18–20 of gestation until delivery, on pregnancy outcomes. Main outcome measures included birth weight and gestational age at delivery. Secondary outcomes assessed were pregnancy-induced hypertension (PIH), intrauterine growth retardation (IUGR), pregnancy-induced hypertension (PIH) with IUGR, duration of labour, mode of delivery, preterm delivery, and intrauterine death (IUD). The number of infants weighing over 2500 g was significantly greater for women who had participated in the yoga condition; however, the mean birth weight of infants did not statistically differ between the two groups. In addition, the number of women who experienced preterm labour (i.e., before 37 weeks) was significantly lower and complications such as IUGR and PIH with associated IUGR occurred significantly less often in the yoga group. The statistical analysis was inappropriate: assumptions of normality were not assessed and t-tests were conducted to analyze continuous variables, rather than a two-way repeated measures (group $\times$ time) ANOVA. The authors did not report the numeric values of the t-tests and chi-square tests, nor did they report any measures of variability for the relevant outcome variables. Moreover, this study was not randomized and contains a participant self-selection bias. Notwithstanding these problems, a strength of this study is that it did not exclude women with medical conditions associated with pregnancy, such as gestational diabetes, or hypertension, making the results generalizable.

In a publication stemming from the aforementioned trial [30], Narendran et al. [29] evaluated the same outcomes in women who were specifically selected as having abnormal Doppler readings of umbilical and uterine arteries. In this subsample of women, the authors reported that infants who were born to mothers in the yoga condition weighed significantly more and that a greater number of them weighed at least 2500 g when compared to the control group. By contrast, there were only trends in favour of the yoga group for pregnancy related complications and number of preterm deliveries. The study authors used the same statistical analysis as in the above trial and so problems resulting from an overliberal approach are present for this study as well, and given the nonrandomized design, the results of this study are not definitive. Since abnormal readings of Doppler scores are associated with IUGR, this trial provides information about the safety of a yoga intervention for a high-risk population. Both publications [29, 30] from this trial reported that adverse effects did not occur in the yoga group.

5. Discussion

The purpose of the present paper was to evaluate evidence from controlled trials regarding the effects of yoga on the maternal experience during pregnancy and in labour as well as on birth outcomes. Overall, the results suggest that yoga is well indicated for pregnant women at a time in their lives when their hormonal, muscular, and psychological functioning undergo rapid change. The reviewed trials all use an integrated prenatal yoga program that spanned 10–20 weeks and all studies found improvements on a minimum of 1 outcome variable. Each study used at least two components of a yoga practice, postures, and meditation (*asana* and *dharana*), and the majority of the studies employed a gentle and integrated approach to Hatha yoga that also included breathing exercises (*pranayama*), lectures, chanting, and deep relaxation.

Notably, only three of the studies used a randomized, controlled design, and of those that did, only two described the randomization process; accordingly, only two studies received the maximum two points for randomization on the Jadad scale. It is difficult to double blind a yoga intervention and several of the included studies explained valid reasons why the double-blinding process was not appropriate for the design of their study. It is recognized that RCTs impose some logistical disadvantages, such as matters of cost, time, and geographical accessibility. In particular, Narendran et al. [30] would have compromised the large sample size if an RCT design had been used, given that women were travelling from neighbouring regions and may have dropped out if they had been assigned to a less accessible condition. Although care was taken to prevent between-group contamination [31, 32], some authors reported that they could not entirely prevent this, which may have confounded the results in that participants in the control condition may have utilized aspects of the yoga program (e.g., yogic theory or breathing exercises) [32] and others reported potential contamination bias from expectancy effects [28].

Three studies documented the presence or absence of adverse effects of the yoga intervention [28–30]; of these, two reported that there were no adverse effects observed. Information on rates of uterine contractions or other possible adverse effects of yoga during pregnancy, combined with details on the type of intervention used, would be informative for researchers designing future interventions. Early adverse events during pregnancy have been shown to have fetal neurobehavioural developmental consequences, so safety of the mother and infant during exercise-related activities is imperative [34]. Despite the general recommendations for physical exercise during pregnancy, there are still possible negative consequences, such as uterine contractions, maternal-fetal transfer of catecholamines, decrease of oxygen, premature labour, and nutrient flow or attenuation/decrease of fetal heart rate [9]. Guidelines have been proposed to ensure adequate management for the safety of the mother and fetus in exercise and related activities [9]. Various forms of exercise (e.g., aerobic and weight bearing) have different consequences on maternal and fetal physiology, especially across trimesters. For example, during the third trimester, both the mother and fetus are more vulnerable to physical stress [35]. With the exception of one study [28], most of the yoga programs evaluated in the present paper did not place an emphasis on "yoga as exercise" per se, and so are unlikely to be susceptible to the risks of more rigorous exercise regimes. Empirical evidence is needed to create guidelines outlining postures that are safe for pregnant women across trimesters. Regardless of the type of yoga or specific postures used, modifications should be made according to the specific needs of the individual woman, in the prevention of overexertion, stress on the fetus, and premature labour. Yoga is a low impact, easily modifiable and mindful activity, considering it is a safe and sustainable activity for pregnant women.

