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OBM Integrative and Complementary Medicine

Review

Effects of Different Components of Yoga: A Meta-Synthesis

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Academic Editor: Viann N. Nguyen-Feng

Special Issue: Yoga and Mindfulness

OBM Integrative and Complementary Medicine
2021, volume 6, issue 3
doi:10.21926/obm.icm.2103030

Received: March 08, 2021
Accepted: August 30, 2021
Published: September 13, 2021

Abstract

Traditional yoga encompasses a variety of practices, such as postures, breathing techniques, meditation, and ethical teachings. However, little is known about how different components of yoga contribute to its overall effect. In this meta-synthesis, we comprehensively summarized the current evidence on differential and incremental effects of various yoga components collected from available meta-analyses. For this meta-analysis, we searched Medline/PubMed, Scopus, PsychInfo, and the Cochrane Library in July 2021. We selected only meta-analyses that performed subgroup analyses comparing the effects of different yoga components. There were no restrictions regarding yoga type, study population, or outcome variables. Nineteen meta-analyses were identified that evaluated a multitude of variables. These meta-analyses varied greatly with regard to population, study design, and yoga components under investigation. However, combined interventions incorporating multiple components consistently outperformed simple interventions. In this regard, adding breathing

and/or meditation practices to yoga interventions proved particularly beneficial. However, specific components or combinations were more effective in enhancing certain variables or clinical conditions, suggesting a need for customized programs. Comparable multi-component mind–body interventions, such as yoga and mindfulness-based stress reduction, were often equally efficient. Nevertheless, most findings are preliminary, and certain components such as the ethical part of yoga are particularly under-researched.
Conclusion: Future studies should isolate and compare all components of yoga and evaluate additive effects by investigating their different combinations. The researchers should refer to theoretical frameworks, use rigorous methodology, and consider individual factors.

Keywords
Yoga components; mind–body interventions; postures; breathing practices; meditation; ethics

1. Introduction

With an increasing number of people practicing yoga, it has emerged as one of the most widely practiced mind–body interventions in the West [1, 2]. It is commonly used for preventing stress and relaxing the body and mind [3, 4]. An increasing number of studies are acknowledging the positive effects of yoga on alleviating stress [5, 6] and promoting mental and physical health [7-9]. However, yoga encompasses a variety of practices, and it is unclear how these practices contribute to the overall effect of yoga. The ancient discipline of yoga originated in India and includes diverse practices such as ethical teachings (*yamas* and *niyamas*), physical postures (*asana*), breathing techniques (*pranayama*), and meditation techniques (*pratyahara*, *dharana*, *dhyana*, and *samadhi*) [10, 11]. Research has shown that these practices can produce considerably different effects [12-14]. Conversely, comparative and in-depth studies into the differential and incremental effects of yoga components are scarce. Furthermore, previous research often suffered from poor methodological quality and high heterogeneity among yoga interventions. Thus, more studies are warranted to evaluate and disentangle the effects of different components of yoga [15-18].

Recent theoretical proposals have delineated possible working mechanisms of various yoga components. For instance, Gard et al. [15] proposed an integrative framework and neurophysiological network model of yoga that focused on the enhancement of top-down and bottom-up self-regulatory mechanisms. The authors posited that yoga can be broken down into a skillset of four major tools, namely, ethics, postures, breath regulation, and meditation. All four tools contribute to optimizing self-regulation and developing an adaptive stress response. In their model, ethical beliefs promote the top-down initiation, monitoring, and maintenance of behavioral change. In contrast, postures, breath regulation, and meditation elicit both top-down and, particularly, bottom-up processes. The sustained practice of meditation and "meditation in motion" during posture and breath practices facilitates top-down attention control, which eventually supports behavioral change. In addition, the aspect of the embodiment in these practices enhances the bottom-up processes of sensory awareness, viscerosomatic integration, and parasympathetic control. With continued practice, these regulatory pathways are believed to become more

automatized, leading to increased cognitive, emotional, and behavioral regulation and psychological and physical well-being. In the context of yoga components, meditation often refers to sitting meditation, referring to Patanjali's eight limbs, and distinguishing it from yoga postures [11]. However, yoga postures are sometimes described as a meditative movement [15]. Current research has delineated meditation with movement as a rightful category of meditation in itself [19]. Yet, in this synthesis, we will conform with the traditional interpretation of meditation as sitting meditation.

Two other proposals have described yoga as either a modern psychophysiological therapeutic practice consisting of movement-, breath-, and attention-based techniques [18] or an ethically grounded, transformational process of exploring values, causes of suffering, and eudaemonic well-being [20]. Schmalzl et al. [18] outlined the bottom-up neurophysiological and top-down neurocognitive processes affected by yoga movement, breath, and attention practices, independent of the traditional or ethical background. In contrast, Sullivan et al. [20] delineated how the ethical first-person inquiry through *yamas* and *niyamas* leads to an intentional reorientation of the identity, meaning, and purpose in life. Postures, breath regulation, and meditation can support the shifting from the experience of suffering to the experience of eudaemonic well-being.

