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Title:

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Date:

2021-08-01

Citation:

Gonzalez, M., Pascoe, M. C., Yang, G., de Manincor, M., Grant, S., Lacey, J., Firth, J. & Sarris, J. (2021). Yoga for depression and anxiety symptoms in people with cancer: A systematic review and meta-analysis. *Psycho Oncology*, 30 (8), pp.1196-1208. <https://doi.org/10.1002/pon.5671>.

Persistent Link:

<https://hdl.handle.net/11343/298380>

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Yoga for depression and anxiety symptoms in people with cancer: A systematic review and meta-analysis

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Word Count: 5,994

Tables/Figures: 1 Table, 2 Figures

Supplementary Material: 1

Keywords: Psycho-oncology, Anxiety, Cancer, Depression, Yoga, Survivorship, Supportive Cancer Care, integrative Oncology

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This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as doi: [10.1002/pon.5671](https://doi.org/10.1002/pon.5671).

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Abstract

Objective: Cancer and its treatment can lead to a variety of physical and emotional concerns impacting on those affected, including subclinical or clinical depression and anxiety, which in turn have a significant impact on wellbeing, quality of life and survival. The aim of this review was to evaluate the effect of yoga-based interventions on self-reported depression and anxiety symptoms in people with cancer in randomized controlled trials.

Method: Six databases were searched to identify relevant studies. Systematic review procedures were followed including a quality assessment. Meta-analysis of suitable studies was conducted.

Results: 26 studies from our search criteria were eligible for inclusion for depressive and 16 for anxiety symptoms. Meta-analyses revealed evidence for significant medium effects of yoga on depression symptoms (N=1,486, $g=-0.419$, 95% CI=-0.558 to -0.281, $p<0.001$) and anxiety (N=977, $g=-0.347$, 95% CI=-0.473 to -0.221, $p<0.001$) compared to controls. Subgroup analyses for depressive symptoms revealed significant effects for all analyses performed (type of cancer, type of control, treatment status, duration of intervention or frequency of yoga sessions), with effect sizes being comparable between subgroups. Similar findings were found for anxiety symptoms except for treatment status, where the only significant effect was found when yoga was delivered during active treatment.

Conclusions: This review provides evidence that in people with cancer, yoga-based interventions are associated with amelioration of depression and anxiety symptoms and therefore a promising therapeutic modality for their management. However, the potential for risk of bias together with control group design challenges means the results should be interpreted with caution.

Introduction

Cancer represents a major cause of illness, with a considerable social and economic impact on individuals, their families, and the community. The worldwide incidence and mortality of cancer is growing rapidly and was estimated to affect 18.1 million people and cause 9.6 million deaths in 2018.¹

Advances in cancer detection and treatment have improved net survival rates,² however, despite this increased survival people with cancer experience significant psychosocial effects both from the cancer itself and its treatment. In particular, mental health disorders such as anxiety and depression are prevalent, and occur more frequently in people who have been diagnosed with cancer compared with healthy controls.³ Several studies have investigated prevalence rates for these disorders. For example, a large Canadian study (N=10,153) that used a survey based on DSM-IV defined disorders found that 19% had clinical, and another 22.6% had subclinical, symptoms of anxiety, while 12.9% reported clinical and 16.5% subclinical symptoms of depression.⁴ Similarly, in a large German study (N=4,020) the 4-week prevalence rates for any mental disorder, anxiety and mood disorder were 32%, 12% and 7%, respectively.⁵ A meta-analysis of studies using only psychiatric interviews reported prevalence of any mood disorder of 38.2%, all types of depression (major, minor or dysthymia) 20.7% and anxiety 10.3%.⁶ These conditions can occur anytime from diagnosis through treatment and into survivorship, and in some cases persist for years following successful treatment, leaving survivors with long-term symptom-management needs.⁷⁻⁹ In addition, patient psychological distress is often undetected, with reports of accurate detection of clinical depression as 6% and 17% for clinical anxiety;¹⁰⁻¹² thus creating a high unmet need for psychological care in people with cancer.¹³ Therefore, developing and evaluating therapies that can alleviate and improve management of these symptoms is important for improving patient outcomes.

Yoga is increasingly recognized as a complementary approach for various cancer-related symptoms including depression and anxiety.¹⁴ Yoga originates from the ancient Vedic

tradition, emerging over 5,000 years ago.¹⁵ It is based on a holistic health system that incorporates mind, breath, body and relaxation as well as ethical and lifestyle factors.¹⁶ The techniques of yoga, known as the “eight limbs of yoga” include cultivation of social and personal values (yamas and niyamas); physical postures (asanas); conscious breathing exercises (pranayama); internal sensory awareness or interoception (pratyahara); and three stages of “meditation” - concentration, meditation, and absorption (dharana, dhyana, and samadhi).^{17, 18} Different types or styles of yoga have been developed based on various combinations of these components (such as Hatha, Restorative, Iyengar, Ashtanga).¹⁹ The mechanisms that allow for the potential therapeutic effects of yoga include biological (including neurophysiological), psychological (including emotional and cognitive), and behavioral correlates,²⁰⁻²² and the magnitude of these effects may depend on the type of yoga being studied.²³