Although the studies reviewed in the present paper contribute valuable information about the potential effects of yoga on pregnancy outcomes, several limitations were noted. Firstly, four of the six studies that were included in this paper used an overly-liberal statistical approach, which should be considered in the interpretation of the effects of yoga for the corresponding outcome measures, including quality of life, interpersonal relationships, discomfort, self-efficacy, and birth outcomes [28–31]. Of the three studies that employed an RCT design, only two used an appropriate statistical analysis and so the results from these studies concerning stress, heart rate variability, comfort, pain, and length of labour are the most definitive [32, 33]. A second limitation observed is that many of the studies relied on a home-based yoga practice for logistical reasons, and, therefore, depended on self-report diaries and phone calls to assess adherence [28, 31–33]. None of the studies that monitored compliance reported any results on frequency or engagement of participants' yoga practice and only two listed this methodology as a limitation [31, 33].

A third limitation is that the use of a prenatal yoga program was primarily evaluated in populations of Asian nationalities (Taiwanese, Indian, and Thai); research is needed to evaluate the efficacy of yoga for pregnancy in populations from other continents. Cultural and demographic variables should also be considered in the interpretation of some results; it has been suggested that low birth weight and premature birth are persistent problems with no current solution and that prenatal yoga programs may prevent poor outcomes for these factors [29, 30]. Cultural context and health related issues of infant weight should be considered in the interpretation of the effects of a yoga program on infant weight. Lastly, the majority of the women in the reviewed studies were of middle-to-high socioeconomic status, presenting a selection bias of participants [28, 32, 33], thus reducing generalizability.

6. Future Directions

6.1. Methodological Improvements. In light of the limitations of existing research, we recommend several methodological improvements for future studies, including a more rigorous statistical approach when evaluating multiple outcome measures, use of more intensive self-report measures to monitor adherence such as interactive web-based monitoring systems, and inclusion of more diverse samples in terms of ethnicity and socioeconomic status. Future studies evaluating the effects of a yoga intervention on pregnancy-related outcomes should strive to use an RCT design, and, where possible in the research protocol, use methodology to prevent chance outcomes, allocation biases, and both researcher and participant expectancy effects. There is also a need to evaluate the efficacy of yoga for high-risk pregnancy populations, such as women with pregnancy-induced hypertension or diabetes and for women over the age of 35 years.

6.2. Dismantling Approach: The Challenge of Identifying the Critical Ingredients of Yoga. The present paper evaluated the components of the various yoga interventions (postures, breathing exercises, meditation, deep relaxation, anatomy, lectures, and chanting), which provides useful information on the quality, depth, and scope of each program. Given that the term "yoga" is broad and may denote any combination of the aforementioned components, it is important to operationally define what constitutes a yoga program in order to discern what is being evaluated. There is a debate in the field regarding the utility of a dismantling approach, as it does not acknowledge that yoga is inherently a holistic health practice and that such an approach will fail to capture its essential features or core mechanisms. This conflict reflects the different paradigms of yoga and science and their emphasis on holism and reductionism, respectively.

From a research perspective, there is interest in better understanding which of the components are responsible for the observed effects and to uncover their putative mechanisms. It is possible that a dismantling approach, if done appropriately, may have theoretical and clinical value in that it may provide important information about the specific components that lead to particular psychological and physiological effects. On the other hand, dismantling yoga into various components presents both theoretical and practical challenges. When dismantled into specific components, it can be argued that the practice is "yoga-like" but not yoga, and that the beneficial effects accrue only when yoga is practiced as a holistic entity, not unlike the experience of musical harmony that emerges from a barbershop quartet and disappears if one was to listen separately to each of the four parts. Nevertheless, this is an empirical question that can be tested by ensuring that any dismantling study incorporates as a control group a true yoga condition. Another challenge of the dismantling approach is the logistical difficulty of matching interventions based on the various elements of yoga; classes based upon meditation or chanting may differ in length from classes of asana, making them difficult to compare. Finally, there is a risk for the dismantling approach to be conducted ad infinitum, in which types or sequences of asanas or forms of pranayama may be compared. It may be most effective, from a clinical perspective, to compare yoga interventions to other commonly used approaches to treatment, such as aerobic exercise, pharmacological management, or other mind-body practices such as Tai Chi and Qi-Gong.

6.3. Mindfulness and Other Mind-Body Interventions. An active ingredient in a yoga program may be mindfulness, which has been effective in symptom reduction and general health improvement in a variety of conditions that are relevant to pregnancy, such as anxiety, depression, back pain, and stress [36]. Moreover, preliminary research from a mindfulness-based childbirth and parenting education adaptation of a traditional mindfulness-based Stress reduction program found improvements in measures of anxiety, depression, and positive affect in women participating in their third trimester of pregnancy [37]. Similarly, an RCT evaluating a psychosocial mindfulness-based intervention administered in the second half of pregnancy found reductions in anxiety and negative mood when compared to waitlist control, indicating mindfulness-based interventions are a possible mental health approach to managing stressors associated with pregnancy [38]. The evaluation of mindfulness and endocrine, immune, or neurological variables in an integrated prenatal yoga program or in dismantled components may provide valuable insight regarding the key components responsible for generating change. In addition to evaluating mindfulness as a construct within a yoga intervention, we also recommend that future research compare the effects of a prenatal yoga program with the effects of traditional mindfulness-based stress reduction programs, mindfulness based therapies, and other mind-body practices, such as tai chi, on maternal and infant prenatal outcomes.