These proposals strongly encourage the empirical investigation and systematic evaluation of the hypothesized links and mechanisms. These specifically suggest conducting longitudinal, comparative, or dismantling studies. However, the heterogeneity of yoga styles and the multitude of possible "active ingredients" in yoga and their manifold interactions make the investigation of its components challenging. Modern styles of yoga vary considerably with respect to the level of emphasis placed on various components. Although certain styles primarily focus on postures and breathing practices (e.g., Iyengar, Hatha), others comprise mainly breathing practices (e.g., Sudarshan Kriya) or meditation (e.g., Sahaja). Some styles include mantras and chanting (e.g., Kundalini), whereas others integrate and synthesize as many aspects and components as possible (e.g., Kripalu). Almost all styles end their yoga practice with a period of deep relaxation in a supine position (*shavasana*). McCrary provides an overview of different yoga styles [21]. Scientific yoga interventions mirror this diversity of styles, making it hard to reliably conclude about the relative effects or importance of each yoga component.

1.1 Evidence from Comparative Studies

Previous yoga studies have evaluated and partially compared postures, breathing techniques, relaxation, chanting, meditation, and ethical education. These studies vary greatly in the degree of specificity and disassembling of components and practices under investigation. Certain studies compared, for example, very specific breathing practices to each other [22, 23], whereas others compared rather complex yoga interventions to meditation or relaxation techniques [24, 25] or stress management programs [26, 27]. Still, other studies more specifically examined the inclusion/exclusion of specific yoga components or different combinations of postures, breathing practice, and/or meditation [12, 14, 28-30] with often inconclusive results. The majority of studies investigated the effects of more or less intense yoga interventions of mostly 6 to 12 weeks, although certain studies compared single sessions of different yoga components [31, 32]. Furthermore, there existed variations regarding outcome variables, the intensity of treatments, methodological quality, sample size, and population, undermining the possibility of generalizing their findings.

Interestingly, a review of the available comparative studies revealed that combined interventions seemed more effective than simple interventions. Comparative treatments in a given study were often equal in length. Nonetheless, outcomes were better for treatments combining several elements of yoga practice [14, 27, 29, 31, 33-40]. Combined treatments improved depression, anxiety, mood, sleep latency, interoceptive awareness, mindfulness, emotion and self-regulation, and physiological markers of stress.

However, findings were not always consistent, indicating a mixed state of affairs. Certain studies reported no difference between yoga interventions and progressive muscle relaxation [25], stress management [26, 41], or different forms of (mindfulness) meditation [42, 43] on similar outcome variables. In these cases, the effect was the same in both simple and combined interventions. Additionally, a multi-component mindfulness intervention exerted a greater effect on working memory capacity than a multi-component yoga intervention [24]. Interestingly, in the latter study, stress and anxiety scores improved for all conditions, including the waitlist control. Thus, this amelioration could not be attributed to the "active ingredients" of the two treatments. Nonetheless, a comparison of simple meditation treatments to multi-component yoga interventions showed that the latter was more effective in improving obsessive–compulsive pathology and mood [37, 38]. Another study reported that a combination of yoga and physical exercise outperformed both single treatments in enhancing well-being and reducing anxiety and stress [44]. Yet, in this study, this could be ascribed to higher dosage and exercise time in the combined treatment. Interestingly, customized treatments such as cognitive–behavioral therapy for a generalized anxiety disorder or self-hypnosis for cancer patients were more effective than combined yoga treatments [45, 46].

Frequently, the combined yoga treatments mentioned above included certain forms of yoga postures or breathing techniques; the latter appeared to be particularly relevant. For example, Bhavanani et al. [47] found that yoga breathing practice was more effective than yoga postures in enhancing reaction to visual stimuli. In addition, breathing practice helped dental students stay calm during their first surgical procedure more than a short stress-management lecture [36]. Schmalzl et al. [30] compared a movement-based yoga intervention to a breathing-based yoga intervention and found that both treatments reduced stress and salivary cortisol; however, sustained attention only improved in the breathing-based intervention. Similarly, incorporating a breathing practice into a combined yoga treatment was more effective in reducing stress and increasing mindfulness than including a visualization meditation technique [28]. In contrast, Vasanthan et al. [48] found that 6 months of either yoga postures or breathing practices equally improved cardiovascular autonomic functions. Yoga involves diverse breathing techniques with considerably different, and sometimes even opposing, effects on practitioners [22, 23]. Brown and Gerbarg [49] studied different breathing techniques and their psychological, physiological, and neurological effects and proposed an integrative neurophysiologic model.

Previous studies compared different treatments to each other, such as multi-component yoga programs and stress-reduction or mindfulness programs. Only a few truly contrasted isolated components of yoga practice, such as yoga postures versus breathing practice [14, 47, 48], or supine meditation versus supine relaxation [50], with often inconclusive results. A few studies used an incremental design to compare the same intervention but removed or added a specific component to it. In most cases, the more complex treatment was superior to the reduced one [34, 35, 39]. Two of these studies explicitly examined the effects of adding an ethical education component to a yoga or meditation intervention. Smith et al. [39] reported a higher efficiency of the ethical yoga

intervention in decreasing anxiety and salivary cortisol. Similarly, Matko et al. [34] reported that ethical education significantly enhanced the well-being of participants. According to traditional yoga experts, yoga should be practiced in its entirety, including its ethical aspects [51]. Similarly, a panel of experienced yoga teachers deemed the cultivation of positive values, attitudes, and behaviors important or essential for alleviating mental health conditions [52]. Thus, research findings are equivocal and more studies are required to evaluate yoga in its completeness and disentangle the specific effects of yoga ethics, postures, breathing practices, and meditation. In addition, each component of yoga interventions should be accurately described to facilitate the comparison between studies using, for example, the specifically developed Essential Properties of Yoga Questionnaire (EPYQ; [53]).