Various studies have reported the prevalence of yoga use among people diagnosed with cancer. A large survey (N=17,639) conducted with individuals presenting to a US comprehensive cancer center found 8% had practiced yoga within the past 12 months.²⁴ Studies in Australian and Swedish populations found similar prevalence rates (7% and 6.9%, respectively).^{25, 26} Yoga may help reduce stress and anxiety, combat depression, improve sleep, and minimize side effects of treatment,²⁷ with patient reported outcomes including better coping with anxiety and uncertainties, improved mood/reduced depression and better stress management.²⁸⁻³¹

Establishing the effects of yoga for mental health in cancer is critical for appropriate supportive care and survivorship planning. Although systematic reviews and meta-analyses have been published in this area, their emphasis has been on the effects in breast cancer only;³²⁻³⁶ yoga was not the main component of the intervention (e.g. mindfulness-based stress reduction)^{35, 37, 38} or were conducted over 5 years ago and necessitating update due to data from more recent studies.^{37, 39} Therefore, we conducted this review to examine the effects of asana-based yoga interventions on self-reported depression and anxiety symptoms, across a number of cancers.

Methods

The PRISMA statement was followed to ensure comprehensive and transparent reporting of methods and results.⁴⁰ The protocol was developed in advance and registered on PROSPERO (Registration number: CRD42019139652).

Search strategy

We conducted an electronic search of the following databases: OVID MEDLINE Cochrane Central Register of Controlled Trials, Health Technology Assessment Database, Allied and Complementary Medicine (AMED), Embase, Health Management Information Consortium (HMIC) and PsycINFO, from inception to June 2020. The search terms can be found in

Supplementary Material 1. A Google Scholar search was conducted using the same key words to identify any additional articles and reference lists of retrieved articles were searched.

After removal of duplicates, one reviewer screened titles and abstracts of potentially eligible articles (MG). Full-text articles were assessed for eligibility by two independent reviewers (MG and GY).

Eligibility criteria

Studies were included if they: (1) were randomized controlled trials (RCTs) of asana-based yoga interventions; (2) were written in English; (3) included an adult sample (≥ 18 years old) with a diagnosis of any cancer (active treatment or post-treatment); (4) reported anxiety or depression symptoms using a validated self-report assessment tool. If there were multiple assessment time points, the time point of post-intervention was chosen. If the data necessary to calculate an effect size were not reported, attempts were made to obtain the data from the study authors by e-mail.

Non-randomized or non-controlled trials, case series, conference presentations, and dissertations were excluded. Studies were excluded if they did not provide the data needed to calculate an effect size or were duplicate studies.

Data extraction

The predetermined data extraction form included study characteristics (first author, year and country of publication), participant details (mean age, % female, cancer site), treatment status (active or pre/post-cancer treatment, or mixed), sample size, the comparison group (e.g. wait-list), intervention details (type of yoga, duration of intervention, duration of individual sessions, frequency of sessions), safety, adherence and depression/anxiety outcome data. One author (MG) extracted the data and a second author checked it (MP).

Statistical analyses

Analyses were performed in Comprehensive Meta-Analysis 3.0,⁴¹ with a random-effects model applied throughout to account for the expected heterogeneity between studies.⁴² Intervention effect sizes (differences between yoga and control groups) for depression and anxiety symptoms were calculated using Hedges's *g* statistic, along with 95% confidence intervals (CI) around the estimated effect size. In cases where more than one control group was employed, the outcome data was combined. In line with conventional interpretations, Hedges's *g* were classified as small (0.2–0.4), medium (0.4–0.8) and large (>0.8).⁴³

When the original studies reported no standard deviations, they were calculated from standard errors or CIs. The heterogeneity between studies was quantified using Cochran's *Q* and I^2 values, which estimate the amount of heterogeneity resulting from between-study variance, rather than by chance. Heterogeneity was categorized as low ($I^2=0-40\%$), moderate ($I^2=30-60\%$), substantial ($I^2=50-90\%$) and considerable ($I^2=75-100\%$).⁴³

Publication bias was examined using funnel plot analysis as well as Egger's regression test to yield the degree of funnel plot asymmetry. Additionally, a Duval and Tweedie's trim-and-fill analysis was used to estimate the effect size after imputing potentially missing studies. Finally, the number of articles required to dismiss the results of the meta-analysis was analyzed through a fail-safe *N* and estimating the number of non-significant unpublished trials which would be needed to cause the observed *p* value to exceed 0.05.

A range of exploratory post-hoc subgroup analyses were conducted in order to examine which factors may impact the effectiveness of yoga interventions, particularly with regard to control conditions (active vs inactive), sample details (cancer site, treatment status), and treatment characteristics (duration of intervention, number of classes per week).

Quality

Risk of bias was assessed independently by two researchers (MG and MP) using the Cochrane risk of bias tool⁴³ which assesses six aspects of trial methodology (sequence generation, allocation sequence concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, and selective outcome reporting) and any other bias that could potentially introduce different sources of bias. Under each domain, studies were classified as low, high or unclear risk of bias.

Results

Study Selection

The search of the electronic databases retrieved 658 citations. After removal of duplicate studies and exclusion during the title and abstract level review, 46 full texts remained. Following application of the eligibility criteria, 26 articles were eligible for inclusion.⁴⁴⁻⁶⁸ Reasons for exclusion of the other 21 articles is presented in **Supplementary Table 1**. A further article was identified from a Google Scholar search.⁶⁹ Details of the search results are summarized in **Figure 1**.

