

# Yoga for Symptom Management in Oncology: A Review of the Evidence Base and Future Directions for Research

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Because yoga is increasingly recognized as a complementary approach to cancer symptom management, patients/survivors and providers need to understand its potential benefits and limitations both during and after treatment. The authors reviewed randomized controlled trials (RCTs) of yoga conducted at these points in the cancer continuum (N = 29; n = 13 during treatment, n = 12 post-treatment, and n = 4 with mixed samples). Findings both during and after treatment demonstrated the efficacy of yoga to improve overall quality of life (QOL), with improvement in subdomains of QOL varying across studies. Fatigue was the most commonly measured outcome, and most RCTs conducted during or after cancer treatment reported improvements in fatigue. Results also suggested that yoga can improve stress/distress during treatment and post-treatment disturbances in sleep and cognition. Several RCTs provided evidence that yoga may improve biomarkers of stress, inflammation, and immune function. Outcomes with limited or mixed findings (eg, anxiety, depression, pain, cancer-specific symptoms, such as lymphedema) and positive psychological outcomes (such as benefit-finding and life satisfaction) warrant further study. Important future directions for yoga research in oncology include: enrolling participants with cancer types other than breast, standardizing self-report assessments, increasing the use of active control groups and objective measures, and addressing the heterogeneity of yoga interventions, which vary in type, key components (movement, meditation, breathing), dose, and delivery mode. *Cancer* 2019;0:1-11. © 2019 American Cancer Society.

**KEYWORDS:** anxiety, cancer, depression, fatigue, mind-body, quality of life, sleep, symptoms, yoga.

## INTRODUCTION

Cancer is one of the most common causes of morbidity and mortality, with approximately 14 million new cases and nearly 9 million cancer deaths annually worldwide.<sup>1</sup> Psychosocial and biomedical sequelae of cancer and its treatment include psychological distress (eg, depression, anxiety, fear of recurrence), fatigue, sleep disturbance, pain, nausea/vomiting, cognitive difficulties, immunosuppression, and cardiotoxicity.<sup>2-6</sup> This symptom burden is greater in adults with cancer than in patients without cancer and is associated with decreased functioning, increased disability, and poor quality of life (QOL).<sup>2,4,7-9</sup> In some patients, cancer-related sequelae resolve; however, persistent and late effects leave many survivors with long-term symptom-management needs.<sup>3,10-13</sup>

Yoga is increasingly recognized as a complementary approach to diminishing the onset and severity of cancer-related symptoms and/or treating such symptoms (Fig. 1).<sup>14</sup> Research has demonstrated the feasibility and acceptability of yoga among patients with cancer who are undergoing treatment and those who have transitioned out of the medical setting.<sup>15-17</sup> Most National Cancer Institute-designated comprehensive cancer centers now include information about yoga on their websites (87%) and offer on-site yoga instruction (69%).<sup>18</sup> A population-based study of adults in the United States indicated that approximately 10% of cancer survivors have ever tried yoga, and 5.5% have tried it in the past year.<sup>19</sup> Reasons for use of yoga among cancer survivors include: relaxation; coping with cancer-related distress; taking an active, positive role in their cancer recovery; managing noncancer conditions (eg, cardiovascular disease, arthritis); and increasing energy, physical activity, immunity, and overall wellness.<sup>20-22</sup>

