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## Comparison Groups in Yoga Research: A Systematic Review and Critical Evaluation of the Literature

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### Abstract

**Objectives**—Comparison groups are essential for accurate testing and interpretation of yoga intervention trials. However, selecting proper comparison groups is difficult because yoga comprises a very heterogeneous set of practices and its mechanisms of effect have not been conclusively established.

**Methods**—We conducted a systematic review of the control and comparison groups used in published randomized controlled trials (RCTs) of yoga.

**Results**—We located 128 RCTs that met our inclusion criteria; of these, 65 included only a passive control and 63 included at least one active comparison group. Primary comparison groups were physical exercise (43%), relaxation/meditation (20%), and education (16%). Studies rarely provided a strong rationale for choice of comparison. Considering year of publication, the use of active controls in yoga research appears to be slowly increasing over time.

**Conclusions**—Given that yoga has been established as a potentially powerful intervention, future research should use active control groups. Further, care is needed to select comparison conditions that help to isolate the specific mechanisms of yoga’s effects.

### Keywords

Yoga; Randomized Controlled Trials; Systematic Review; Control Group; Comparison Group

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Research on yoga interventions is rapidly proliferating; <sup>1</sup> researchers are studying the effects of yoga on a wide range of mental and physical health conditions. Researchers have demonstrated preliminary efficacy for many conditions, including arthritis<sup>2</sup> stress<sup>3</sup> metabolic syndrome<sup>4</sup> asthma<sup>5</sup>, pain<sup>6</sup> and depression.<sup>7</sup> However, the literature is replete with many contradictory findings and generally characterized as inconclusive due to the weak design of many studies.<sup>4,5</sup>

A common methodological limitation of many yoga intervention studies is the lack of an adequate control condition. Although trials of the effects of yoga have often been conducted without a control condition, using pre-post designs, more recent research typically employs a control condition as well as randomization and other elements of experimentation.<sup>1</sup> Selection of an appropriate control group is very important in intervention studies because comparison of the intervention and control groups allows researchers to isolate and test the purported active ingredient of the intervention and hold all other factors constant.<sup>8</sup>

Unlike in studies of drug effects, where a placebo is relatively straightforward, selection of a control condition is much more complex for behavioral interventions. <sup>8</sup> Yet because of its centrality to the interpretation of the study results, the comparison group is essential and must be selected with care and deliberation. The appropriateness of a comparison group depends on the specific research question being asked, so that researchers can be confident that differences found between groups is due to the hypothesized active ingredient of the yoga intervention.<sup>9,10</sup> Thus, the theoretical mechanism through which the yoga is presumed to operate and the comparison condition would ideally include all of the elements of the yoga condition minus that active ingredient. Of course, in behavioral interventions, the “active ingredient” is complex and difficult to identify. Still, when interpreting the results of a study, it is critically important to have an adequate condition to which to compare the yoga intervention group so that the effective ingredient(s) of the yoga can be isolated and tested. Yet, perhaps because of the heterogeneous nature of yoga,<sup>11,12</sup> the rationale for selecting the comparison is rarely explicated in published reports.<sup>10</sup>

One common solution is a passive control, such as a wait-list or usual treatment.<sup>9</sup> Wait-list typically means that participants in the comparison group get usual care for the intervention period but then are able to receive the intervention after the study ends, while participants in a usual care condition simply receive no additional treatment. Participants in wait-list or usual care groups are sometimes asked to avoid changing their usual treatment unless medically necessary. While inclusion of these groups in the research design controls for the passage of time and natural course of a given problem or condition, they are limited as controls in mind-body interventions such as yoga, given the many nonspecific factors that may confound results or even constitute important elements of the intervention.<sup>10</sup> However, passive control groups are reasonable in early stages of research, given the practical demands of active comparison groups, whose inclusion require investigators to recruit many more participants and to deliver the comparison condition.