1.2 The Present Meta-Synthesis

Numerous meta-analyses and reviews have in the past attempted to synthesize the vast number of yoga studies; however, these suffered from heterogeneity and the lack of methodological rigor. Meta-analyses overcome the limitations of single studies as they aggregate the effects of multiple studies, thereby allowing more robust statements concerning the effects of different yoga components. However, only a few meta-analyses explicitly conducted subgroup analyses of studies with varying yoga components. These summaries are of particular relevance to understanding yoga practice as a whole as well as for the development of interventions tailored to the needs of specific clinical and non-clinical populations [17, 18].

This meta-synthesis summarizes the current evidence on the differential and incremental effects of various yoga components. We conducted a systematic review of all available meta-analyses that have conducted subgroup analyses based on the inclusion or exclusion of specific yoga components. This process was based on the theoretical framework proposed by Gard et al. [15], which delineates yoga postures, breathing practices, meditation, and ethics as the main components of yoga practice. In addition, we included meta-analyses that compared studies on yoga and studies on mindfulness-based interventions, such as mindfulness-based stress reduction (MBSR; [54]) or its derivatives. MBSR is one of the most researched mind–body interventions to date. It combines mindfulness meditation and certain components of Buddhist practice with yoga postures and movement practices. Thus, its multi-component structure is comparable to that of traditional yoga. Lately, several attempts have been made to dismantle and evaluate single components of MBSR interventions. Two studies asked participants to log their respective daily practice times of each component. In one study [55], yoga practice time was more strongly related to improvements in mindfulness, perceived stress, anxiety, and psychological well-being than formal sitting meditation. Gallegos et al. [56] found that both yoga practice and sitting meditation time were associated with a higher posttreatment insulin-like growth factor; however, only yoga significantly increased positive affect. Other studies evaluated different components of MBSR by comparing active treatment groups and reported differential effects of yoga postures and diverse meditation techniques [13, 57-60]. In two of these studies, the yoga component reduced stress or increased well-being more than the meditative components [13, 58]. Therefore, it appeared promising to compare and evaluate the components of mind–body interventions that shared similar practices, such as yoga and mindfulness-based interventions. With this approach, we aim to shed light on the

undeniable diversity in yoga research and support future research efforts on evaluating yoga components.

2. Methods

2.1 Literature Search

The meta-synthesis was planned and conducted in accordance with the recommended procedures for research syntheses [61]. A systematic literature search was performed in July 2021 using the databases Medline/PubMed, Scopus, PsychINFO, and the Cochrane Library. The following search strategy was used for all databases: ("Yoga" [Title] AND "Meta-analysis" [Title]). After removing the duplicate entries, the search yielded 125 potentially relevant meta-analyses (Figure 1). Next, protocols, comments, corrections, and reprints of meta-analyses were excluded, and 108 full-text meta-analyses were assessed for eligibility.

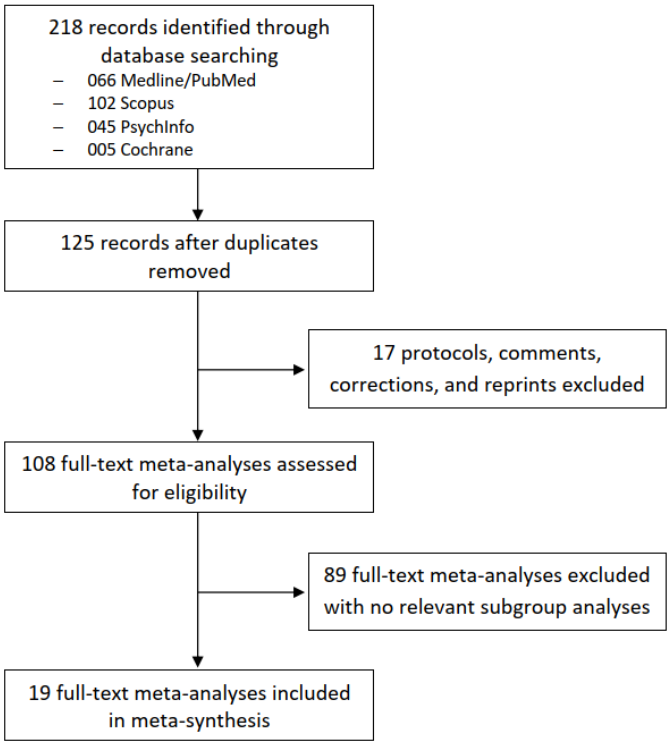

Figure 1 Flow diagram showing the search strategy.

2.2 Eligibility Criteria

All meta-analyses on the effects of yoga were considered eligible if they conducted relevant subgroup analyses that compared different yoga components. These yoga components could be postures/asana, breathing practice/pranayama, meditation/dhyana/mindfulness, education/ethics/philosophy/yamas/niyamas. Meta-analyses contrasting yoga and mindfulness-based approaches were eligible when they differentiated both types of practice in the subgroup analyses. There were no restrictions regarding the yoga type, study population, or outcome variables.