6.4. Effects of a Prenatal Yoga Program on Pre- and Postnatal Maternal and Fetal Variables. The reviewed studies provide empirical support for the efficacy of integrative yoga programs for pregnant women, but we know little about how the specific components of yoga may impact maternal pain, physiological, and psychosocial variables as well as fetal or infant parameters. A dismantling design may provide valuable information regarding the ways that different components of yoga may alter maternal nervous system functioning and in turn influence fetal neurophysiology or behaviour. For instance, paced breathing exercises, which might be comparable to a yogic breath practice (*pranayama*), have been shown to be associated with acute changes in fetal heart rate in response to uterine stimulation [39]. In addition, fetuses of mothers who had received an intervention consisting of relaxation techniques, such as progressive muscle relaxation and guided imagery, had higher long-term heart rate variability than controls, and women who had received progressive muscle relaxation had significantly more uterine activity than the guided imagery or control groups [8]. It is possible that elements commonly included in a yoga practice, such as breathing exercises or deep relaxation, may affect both fetal heart rate and fetal movement. We recommend evaluating the effects on the fetus of maternal breathing exercises or deep relaxation when done as part of a comprehensive yoga program.

Pregnancy can be a stressful time for expectant mothers, and it has been suggested that pregnancy associated stress can have adverse effects on fetal development during critical periods, resulting in poor outcomes for length of gestation, fetal growth, birth weight, fetal development, and general programming of the nervous system [5, 8]. For instance, elevated levels of maternal cortisol, a stress hormone, in the second and third trimester of pregnancy are associated with an increased response of infant cortisol to a heel-prick procedure after birth [40]. These results point to the importance of evaluating the effects of a prenatal yoga intervention on the relationships between (1) maternal hypothalamic-pituitary-adrenal axis and sympathomedullary pathway and (2) changes in stress levels of the fetus by measuring variety of stress related maternal (e.g., cortisol, heart rate, and self-reported measures) and fetal (e.g., activity level and heart rate) variables over the course of pregnancy and in the early postpartum period.

It is possible that alteration of maternal sympathetic nervous system functioning, as demonstrated by reduced levels of stress-related hormones such as cortisol, may be one of the mechanisms through which yoga initiates psychophysiological change in pregnant women. An integrated yoga program, including *asana*, *pranayama*, and *dharana*, guided relaxation, and yogic theory in application to pain states, has been shown to alter cortisol levels in a sample of females with chronic pain due to fibromyalgia [41]. Yoga has also been shown to reduce inflammatory markers, decrease heart rate, and produce improvements in physical fitness variables, all of which may work in concert with behavioural change and psychosocial functioning to improve reactivity to stress and pain [2].

Our search strategy did not yield a single published paper examining how a prenatal yoga program affects maternal adjustment to demands in the postnatal period, such as breast feeding, physical healing and recovery from birth, and sleep deprivation, amongst others. Follow up evaluation of these variables or other stress-related measures such as cortisol, at one month or six months after birth may provide insight into the lasting impact of a yoga program. It would also be useful to evaluate stress, pain, cognition, and physiological variables in infants at follow-up time periods in order to better understand the implications of a prenatal yoga program on development in certain domains during the early years of life. In addition, yoga interventions in the postpartum period may be effective in addressing these areas of concern as well as in the treatment or prevention of specific maternal conditions associated with this time period, such as postpartum depression.

7. Summary

Given the specific physical needs of women during pregnancy, a tailored and specialized yoga protocol that uses a variety of elements of a yoga practice is best indicated. Several of the reviewed studies provide a holistic approach to health promotion and stress management, providing participants with a framework with which to integrate the lecture material on yogic philosophy, positive lifestyle change, mindful awareness, stress reduction, and pregnancy and labour into their daily lives. It is recommended that future research studies use yoga interventions that fall under the general category of Hatha yoga or use programs in line with a particular school of yoga that emphasizes a specialized, gentle and modified *asana* programs, such as Iyengar or restorative yoga. Research-based interventions should not use types of yoga that emphasize a physical demanding, strength-based, or heated practice for safety precautions for both the mother and fetus.

The present paper has several limitations. Because of the sparse number of RCTs and the absence of double blind RCTs in the literature, we included studies that were randomized but not double-blinded and also controlled trials that lacked randomization. Due to the relatively few articles included in the paper, the findings outlined are preliminary and not conclusive or generalizable.

8. Conclusions

In conclusion, the present paper suggests that a prenatal yoga program results in benefits during pregnancy as well as throughout labour and on birth outcomes. This budding body of work suggests that improvements were observed on psychological domains during pregnancy and labour (e.g., quality of life and self-efficacy), on physical and pain measures during labour (e.g., discomfort and pain), and on birth variables (e.g., birth weight and number of preterm births). The only adverse health outcome that was reported was uterine contractions, which can be monitored with a modified approach and appropriate activity reduction. Overall, the evidence that yoga is well suited to pregnancy is positive, but methodological problems with the published literature and a general insufficient wealth of published trials make it impossible to draw any firm conclusion. Our recommendations above will allow researchers to work alongside yoga practitioners to craft potent, standardized programs that are also amenable to evidence-based evaluation in a research environment.

Acknowledgment

J. Katz is supported by a Canadian Institutes of Health Research Canada Research Chair in Health Psychology. K. Curtis is supported by an Ontario Graduate Scholarship.