Characteristics of included studies

The detailed characteristics of the eligible studies are presented in **Table 1**. Across the 26 unique studies, there were 1,544 patients with cancer (mean age: 54.4 years; range: 44–68.7 years), from whom 782 were allocated to yoga interventions. The majority of participants were female (86.1%). The studies were published between 2004 and 2020 and were conducted in the United States (N=14), India (N=3), Germany (N=4), Canada (N=2), Netherlands (N=1) and Turkey (N=2). Sample sizes ranged from 19 to 184 participants per study.

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Eighteen studies were conducted in participants diagnosed with breast cancer (the study by Culos-Reed et al was primarily in breast and therefore included in this group),^{45, 47, 49-53, 56-59, 62-68} two studies in mixed cancers,^{46, 69} and one study each in the following cancers: colorectal,⁵⁵ lymphoma,⁵⁴ thoracic,⁶¹ head and neck,⁴⁴ myeloproliferative neoplasms⁴⁸ and glioma.⁶⁰

Participants in eight studies had completed conventional cancer treatment (e.g. surgery, chemotherapy, radiation),^{44, 45, 52, 56-58, 65, 68} participants in twelve studies were undergoing treatment at the start of the study,^{47, 50, 51, 53, 59-64, 66, 67} and participants in six studies were at various stages of cancer treatment.^{46, 48, 49, 54, 55, 69}

Intervention characteristics

Eleven of the included studies used interventions based on Hatha yoga.^{44-46, 48, 55-58, 62, 63, 69} Remaining studies used a variety of yoga styles: Integrated,^{51, 64, 66} Vivekananda,^{53, 60, 61, 67} Classical,⁶⁸ Bali,⁴⁷, Dru,⁵⁹ Integral,⁵⁰ Iyengar,⁵² Restorative,^{49, 65} and Tibetan.⁵⁴

All but one study included one control group with Chandwani and colleagues⁶⁷ including two control groups, one active (stretching) and one inactive (wait-list). Nineteen studies compared yoga versus no specific therapy.^{44-49, 53-61, 63, 65, 67, 69} Six studies compared yoga versus psychosocial or educational interventions (brief supportive therapy, supportive counselling, social support group, wellness/health education).^{50-52, 62, 64, 66} Two studies compared yoga versus physical activity (exercise or stretching).^{67, 68}

Yoga programs were on average 9.3 weeks long (range: 6–24 weeks) with 1–≥3 sessions per week of 45–120 minutes in duration. One study did not report class duration.⁵⁴ Nineteen studies also encouraged additional home-based yoga practice in addition to in-person sessions.^{44, 46, 47, 50, 51, 53-64, 66, 67}

Meta-analysis results

Twenty-six studies reported outcome measures for depression symptoms (see **Table 1**). A random-effects meta-analysis revealed a significant medium effect size in favor of yoga interventions for reducing depression symptoms in comparison to control conditions (N=

1,544, $g=-0.553$, 95% CI=-0.781 to -0.325, $p<0.001$). Considerable heterogeneity was present in the comparison between yoga and control groups ($Q=109.294$, $p < 0.001$, $I^2=77.13\%$). Visual inspection of the individual effects revealed one possible outlier⁵¹ with a particularly strong effect, but low study weighting to the overall analysis. This study was removed in a sensitivity analysis, and the resulting effect size remained significant and the effect size in the small-medium range ($N=1,486$, $g=-0.419$, 95% CI=-0.558 to -0.281, $p<0.001$) (**Figure 2a**), however the heterogeneity was greatly reduced but still significant ($Q=38.04$, $p=0.034$, $I^2=36.91\%$). Egger's regression test indicated no evidence of publication bias ($p=0.15$), and the fail-safe N was 353. Trim and fill analysis identified no outlier studies and thus did not change the observed effect size.

Sixteen studies studied anxiety symptoms as an outcome measure, with a variety of assessment scales being used (see **Table 1**). Meta-analysis revealed a significant medium effect size in favor of yoga interventions for reducing anxiety symptoms in comparison to control conditions ($N=1,035$, $g=-0.554$, 95% CI=-0.878 to -0.231, $p=0.001$), with considerable heterogeneity ($Q=92.79$, $p<0.001$, $I^2=83.84\%$). Similar to the results for depression, a very large effect size was revealed in Banerjee et al.⁵¹ However, after removing this study in a sensitivity analysis, the overall effect remained robust ($N=977$, $g=-0.347$, 95% CI=-0.473 to -0.221, $p<0.001$) (**Figure 2b**), with no heterogeneity present in the comparison between yoga and control groups ($Q=13.8$, $p=0.465$, $I^2=0\%$). There was no evidence of publication bias (Egger's regression test $p=0.41$), and the fail-safe N was 94. Trim and fill analysis identified no outlier studies and thus did not change the observed effect size.

Intervention characteristics and effects on depression and anxiety symptoms

Due to the large effect of the Banerjee et al⁵¹ study, it was not included in the following subgroup analyses.

Subgroup analyses for depressive symptoms

The majority of studies were conducted in the breast cancer population limiting the ability to perform a meaningful subgroup analysis between different cancer patient population groups. We observed however a significant moderate reduction in depressive symptoms in breast cancer patients ($N=17$; $g=-0.413$, 95% CI=-0.590 to -0.236, $p<0.001$), which was comparable

to the overall effect size when all studies were included. Similarly, subgroup analyses based on location of study were precluded by the small number of studies in some locations, however we did not observe any pronounced differences in effect sizes amongst studies in different countries.