2.3 Synthesis of Results

Nineteen meta-analyses were examined and synthesized descriptively. The first author (KM) read all meta-analyses and extracted the study population, the number and designs of the included studies, the major effects reported in each meta-analysis, and the results of relevant subgroup analyses. Only subgroup analyses related to the differential effects of different yoga components were included in this overview. Next, KM deduced a primary conclusion for each meta-analysis in dialogue with all coauthors. Finally, the results of this systematic analysis were summarized and evaluated narratively.

3. Results

Table 1 provides an overview of all 19 meta-analyses summarized in this synthesis. These vary with regard to the outcome variables, population, sample size, study design of included studies, control groups, and yoga components under investigation in the subgroup analyses. The effect sizes of subgroup analyses that yielded significant differences are given in parentheses in the form of (with component vs. without component) if they were reported in the respective meta-analyses. The effect sizes that were not reported are marked as such (n.r.).

Table 1 Results of previous meta-analyses that compared different components of yoga.

Meta-analysis	Population/outcome	Sample	Mean effects	Subgroup analyses	Conclusion
Breedvelt et al. [5]	College students/depression, anxiety, stress	23 RCTs (*n* = 1,373)	*Yoga, meditation, mindfulness, and MBSR interventions* *g* = 0.61 (overall) *g* = 0.42 (depression) *g* = 0.46 (anxiety) *g* = 0.42 (stress) g = 0.61 (overall pooled effect) *g* = 0.52 (waitlist control) *g* = 0.39 (no treatment) *g* = 0.13 (active control, n.s.)	No differences between yoga, meditation, mindfulness, and MBSR interventions	No differences between combined interventions
Chimiklis et al. [62]	Youth with ADHD/ ADHD symptoms, executive function deficits, social functioning	11 studies (*n* = 251)	*Yoga, meditation, and mindfulness-based interventions* ADHD symptoms: *g* = 0.57 (parent reported)/*g* = 0.23 (teacher reported) Inattention and attention problems: *g* = 0.35/*g* = 0.31 Hyperactivity: *g* = 0.39/*g* = 0.22 On-task behavior: *g* = 1.22 (researcher reported) Executive function (teacher report): *g* = 0.31 (metacognitive; n.s.)	Mindfulness-based interventions (e.g., MBSR, MBCT) had a greater effect on hyperactivity than yoga interventions alone or combined yoga plus meditation interventions (n.r.); other measures improved across all types of interventions	Combined intervention is more effective

Meta-analysis	Population/outcome	Sample	Mean effects	Subgroup analyses	Conclusion
			g = 0.67 (behavioral) Child-parent relationship: *g* = 0.50 (child reported) Parent mindfulness: *g* = 0.31 (n.s.) Parent stress: *g* = 0.44		
Cramer et al. [63]	COPD/ Quality of life, dyspnea, exercise capacity, pulmonary function	11 RCTs (*n* = 586)	Yoga compared to no treatment: *SMD* = 0.57 (quality of life, n.s.) *SMD* = -0.23 (dyspnea, n.s.) *SMD* = 0.54 (exercise capacity) *SMD* = 0.47 (forced expiratory volume in one second, n.s.) Positive effects on the quality of life, exercise capacity, and predicted forced expiratory volume in 1 s when analyses were limited to studies using the same COPD assessment test.	Breathing-based yoga interventions had positive effects on dyspnea (*SMD* = -0.43), exercise capacity (*MD* = 22.74), and predicted forced expiratory volume in 1 s (*MD* = 3.97) compared to no treatment; complex yoga interventions had positive effects only on exercise capacity (n.r.).	Breathing is more effective than other combinations
Cramer et al. [64]	Hypertension/blood pressure	7 RCTs (*n* = 452)	Yoga compared to usual care: *MD* = -9.65 (systolic BP) *MD* = -7.22 (diastolic BP) Yoga compared to exercise: No difference	One breathing-based yoga intervention that did not include postures (without P) was more effective (systolic: *MD* = –6.56; diastolic: *MD* = –3.42) than interventions that did (with P) (*MD* = –10.43 n.s.; *MD* = –8.20 n.s.)	Breathing is more effective than postures.

