

Systematic Reviews and Meta- and Pooled Analyses

The Safety of Yoga: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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As yoga has gained popularity as a therapeutic intervention, its safety has been questioned in the lay press. Thus, this review aimed to systematically assess and meta-analyze the frequency of adverse events in randomized controlled trials of yoga. MEDLINE/PubMed, Scopus, the Cochrane Library, and IndMED were screened through February 2014. Of 301 identified randomized controlled trials of yoga, 94 (1975–2014; total of 8,430 participants) reported on adverse events. Life-threatening, disabling adverse events or those requiring intensive treatment were defined as serious and all other events as nonserious. No differences in the frequency of intervention-related, nonserious, or serious adverse events and of dropouts due to adverse events were found when comparing yoga with usual care or exercise. Compared with psychological or educational interventions (e.g., health education), more intervention-related adverse events (odds ratio = 4.21, 95% confidence interval: 1.01, 17.67; $P = 0.05$) and more nonserious adverse events (odds ratio = 7.30, 95% confidence interval: 1.91, 27.92; $P < 0.01$) occurred in the yoga group; serious adverse events and dropouts due to adverse events were comparable between groups. Findings from this review indicate that yoga appears as safe as usual care and exercise. The adequate reporting of safety data in future randomized trials of yoga is crucial to conclusively judge its safety.

adverse events; complementary therapies; meta-analysis; review; safety; yoga

Rooted in Indian philosophy, yoga has been a part of traditional Indian spiritual, philosophical, and psychological practice for millennia (1, 2). The original goal of yoga was uniting mind, body, and spirit through ethical, spiritual, and physical practices (1, 2). Nowadays, it is regarded mainly as a means to promote physical and mental well-being through physical postures (asanas), breathing techniques (pranayama), and meditation (dyana) (2, 3). These more physically oriented yoga forms are gaining increased popularity as a therapeutic practice. In 2008, about 7% of the American adult population reported practicing yoga (4). About half of those started practicing explicitly to improve their health status, resulting in more than 13 million people practicing yoga for health reasons (5).

Although yoga has long been promoted as without harm, this view has been challenged in recent years in a number of lay-press articles (6–8). In particular, a book and articles by *New York Times* correspondent William J. Broad reported a number of alarming cases of yoga-associated injuries and

deaths (8). As these publications seem to have led to a general uncertainty as to the safety of yoga among yoga practitioners and those interested in starting practice (9), it is important to systematically assess the safety of yoga. While 2 systematic reviews have focused on assessing yoga-associated adverse events (10, 11), none of them included all randomized controlled trials on yoga available to date, and none included a meta-analysis.

Therefore, this review aimed to systematically assess and meta-analyze the frequency of adverse events in yoga randomized controlled trials.

METHODS

This review was planned and conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (12) and the recommendations of the Cochrane Collaboration (13). The protocol was not registered on any database.

Eligibility criteria

Types of studies. Randomized controlled trials, cluster-randomized trials, and randomized cross-over studies were eligible. No language restrictions were applied.

Types of participants. Studies including healthy participants or patients with a reported medical condition were eligible. No restrictions were applied regarding sociodemographic characteristics or health status.

Types of interventions. Studies that compared yoga with no treatment, usual care, or any active treatment were eligible. Studies were excluded if yoga was part of a multimodal intervention rather than being the main intervention. No further restrictions were made regarding yoga tradition, length, frequency, or duration of the program. Head-to-head comparisons of different types of yoga without a nonyoga control group were excluded.

Types of outcome measures. For inclusion, studies had to assess adverse events. Adverse events were classified as 1) intervention-related adverse events, 2) nonserious adverse events, and 3) serious adverse events. Studies assessing dropouts due to adverse events were also eligible. Adverse events were defined as any undesirable experience during the course of the study, regardless of whether it was likely associated with the intervention or not. Adverse events resulting in 1) death, 2) life-threatening situations, 3) hospitalization, 4) disability or permanent damage, 5) congenital anomaly/birth defect, or 6) the need for medical or surgical intervention to prevent outcomes 1–5 were defined as serious (14). All other adverse events were regarded as nonserious. Causal relationship to the intervention was assumed only if it was judged as likely by the authors of the original study. Dropouts were regarded as being due to adverse events if an adverse event was explicitly given as the reason for dropout in the original study.

Search methods

Four electronic databases were searched from their inception through February 12, 2014: MEDLINE/PubMed, Scopus, the Cochrane Library, and IndMED. The literature search was constructed around search terms for “yoga” and a filter for retrieving randomized controlled trials (13), with adaptation for each database as necessary. The complete search strategy for MEDLINE/PubMed was as follows:

1. Yoga[MeSH Terms]
2. Yoga*[Title/Abstract] OR Yogic[Title/Abstract] OR Pranayam*[Title/Abstract] OR Asana*[Title/Abstract]
3. 1 OR 2
4. Randomized Controlled Trial[Publication Type] OR controlled clinical trial[Publication Type] OR randomized [Title/Abstract] OR placebo[Title/Abstract] OR random [Title/Abstract] OR randomly[Title/Abstract] OR trial [Title/Abstract] OR group[Title/Abstract]
5. 3 AND 4

Additionally, reference lists of identified original articles or reviews, as well as the tables of contents of the *Journal of Yoga and Physical Therapy* and the *International Scientific Yoga Journal SENSE*, were manually searched.