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2012, Article ID 981523, 7 pages
doi:10.1155/2012/981523

Research Article

Development of Specific Aspects of Spirituality during a 6-Month Intensive Yoga Practice

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Received 3 April 2012; Accepted 13 May 2012

Academic Editor: Andreas Michalsen

The majority of research on yoga focuses on its psychophysiological and therapeutic benefits, while the spiritual aspects are rarely addressed. Changes of specific aspects of spirituality were thus investigated among 160 individuals (91% women, mean age 40.9 ± 8.3 years; 57% Christians) starting a 2-year yoga teacher training. We used standardized questionnaires to measure aspects of spirituality (ASP), mindfulness (FMI—Freiburg Mindfulness Inventory), life satisfaction (BMLSS—Brief Multidimensional Life Satisfaction Scale), and positive mood (*lightheartedness/relief*). At the start of the course, scores of the respective ASP subscales for *search for insight/wisdom, transcendence conviction*, and *conscious interactions/compassion* were high, while those for *religious orientation* were low. Within the 6 month observation period, both *conscious interactions/compassion* (effect size, Cohen's $d = .33$), *Religious orientation* ($d = .21$), *Lightheartedness/Relief* ($d = .75$) and mindfulness ($d = .53$) increased significantly. Particularly non-religious/non-spiritual individuals showed moderate effects for an increase of *conscious interactions/compassion*. The results from this study suggest that an intensive yoga practice (1) may significantly increase specific aspects of practitioners' spirituality, mindfulness, and mood, (2) that these changes are dependent in part on their original spiritual/religious self-perception, and (3) that there are strong correlations amongst these constructs (i.e., *conscious interactions/compassion*, and mindfulness).

1. Introduction

Historically, yoga is a contemplative discipline originating on the Indian subcontinent that incorporates both physical and mental practices with the goal of achieving unitive states of consciousness and spiritual advancement. Modern yoga practices are associated with numerous different schools or types of yoga (i.e., Iyengar, Viniyoga, and Sivananda), each with distinct priorities in terms of their balance of spiritual and physical practices [1]. Components of yoga practice include distinct postures (asanas), control of breath (pranayama), deep relaxation techniques, and the practice of meditation to cultivate awareness and mindfulness. Yoga practices have become popular, in large part, due to their ability to produce psychophysiological changes that reduce the activity of the stress response systems and enhance self-regulation, resilience, mood, well-being, and quality of life [2]. These psychophysiological benefits have contributed to the rationale for the use of yoga as a therapeutic intervention in a variety of physical and psychological conditions [3] including depression [4, 5], chronic pain conditions [6, 7], low back pain [8] and arthritis [9], and several other conditions [10].

Although yoga is a practice that does not require adoption of religious beliefs or dogma, its practices are aimed at the experience of contemplative states of consciousness and spirituality. Yoga can be rightly categorized as a practicaly applied philosophy within the philosophical discipline of mysticism, whose primary tenet is the experience of a transcendent, unitive state of consciousness [11]. However, to date, the majority of research on yoga has been focused on its psychophysiological and therapeutic benefits, and there are relatively fewer studies which address the spiritual aspects of yoga practices.

An early study divided undergraduate meditators into separate categories of meditation experience (transcendental meditation or various Buddhist styles) as nonmeditators, beginners, and short-term and long-term meditators [12]. Subjects were administered the Shor Personal Experience Questionnaire assessing personality variables which predict hypnotizability and reflect state of consciousness and experience, and the Tellegen Absorption Scale that correlates consistently with hypnotizability and defines absorption as a disposition for having episodes of total attention and immersion in an attentional object. Scores on these questionnaires showed significant increases with meditation experience suggesting that meditation practice induces long-term changes in state of consciousness and experience [12].

A study of members of a yoga ashram revealed that they showed statistically greater psychological characteristics of state of consciousness, and after-effects and interpretation of positive life experiences than those experienced by a control group of non-ashram residents [13]. Ashram respondents showed a higher percentage of positive responses on a number of indices, including "Felt a personality change," "Experience resulted in change in life," "Experience of oneness," and "In touch with divine or spiritual" [13]. These data would support the notion that yoga practice may enhance transformational processes, including spiritual, transcendent states.

Monk-Turner and Turner [14] investigated mental wellness in yoga practitioners and college students, and found that the students reported more mental wellness than the yoga practitioners. Moreover, four of five measures of spiritual health differed significantly between yoga practitioners and college students; that is, more yoga practitioners felt "that they expressed their spirituality appropriately and in a healthy way," "recognized the positive contribution faith could make to the quality of life," and "had a positive outlook on life", while more college students "rarely undertook new experiences to enhance their spiritual health" [14]. Although one may criticize the value of these items and whether the samples are comparable, the data are nevertheless important to generate hypotheses for future studies.

In 28 Japanese cancer patients participating in two sessions of mindfulness-based meditation therapy (which included yoga practices), Ando et al. [15] reported a marginal, nonsignificant increase of spiritual well-being. Nevertheless, spiritual well-being was related to anxiety depression, and pain [15]. A recent prospective study of undergraduates with mild to moderate depression, anxiety, or stress reported improvements in a number of mood and stress measures, but not in spiritual well-being after a 7-week yoga intervention [16]. However, the use of relatively naïve subjects over a short time frame in subjects with mood and/or stress impairment may account for this, and it may require longer practice to achieve measurable improvements in spirituality. On the other hand, studies of yoga interventions in cancer patients have reported improvements in measures of spirituality relative to controls [16, 17]. Particularly the meaning/peace component of spiritual wellbeing (FACIT-Sp) increased within 10 weeks in yoga groups (but not their emotional, social, or functional well-being), while in the respective control group these variables would not change or even decrease [17]. This would indicate a specific effect of yoga with respect to spiritual wellbeing.