Meta-analysis	Population/outcome	Sample	Mean effects	Subgroup analyses	Conclusion
Cramer et al. [65]	Chronic neck pain/pain intensity, pain-related disability, quality of life, mood	3 RCTs (*n* = 188)	Yoga compared to usual care: *SMD* = –1.28 (pain intensity) *SMD* = –0.97 (pain-related disability) *SMD* = 0.57 (quality of life) *SMD* = –1.02 (mood)	No differences in effects between exercise-based (with P) and meditation-based (without P) yoga interventions.	No difference between yoga postures and meditation.
Cramer et al. [66]	Depressive disorder or elevated levels of depression/depression, anxiety	12 RCTs (*n* = 619)	Yoga compared to usual care: *SMD* = –0.69 (depression) *SMD* = –0.00 (anxiety, n.s.) Yoga compared to relaxation: *SMD* = –0.39 (depression) *SMD* = –0.79 (anxiety) Yoga compared to aerobic exercise: *SMD* = –0.59 (depression)	Yoga interventions based on meditation and/or breathing (without P) were more effective for reducing depressive symptoms (*SMD* = –0.62) and anxiety (*SMD* = –0.79) than exercise-based (*SMD* = –0.36 n.s.; *SMD* = –0.00 n.s.) or combined yoga interventions (with *p*) (*SMD* = –0.42 n.s.; anxiety n.r.).	Meditation and/or breathing are more effective than postures.
Cramer et al. [67]	Asthma/asthma control, symptoms, quality of life, pulmonary function	14 RCTs (*n* = 824)	Yoga compared to usual care: Risk ratio = 10.64 (asthma control) *SMD* = –0.37 (asthma symptoms) *SMD* = 0.86 (quality of life) *SMD* = 0.49 (peak expiratory flow) Yoga compared to psychological interventions: *SMD* = 0.61 (quality of life)	Combined (P, B, M) and breathing-based yoga interventions were similarly effective, whereas meditation-based yoga was not effective (n.r.).	Combined interventions (especially breathing) are more effective.

Meta-analysis	Population/outcome	Sample	Mean effects	Subgroup analyses	Conclusion
			SMD = 2.87 (peak expiratory flow rate) Yoga compared to stretching or breathing exercises: No difference		
Ewais et al. [68]	Inflammatory bowel disease/psychosocial and physical outcomes	8 RCTs (*n* = 501)	*Mindfulness-based, mindfulness, and yoga interventions* Stress: *SMD* = –0.48 (short term)/*SMD* = –0.55 (long term) Depression: *SMD* = –0.29 (n.s.)/*SMD* = -0.36 Quality of life: *SMD* = 0.22 (n.s.)/*SMD* = 0.38 Anxiety: *SMD* = –0.19 (n.s.)/*SMD* = –0.27 (n.s.) No effect on physical outcomes.	Yoga and mindfulness interventions were both effective in reducing stress and improving quality of life, but one yoga study outperformed three mindfulness studies in decreasing depression (*SMD* = –0.68 vs. *SMD* = 0.01) and anxiety (*SMD* = –0.36 vs. *SMD* = 0.06) scores.	Yoga is more effective than MBSR.
Gong et al. [69]	Prenatal depression/depression	6 RCTs (*n* = 375)	Yoga compared to active control: *SMD* = -0.59 (prenatal depression)	Combined yoga interventions (P + R/B/M) significantly reduced the level of prenatal depression (*SMD* = -0.79), whereas exercise-based yoga (P) did not (*SMD* = -0.41 n.s.).	Combined interventions are more effective.

Meta-analysis	Population/outcome	Sample	Mean effects	Subgroup analyses	Conclusion
Gothe & McAuley [70]	Any population/cognitive function	15 RCTs and 7 repeated-measures studies (*n* = 1,894)	RCTs: *g* = 0.33 (overall cognitive function) *g* = 0.29 (attention, processing speed) *g* = 0.27 (executive function) *g* = 0.18 (memory, n.s.) Repeated measures (acute effects): *g* = 0.58 (overall cognitive function) *g* = 0.49 (attention, processing speed) *g* = 0.39 (executive function) *g* = 0.78 (memory)	Breathing and meditative exercises, but not physical exercises, were consistently associated with improved cognitive performance (n.r.).	Meditation and breathing are more effective than postures.
Hagins et al. [71]	Hypertension/blood pressure	17 controlled studies (*n* = 1,013)	Overall effect: *MD* = –4.17 (systolic BP) *MD* = –3.62 (diastolic BP) Yoga compared to usual care/no treatment: *MD* = –7.96 (systolic BP) *MD* = –5.52 (diastolic BP) Yoga compared to physical exercise or active control: No difference	Significant reductions in BP only in yoga interventions that incorporated three components of practice (P, B, M) (systolic: *MD* = –8.17; diastolic: *MD* = –6.14), and not in interventions with fewer components (*MD* = 0.19 n.s.; *MD* = 0.38 n.s.).	Combined interventions are more effective.

Meta-analysis	Population/outcome	Sample	Mean effects	Subgroup analyses	Conclusion
Hendriks et al. [8]	Healthy adults/indicators of positive mental health	17 RCTs (*n* = 1,901)	Yoga compared to no treatment: *SMD* = 0.69 (well-being) No effects on life satisfaction, social relationships, or mindfulness *Yoga compared to physical exercise:* No difference	The positive effect of yoga on well-being was comparable to the effects of meditation or physical exercise; mindfulness meditation had a greater effect on mindfulness compared to yoga (*SMD* = -0.30)	No difference between yoga and meditation.
Jiang et al. [72]	People living with HIV/immune function, mental health	19 RCTs (*n* = 1,300)	*Yoga and mindfulness-based interventions* *d* = 0.21 (CD4 T-cell counts) *d* = 0.43 (long-term CD4) *d* = 0.51 (depression) *d* = 0.71 (anxiety) *d* = 0.42 (stress/distress) *d* = 0.67 (quality of life)	No significant differences between yoga and mindfulness-based interventions on any outcome variable.	No differences between complex interventions.
Kumar et al. [73]	Type II diabetes mellitus/glycemic control	17 RCTs (*n* = 1,358)	Yoga compared to control: *SMD* = –1.40 (fasting blood sugar) *SMD* = –0.91 (postprandial blood sugar) *SMD* = –0.64 (glycosylated hemoglobin)	In contrast to the overall positive effect, a subgroup of breathing-based interventions showed no effect on any of the three outcome measures (fasting: *SMD* = –0.62 n.s.; post-prandial: *SMD* = –0.49 n.s.; hemoglobin: *SMD* = –0.05 n.s.).	Combined interventions are more effective.