However, as research advances, the need for more active comparisons becomes obvious. Yoga involves ongoing interaction with an instructor, which can have substantial effects on some outcomes. In addition, a passive control does not account for other potential

nonspecific factors, including expectancy effects, attention and time spent in the intervention.<sup>11,10</sup> Further, passive control conditions do not typically entail the same amount of participant burden or investment. In addition, some researchers have argued that using a waitlist control may spuriously amplify the difference in treatment effect between the intervention and the control because people assigned to the waitlist may expect to *not* get better without active treatment.<sup>8,13</sup>

Study designs that include information-only or self-study control groups in which participants are given informational materials to read on their own are somewhat closer to designs that include an active comparison. Although a few especially motivated participants may read everything they are given and take action that will change their health, these control groups are usually expected to have minimal effects across the whole group of participants randomized to that condition.<sup>14</sup> However, this option may have some appeal to potential participants during recruitment and alleviate the potential disappointment some participants experience when getting randomized to the “usual care” condition.<sup>10</sup>

Investigators may also employ active control conditions such as relaxation or exercise in their studies.<sup>10</sup> These control conditions may constitute a stronger comparison group for discerning the effects of yoga, but because few authors reporting on yoga interventions explicitly state the mechanism through which they believe the yoga will affect the outcome, the rationale for the choice of control is often not provided. Active control conditions may or may not control for multiple aspects of the intervention (time, attention from a provider, group setting). Active control groups provide an important practical advantage in research as well, making participation in studies more appealing and improving retention rates.<sup>8</sup>

To better understand the current state of yoga intervention research, we undertook a systematic review of the control groups employed by investigators in randomized controlled trials (RCTs) of yoga, which are more methodologically rigorous and may be more heavily weighted in determining evidence regarding yoga’s effects. For those studies in which an active control was included, we attempted to examine the rationales provided for that choice. With this information, we endeavor to provide some direction for future studies of yoga interventions.

## Method

The results of this paper focus on a subset of data produced for a review of all intervention trials of yoga conducted by the authors. The larger project followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for conducting and reporting items for systematic reviews.<sup>8</sup> Two authors searched four electronic databases (PsycInfo, OVID, AgeLine, Pub Med) using the text term “yoga”, from the inception of the database until the end review date of April 27, 2012. In addition, we hand-searched the electronic table of contents of five key journals, selected because of their prominence in our electronic database search (*Arch Intern Med*, *BMC Complement Altern Med*, *Evid Based Complement Alternat Med*, *Int J Yoga* and *J Altern Complement Med*). Studies were selected for review if they met the following four criteria: 1) the study consisted of a yoga intervention, defined as providing at least one yoga session to a cohort of people and

measuring any outcomes with at least a pre- and post-test; 2) participants in the intervention were at least 18 years of age; 3) the published paper was written in English, and 4) the full text of the article was available for review. If an article was not available in electronic format, we purchased it through one of two university library centers. If a university library was unable to obtain the article, one of the authors wrote to the first author requesting a reprint of the article. The complete search strategy, including our PRISMA Flowchart, is detailed in Elwy et al.<sup>15</sup>

This review of all yoga interventions identified 3,062 articles reporting on yoga interventions, with 465 studies meeting the above inclusion criteria. For this paper, we focused on the subset of these, 154 studies, coded as RCTs, meaning that, at minimum, participants were randomly assigned to a group that received yoga or to a comparison group. Of these, authors of 13 articles were reporting additional results beyond those initially reported for that study, 2 were studies in which only two yoga conditions were compared (e.g., yoga versus yoga plus Tui Na<sup>16</sup>), 4 were reports of combination treatments where yoga was only a small part of the intervention (e.g.,<sup>17</sup>) and 7 were reports of single sessions that were designed to examine very specific effects of yoga (e.g., optical illusions<sup>18</sup>). These 26 studies were removed from the present review, which was designed to examine the control conditions used in studies of yoga as an intervention to meaningfully improve health or well-being. Thus, 128 randomized controlled studies were included.

## Results

The 128 RCTs of yoga, representing 28% of the studies eligible for inclusion in the larger review, were nearly evenly split between those in which researchers included only a waitlist or no treatment control and those in which at least one active control was included (see Figure 1). Of the 80 studies in which investigators employed an inactive control condition, 33 included a waitlist control, 32 included usual care, two included patients who were asked avoid usual care, and 13 included a no treatment condition; this latter condition was often the case for non-patient population interventions such as stress management for employees or caregivers (see Table 1).

Among studies that included at least one active comparison group, physical exercise interventions were the most common comparison condition (see Table 2). Most of these conditions comprised group exercise sessions that consisted of aerobics and calisthenics. In four studies, investigators used a stretching group (sometimes referred to as *sham yoga*), as the comparison, in four, investigators used a walking group as the comparison, and in one study each, investigators used bicycling and sports climbing as the comparison. In these studies, investigators tended to control for amount of time and teacher attention as well as other nonspecific effects such as expectancies and experience within the group.