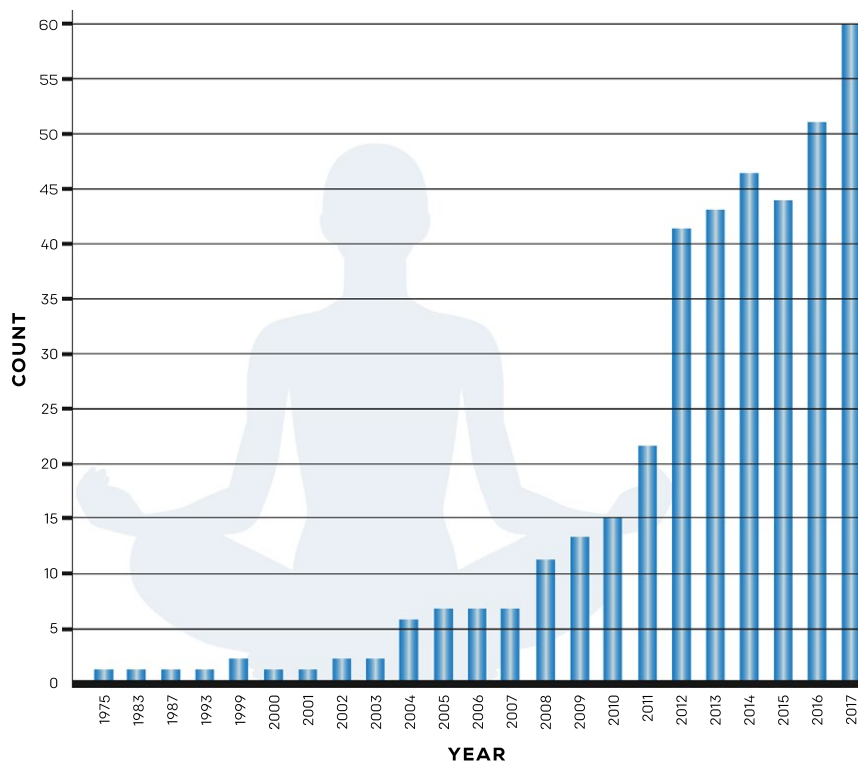
Cancer survivors turn to complementary therapies like yoga to enhance recovery and wellness and are particularly likely to approach yoga as a complementary option based on recommendations from health care providers.<sup>19</sup> Therefore, establishing the efficacy of yoga for cancer symptom management is critical for appropriate supportive cancer care and

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**Figure 1.** The number of yoga research reports over time is illustrated. The count per year includes the total number of peer-reviewed articles with “yoga and cancer” as the search terms regardless of study design (ie, including both nonrandomized and randomized controlled trials).

survivorship planning. Patients/survivors and providers need to understand the potential benefits and limitations of yoga at each point in the cancer continuum from diagnosis through long-term survivorship. Thus, the current review examines evidence for use of yoga both *during* and *after* cancer treatment.

## METHODS

We searched the CINAHL (Cumulative Index of Nursing and Allied Health), MEDLINE, PsycINFO, and PubMed databases using the terms yoga, cancer, and related Medical Subject Headings (eg, neoplasm). We ascertained additional reports from reference lists of identified articles. Inclusion criteria were: 1) randomized controlled trials (RCTs) of yoga, including yoga postures or breathing techniques; 2) a sample that included adults with current/past cancer, regardless of treatment status; and 3) published quantitative results from peer-reviewed journals in English through December 2017. Trials were excluded if they: 1) delivered meditation only, 2) taught yoga as part of a multimodal program (eg, mindfulness-based stress reduction), or 3) were designed primarily to evaluate feasibility and/or acceptability.

## RESULTS

### *Study Characteristics*

We identified 29 RCTs (see Table 1<sup>23-69</sup>): 13 RCTs were conducted during treatment (23 publications), 12 were conducted after treatment was completed (20 publications), and 4 included participants both during and after treatment. Only 4 studies included an active comparison group, such as supportive counseling, stretching, or a physical-activity control group, and the others used a waitlist method or a usual-care control group. Samples predominantly included women with breast cancer. Of 13 RCTs that were conducted during treatment, all but 1 were in women with breast cancer, with 5 were conducted during radiotherapy only, 5 were during chemotherapy only, and 3 were conducted across both radiotherapy and chemotherapy.

Yoga interventions varied considerably in the components taught. With the exception of a single study focused only on yogic breathing,<sup>40</sup> most studies conducted during treatment involved multicomponent protocols (ie, movement/postures, breathing, and meditation) based on several different yoga types (Anusara, Eischens, Iyengar, Tibetan, and Yoga in Daily Life