Meta-analysis	Population/outcome	Sample	Mean effects	Subgroup analyses	Conclusion
Park & Han [74]	Hypertension/blood pressure	13 RCTs (*n* = 753)	*Yoga and meditation (MBSR and TM)* Yoga: *MD* = -4.59 (systolic BP) *MD* = -3.65 (diastolic BP) *Meditation*: *MD* = -7.37 (systolic BP) *MD* = -5.43 (diastolic BP)	No significant differences between yoga and (combined) meditation interventions.	No differences between combined interventions.
Pascoe et al. [6]	Any population/stress-related physiological measures	42 RCTs (*n* = 2,944)	*Yoga and MBSR* Compared to active controls: *MD* = –1.51 (waking cortisol) *MD* = -0.60 (afternoon cortisol) *MD* = –0.88 (evening cortisol) *MD* = –3.66 (resting diastolic BP) *MD* = –6.82 (resting mean arterial pressure) *MD* = -3.20 (resting heart rate) Positive effects also on heart-rate variability, fasting blood sugar, cholesterol, low-density lipoprotein No effects on other measures	Positive effects of MBSR over yoga on decreasing interleukin-6 (*SMD* = –0.48 vs. *SMD* = –0.10) and of yoga over MBSR on systolic blood pressure (n.r.); both types of interventions reduced salivary cortisol, BP, and cytokine levels to a greater extent than active controls	No differences between combined interventions
Taylor et al. [75]	Adults with trauma exposure/trauma-related symptoms (PTSD, stress, anxiety)	24 controlled studies (*n* = 759)	*Yoga, mindfulness/MBSR, and integrative exercise* *g* = 0.48 (overall pooled effect) *g* = 0.46 (overall – yoga) *g* = 0.45 (overall – mindfulness)	No differences between mindfulness-based and yoga interventions with at least two limbs of yoga.	No differences between combined interventions.

Meta-analysis	Population/outcome	Sample	Mean effects	Subgroup analyses	Conclusion
			g = 0.94 (overall – integrative exercise) *g* = 0.48 (passive control) *g* = 0.49 (active control)		
Thind et al. [76]	Type II diabetes mellitus/glycemic control, markers of diabetes management	21 controlled studies (*n* = 2,473)	Yoga compared to control: *d+* = 0.58 (fasting blood sugar) *d+* = 0.40 (post prandial blood sugar) *d+* = 0.36 (glycosylated hemoglobin) *d+* = 0.51 (total cholesterol) *d+* = 0.67 (triglyceride) *d+* = 0.22 (systolic BP, n.s.) *d+* = 0.73 (diastolic BP) *d+* = 0.64 (fasting cortisol) *d+* = 0.52 (body mass index) *d+* = 0.28 (weight) *d+* = 0.36 (waist-to-hip ratio, n.s.) Positive effects also on very-low, low, and high-density lipoproteins	Yoga interventions were more successful in reducing triglyceride levels (*d+* = 1.17 vs. *d+* = 0.35) and lowering body weight (*d+* = 0.76 vs. *d+* = 0.09) when they included meditation practice; inclusion of relaxation techniques was associated with lower body mass index (*d+* = 0.70 vs. *d+* = 0.15); no differences in other variables.	Combined interventions are more effective.
Wu et al. [77]	Any population/blood pressure	49 controlled studies (*n* = 3,517)	Yoga compared to passive control: *SMD* = –0.47 (for both systolic and diastolic BP)	Reductions in systolic BP were greater in yoga interventions that included breathing techniques (*MD* = –7.9 vs. *MD* = –2.7); reductions in diastolic BP	Combined interventions are more effective.

Meta-analysis	Population/outcome	Sample	Mean effects	Subgroup analyses	Conclusion
				were greater in yoga interventions that included meditation/mental relaxation (*MD* = –4.3 vs. *MD* = –1.6).	

Note. ADHD = attention-deficit/hyperactivity disorder; B = breathing; BP = blood pressure; COPD = chronic obstructive pulmonary disease; *d+* = weighted mean effect size with positive values favoring the intervention relative to control; *g* = Hedges' *g*; M = meditation; MBCT = mindfulness-based cognitive therapy; MBSR = mindfulness-based stress reduction; *MD* = mean difference; n.r. = not reported; P = postures; R = relaxation; *SMD* = standardized mean difference; TM = Transcendental Meditation. Reported effects are significant unless otherwise stated.

The meta-analyses summarized in Table 1 are very diverse. The majority of them investigated clinical populations with conditions such as depression, hypertension, chronic pain, asthma, chronic obstructive pulmonary disease (COPD), inflammatory bowel disease, type II diabetes, HIV, trauma, and attention-deficit/hyperactivity disorder. Three meta-analyses used mixed samples, including healthy and clinical populations, and examined the effect of yoga on cognition [70], stress-related physiological measures [6], and the prevention of and therapy for hypertension [77]. Only two meta-analyses investigated healthy populations. One of them looked at depression, anxiety, and stress in college students [5], and the other explored positive mental health [8]. The latter concluded that there was a scarcity of studies investigating the effects of yoga on healthy populations, and specifically those measuring positive outcomes. This is surprising as yoga initially was developed as a spiritual path for healthy people and not as a treatment for clinical conditions [78].