Studies using active (N=7; e.g. supportive counselling, wellness education, stretching) and inactive control interventions (N=19; e.g. wait-list, usual care) had a significant, medium to small effect size post-intervention (active: $g=-0.468$, 95% CI=-0.751 to -0.185, $p=0.001$; inactive: $g=-0.390$, 95% CI=-0.562 to -0.218, $p<0.001$).

Studies were pooled into groups reporting on the effects of yoga while receiving cancer treatment (N=11), following treatment (N=8), or mixed treatment status (N=6). Yoga interventions provided a medium reduction in depressive symptoms in all subgroups (either receiving or finished active treatment: $g=-0.519$, 95% CI=-0.788 to -0.250, $p<0.001$; only receiving treatment: $g=-0.384$, 95% CI=-0.572 to -0.196, $p<0.001$; following treatment: $g=-0.428$, 95% CI=-0.740 to -0.177, $p=0.007$).

We grouped studies into those less than 10 weeks, and 10 weeks and over. Ten weeks was chosen as the average intervention duration across all studies was 9.4 weeks. Both resulted in significant and similar effects (<10 weeks: N=14, $g=-0.442$, 95% CI=-0.624 to -0.260, $p<0.001$; ≥ 10 weeks: N=11, $g=-0.395$, 95% CI=-0.615 to -0.176, $p<0.001$). Similarly, significant effects were found where grouped by class frequency (1 class per week: N=15, $g=-0.514$, 95% CI=-0.699 to -0.329, $p<0.001$; ≥ 2 classes per week: N=10, $g=-0.284$, 95% CI=-0.459 to -0.109, $p=0.001$).

Subgroup analyses for anxiety symptoms

Regarding the effects of yoga interventions in participants with breast cancer, a similar effect was observed as that for the overall effect size when all cancer types were included (N=10, $g=-0.365$, 95% CI=-0.511 to -0.219, $p<0.001$). Similar to the observations for depression symptoms and location of study, we did not observe any marked differences in effect sizes.

Analysis of the subgroup of studies employing active controls (N=3) revealed a significant, medium effect size post-intervention ($g=-0.441$, 95% CI=-0.703 to -0.179, $p=0.001$), whereas

studies using a no-intervention control group (N=12) showed a weaker but still significant effect size ($g=-0.323$, 95% CI=-0.476 to -0.221, $p<0.001$).

During cancer treatment, a medium effect was observed on anxiety symptoms (N=7, $g=-0.508$, 95% CI=-0.690 to -0.326, $p<0.001$). There was no significant effect in participants who had completed cancer treatment (N=4, $g=-0.164$, 95% CI=-0.391 to -0.063, $p=0.157$) or in the mixed treatment status group (N=4, $g=-0.234$, 95% CI=-0.545 to -0.077, $p=0.141$).

Yoga programs less than 10 weeks in duration yielded significant overall reductions in anxiety symptoms (N=8, $g=-0.394$, 95% CI=-0.595 to -0.192, $p<0.001$), as did those ≥ 10 weeks (N=7, $g=-0.301$, 95% CI=-0.473 to -0.129, $p=0.001$). Similar effects were found with once-per-week yoga classes (N=10, $g=-0.340$, 95% CI=-0.513 to -0.168, $p<0.001$) as with ≥ 2 classes per week (N=5, $g=-0.392$, 95% CI=-0.623 to -0.162, $p=0.001$).

Risk of bias

Risk of bias for each study is shown in **Supplementary Figure 1**. Overall, no studies had a low risk of bias across all domains. Fifteen studies were assessed as having a high risk of bias for at least one domain.^{44, 47, 48, 50, 51, 55, 56, 58-60, 65-69} Sixteen studies were at low risk of bias for allocation concealment,^{44, 47, 48, 51, 52, 54-57, 59, 61, 62, 64-67} one high risk⁶⁸ and the remaining nine unclear.^{45, 46, 49, 50, 53, 58, 60, 63, 69} Twenty studies rated low risk of bias for random sequence generation,^{44, 47, 48, 51-62, 64-67} one high risk⁶⁸ and five unclear risk.^{45, 46, 49, 50, 63} Nineteen studies rated unclear for risk of bias relating to detection bias (blinding of outcome measurement),^{44-47, 49, 51, 53, 54, 56, 59-61, 63-69} two studies had a high risk of detection bias,^{50, 55} and five rated low risk.^{48, 52, 57, 58, 62} Seven studies rated high risk for performance bias (blinding of participants and personnel),^{47, 48, 50, 55, 56, 58, 67} with eighteen studies rating unclear^{44-46, 49-51, 53, 54, 57, 59-66, 68, 69} and one having a low risk of performance bias.⁵² Twenty-one studies were at unclear risk of bias for reporting bias,^{44-54, 58, 60-68} four low risk^{55-57, 59} and one high risk.⁶⁹ Seventeen studies rated low risk of attrition bias (incomplete outcome data),^{45, 47-50, 52-57, 60-64, 67} four rated unclear risk^{46, 59, 68, 69} and five were at high risk.^{44, 51, 58, 65, 66} Fourteen studies were rated low risk of other bias,^{44, 47-49, 52-54, 56, 61-65, 67} seven had an unclear risk,^{45, 46, 51, 57, 66, 68, 69} and five were high risk.^{50, 55, 59, 60, 70}