The two other large groups of comparison conditions were relaxation/meditation and psychotherapy/counseling. These conditions were primarily administered in group format and usually attempted to control for nonspecific effects. Within each category, there was a great deal of variation. For example, meditation comparisons included techniques focusing on mindfulness<sup>20</sup> and breathing.<sup>21</sup> Similarly, studies in which investigators used comparison

groups comprised of psychotherapy/counseling included cognitive behavioral therapy,<sup>21</sup> Acceptance and Commitment Therapy,<sup>23</sup> dynamic psychotherapy<sup>24</sup> and supportive counseling.<sup>25</sup> Most of the relaxation/meditation and psychotherapy/counseling comparisons controlled reasonably well for the nonspecific intervention elements such as time and attention.

Some of the education comparisons were well-designed and attempted to control for nonspecific effects. Exemplary in this regard is the comparison intervention designed by Innes and her colleagues that involves watching a series of health films and having group discussions. This condition carefully matched staff attention, class time and setting, and social interaction.<sup>4</sup> Most education comparison conditions, however, did not attempt to control for nonspecific effects (e.g., giving participants booklets related to back pain<sup>1</sup>). Some studies included a comparison group whose participants received a medical approach, either a holistic treatment through Ayurveda (e.g.,<sup>26</sup>) or a specific treatment such as medication or electroconvulsive therapy for depression (e.g.,<sup>27</sup>).

To examine trends in the use of active control conditions in yoga intervention research over time, we examined the absolute and relative number of yoga trials with and without an active condition over time (see Figure 2). Results indicate that while yoga intervention research has become increasingly popular over the past decade, a substantial amount of this research has continued to include only a passive control group.

## Discussion

Although researchers have been studying yoga for many years and the pace of yoga research has accelerated considerably in recent years, the number of RCTs remains small. Only 28% of the published studies examining yoga on health or well-being outcomes were RCTs. Of that 28%, about half included only inactive wait-list or usual care control groups, while in the other half, participants were randomized to a more active treatment condition with elements that comprised attempts to control for a variety of specific or nonspecific effects. Only one study design involved more than one experimental condition, allowing those researchers to compare a yoga intervention to both an inactive group and another active control condition.<sup>28</sup>

The 63 studies in which researchers included an active comparison condition provide important insights into the theories driving these studies and the mechanisms of effect that the researchers are testing. Among these mechanisms are physiological (e.g., immunological, cardiovascular, musculoskeletal) and psychological (e.g., affect, stress)<sup>3, 7</sup>. It should be noted that few authors explicitly laid out their hypotheses regarding the purported mechanism of effect or tied it explicitly to their selection of a control condition. However, it may be that although these investigators had a sound rationale for their choice of control group, its omission in the published manuscript was due to journal space constraints.

The most commonly-used active control condition employed by researchers was exercise. Studies in which yoga is compared to an exercise condition can help investigators to

determine whether yoga's effects are "merely" exercise or whether yoga provides something above and beyond physical activity. For example, in a recent study of chronic low back pain, researchers compared yoga to stretching exercises in a condition matched for time, attention, and expectations for improvement, finding that participants in both conditions improved to a similar degree relative to those who received only an educational booklet.<sup>14</sup> These results suggest that the effects of yoga on lower back pain may be due to stretching that occurs during asana, although both stretching and yoga may exert unique salutary effects as well.<sup>29</sup>

Importantly, exercise also produces documented psychological effects as well as physical effects; these psychological effects may also be a pathway through which yoga influences well-being.<sup>30</sup> Thus yoga may provide the same psychological and physical benefits that other types of exercise do, as well as providing additional benefits, such as relaxation.<sup>29</sup> For example, a study of yoga in healthy participants in which investigators compared yoga to walking found that those in the yoga condition showed greater increases in positive mood and reductions in anxiety.<sup>31</sup> Investigators designed this study to test whether yoga adds to the known effects of physical exercise in improving mood and reducing anxiety, and carefully controlled for staff attention and interaction as well as energy expenditure. Based on their findings, the authors speculated that the effect of the yoga intervention (reduction in GABA levels) may be due to the ability of yoga practices to increase parasympathetic nervous system activity.

The second-largest group of comparison conditions was relaxation and meditation. Researchers do not typically provide their rationale for examining yoga vis-à-vis meditation or relaxation in published articles, but some have described the effort to control for relaxation to see whether yoga contributes above and beyond nonspecific effects. For example, Manocha and colleagues<sup>32</sup> employed a meditation/relaxation condition "to control for nonspecific effects associated with reduction in physiological arousal (i.e., "rest") as well as other nonspecific factors such as therapeutic contact, credibility, and expectancy associated with any behavioral intervention" (p. 3).