**TABLE 1.** Study Characteristics

Study	Publication	No. <sup>a</sup>	Cancer Type(s) (Stages)	Cancer Treatment(s)	Control(s)
<b>During treatment</b>					
1	Banerjee 2007 <sup>23</sup>	68	Breast (II-III)	C, R	SC
2	Rao 2017, <sup>24</sup> Raghavendra 2007, <sup>25</sup> Rao 2008, <sup>26,27</sup> 2009, <sup>28</sup> 2015 <sup>29</sup>	98	Breast (II-III)	C, R, S	SC
3	Vadiraja 2009 <sup>30-32</sup>	88	Breast (I-III)	R	SC
4	Chandwani 2010 <sup>33</sup>	61	Breast (0-III)	R	WL
5	Kovacic & Kovacic 2011, <sup>34,35</sup> Kovacic 2013 <sup>36</sup>	32	Breast (I-II)	C, R, S	UC
6	Chandwani 2014, <sup>37</sup> Ratcliff 2016 <sup>38</sup>	163	Breast (0-III)	R	ST, WL
7	Taso 2014 <sup>39</sup>	60	Breast (I-III)	C	UC
8	Chakrabarty 2015 <sup>40</sup>	160	Breast (I-III)	R	UC
9	Lanctot 2016 <sup>41</sup>	101	Breast (I-III)	C	WL
10	Lotzke 2016 <sup>42</sup>	92	Breast (I-III)	C	PE
11	Anestin 2017 <sup>43</sup>	82	Breast (I-III)	C	WL
12	Ben Josef 2017 <sup>44</sup>	68	Prostate (I-II)	R	UC
13	Chaoul 2018 <sup>45</sup>	227	Breast (I-III)	C	ST, UC
<b>Post-treatment</b>					
14	Culos-Reed 2006 <sup>46</sup>	38	Mixed (I-III)		WL
15	Carson 2009 <sup>47</sup>	37	Breast (I-II)		WL
16	Banasik 2011 <sup>48</sup>	18	Breast (II-IV)		WL
17	Littman 2012 <sup>49</sup>	63	Breast (0-III)		WL
18	Bower 2012, <sup>50</sup> 2014 <sup>51</sup>	31	Breast (0-II)		HE
19	Mustian 2013 <sup>52</sup>	410	Mixed (0-IV)		WL
20	Peppone 2015 <sup>53 b</sup>	167	Breast (0-III)		WL
21	Sprod 2015 <sup>54 b</sup>	97	Mixed (0-IV)		WL
22	Janelins 2016 <sup>55 b</sup>	328	Mixed (0-IV)		WL
23	Kiecolt-Glaser 2014, <sup>56</sup> Derry 2015 <sup>57</sup>	200	Breast (0-IIIa)		WL
24	Loudon 2014, <sup>58</sup> 2016 <sup>59</sup>	28	Breast (0-III)		WL
25	Cramer 2015 <sup>60</sup>	40	Breast (I-III)		WL
26	Hughes 2015, <sup>61</sup> Long Parma 2015 <sup>62</sup>	94	Breast (NR)		PE <sup>c</sup>
27	Taylor 2018 <sup>63</sup>	33	Breast (I-III)		WL
28	Rao 2017, <sup>64</sup> Vadiraja 2017 <sup>65</sup>	91	Breast (IV)		SC
<b>Combined (during and post-treatment)</b>					
29	Cohen 2004 <sup>66</sup>	39	Lymphoma (I-IV)	C	WL
30	Moadel 2007 <sup>67</sup>	164	Breast (I-IV)	C, H, R	WL
31	Danhauer 2009 <sup>68</sup>	44	Breast (0-IV)	C, R	WL
32	Cramer 2016 <sup>69</sup>	54	Colorectal (I-III)	C	WL

Abbreviations: C, chemotherapy; H, hormone treatment; HE, health education; NR, not reported; PE, physical exercise; R, radiation therapy; S, surgery; SC, supportive counseling; ST, stretching; UC, usual care; WL, waitlist.

<sup>a</sup>Values indicate the total sample enrolled/randomized even if fewer individuals were analyzed.

<sup>b</sup>These were secondary analyses of a subgroup from the study by Mustian et al, 2013.<sup>52</sup>

<sup>c</sup>There were 2 PE comparison groups.