MacDonald and Friedman [18] provided information on putatively relevant measures of spiritual and transpersonal constructs which could be used in yoga research. They stated that it was their intention "that the information presented in this article serves as a catalyst for new avenues of spiritual and transpersonal research in the area of yoga studies". Whether or not this paper has encouraged studies on this topic remains unclear.

We thus intended to investigate whether and how specific aspects of spirituality may change within a 6-month intensive yoga practice. To address this question we chose individuals who were already practicing yoga and decided to start a yoga teacher training, which would subject them to a greater intensity, frequency, and duration of practice. As a standardized measure of specific aspects of spirituality, we used an instrument which addresses secular aspects of spirituality (i.e., conscious interaction, compassion, and existential issues), religious issues, and cognitive transcendence convictions. This *Aspects of Spirituality* (ASP) Questionnaire differentiates and quantifies cognitive, emotional, intentional, and action-oriented matters [19, 20].

2. Materials and Methods

2.1. Participants. In an anonymous prospective pre-post study, we enrolled 191 individuals at the beginning of a 2-year yoga teacher training in Yoga Vidya Centers of Bad Meinberg and Westerwald (Germany) who gave informed consent to participate (90% of all participants).

At the first training weekend in these centers a Yoga Vidya cooperator gave a short instruction of the study to the participants. All provided informed consent to participate prior to completing the questionnaire (starting in March 2010) which neither asked for name nor initials nor address. The study was approved by the ethical commission of our institution (no. 23/2010).

We acquired outcome measures at the start of the intensified training (T1), 3 months later (T2) and again 6 months later (T3). Finally, 160 individuals identified by self-given code names provided sufficient data quality with at least two time points (75.5% of all participants). We excluded individuals because of nonidentification, insufficient answering, or missing follow-up questionnaires.

2.2. Practices. During the first 6 months of the 2-year standardized Yoga Vidya yoga teacher-training program, the trainees learned and practiced specific postures (asanas); breathing practices (pranayama), relaxation and meditation practices, and specific mantras. Moreover, they were also provided with instructions in the cultivation and development of positive qualities and attitudes based on the classical yoga teachings, and given lectures on yoga philosophy, and so forth. Trainees were also encouraged to read recommended books on yoga practices at home.

Specifically, the basic schedule included a weekly 3 h evening tutorial in small groups at individual subcenters all over Germany. Within each session, they were given special and sometimes personal exercises to practice during the week. Additionally, participants attended intensive training weekends in the main centers about every 2 months. The first one was after 3 weeks after the beginning in the individual subcenter. The surveys at T1, T2, and T3 took part in the first 3 sessions in the main centers.

Furthermore, participants were advised to read and study the Yoga Vidya teacher manual and practice at least 1 h daily at home, including asana, pranayama, meditation, relaxation, and/or mantras. Also, they were encouraged to follow the yogic lifestyle as far as possible in their daily life, including adoption of a vegetarian diet, renunciation from drugs (including caffeine), and ethical behavior as described in Patanjali's Yoga Sutras.

Subjects within each tutorial or intensive training weekend were a mixture of theory of yoga and its lifestyle, asana, pranayama, relaxation, mantra, and meditation. Each subject was instructed in both theoretical and practical aspects of yoga practice. The focus of the tutorials was on achieving proper practice for each participant, self-development, and development of skills for yoga instruction as a teacher.

2.3. Measures

2.3.1. Aspects of Spirituality. To measure a wide variety of important aspects of spirituality beyond conventional conceptual boundaries, we used an instrument which was developed on the basis of the answers of expert representatives of various spiritual orientations who were asked to report on which aspects of spirituality are relevant to them (i.e., Catholics, Protestants, members of the Anthroposophic "Christengemeinschaft", Bahá'í, Muslims, Jews, Buddhists, and atheists) [19]. The identified motifs we condensed to 40 items of the original ASP questionnaire [18]. For this analysis, we used the 25-item ASP 2.1 [20] which differentiates (1) *religious orientation: prayer/trust in God* (religious views; 9 items, Cronbach's alpha = .93), (2) *search for insight/wisdom* (philosophical/existentialist views; 7 items, alpha = .88), (3) *conscious interactions/compassion* (conscious interactions with other, self, environment, compassion, generosity; 5 items, alpha = .83), and (4) *transcendence conviction* (beliefs in rebirth, existence of higher powers and beings, soul has his origin in a higher dimension, and man is a spiritual being; 4 Items, alpha = 85). The specific term *God* was used only once. All items were scored on a 5-point scale from disagreement to agreement, that is, 0: disagree strongly; 1: disagree; 2: neutral; 3: agree somewhat; 4: agree strongly). The scores refer to a 100% level, where 4: agree strongly = 100%.