Adherence

Yoga class attendance was reported in 21 studies, though the unit of measurement was inconsistent between studies. Three studies reported the percentage of participants who attended all classes, which ranged from 32%⁵⁴ to 50%.^{53, 59} Other studies reported the average number of classes attended by participants. The lowest attendance was an average of 5.3 out of 10 classes,⁵⁵ and the highest 10.6 of 12 classes.⁶⁰ Eyigor et al⁵⁸ reported only the highest rate of attendance, that being 95.45%. The intervention used in Huberty et al⁴⁸ consisted of pre-recorded yoga videos delivered online, and found the average weekly participation was 40.8 min/week when analyzed using web analytics (the required weekly amount being 60 min/week). Two studies reported attendance as the percentage of classes attended over a certain number: participants in the Pruthi et al⁶³ study, attended 87% of the 3 individual and 40% attended ≥ 5 of 8 of the group classes. In the Chandwani et al⁶⁷ study 87% attended ≥ 12 of 18 classes. Rao et al⁶⁴ reported the number of participants who practiced at different levels, the highest being “regularly” (defined as ≥ 6 times per week). Most participants at the various stages of conventional treatment (post-surgery: 79%; during radiotherapy: 91%; during chemotherapy: 43%) practiced at this level. Lastly, Adair et al⁴⁴ reported that the median percent compliance per participant was 100% for supervised sessions and 97.2% for home sessions. Associations between intervention adherence and treatment efficacy were mentioned in four studies. Of these, two studies found that regularity of practice was linked to significant reductions in depressive symptoms,^{56, 64} while the other two did not find an effect.^{49, 55}

Safety

Eleven of the 26 RCTs reported safety-related data: seven reported no adverse events,^{44, 47-49, 61, 62, 69} two reported no serious adverse events but some minor adverse events including transient abdominal pain, neck and hip pain and muscle soreness.^{55, 56} Bower et al⁵² reported a back spasm in a participant with a history of back problems. The remaining study⁵⁹ stated that 81% of participants reported adverse events, although all of these were assessed as likely being associated with the cancer or its treatment as opposed to the yoga, and a similar percentage (80%) of participants in the control group also reported adverse events.

Discussion

This systematic review and meta-analysis examined yoga as an intervention to reduce depression and anxiety symptoms in people with cancer. These were found to have a statistically significant small to moderate effect on reducing self-reported depression and anxiety symptoms, and the effect maintained even after an outlier and was removed following sensitivity analyses.

Only minor adverse events were reported however safety of the interventions was stated in less than half of the included studies. This is in agreement with previous reviews of adverse events associated with yoga practice, where most events are mild and transient.^{19, 71} Nevertheless, an adequate reporting of safety data in future yoga trials in cancer populations is crucial in order to better evaluate its safety. This is important, as the presence of pre-existing medical conditions or illnesses has been found to increase the risk of adverse events in yoga-based interventions, although using a yoga style that is tailored to the needs and circumstances of the individual (also known as viniyoga) appears to decrease this risk.¹⁹

Studies varied in their reporting of participant adherence to the yoga interventions and its effects on treatment efficacy. Of the studies that reported the percentage of participants who attended all classes, the range was a modest 32–50%. Interestingly, conducting the intervention online (which may be thought to encourage greater adherence) resulted in only 15% of participants averaging the required 60-minute weekly yoga prescription, as measured by a web analytics program, though participants still averaged almost 41 minutes per week of practice.⁴⁸ Regarding the influence of adherence on outcomes, only a handful of studies stated findings. Of those that did, results were mixed, with some finding an effect^{56, 64} while others did not.^{49, 55} Further data is needed to elucidate which factors maximize adherence and how regularity of practice influences the effect of yoga on depression and anxiety outcomes.

The findings of this review broadly align with previous similar systematic reviews and meta-analyses that have found significant effects for depression and anxiety symptoms in breast^{33, 36} and mixed cancers.³⁹ Another study by Zhang et al³² found no effects of yoga-based

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interventions on depression or anxiety symptoms, however the analysis was based on two studies only, for both depression and anxiety outcomes. Strengths of this present study comprise the inclusion of newly published clinical trials in a variety of cancers and performing a number of novel subgroup analyses compared to previous reviews.

We explored a number of factors which may drive the effects of yoga interventions using a range of post-hoc subgroup analyses. No substantial differences were seen between any of the subgroups for depressive symptoms. Similarly, effects were not largely different for anxiety symptoms for type of control, cancer site or program duration. However, a large significant effect was observed when yoga was applied during cancer treatment, while studies in participants who had completed treatment or had a mixed treatment status, failed to demonstrate a significant effect. This finding suggests differences in baseline anxiety symptoms or differences in the delivery or components of the yoga intervention.