Pairs of 2 review authors (H.C. and R.L.; H.C. and L.W.; R.L. and L.W.) independently screened abstracts identified during the literature search and read potentially eligible articles in full to determine whether they met eligibility criteria. Disagreements were discussed with a third review author (L.W.; R.L.; H.C.) until consensus was reached.

Data extraction and management

Pairs of 2 authors (H.C. and R.L.; H.C. and L.W.; R.L. and L.W.) independently extracted data on design (e.g., origin, setting), participants (e.g., condition, age, sex, race), interventions (e.g., yoga type, components, duration), control interventions (e.g., type, duration), and adverse events using an a priori developed data extraction form. Discrepancies were discussed with a third review author (L.W.; R.L.; H.C.) until consensus was reached.

Risk of bias in individual studies

Pairs of 2 authors (H.C. and R.L.; H.C. and L.W.; R.L. and L.W.) independently assessed risk of bias using the Cochrane risk of bias tool (13). This tool assesses risk of bias on the following domains: selection bias (random sequence generation, allocation concealment), performance bias (blinding of participants and personnel), detection bias (blinding of outcome assessment), attrition bias (incomplete outcome data), reporting bias (selective reporting), and other bias. For each criterion, risk of bias was assessed as 1) low, 2) unclear, or 3) high risk of bias (13). Discrepancies were rechecked with a third reviewer (L.W.; R.L.; H.C.) and consensus achieved by discussion.

Data analysis

Assessment of adverse events. Nonyoga control interventions were grouped into 3 categories of usual care or no treatment, exercise, and psychological or educational interventions (e.g., health education). Adverse events of yoga compared with each control group category were analyzed separately. Meta-analyses were conducted by using Review Manager 5 software (Version 5.1; The Nordic Cochrane Centre, Copenhagen, Denmark), using a random effects model, if at least 2 studies assessing a specific type of adverse event were available.

Using a standardized Excel sheet (Microsoft Corporation, Redmond, Washington), we calculated odds ratios by dividing the odds of an adverse event in the intervention group (i.e., the number of participants with the respective type of adverse event divided by the number of participants without the respective type of adverse event) by the odds of an adverse event in the control group. Where studies had reported 0 adverse events in 1 or both intervention groups, a value of 0.5 was added to all cells of the respective study (15, 16). Meta-analysis was based on log(odds ratio) and respective standard errors using the generic inverse variance method.

Additionally, risk difference with 95% confidence intervals, a measure of absolute effect, was calculated in a sensitivity analysis by subtracting the risk of adverse event in the control group (i.e., the number of participants with the

respective type of adverse event divided by the total number of participants) from the risk of adverse event in the experimental group and meta-analyzed by the Mantel-Haenszel method (13).

Assessment of heterogeneity. Statistical heterogeneity between studies was analyzed by using the I^2 statistic, a measure of how much variance between studies can be attributed to differences between studies rather than chance. The magnitude of heterogeneity was categorized as low ($I^2 = 0\%–24\%$), moderate ($I^2 = 25\%–49\%$), substantial ($I^2 = 50\%–74\%$), or considerable ($I^2 = 75\%–100\%$) (13, 17). The χ^2 test was used to assess whether differences in results were compatible with chance alone. Given the low power of this test when only few studies or studies with low sample size are included in a meta-analysis, $P \leq 0.10$ was used to indicate significant heterogeneity (18).

Subgroup and sensitivity analyses. Subgroup analyses were conducted for type of participants (healthy participants vs. participants with physical and mental health conditions) and length of follow-up (less than median follow-up period vs. median or longer follow-up period). Subgroup differences were analyzed by means of the I^2 statistic and χ^2 tests (13).

To test the robustness of the results, sensitivity analyses were conducted for studies with low risk of selection bias. Additional sensitivity analyses were conducted by repeating all analyses using risk differences (see above).

Risk of publication bias

Risk of publication bias was assessed for each meta-analysis that included at least 10 studies (13). Funnel plots (scatterplots of the intervention effect estimates from individual studies against the studies' standard error) were generated by using Review Manager 5 software. Publication bias was assessed by visual analysis, with roughly symmetrical funnel plots regarded as indicating low risk and asymmetrical funnel plots regarded as indicating high risk of publication bias (13).

RESULTS

Literature search

The search strategy yielded a total of 2,520 records. After exclusion of duplicates, 1,531 records were screened, of which 1,041 were subsequently excluded because they were not randomized or they did not include yoga interventions. Of the remaining 490 full texts, 135 were excluded because they were not published as a full article, were not randomized, did not include yoga interventions, or did not include nonyoga control groups. A total of 355 full-text articles reporting 301 randomized controlled trials of yoga were screened for adverse events. Of those, 200 full-text articles on 171 studies (57%) did not report any safety-related data, and 44 full-text articles on 36 studies (12%) reported either insufficient or contradictory safety-related data. Finally, 111 full-text articles on 94 studies (31%) that reported data on at least 1 type of adverse events were included (19–129). Two studies that were included in the qualitative assessment were excluded from meta-analysis because their control groups were not comparable to those of any other study (63, 77) (Figure 1).