The majority of the meta-analyses reported favorable effects of yoga (and other mind–body interventions) on depression, anxiety, stress, and stress-related physiological measures, well-being, mood, quality of life, cognitive function, and several other clinical symptoms. Most effects were small to moderate and usually large when yoga was compared with passive control or usual care. Compared with active control conditions, yoga/mind–body interventions exerted a moderate effect on several physiological measures [6], trauma symptoms [75], and levels of depression in clinical samples [66, 69]. However, yoga's positive effects diminished compared to physical exercise or other active controls in healthy populations [5, 8] and in populations with asthma [67] or hypertension [64, 71].

In an earlier summary of reviews, Büssing et al. [7] concluded that yoga postures could be particularly beneficial for fitness, physical flexibility, and mental state. In contrast, breathing, relaxation, and meditation techniques could lead to greater awareness, less stress, and higher well-being and quality of life. This conclusion might also apply to the more recent meta-analyses displayed in Table 1.

A majority of the meta-analyses reported that combined interventions led to moderately higher effects than simpler yoga interventions or yoga postures [62, 66, 67, 69-71, 73, 76, 77]. Sometimes, this implied that positive results were only obtained for interventions that included specific yoga components and were absent in other interventions that did not [68, 76]. In other instances, differences between interventions were small, but significant for one specific component or for one combination and insignificant for others [64, 66, 69, 71, 73]. Combined interventions appeared to be beneficial, specifically for clinical samples. Breathing and meditation techniques were particularly advantageous in this regard, and interventions based on these practices were more effective than yoga postures in increasing cognitive performance [70], reducing depressive symptoms [66], and downregulating blood pressure [64]. Similarly, including breathing and/or meditation practices in yoga interventions increased their effectiveness in reducing prenatal depression [69] and elevated blood pressure [71, 77]. Unsurprisingly, yoga interventions based on or including breathing practices were particularly helpful in alleviating respiratory diseases, such as asthma [67] and COPD [63]. In contrast, breathing-based yoga was not as effective in improving glycemic control and other diabetes-related measures [73, 76]. The latter meta-analysis found that including meditation or relaxation practices was more helpful in this respect. No differences were found between exercise-based and meditation-based yoga interventions in alleviating chronic neck pain [65].

Consequently, specific clinical conditions or objectives could require specific combinations of yoga practices to elicit the highest benefits. Future research should examine these combinations in

more detail and evaluate what combinations apply to a given condition/objective. This could eventually lead to the development of programs tailored to the needs of specific populations [17, 18, 79].

Meta-analyses on healthy populations reported no differences between meditation, mindfulness-based, or yoga interventions [5, 8]. Similarly, no differences were observed between these interventions regarding hypertension [74], trauma symptoms [75], stress-related physiological measures [6], and immunological outcomes and mental health of people living with HIV [72]. However, these meta-analyses did not differentiate the components of yoga or mindfulness-based practices and are, thus, less informative than other meta-analyses that do. However, these meta-analyses suggest that equally complex interventions such as yoga and mindfulness-based treatments yield similar effects. Conversely, MBSR was more effective than yoga in reducing hyperactivity [62], and yoga was more effective than MBSR in decreasing depression and anxiety in patients with inflammatory bowel disease [68]. Thus, the findings are inconclusive. More research is required to determine the unique contribution of each component to the globally positive effect of combined interventions.

4. Discussion

Overall, the yoga studies and meta-analyses reviewed above highly vary with regard to the population, yoga components under investigation, intervention length, and control intervention(s). This appears to be symptomatic of yoga research, in general [80, 81]. To increase the transparency and replicability of intervention studies, an extensive framework for developing yoga treatment protocols has been proposed and recommended [82]. However, a systematic empirical investigation into the various components of yoga practice is missing.

One finding that was consistent throughout the reviewed literature was the superiority of combined over simple interventions. Treatments that included more components of traditional yoga, such as ethical education, postures, breathing, or meditation, were more effective than those that were based on fewer components. Particularly, breathing and meditation practices enhanced the efficacy of yoga treatments. However, certain combinations of yoga practices were more useful for specific study populations or outcome variables than others—which combinations exactly has to be determined in future studies as the available evidence on this matter is still sparse.

None of the meta-analyses we reviewed examined the additive value of including the ethical aspect of yoga in intervention studies. Similarly, only a few comparative investigations explicitly studied the effects of (ethical) education. This is one of the major shortcomings of previous yoga research. The idea of integrating more philosophical or ethical components into mind–body interventions has recently been discussed in the mindfulness literature [83-86]. Chen and Jordan [87] compared an ethically enriched intervention with a standard mindfulness intervention and reported that both interventions reduced stress and increased life satisfaction. However, the ethical intervention also enhanced personal growth and prosocial behavior. Similar results were obtained in the abovementioned ethical yoga studies [34, 39]. Moreover, recent theoretical proposals [15, 20] suggest evaluating yoga holistically, including its ethical aspects. Therefore, it is essential to study the impact of ethical education on the outcomes of yoga treatments. The recently developed mind–body intervention meditation-based lifestyle modification [88] could be useful in this regard as it explicitly incorporates lectures on yogic *yamas* and *niyamas*.