The other large group of comparison conditions involved psychotherapy or counseling. Few of the articles reporting on these studies provided a rationale for selecting psychotherapy or counseling as a comparison. Granath and colleagues<sup>33</sup> used a cognitive-behavioral therapy (CBT) comparison group, hypothesizing that yoga and CBT may both improve stress levels but have somewhat different impacts on specific outcomes (but did not make more specific hypotheses). Rao and colleagues<sup>25</sup> used a supportive counseling intervention to control for nonspecific effects of the intervention, hypothesizing that the yoga intervention would have additional effects on anxiety (which supportive counseling was apparently presumed not to have).

Factors that affect the choice of a control group for behavioral researchers include the level of existing evidence for intervention efficacy, availability of funding for more rigorous studies, the nature of usual care, the complexity of the intervention being studied and the availability and effectiveness of alternative treatments for the targeted disease or condition. Without inclusion of an active control, conclusions regarding the extent to which yoga had effects above and beyond non-specific effects are limited. Comparing yoga (or essentially

any psychosocial intervention) to nothing or to usual care is well-established to demonstrate superior effects for the (yoga) intervention group.<sup>9,34</sup>

Yet studies that used only a wait-list or usual care control have been important in paving the way towards more sophisticated research by demonstrating acceptability and preliminary efficacy. Thus, if yoga has never been used to treat a certain disease or health issue, we may expect to see pilot or proof-of-concept studies without control groups followed by some RCTs with wait-list or usual care groups. We note that the issue of usual care is more complex than it may seem, as some conditions have fairly well-established treatment, yet also some latitude in the care provided. For example, investigators in one study compared three treatments for depressed patients: yoga, electroconvulsive therapy, and antidepressant medication.<sup>27</sup> When compared with usual care alone, a wait-list condition has the advantage of limiting the amount of disappointment that may be felt by the group that does not receive the yoga intervention.

However, considerable evidence has already been presented for the efficacy of yoga for treating many diseases, including arthritis,<sup>2</sup> stress,<sup>3</sup> metabolic syndrome,<sup>4</sup> asthma,<sup>5</sup> chronic pain<sup>6</sup> and depression.<sup>7</sup> Thus, investigators for many health conditions should will best advance science by employing more active comparison groups in order to control for nonspecific effects of group participation, attention, and activity. Inclusion of these active controls will enable the isolation and elucidation of the important elements of yoga that impact various health conditions. Such studies are essential for identifying the mechanisms of effect through which yoga affects health outcomes; these mechanisms may vary by outcome, and only through careful selection of comparison groups can this line of research progress.

Investigators' use of active comparison groups will almost certainly become the standard in yoga research as this area of science matures. Funding for yoga interventions is increasingly available, removing an important barrier to more sophisticated research. For illnesses and other conditions for which other types of interventions have established a level of efficacy, a comparative effectiveness trial may be the next step. Comparative effectiveness designs, implementation considerations and cost-effectiveness analyses are important next steps for expanding the impact of yoga on health.

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### Highlights

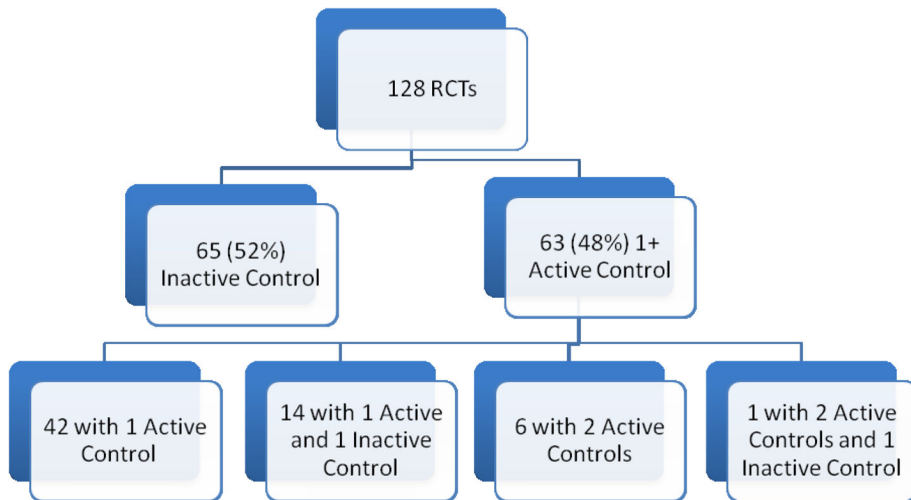
Our systematic review of control and comparison groups of yoga yielded 128 RCTs.