Participant and setting characteristics

Country of origin, characteristics of the sample, interventions, and outcome assessment of the included studies are shown in Web Table 1, available at <http://aje.oxfordjournals.org/>.

The 94 studies included a total of 8,430 participants; the sample size ranged from 13 to 410, with a median of 61.5 (interquartile range, 37.8–108.8). Of the 94 included studies, 43 studies originated from North America (42 from the United States, 1 from Canada; total of 3,514 participants); 1 study from South America (Brazil; 61 participants); 12 studies from Europe (5 from the United Kingdom, 3 from Germany, 1 each from Ireland, Spain, Sweden, and Turkey; 1,104 participants); 30 studies from Asia (26 from India, 2 each from Japan and Taiwan; 3,292 participants); and 8 studies from Australia (459 participants). Fifteen studies were conducted with healthy participants or those not selected on the basis of their health status (1,316 participants). The remaining 77 studies included patients with a variety of physical and mental health conditions (7,114 participants) (Web Table 1).

Participants' mean age ranged from 10.1 to 84.5 years, with a median of 48.8 (interquartile range, 38.0–57.8) years; 7 studies did not report mean age. The percentage of female participants ranged from 0% to 100% with a median of 75.0% (interquartile range, 48.0–100.0). Three studies did not report the sex of participants ($n = 122$). Those reporting sex included a total of 5,878 women and 2,430 men.

Fifty-seven studies did not report ethnicity; in the remaining studies, the percentage of Caucasian participants ranged from 3% to 100% with a median of 83.0% (interquartile range, 61.5–93.0).

Intervention characteristics

Of the 94 included studies, 32 did not define the specific style of yoga used in the intervention; 8 stated that hatha yoga (a term for yoga styles that focus mainly on physical postures (3)) was used; and 4 stated that yogic breathing or pranayama was used. The remaining 50 studies used a variety of different yoga styles, the most prominent being Iyengar yoga, used in 19 studies (Web Table 1). The yoga interventions ranged in length from 1 day to 18 months, with a median duration of 10 (interquartile range, 7.3–12) weeks (Web Table 1). A total of 3,991 participants were included in the yoga interventions.

Fifty-three studies compared yoga with usual care or no treatment ($n = 2,221$), 26 studies compared yoga with exercise interventions ($n = 1,445$), and 22 studies compared yoga with psychological or educational interventions ($n = 625$). Two studies used diet ($n = 44$), and 1 study each used an herbal compound ($n = 29$), reiki ($n = 9$), or a placebo breathing device ($n = 11$) as its control intervention (Web Table 1).

Risk of bias in individual studies

The risk of bias assessment of the 94 studies is shown in Web Table 2. Thirty-four studies (36%) reported adequate random sequence generation and allocation concealment, 3 studies (3%) reported adequate blinding of participants, and 44 studies (47%) reported adequate blinding of outcome assessment (Web Table 2).