Regarding control types, our results differ from those reported by Cramer et al³³ who found significant decreases in self-reported depressive and anxiety symptoms when yoga was compared to active controls but not inactive ones. Though their groups included only 2–4 studies in each subgroup and included the study by Banerjee et al,⁵¹ which showed an unusually large effect size, potentially impacting on this observed outcome. Similarly, a 2017 Cochrane review³⁴ found significant effects only when yoga was compared to psychosocial or educational interventions (not when compared to no intervention), although studies included yoga-based interventions both with and without asana practice (one study for anxiety included relaxation only). While we found significant results for both groups, our results revealed a similar trend to these earlier reviews, with effect sizes when yoga was compared to active controls being slightly larger than those employing inactive controls (for both depression and anxiety symptoms). Possible explanations for this include the nature of the controls, either not being tailored to addressing depression or anxiety symptoms specifically or resulting in higher attrition and lower adherence (due to disappointment of not being randomized to the yoga group); and/or not controlling for time and attention. Indeed, the subject of control group design for yoga studies is a challenging one given the multifaceted nature of yoga, and the need for careful design of comparison conditions has been previously emphasized.^{72, 73}

All studies included here had inevitable limitations and several avenues for future research are evident. First, despite the significant effects of yoga-based interventions on self-reported depressive and anxiety symptoms, no studies investigated the impact of yoga-based interventions in clinical populations of cancer survivors (i.e. individuals diagnosed with major depressive disorder or an anxiety disorder such as generalized anxiety disorder) or those with elevated symptoms at baseline as an inclusion criteria. This has been identified as important in psychological and pharmacological studies,^{74, 75} as stronger effect sizes have been observed for each of these treatment modalities when symptom severity is higher at baseline.^{76, 77} Hence future studies should include participants who meet clinical criteria to allow for greater improvement in symptoms. This would allow for greater statistical power to detect intervention effects as well as making findings generalizable to those with clinically significant symptomatology; and thus generate findings of greater relevance to clinical practice. Furthermore, depression and anxiety symptoms were not commonly the focus of the included RCTs, with only 3 of the 26 included studies primarily aimed at alleviating psychological symptoms. Therefore yoga interventions may not have been tailored to address these symptoms. Second, we found an overrepresentation of studies in women with breast cancer, with 18 of the 26 included studies (69.2%) in this population, thus future studies should examine the use of yoga in a variety of cancers, as well as examining gender-specific responses. Third, we observed an unclear or high risk of bias in almost all of the included studies with respect to blinding (both detection and performance bias). It is generally considered difficult and impractical to reduce the risk of performance bias in trials of behavioral studies such as yoga, and this is likely to introduce non-specific effects. As a variety of yoga styles exist and positive effects are often found for different types,⁷⁸ future, larger studies powered to assess such differences could compare different types and forms of yoga (e.g. group classes versus individual sessions, duration and frequency of sessions). This would control for intervention effects while also gaining new insights into which styles and doses of yoga may be most beneficial for mental health in cancer patients and survivors. In addition, given this study focused on immediate effects, future studies should investigate the long-term effects of yoga-based interventions in this population. Fourth, while adherence in some of the interventions was high, a number of studies reported a relatively low rate of attendance to yoga sessions. Given the substantial physical and psychological sequelae experienced by

people diagnosed with cancer as well as a need to develop interventions that are widely accessible, there is unique potential in using novel delivery methods such as online yoga classes (or “TeleYoga”) which may provide convenience and increased participation, however further research is required to determine the optimal delivery methods to increase adherence.

Clinical implications

Yoga-based interventions may be a valuable tool to alleviate depression and anxiety symptoms in people with cancer and thus important for supportive cancer care and survivorship planning. More high-quality RCTs are needed to assess the effectiveness of this therapeutic modality.

Limitations

This review provides a thorough synthesis and compilation of data currently available for the treatment of affective symptoms in people with cancer. However, a number of limitations were present. Firstly, included studies were limited to those in English and asana-based yoga interventions (studies investigating for example meditation or breathing techniques only were not included), potentially biasing our results. Secondly, publication bias, resulting in studies with positive findings being more likely to be published, is always a risk when conducting meta-analyses. A further limitation was the inability to perform subgroup analyses across a variety of cancers - due to the majority of studies being in breast cancer - thus restricting the ability to establish the generalizability of the intervention across different cancer types.

In summary, our findings show potential beneficial effects of yoga on depression and anxiety symptoms in people with cancer. More work is needed to better understand what aspects of these interventions are most effective across different cancer diagnoses and time points in the treatment and survivorship journeys.

Acknowledgements

We thank Drs Derry and Pruthi for providing the data for inclusion in the meta-analysis. Jerome Sarris is supported by an NHMRC Clinical Research Fellowship (APP112500).

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Conflict of interest statement

MdM is a practicing psychologist and yoga therapist, Director of a yoga teacher training center, and Director of a charity that provides yoga to the underserved.

Ethics approval

Ethical approval was not required for this systematic review.

Data availability statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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Figures and tables

Figure 1. PRISMA flowchart of study selection.