2.3.2. Spiritual/Religious Self-Categorization. According to their responses to the SpREUK items f2.6 ("To my mind I am a religious individual" = R) and f1.1 ("To my mind I am a spiritual individual" = S), the practitioners were categorized as religious but not spiritual (R+S−), as not religious but spiritual (R−S+), as both religious and spiritual (R+S+), or as neither religious nor spiritual (R−S−). To avoid internal conflicts, we did not provide information how a religious or a spiritual individual should be defined; nevertheless, previous studies have shown that this self-categorization is consistent with patients' spiritual/religious convictions [21, 22] and their engagement in specific forms of spiritual/religious practices [23, 24].

2.3.3. Mindfulness. Mindfulness was measured with the Freiburg Mindfulness Inventory (FMI) [25]. For this study, we used the 14-item short version [26] which was found to be semantically robust and psychometrically stable (Cronbach's alpha =.83). "Examples of items are "watch my feelings without getting lost in them", "open to the experience of the present moment", "feel connected to my experience in the here-and-now", "in difficult situations, I can pause without immediately reacting", "experience moments of inner peace and ease, even when things get hectic and stressful" and so forth". All items were scored on a 4-point scale (0: rarely; 1: occasionally; 2: fairly often; 3: almost always). FMI scores are given as sum scores.

2.3.4. Life Satisfaction. Life satisfaction was measured using the *Brief Multidimensional Life Satisfaction Scale* (BMLSS) [27] which uses items of Huebner's "Brief Multidimensional Students" Life Satisfaction Scale [28, 29] and was tested among adults [23]. The eight items of the BMLSS address intrinsic (*Myself*, *Life in general*), social (*friendships*, *family life*), external (*School situation*, *Where I live*) and prospective (*Financial situation*, *Future prospects*) dimensions. The internal consistency of the instrument was good (Cronbach's alpha =.87) [27]. Each item was introduced by the phrase "I would describe my level of satisfaction as . . .", and scored on a 7-point scale from dissatisfaction to satisfaction (0: terrible; 1: unhappy; 2: mostly dissatisfied; 3: mixed (about equally satisfied and dissatisfied); 4: mostly satisfied; 5: pleased; 6: delighted). The BMLSS sum score refers to a 100% level (delighted).

2.3.5. Lightheartedness/Relief. The *lightheartedness/relief* scale was taken from the German language ERG (emotional and physical reactions) questionnaire [30], asking for specific perceptions, reactions, and feelings in terms of patient's dealing with illness. The intention was to assess the association of distinct (emotional and behavioral) attitudes with a revival of vitality and zest of life, that is, positive internal attitudes such as easiness and subsequent openness to external contacts ("*social interest/contacts*"). These attitudes were operationalized in the context of an increasing positive health/well-being instead of a decrease of functional and emotional health affections and deficiencies. The primary scale to address this "external warming" has 9 items, and a 2-factorial structure with satisfying internal consistency coefficients, that is, Lightheartedness/Relief (LHR; Cronbach's $alpha = .74$) and Social Interest/Contact (Cronbach's $alpha = .79$) [30]. For this analysis we focused on the 5-item subscale LHR because in a previous study it showed significant contrary qualities to psychical exhaustion (correlation $r = -.49$) and disturbed sleep regeneration ($r = -.53$), correlated moderately with *social interest/contacts* ($r = .43$) [30], strongly associated with positive mood, and moderately associated with mindfulness, mental health, and life satisfaction [31]. The items address feelings such as "felt (internally) deeply relieved," "specific affairs succeeded better and better," "movements are easy and fluid," "filled with bright happiness," and a reverse statement "felt empty within". They were scored on a 5-point scale, from disagreement to agreement (0: does not apply at all; 1: does not truly apply; 2: I cannot decide/cannot say; 3: applies quite a bit; and 4: applies very much). The final scores referred to a 100% level (transformed scale score).

2.4. Statistical Analyses. All statistical analyses were performed with SPSS 17.0/20.0 for Windows (SPSS GmbH Software, Munich). We considered a level of $P < 0.05$ as statistically significant. To assess the pre-post effects, we compared data from the start (T1), after 3 months (T2), and after 6 months (T3), using the Wilcoxon signed rank test (T1 versus T2, T1 versus T3, and T3 versus T2), and to assess differences across the time (T1 ≤ T2 ≤ T3) the Friedman test. Effect sizes were expressed as Cohen's d [32] using T1 and T3 data. According to Cohen [32] and Wolff [33], we judged effect sizes >0.8 as indicators of large effects and effect sizes from 0.5 to 0.8 as indicators of moderate effects.

3. Results

3.1. Individuals. Among the 191 enrolled individuals (90% of all participants), 160 individuals provided sufficient data quality with at least two time points (75.5% of all participants). Their mean age was 40.9 ± 8.3 years; 11% were <31 years of age, 37% between 31 and 40 years, 36% between 41 and 50 years, and 16% >51 years. Their mean duration of yoga practice was 39 ± 53 months; range: 2 to 384 months).

Most were women (91%), were living with a partner (67%), and had a high school education (55%). Sixty-eight percent stated to be healthy, 9% had psychological/psychiatric disorders, 4% chronic pain diseases, 2% cancer, and 17% other chronic conditions (Table 1).

A large fraction (38%) stated that they have no religious orientation, 57% had a Christian denomination, and 5% other. Among them, 29% regarded themselves as religious and spiritual (R+S+), 5% as religious but not spiritual (R+S−), 43% as not religious but spiritual (R−S+), and 23% as neither religious nor spiritual (R−S−) (Table 1).