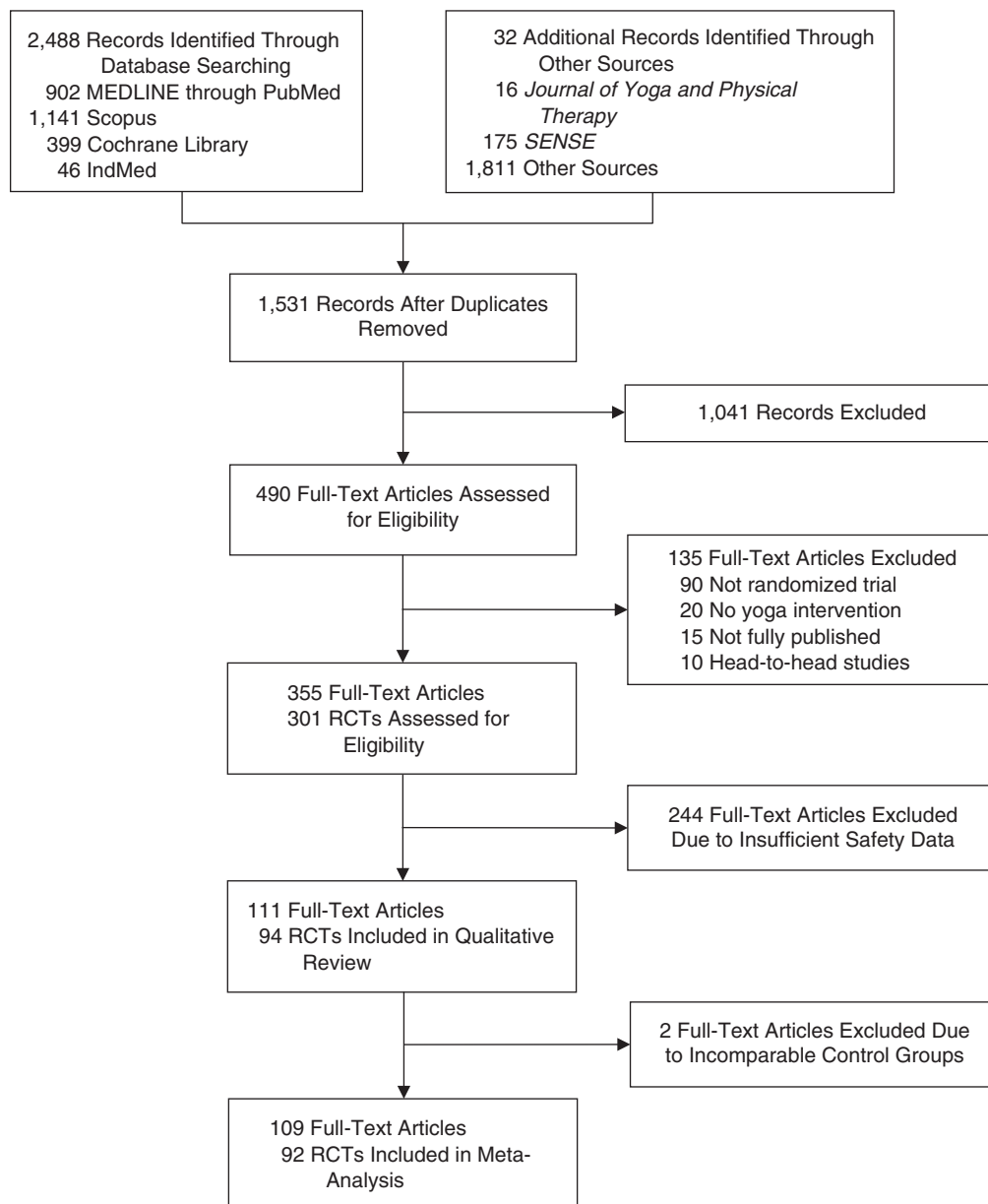


Figure 1. Flowchart of the results of the literature search. RCT, randomized controlled trial.

Analyses of adverse events

Adverse events were assessed from 1 day to 18 months after randomization, with a median of 12 (interquartile range, 8–24) weeks including follow-up periods after the end of the intervention.

The absolute numbers of studies, participants, and adverse events in each analysis are shown in Figures 1–4 and Table 1. In meta-analyses, no differences in the frequency of intervention-related adverse events, of nonserious or serious adverse events, or of dropouts due to adverse events were found when comparing yoga with usual care/no treatment (Figures 2–5) or with exercise (Table 1; Web Figures 1–4).

However, compared with psychological/educational interventions, more intervention-related adverse events (odds ratio = 4.21, 95% confidence interval: 1.01, 17.67; $P = 0.05$) and more nonserious adverse events occurred in the yoga group (odds ratio = 7.30, 95% confidence interval: 1.91, 27.92; $P < 0.01$). No other group differences were found for this comparison (Table 1; Web Figures 5–8).

Heterogeneity was low in all meta-analyses (Table 1; Figures 1–4); confidence intervals were relatively wide for a number of analyses (Table 1; Figures 1–4).

Two studies compared yoga with diet and reported that no intervention-related adverse events (77) and no dropouts due