Our review suggests that comparable multi-component mind–body interventions, such as yoga and mindfulness-based interventions, produce similar effects. Although the two types of interventions originate from different spiritual traditions (Hinduism and Buddhism, respectively), they share similar exercises. Both yoga and MBSR (but not necessarily other mindfulness-based interventions) include yoga postures, relaxation, meditation, and an educational component. Yet, the yoga posture component of MBSR treatments is rather basic compared to most yoga interventions. Recently, two studies dismantled MBSR treatments and found differential effects of its components [13, 58, 59]. Nevertheless, more research is necessary to thoroughly understand how each component and also the relative emphasis placed on each component within MBSR or yoga contribute to the efficacy of combined treatments. In addition, current research has demonstrated that Hindu and Buddhist meditators had extremely distinct preferences for specific meditation techniques [89]. These differences between traditions might ultimately influence the outcomes of both related interventions and account for the observed differences reviewed above.

To disentangle the components of yoga and other mind–body interventions, future studies should aim at either comparing specific, isolated components to each other or using additive designs to evaluate the incremental effects of different combinations of yoga practices. Moreover, it is essential to evaluate yoga in its entirety, including postures, breathing, meditation, and ethics. This is particularly relevant in the light of the undeniable diversity of yoga studies and interventions reviewed above. To understand the basic working mechanisms of yoga, comparative studies should rely on healthy populations and aim for representative samples. In contrast, clinical studies could evaluate diverse combinations of yoga practices to find those most suited to specific clinical conditions. Furthermore, long-term effects should be considered. For example, Cramer et al. [12] showed that although a yoga intervention without postures was immediately more effective in reducing hypertension than an intervention with postures, the effect reversed in long-term follow-up. The authors argue that more participants continued to practice yoga postures regularly after the intervention had ended. Yoga postures might, thus, be easier to integrate into participants' daily activities.

Future studies should also take personality factors into account, as several authors have pointed out that individual differences could tremendously influence the effects of yoga and other mind–body interventions [15, 18, 90]. Researchers could achieve this by using more elaborate research designs offering a higher time resolution and keeping a better track of individual responses. Single-case research designs [91] or ecological momentary assessment [92] appear to be promising approaches in this regard.

The majority of studies reviewed here investigated the effects of yoga on depression, anxiety, stress, well-being, and mood. Although yoga interventions, particularly the combined ones, commonly yielded positive effects on these variables, future studies should focus more on positive outcome variables [8]. This could lead to a holistic understanding of yoga and move the discipline away from a deficiency-oriented and toward a more flourishing-oriented perspective. Furthermore, several variables in the previous research were selected ad hoc without referring to specific theoretical frameworks. This is another issue that is symptomatic of yoga research [15, 18]. Accordingly, future studies should compare not only different yoga components but also base these comparisons and the selection of appropriate variables on existing traditional or contemporary theoretical proposals.

There are a couple of limitations to the findings of this meta-synthesis. First, the quality of studies differed widely within and between the meta-analyses reviewed. Although most meta-analyses included only RCTs, others were more liberal regarding study design, increasing the risk of biased or overestimated results. In addition, not all meta-analyses differentiated between different types of control conditions, making it difficult to achieve reliable conclusions. However, this was not the primary focus of this synthesis as we were interested majorly in studying the differential effects of yoga components. Second, certain meta-analyses could have had some overlap between included studies, particularly the several meta-analyses on hypertension reviewed here. Nevertheless, conclusions varied across these meta-analyses, reinforcing the need for more systematic research. Third, subgroup analyses differed between meta-analyses with certain comparing rather broad categories of mind-body interventions. Most meta-analyses differentiated between interventions, including postures, breathing and/or meditation practices, or combinations of the three; however, which subgroups exactly were compared to each other differed widely. Several meta-analyses we screened during the review process stated that they had planned to conduct subgroup analyses on yoga components. Yet, these were mostly not able to do so because of insufficient studies available or yoga interventions not described in enough detail. Consequently, future research would benefit greatly from a more systematic approach and more detailed descriptions of interventions.

Overall, there exists a high variability and ambiguity in yoga research with repeated calls to investigate differential effects of yoga components systematically. One particularly under-researched area is the incorporation of yoga ethics into intervention studies. We encourage researchers to use rigorous and elaborate research designs to examine all components of yoga, individually and in diverse combinations. In the end, these research efforts could contribute substantially to a deep understanding of the manifold effects of the multifaceted practice of yoga.

Acknowledgements

We thank Annika Sternkopf and Nele Boll for their help in gathering and screening the literature. Thank you to Anita Todd and two anonymous reviewers for their valuable comments on a previous version of this manuscript.

Author Contributions

KM designed and executed the meta-synthesis and wrote the paper. PS and HCB collaborated on the editing process. All authors approved the final version of the manuscript.

Funding

This work was supported by Karl and Veronica Carstens Foundation under Grant Number KVC 0/098/2018.

Competing Interests

The authors declare that no competing interests exist.

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