As compared to reference data [26], their life satisfaction and *social interest/contacts* scores were high, while *lightheartedness/relief* scores were in the medium range with respect to the 0–100 scale (Table 2).

3.2. Aspects of Spirituality. At the start of the course, scores for *Search for insight/wisdom*, *Transcendence conviction and Conscious interactions/compassion were high*, *while Religious orientation*: *prayer/trust in God* were very *weak* (Table 2).

Religious orientation was strongly associated with *Transcendence conviction*, *Search for insight/wisdom* and *Conscious interactions/compassion* (Table 3). *Transcendence conviction* was also strongly associated with *Search for insight/wisdom*. *Conscious interactions/compassion* was moderately correlated with life satisfaction, *lightheartedness/relief* and *social interest/contacts*, and strongly with mindfulness. Similarly, *Religious orientation* was moderately associated with mindfulness, life satisfaction and *lightheartedness/relief* (Table 3).

Table 1: Demographic data of yoga practitioners.

Gender (%)	
Women	91
Men	9
Mean age (years)	40.9 ± 8.3
Family status (%)	
Married	50
Living with partner, not married	17
Alone	20
Divorced	13
Educational level (%)	
Secondary (Hauptschule)	8
Junior high school (Realschule)	27
High school (Gymnasium)	55
Other	11
Religious denomination (%)	
Christian	57
Other	5
None	38
Spiritual self-categorization* (%)	
R+S+	29
R+S−	5
R−S+	43
R−S−	23
Chronic diseases (%)	32
Psychic disorders	9
Chronic pain diseases	4
Cancer	2
Other chronic affections/disorders	17
Mean duration of yoga practice (months)	39 ± 53

* R: religious; S: spiritual.

Within the 6-month observation period (Table 2), both *Conscious interactions/compassion* ($d = .33$) and *Religious orientation* ($d = .21$) increased significantly, while *Transcendence conviction* did not change significantly over time ($d = .02$), and *Search for Insight/wisdom* showed a marginal change ($d = .10$). In parallel, *lightheartedness/relief* ($d = .75$) and mindfulness ($d = .53$) increased significantly within the 6-month observation period, while life satisfaction increased marginally ($d = .14$) and *social Interest/contacts* remained unchanged ($d = .09$) (Table 2).

Detailed analyses revealed that the underlying SpR attitude (self-categorization) may have had an impact on which aspects of spirituality develop over the course time. Table 4 indicates that particularly R−S− individuals showed a moderate effect with respect to *Conscious interactions/compassion*. Moreover, both R+S+ and R−S− individuals showed strong effect sizes for mindfulness and *lightheartedness/relief*, while their R+S− counterparts showed only weak effect sizes. While individuals with chronic conditions had stronger

Table 2: Course of tested variables.

	Mean ± SD (Wilcoxon)			P value	Effect size d
	T1	T2	T3	(Friedman)	T1 : T3
Religious orientation	61.0 ± 23.3	62.0 ± 24.4	65.9 ± 23.4[2**3***]	<0.0001	0.21
Insight/wisdom	82.6 ± 14.3	80.0 ± 15.9	81.3 ± 14.7	0.009	0.10
Conscious interactions/compassion	75.2 ± 13.8	77.3 ± 13.6[1*]	79.6 ± 12.6[2***3**]	0.009	0.33
Transcendence conviction	79.9 ± 17.5	78.9 ± 20.1	81.9 ± 28.9	0.399	0.02
Mindfulness	1.78 ± 0.35	1.86 ± 0.35[1**]	1.98 ± 0.37[2***3***]	<0.0001	**0.53**
Life satisfaction	75.4 ± 13.8	77.0 ± 14.5[1**]	77.4 ± 13.8[2*]	0.016	0.14
Lightheartedness/relief	55.7 ± 11.9	58.3 ± 14.4[1*]	66.3 ± 17.2[2***3***]	<0.0001	**0.75**
Social interest/contacts	71.1 ± 17.9	71.1 ± 18.0	72.6 ± 17.0	0.274	0.09

[1]T1 : T2; [2]T1 : T3; [3]T2 : T3 *** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$ (Wilcoxon; 2-tailed).

Table 3: Correlation analyses (T1).

	Religious orientation	Insight/wisdom	Conscious interactions/compassion	Transcendence conviction
Religious orientation	1	**.505****	**.576****	**.708****
Insight/wisdom		1	.447**	**.629****
Conscious interactions/compassion			1	.448**
Transcendence conviction				1
Mindfulness	.482**	.298**	**.542****	.308**
Life satisfaction	.349**	.042	.330**	.143
Lightheartedness/relief	.313**	.136	.349**	.179
Social interest/contacts	.175	.196	.343**	.165

Strong correlations were highlighted (bold).
** $P < 0.01$ (Pearson).

Table 4: Effect sizes with respect to SpR self-categorization and chronic conditions versus healthy.