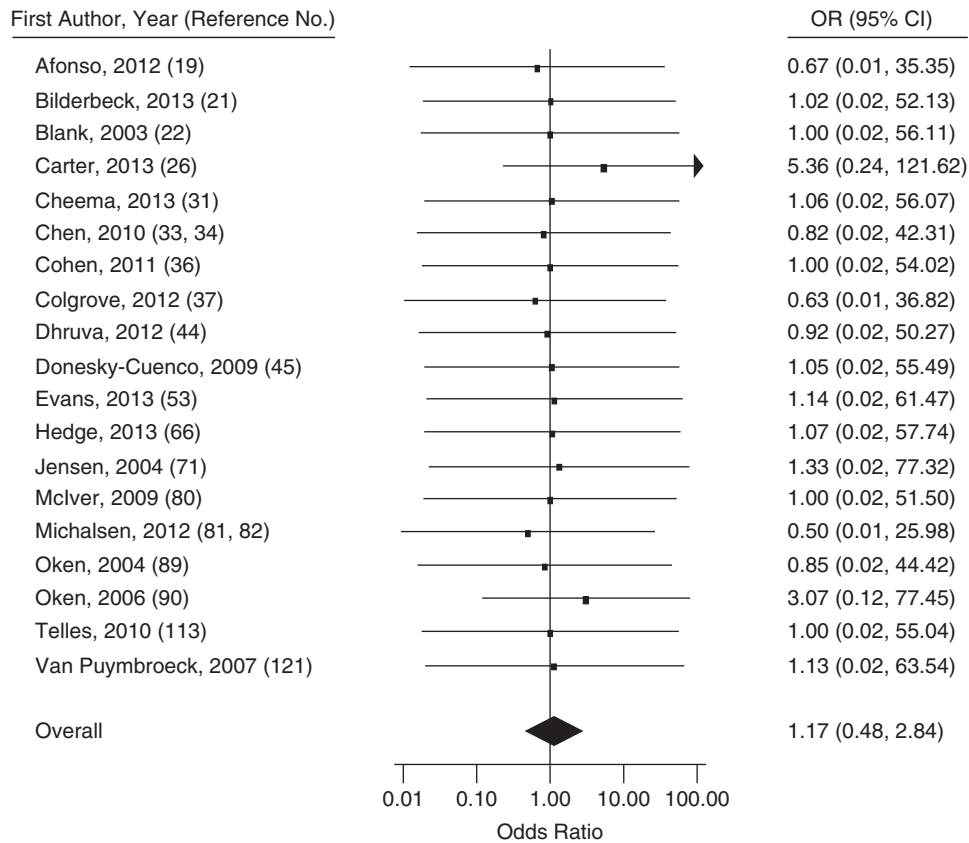


Figure 2. Forest plot for comparison of yoga versus usual care, with the outcome intervention-related adverse events, 2003–2013. Test for overall effect: $Z = 0.34$, $P = 0.73$. Assessment of heterogeneity: $\chi^2 = 1.71$, $df = 18$, $P = 1.00$, $I^2 = 0\%$. CI, confidence interval; OR, odds ratio. Bars, 95% CIs.

to adverse events (111) occurred in either group. One study each compared yoga with 1) an herbal medication and reported no serious adverse events in either group (63),

2) reiki and reported that 3 of 10 participants (30%) in the yoga group dropped out because of adverse events compared with 2 of 9 (22%) in the reiki group (93), or 3) a placebo

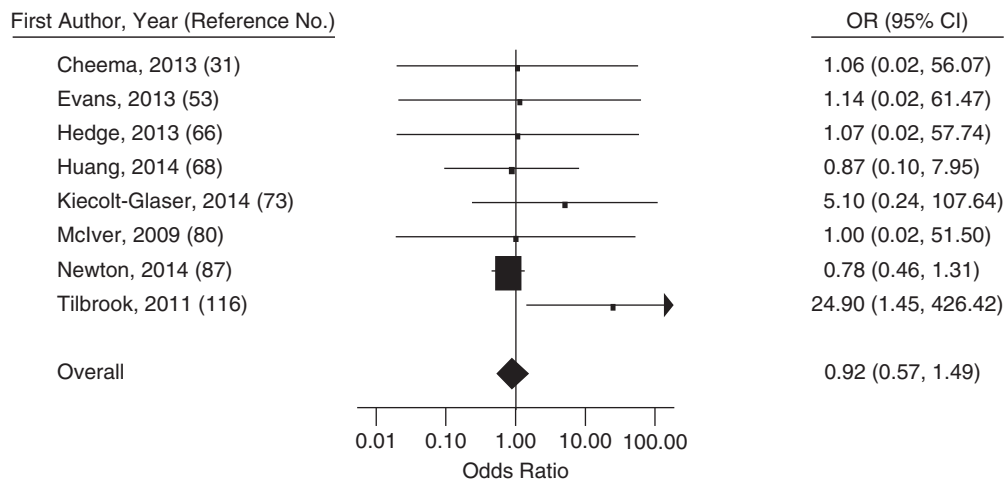


Figure 3. Forest plot for comparison of yoga versus usual care, with the outcome nonserious adverse events, 2007–2013. Test for overall effect: $Z = 0.33$, $P = 0.74$. Assessment of heterogeneity: $\chi^2 = 6.81$, $df = 7$, $P = 0.45$, $I^2 = 0\%$. CI, confidence interval; OR, odds ratio. Bars, 95% CIs.

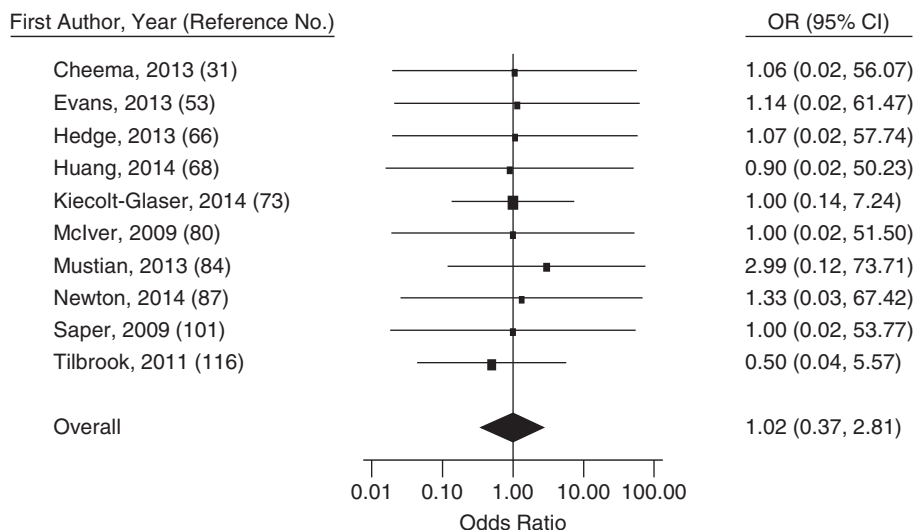


Figure 4. Forest plot for comparison of yoga versus usual care, with the outcome serious adverse events, 2007–2014. Test for overall effect: $Z = 0.03$, $P = 0.98$. Assessment of heterogeneity: $\chi^2 = 0.79$, $df = 9$, $P = 1.00$, $I^2 = 0\%$. CI, confidence interval; OR, odds ratio. Bars, 95% CIs.