[1 study each]; Bali [2 studies]; and Vivekananda Yoga Anusandhana Samsthana [5 studies]). Yoga typically was delivered in a group format, although individual instruction occurred in 1 study by design<sup>26</sup> and in 2 studies because of patients' schedules.<sup>33,45</sup> Dose varied widely, with classes lasting up to 90 minutes and occurring from 1 to 6 days per week over 1 to 8 weeks. Furthermore, in most studies, home practice was prescribed.<sup>23,26,30,33,34,37,41-43,45</sup> For the post-treatment yoga studies, interventions were designed as gentle stretching and strengthening exercises, including breathing techniques (Pranayama), postures (Asanas), meditation, and relaxation. Sessions were group-based and used a variety of yoga styles: Hatha<sup>48,49,56,60,61,70</sup> (n = 4), Iyengar<sup>48,50</sup> (n = 2), gentle/restorative<sup>52,63</sup> (n = 2), and Satyananda<sup>58</sup> (n = 1). Dose varied widely, with programs

varying from 4 weeks to 6 months in length, classes offered 1 to 3 times weekly, and each class lasting from 60 to 120 minutes. Home-based practice was encouraged across most studies. For the combined sample studies, the yoga intervention involved 7 to 12 weekly group classes (2 Hatha yoga,<sup>67,69</sup> 1 restorative yoga,<sup>68</sup> 1 Tibetan yoga<sup>66</sup>), and home practice was encouraged in 2 of those studies.<sup>67,69</sup>

Intervention adherence (class attendance or practice outside of class) and its reporting were inconsistent. Among studies that were conducted during treatment, several did not report or only partially reported adherence.<sup>23,26,30,34,40,42</sup> Some studies reported the mean number of classes attended (eg, 5.5 of 8 possible classes)<sup>41,43</sup> and mean hours of home practice (eg, 2.25 hours per week).<sup>41</sup> Others reported adherence ranging up to 81%

of participants attending all classes<sup>39</sup> and 100% engaging in 5 to 7 days of home practice per week.<sup>34</sup> Among studies that were conducted post-treatment, reporting of program adherence also varied (10 studies reported some measure of adherence). Studies that reported average attendance reported attendance as high as 97%, with a self-reported home practice adherence of 86%. In contrast, 1 study reported 61% average adherence (across 14 yoga participants). In a 6-month intervention, average attendance at facility-based classes was 19.6 times, and average home practice was reported as 55.8 times.<sup>49</sup> Among the 4 studies with combined samples, all reported on adherence either as the percentage of classes attended<sup>66,68</sup> and/or as the mean number of classes attended (ie, mean, 9.7 of 12 classes).<sup>67-69</sup>

### Outcomes

Table 2 provides an overview of outcomes assessed and statistical significance of between-group main effects, broken down by self-reported measure of physical function, objective physical measures (fitness, actigraphy, biomarkers), and self-reported measures of psychological and cognitive outcomes. Table 3 and Figure 2 provide a summary of the outcome categories and findings across studies.

### Summary of Findings

#### During cancer treatment

RCTs of yoga conducted during cancer treatment most commonly measured fatigue (n = 8), anxiety (n = 8), depression (n = 7), and QOL (n = 6). For QOL, 5 of 6 studies demonstrated favorable effects of yoga on global<sup>24</sup> and domain-specific (physical,<sup>33,37</sup> emotional,<sup>30,44</sup> social,<sup>44</sup> and cognitive<sup>30</sup>) measures, but studies also reported non-significant findings (global,<sup>42</sup> social,<sup>31</sup> role function,<sup>31</sup> mental,<sup>33</sup> functional,<sup>44</sup> and physical<sup>44</sup>). Consistent findings, albeit among only a few studies, included improved distress (n = 2), perceived stress (n = 3), and various biomarker levels (eg, proinflammatory cytokines, cortisol; n = 4). Three trials reported improvements in psychosocial outcomes, such as benefit finding and spirituality. No RCTs conducted during treatment measured physical fitness or cognitive outcomes.