T1 : T3 effect size d (mean difference)	Religious orientation	Insight/wisdom	Conscious interactions/compassion	Transcendence conviction	Mindfulness	Lighthearted-ness/relief
R+S+ (29%)	0.28 (4.20)	0.03 (0.30)	0.20 (2.50)	0.09 (1.20)	**0.87** (0.27)	**1.08** (14.20)
R−S+ (43%)	0.30 (7.00)	0.20 (−2.60)	0.25 (3.50)	0.09 (1.50)	0.36 (0.14)	0.32 (5.20)
R−S− (23%)	0.35 (7.50)	0.10 (1.40)	**0.66** (7.90)	0.06 (1.20)	**1.00** (0.34)	**0.98** (12.60)
Chronic conditions (32%)	0.32 (7.30)	0.25 (−3.40)	0.32 (4.70)	0.08 (1.50)	**0.51** (0.20)	**0.82** (11.60)
Healthy (68%)	0.16 (3.70)	0.04 (0.60)	0.35 (4.30)	0.01 (0.20)	**0.55** (0.19)	**0.68** (10.00)

Strong effects were highlighted (bold).
*R+S− was not depicted (5%).

effects with respect to *Religious orientation*, *Search for insight/wisdom* (which decreased) and *lightheartedness/relief* than their healthy counterparts, the effect sizes of the other variables did not differ.

4. Discussion

We have shown that among yoga practitioners, compared to their *Religious orientation*, scores on the scales for *Search for insight/wisdom* and *Transcendence conviction* were high even before the start of their intensive practice; nevertheless, compared to reference values of a population of the same age [30], these data are slightly lower, but within the range. Nevertheless, it was obvious that the yoga practitioners' *Transcendence conviction* was strongly related with their *Search for insight/wisdom* and also conventional *Religious orientation*. This suggests that constructs such as belief in rebirth and existence of higher powers and beings, and so forth, religious beliefs including praying, trust in God who guides and shelters, and the attempt to "express the Divine in the creation" are not necessarily independent of yoga practitioners' spirituality. Moreover, in contrast to the reference population, where *Religious orientation* was just moderately associated with *Search for insight/wisdom* and *Conscious interactions/compassion* [19], these associations were strong in the yoga practitioners. However, most of these yoga practitioners do not regard themselves as religious (66%), but at least spiritual. One could argue that their

Religious orientation is defined by specific attitudes and private practices which are compatible with, or possibly enhanced by, their yoga practice. On the other hand, some practitioners stated that while they have turned away from institutionalized religion years before, they have now rediscovered their relationship to their Christian traditions and have become more familiar with the underlying beliefs and practices—via their yoga practice (personal communications). In fact, the intense yoga practice appears to be associated with weak increases of both *Conscious interactions* (with others, self and environment) and *Religious orientation*.

The fact that *Conscious interactions/compassion* increased within the observation period would mean that they may have developed a heightened awareness of their actions and their implications, suggesting an increase in moral development. Similarly, their mindfulness scores increased strongly. Although one cannot exclude the possibility that these increases could be also attributed to their positive (and socially desired) expectation that the yoga practice should result in mindful interactions with others, self, and environment, this would not necessarily explain the strong increase of *lightheartedness/relief.* This scale addresses feelings such as "felt (internally) deeply relieved," "specific affairs succeeded better and better," "movements are easy and lope," "filled with bright happiness," and a reverse statement "felt empty within." One may expect that an intense yoga practice would foster these experiences in terms of a physical and psychoemotional development. But it did not result in a further increase of life satisfaction (the increase was just marginal) or *social interest/contacts*.

Of interests are additional analyses which indicate that R−S− had a stronger increase *of Conscious interactions* and *Religious orientation* when compared to their R+S+ or R−S+ counterparts. This might suggest that because of their primarily low interest in spiritual issues and thus low practical experience, they seemed to benefit from the spiritual component of the yoga practice. In contrast, both R+S+ and R−S− individuals showed strong effect sizes for mindfulness and *lightheartedness/relief*, while their R+S− counterparts showed just weak effects. We have so far no sound explanations for this observation. Further analyses revealed that the individuals with chronic conditions had a stronger positive development of their *Religious orientation* and *lightheartedness/relief* than their healthy counterparts. This might suggest that these individuals who have experienced chronic diseases are more open or even in need of a religious resource to assist in coping which seems to be provided by the yoga practice. In fact, there is an increasing amount of evidence that spirituality/religiosity can be an important coping strategy related to improved medical outcomes (reviewed by [34]).

One limitation of this study is that we had no control group. However, it is unlikely that spiritual characteristics and mindfulness would have changed in a passive control group within a six-month observation period by chance. Therefore, we have defined cohorts of practitioners that differ with respect to their "inner involvement" (ICPH) with the (yoga) practices [35] which has allowed us to assess the practitioners' courses of variables addressing spirituality and mental health. The respective findings will be addressed in a different paper.

5. Conclusion

The results from this study suggest (1) that an intensive yoga practice may significantly increase specific aspects of practitioners' spirituality, mindfulness, and mood, (2) that these changes are dependent in part on their original spiritual/religious self-perception, and (3) that there are strong correlations amongst these constructs. Future studies are needed to further evaluate the potentially important role of yoga practices in enhancing positive psychology. These studies are currently underway. Yoga may be a practice that could effectively contribute to manifesting the World Health Organization's definition of health as a "state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity" [36], but could extend beyond this to also include the cultivation of spiritual wellbeing.

Acknowledgments

We are grateful to Yoga Vida e.V. (Horn-Bad Meinberg, Germany) for their support, and to the yoga practitioners willing to fill the questionnaires.

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