breathing device and reported 2 dropouts due to adverse events of 11 participants in each group (108).

Considering only the yoga groups, the frequency of intervention-related, nonserious, and serious adverse events in individual studies ranged from 0.0% to 14.1%, 0.0% to 48.0%, and 0.0% to 2.8%, respectively. Across studies, 2.2% (19 of 856), 10.9% (87 of 800), and 0.6% (6 of 1,019) of participants in the yoga groups reported intervention-related, non-serious, and serious adverse events, respectively.

Subgroup and sensitivity analyses

No group differences were found when comparing studies of different participant groups (Web Table 3). More

intervention-related and nonserious adverse events were found for yoga compared with psychological/educational interventions in studies with 12-week or longer follow-up periods but not in studies with less than 12-week follow-up periods (Web Table 4).

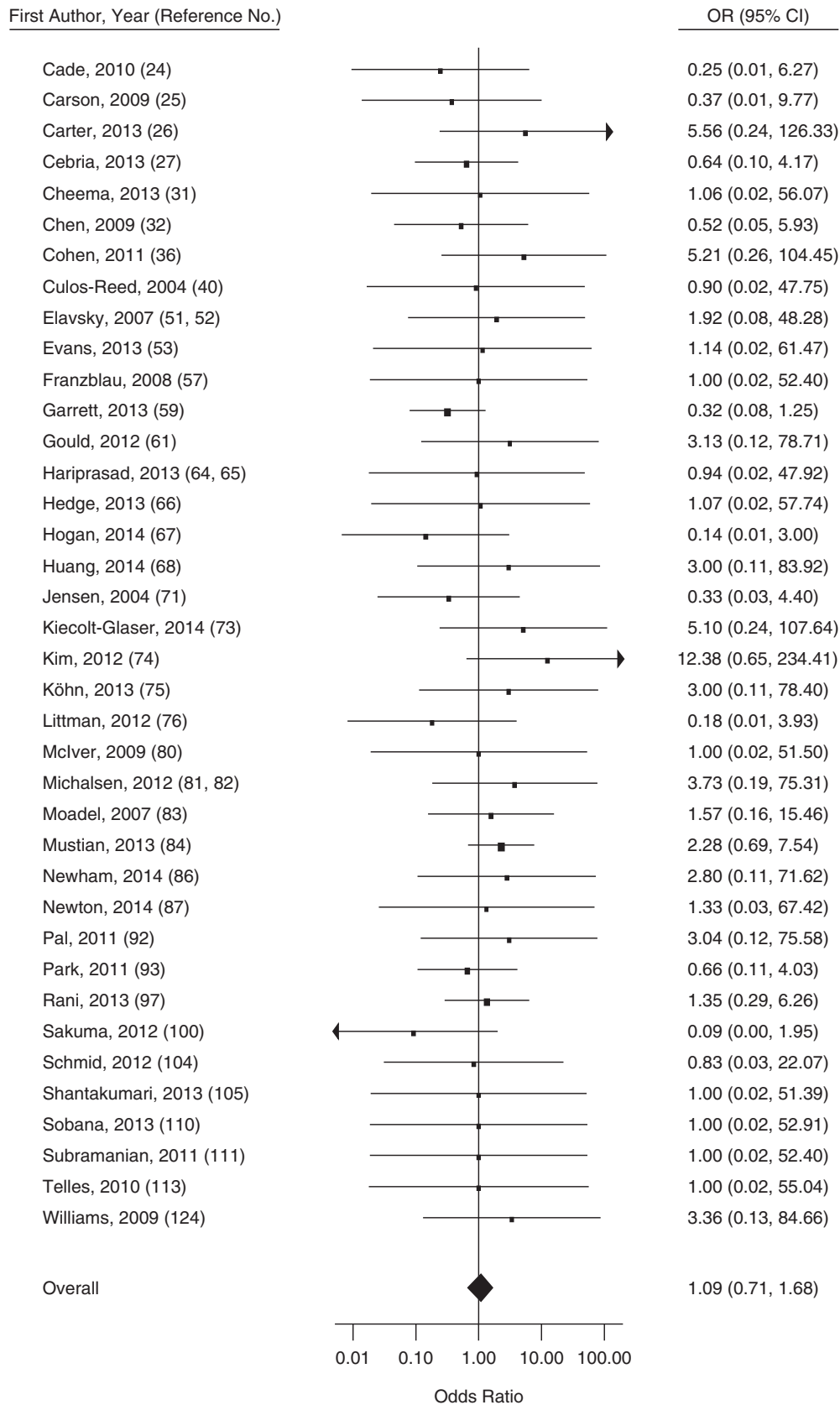
When risk differences were used, group differences for intervention-related adverse events in yoga compared with psychological/educational interventions were no longer significant (risk difference = 0.05, 95% confidence interval: -0.02, 0.12; $P = 0.10$). The remaining results did not change substantially (Web Table 5).