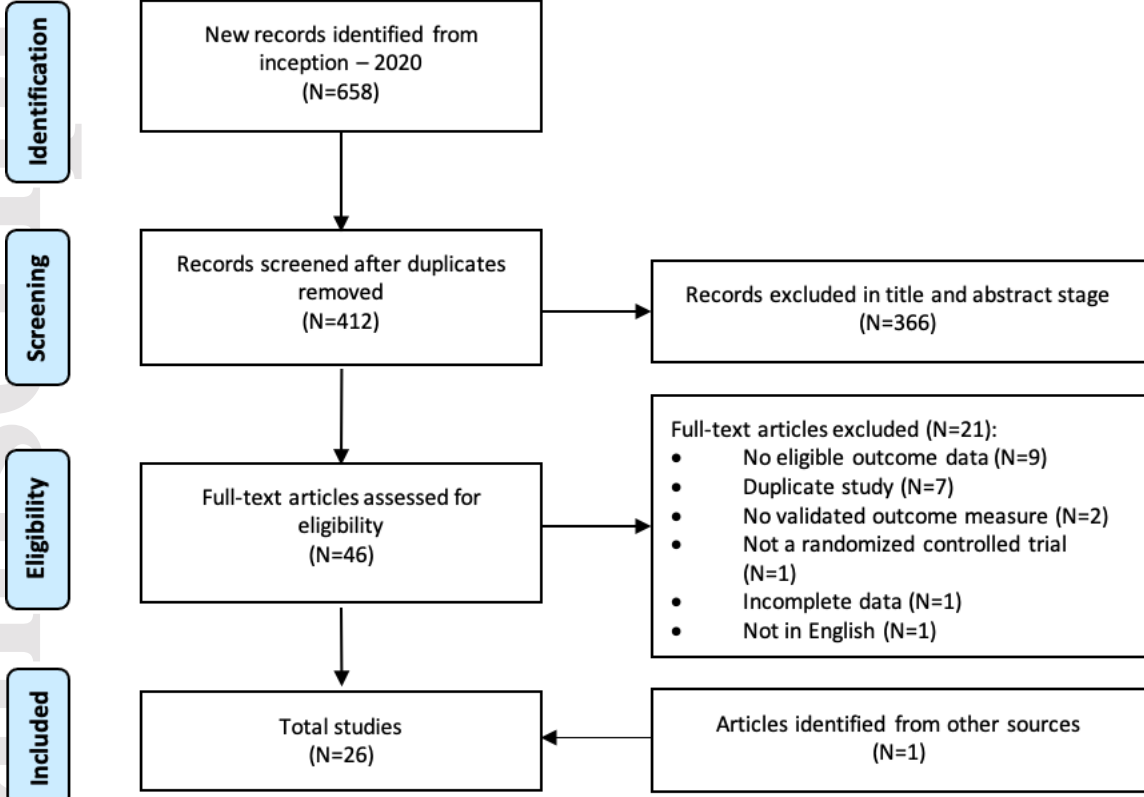
Table 1. Details of included studies.

Study	Sample size (yoga/control)	Dosage of yoga-based intervention	Cancer site	Yoga type	Outcome measures	Mean age	% Female	Control type/Dosage of control intervention	Treatment status (undergoing or finished treatment)
Adair et al 2018 ⁴⁴	15/20	Tailored yoga sessions 3x per week for 4 weeks then 2x per week for 4 weeks, 30–90 min, 8 weeks	Head and neck	Hatha	HADS	63	37.1	Wait-list	Post-treatment
Banerjee et al 2007 ⁵¹	35/23	90 min, 6 weeks	Breast	Integrated	HADS	44	100	Supportive counselling (dosage not stated)	Undergoing treatment
Bower et al 2012 ⁵²	16/15	90 min 2x per week, 12 weeks	Breast	Iyengar	BDI-II	54	100	Health education (120 min per week, 12 weeks)	Post-treatment
Chandwani et al 2010 ⁵³	30/31	60 min up to 2x per week, 6 weeks	Breast	Vivekananda	CES-D, STAI state	52.7	100	Wait-list	Undergoing treatment
Chandwani et al 2014 ⁶⁷	53/56/54	60 min ≤ 3x per week, 6 weeks	Breast	Vivekananda	CES-D	52	100	Stretching (≤ 3x per week, 6 weeks); Wait-list	Undergoing treatment
Cramer et al 2015 ⁵⁶	19/21	90 min 1x per week, 12 weeks	Breast	Hatha	HADS	49	100	Usual care	Post-treatment
Cramer et al 2016 ⁵⁵	27/27	90 min 1x per week, 10 weeks	Colorectal	Hatha	HADS	68	39	Wait-list	Mixed active and pre/post-treatment
Cohen et al 2004 ⁵⁴	16/14	1 weekly class, 7 weeks	Lymphoma	Tibetan	STAI state, CES-D	51	30.8	Wait-list	Mixed active and pre/post-treatment
Culos-Reed et al 2006 ⁴⁵	18/18	75 min 1x per week, 7 weeks	Breast, other	Yoga therapy (based on Hatha)	POMS	51	95	Wait-list	Post-treatment
Danhauer et al 2009 ⁴⁹	13/14	75 min 1x per week, 10 weeks	Breast	Restorative	CES-D	56	100	Wait-list	Mixed active and pre/post-treatment
Danhauer et al 2015 ⁵⁰	18/14	75 min 1x per week, 10 weeks	Breast	Integral	CES-D	48	100	Wellness education (75 min 1x per week, 10 weeks)	Undergoing treatment
Derry et al 2015 ⁵⁷	94/90	90 min 2x per week, 12 weeks	Breast	Hatha	BAI, CES-D	52	100	Wait-list	Post-treatment
Eyigor et al 2018 ⁵⁸	22/14	60 min 2x per week, 10 weeks	Breast	Hatha	BDI	52	100	Usual care	Post-treatment
Jong et al 2018 ⁵⁹	40/29	75 min 1x per week, 12 weeks	Breast	Dru	HADS	51	100	Standard care	Undergoing treatment
Haradoerfer et al 2018 ⁴⁶	32/32	60 min 1x per week, 8 weeks	Breast, lymphoma/leukemia, colorectal, brain, gynecological, prostate, melanoma, other	Hatha	GAD-7, PHQ-2	58	89	Wait-list	Mixed active and pre/post-treatment
Huberty et al 2019 ⁴⁸	27/21	60 min 1x per week, 12 weeks	Myeloproliferative neoplasm	Hatha and Vinyasa	Emotional Distress-Depression/Anxiety Short Form 8a	57	93.8	Wait-list	Mixed active and pre/post-treatment