65 included only a passive control and 63 included an active comparison group.

Physical exercise, relaxation, and education were the most common active groups.

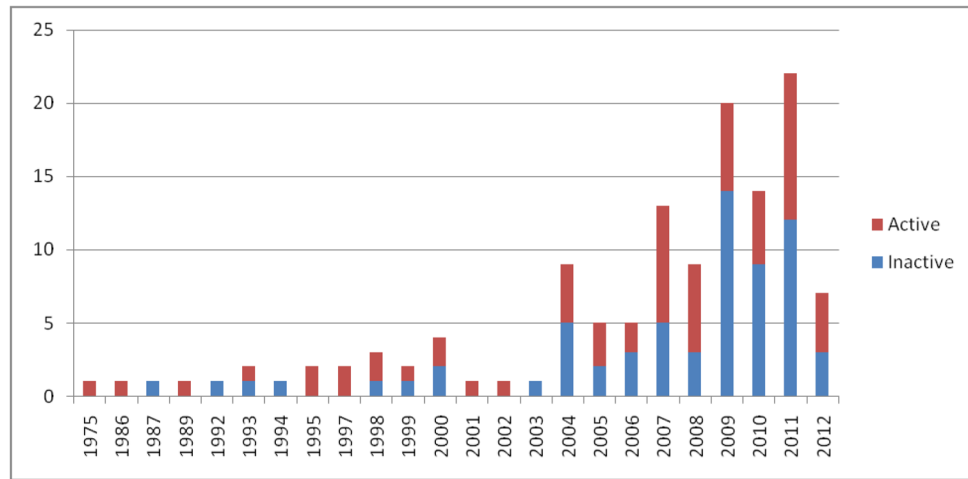
Use of active controls in yoga research appears to be slowly increasing over time.

Future yoga research should carefully consider appropriate control conditions.



**Figure 1.**  
Number of yoga intervention studies using passive and active comparison conditions





**Figure 2.**  
 Number of Studies with Passive Only Control Conditions versus Studies with Active Comparison Conditions by Year (ending mid-2012)

**Table 1**

Passive control conditions in yoga intervention studies that used at least one passive control condition

Condition	N	Studies
Wait list control	33	35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 26, 51, 52, 53, 54, 32, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 20
Usual care	32	65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96
No treatment/Less than usual care	2	97, 98
No intervention	13	99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110 111

**Table 2**

Active control conditions in yoga intervention studies that used at least one active control condition

	Number	Reasonable Effort to Control for Nonspecific Effects	Studies
<b>Physical Exercise</b>	<b>30 (43%)</b>		
Physical Exercise Program/Physical Therapy	20	Yes	2, 3, 14, 38, 47, 52, 56, 57, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123,
Sham yoga/stretching	4	Yes	19, 35, 105, 124
Walking	4	Mixed	31, 46, 87, 108
Bicycling	1	Yes	125
Sports Climbing	1	Yes	126
<b>Relaxation and Meditation</b>	<b>14 (20%)</b>		
Relaxation	6	Yes	7, 45, 53, 32, 127, 128
Meditation/Breath Awareness	4	Yes	21, 28, 129, 130
Progressive Muscle Relaxation	3	Yes	131, 132, 133
Brain Wave Vibration	1	Yes	129
<b>Education</b>	<b>11 (16%)</b>		
Education Materials	3	No	14, 123, 134
Education Group/Lecture	3	Mixed	135, 136, 137
Nutritional Counseling	2	Mixed	65, 138
Film Discussion	2	Yes	22, 49
Workshop Luncheons	1	No	139
<b>Psychotherapy/Counseling</b>	<b>8 (11%)</b>		
Psychotherapy Group (e.g., ACT, CBT)	5	Yes	23, 24, 76, 136, 140
Supportive Counseling	3	Mixed	25, 37, 141
<b>Medical Intervention</b>	<b>7 (10%)</b>		
Ayurveda	2	No	26, 54
Additional medical treatment (e.g., medication)	3	No	27 (ECT), 27 (imipramine), 142
Dietary change (salt reduction)	2	No	87, 143