Results remained similar when only studies with low risk of selection bias were included in the sensitivity analyses (Table 2).

Table 1. Adverse Events of Yoga Versus Exercise and Psychological or Educational Interventions, 1975–2014

Type of Adverse Event	No. of Studies	Yoga		Control		Odds Ratio	95% CI	P Value	Heterogeneity		
		No. of Events	No. of Participants	No. of Events	No. of Participants				I^2 Statistic, %	χ^2 Test	P Value
<i>Yoga Versus Exercise</i>											
Intervention related	11	16	420	15	404	1.02	0.52, 1.99	0.95	0	0.51	1.00
Nonserious	6	27	284	24	255	1.12	0.60, 2.09	0.71	0	0.36	1.00
Serious	8	2	353	0	324	0.87	0.50, 1.52	0.64	0	9.85	0.77
Dropouts due to adverse event	15	25	867	45	1,049	0.87	0.50, 1.52	0.64	0	9.85	0.77
<i>Yoga Versus Psychological or Educational Intervention</i>											
Intervention related	4	15	174	1	150	4.21	1.01, 17.67	0.05	0	0.53	0.91
Nonserious	4	23	180	1	126	7.30	1.91, 27.92	<0.01	0	0.71	0.87
Serious	4	1	180	2	126	0.54	0.10, 2.92	0.47	0	0.26	0.97
Dropouts due to adverse event	20	21	593	18	595	1.09	0.58, 2.04	0.78	0	7.27	0.99

Abbreviation: CI, confidence interval.



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Figure 5. Forest plot for comparison of yoga versus usual care, with the outcome dropouts due to adverse events, 2004–2013. Test for overall effect: $Z = 0.39, P = 0.70$. Assessment of heterogeneity: $\chi^2 = 22.10, df = 37, P = 0.98, I^2 = 0\%$. CI, confidence interval; OR, odds ratio. Bars, 95% CIs.

Table 2. Sensitivity Analysis of Adverse Events of Yoga Versus Controls When Only Studies With Low Risk of Selection Bias Were Included, 2002–2014

Type of Adverse Event	No. of Studies	Yoga		Control		Odds Ratio	95% CI	P Value	Heterogeneity		
		No. of Events	No. of Participants	No. of Events	No. of Participants				I ² Statistic, %	χ ² Test	P Value
<i>Yoga Versus Usual Care or No Treatment</i>											
Intervention related	5	1	130	0	103	1.10	0.20, 6.02	0.91	0	0.62	0.96
Nonserious	2	36	125	56	161	0.78	0.47, 1.32	0.35	0	0.02	0.88
Serious	4	1	346	0	380	1.56	0.24, 10.04	0.64	0	0.25	0.97
Dropouts due to adverse event	10	19	673	12	619	1.30	0.63, 2.67	0.48	0	5.65	0.77
<i>Yoga Versus Exercise</i>											
Intervention related	7	16	297	15	290	1.04	0.51, 2.11	0.92	0	0.49	1.00
Nonserious	5	27	235	24	206	1.13	0.60, 2.11	0.71	0	0.36	0.99
Serious	6	2	273	0	245	1.31	0.29, 5.84	0.72	0	0.34	1.00
Dropouts due to adverse event	7	16	363	15	358	0.95	0.46, 1.96	0.89	0	3.78	0.71
<i>Yoga Versus Psychological or Educational Intervention</i>											
Intervention related	3	15	144	1	90	4.72	1.01, 21.99	0.05	0	0.37	0.83
Nonserious	4	23	180	1	126	7.30	1.91, 27.92	<0.01	0	0.71	0.87
Serious	4	1	180	2	126	0.54	0.10, 2.92	0.47	0	0.26	0.97
Dropouts due to adverse event	8	11	268	10	262	1.03	0.42, 2.53	0.95	0	5.25	0.63

Abbreviation: CI, confidence interval.

Risk of publication bias

All funnel plots were generally symmetrical, indicating low risk of publication bias (Web Figures 9–14).

DISCUSSION

Summary of evidence

This systematic review of randomized controlled trials of yoga found evidence that yoga is not associated with an increased frequency of intervention-related, nonserious, or serious adverse events or of dropouts due to adverse events compared with usual care or exercise. Yoga was associated with an increased frequency of intervention-related, nonserious, and adverse events compared with psychological/educational interventions; interestingly, frequencies were comparable between groups for serious adverse events and dropouts due to adverse events. Expectedly, the odds of (nonserious) adverse events increased with longer follow-up periods. Overall, the frequency of adverse events in the yoga groups was relatively low: 2.2%, 10.9%, and 0.6% for intervention-related, nonserious, and serious adverse events, respectively.