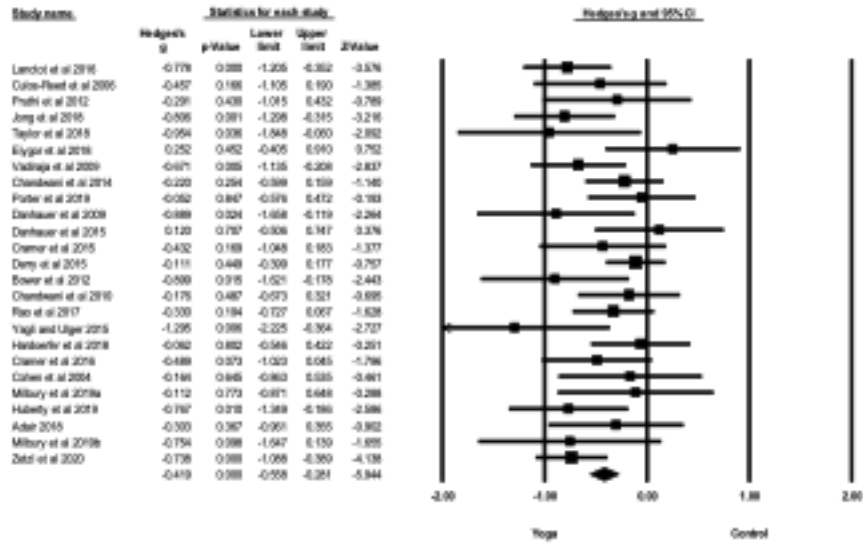
Lanctot et al 2016⁴⁷	54/38	90 min 1x per week, 8 weeks	Breast	Bali	STAI, BDI-II	51	100	Wait-list	Undergoing treatment
Milbury et al 2019a⁶¹	12/13	60 min 2–3x per week (15 total), 6 weeks	Thoracic	Vivekananda	CES-D	67	38	Wait-list	Undergoing treatment
Milbury et al 2019b⁶⁰	9/10	45 min 2–3 weekly (12 total), 6 weeks	Glioma	Vivekananda	CES-D	46.3	50	Wait-list	Undergoing treatment
Porter et al 2019⁶²	43/20	120 min 1x per week, 8 weeks	Breast	Mindful yoga (based on Hatha)	HADS	57	100	Social support group (120 min 1x per week, 8 weeks)	Undergoing treatment
Pruthi et al 2012⁶³	14/14	60 min 3x individual sessions, 4 weeks and 60 min 1x per week classes, 8 weeks (12 weeks total)	Breast	Gentle and Hatha	POMS-SF	57	100	Usual care	Undergoing treatment
Taylor et al 2018⁶⁵	9/11	75 min 1x per week, 8 weeks	Breast	Restorative	CES-D	54	100	Wait-list	Post-treatment
Rao et al 2017⁶⁴	45/53	60 min 4 sessions during pre-postoperative period, 3x per week x6 weeks during radiotherapy, 1x in 21 days during chemotherapy, 1x per week during chemotherapy 24 weeks	Breast	Integrated	STAI state and trait, BDI	49	100	Supportive counselling (1x 60 min, 15 min sessions 1x per 10 days, 6 weeks)	Undergoing treatment
Vadiraja et al., 2009⁶⁶	42/33	60 min at least 3x session per week, 6 weeks	Breast	Integrated	HADS	46	100	Brief supportive therapy (15 min sessions 1x per 10 days, 6 weeks)	Undergoing treatment
Yagli and Ulger 2015⁶⁸	10/10	60 min 1x per week, 8 weeks	Breast	Classical	BDI	68.7	100	Exercise (60 min 1x per week, 8 weeks)	Post-treatment
Zetzi et al 2020⁶⁹	69/64	60 min 1x per week, 8 weeks	Breast, prostate, gastrointestinal, lung, lymphoma, gynecological, head and neck, central nervous system, skin cancer, other	Hatha	PHQ-9	60.4	69.8	Wait-list	Mixed active and pre/post-treatment

Notes: BAI – Beck Anxiety Inventory, BDI– Beck Depression Inventory, BDI-II – Beck Depression Inventory II, CES-D – Center for Epidemiological Studies – Depression, GAD-7 – Generalized Anxiety Disorder-7, HADS – Hospital Anxiety Depression Scale, Patient Health Questionnaire-2 – PHQ-2, Patient Health Questionnaire-9 – PHQ-9, POMS – Profile of Mood States, State Trait Anxiety Inventory – STAI. Control groups with dosages are active controls; those without are inactive.

Figure 2. Forest plot for the effects of yoga interventions on (a) depression and (b) anxiety symptoms. Box size represents study weighting. Diamond represents overall effect size and 95% confidence intervals.



(a)



(b)