Although the findings were robust against methodological bias, they should be interpreted in the light of the insufficient reporting of safety data in randomized trials of yoga: Less than one-third of all published studies (94 of 301 originally located randomized trials) reported sufficient data for quantitative analysis. While funnel plot symmetry suggests a low risk of publication bias, clearly only a minority of studies included in this systematic review reported adverse events from their yoga trials.

Agreements with prior systematic reviews and other research

To the best of our knowledge, this is the first meta-analysis on adverse events in randomized trials of yoga. In a recent systematic review on the safety of yoga (10), the frequency of adverse events in randomized trials was lower than that in the present meta-analysis; adverse events were reported in 0.4%–6.3% of yoga participants. However, this disparity may be explained by differences in search strategy and inclusion criteria leading to identification of only 199 randomized trials out of which 28 had reported safety data, compared with 94 of 301 trials in the current systematic review. Another systematic review on yoga-associated adverse events in case series and case studies identified a total of 76 published cases, most of which were classified as serious adverse events (11). However, because case reports are anecdotal by nature, the total frequency of adverse events associated with yoga could not be estimated. Previous systematic reviews on the efficacy and safety of yoga for specific health conditions generally concluded that yoga is safe for musculoskeletal conditions (130, 131), cardiorespiratory conditions (132–135), and cancer (136, 137), with the caveat that insufficient reporting hindered definite conclusions. For several other medical conditions, no safety data at all were located (131, 138–140).

Cross-sectional studies on yoga-associated adverse events have reported inconsistent results on yoga-related adverse events. In a small survey of 110 Finnish Ashtanga Vinyasa Yoga practitioners, 62% of respondents reported at least 1 yoga-related musculoskeletal injury (141). Conversely, a large national survey of 2,500 Australian yoga practitioners indicated that 79% had never been injured during yoga (142). The remaining

practitioners reported mainly minor injuries. In a large nationally representative survey of US adults, less than 1% of yoga practitioners reported yoga-related adverse events that led to discontinued practice (143). However, the total frequency of adverse events was not reported. Finally, in a German survey of 303 internal medicine patients that had used yoga for their primary medical complaint, 4.0% reported adverse events associated with their yoga use (144).

Quality of evidence

Overall, risk of bias appeared to be slightly lower than in other systematic reviews on randomized trials of yoga (130, 132–135, 137–140). Specifically, most studies used adequate methods of random sequence generation and blinding of outcome assessment. This finding suggests that safety data are adequately reported mainly in higher quality yoga trials. However, approximately two-thirds of the included trials did not report adequate allocation concealment. Because inadequate allocation concealment has been empirically demonstrated to be the most important source of bias in randomized trials (145), this strongly limits the interpretability of the results. Although the findings were robust against bias, only a few trials with low risk of selection bias could be included in the sensitivity analyses. The quality of evidence may thus be judged as limited but acceptable.

Limitations

The primary limitation of this review is the insufficient reporting of adverse events in the located trials. As 69.7% of the trials reported no quantifiable safety data, the findings can only be regarded as approximate. Another limitation is the heterogeneity of participants, interventions, and follow-up periods, raising the question of the appropriateness of conducting a meta-analysis. However, the robustness of the results with respect to bias, the low score of heterogeneity, and the low risk of publication bias indicate that a meta-analysis was feasible, and subgroup analyses revealed subgroup differences only for a minority of analyses. From a statistical point of view, another limitation is that odds ratio corrections may exert undesirable influences on the results of analyses, especially when 0 events occur in a majority of studies (14, 15). Although sensitivity analyses using risk difference did not change results substantially, measures of absolute effect are associated with their own limitations (13). Finally, less controlled practices outside research settings might be associated with a greater risk of adverse events than estimated in this meta-analysis.

Implications for further research

As the consideration of yoga as a therapeutic intervention is based on both efficacy and safety, the adequate reporting of safety data in future yoga trials is crucial (146). Researchers should clearly report and evaluate the total frequency of non-serious and serious adverse events, as well as the potential causal relationship of adverse events to the intervention. The reporting of adverse events should adhere to internationally accepted guidelines (14). Moreover, future studies should generally ensure more rigorous methodology and adequate

sample sizes (147). Absolute population-based incidence rates of adverse events associated with yoga are best estimated from large prospective surveys. However, such data have only occasionally been reported; more large representative surveys are needed.

Implications for clinical practice

The findings of this meta-analysis suggest that the frequency and severity of adverse events associated with yoga in randomized trials are comparable to levels associated with physical activity or usual care. However, yoga may be associated with more frequent nonserious adverse events than psychological or educational interventions, that is, interventions that do not normally involve physical activity. Despite the limitations of the available evidence, yoga presents as a generally safe intervention. Recommending yoga to healthy or ill people should not be discouraged on the basis of safety and can be considered if sufficient evidence of efficacy is available and the interventions follow recommendations to prevent yoga-associated adverse events (148, 149).

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