Two examples of methodologically strong studies conducted during cancer treatment stated that they were sufficiently powered to detect differences in pre-specified primary outcomes (power analyses reported) and included both active and usual-care control groups.<sup>37,45</sup> A study conducted by Chandwani and colleagues in 2014<sup>37</sup> reported that their primary outcomes

were the Physical Component Score (PCS) and the Mental Component Score (MCS) from the Medical Outcomes Study 36-Item Short-Form Survey (SF-36) QOL measure 1 month after radiotherapy. Statistically significantly greater increases from baseline were observed in PCS scores for the yoga group compared with the wait-list control group. There were no significant effects of yoga compared with the active stretching control group or for the MCS. Secondary outcomes included significantly steeper cortisol slopes in the yoga group compared with both control groups, suggesting positive effects of yoga on the stress hormone cortisol. In addition, the PCS physical functioning subscale also revealed a statistically and clinically significant difference for yoga compared with the active-stretching control group at the primary time point. Moderator analyses further indicated that the efficacy of yoga for improving the MCS score was more pronounced for women with elevated sleep disturbances and depressive symptoms at the start of radiotherapy.<sup>38</sup>

Another study by Chaoul and colleagues (2018) stated that the primary outcomes were self-reported sleep disturbances (Pittsburgh Sleep Quality Index) and fatigue (Brief Fatigue Inventory) 1 week after the intervention.<sup>45</sup> In their study, no group differences were noted in total sleep disturbances or fatigue levels over time. Yet significant differences were detected between the yoga group and both control groups (ie, active stretching, usual care) for a subscale of the sleep disturbances measure (daily disturbances). Subgroup analyses revealed that patients who practiced yoga at least twice a week self-reported better sleep, as also supported by an objective measure of sleep (ie, actigraphy) at 3 months and 6 months after the intervention compared with those who did not practice and those in the usual-care control group.

#### After cancer treatment

The most commonly assessed category of outcomes in RCTs conducted after completion of cancer treatment was physical, which included fatigue, sleep, and physical fitness. Overall, fatigue (n = 10) was the most studied individual outcome, with improvement reported in 7 studies. Sleep demonstrated improvement in 5 of 7 studies, including 1 that used objective, actigraphy-based measurement.<sup>52</sup> Only 1 of 5 studies reported significant between-group effects of yoga on physical fitness.<sup>61</sup> Nonetheless, this finding is particularly noteworthy considering that it was the only post-treatment RCT to use physical exercise as the control group.

**TABLE 2.** Outcomes of Randomized Controlled Trials of Yoga in Cancer<sup>a</sup>

Treatment Status/Study No.	Physical: Self-Report					Physical: Objective			Psychological/Cognitive					
	Quality of Life	Fatigue	Pain	Sleep	Other <sup>b</sup>	Physical Fitness	Actigraphy	Biomarkers	Anxiety	Depression	Distress	Perceived Stress	Other <sup>c</sup>	Cognition
<b>During treatment</b>														
1	X				X			X	X	X		X		
2	X	X	X	X	X			X	X	X		X		
3	X	NS		NS				X	NS	NS		X	X	
4	X								X			X	X	
5	X	X	X	NS				X	NS	NS		X	X	
6		X	X						NS	NS				
7		X	X						NS	NS				
8		X							NS	NS				
9		NS							NS	NS				NS
10	NS								NS					
11	X	X			NS				NS					
12	X	NS			NS									
13		NS		X			X							
<b>Post-treatment</b>														
14	X	X	X	X	X					NS		NS		NS
15		X	X		X									
16	NS	X								NS				
17	NS	NS												
18		X		NS	X					X		NS		
19				X							X			
20			X											
21					X									
22		X		X	X									X
23	X	NS	NS		X					X				X
24	X	X												
25	X	X			X				NS	NS				
26		NS		NS										
27		X		X	X							NS		
28												X		
<b>Combined during/post-treatment</b>														
29		NS		x					NS	NS				NS
30	X	NS												NS
31	X	NS		NS										NS
32	NS	NS		X	NS				X					X

Abbreviations: NS, nonsignificant; X,  $P < .05$  (significant benefit in favor of yoga group).

<sup>a</sup>Blank cells indicate that the outcome was not measured.

<sup>b</sup>The category "other" includes general symptoms (intensity/frequency), prostate symptoms, nausea/vomiting, dyspnea, menopausal symptoms, lymphedema, and vigor/vitality.

<sup>c</sup>The category "other" includes benefit-finding, intrusive/avoidant thoughts, life satisfaction, mindfulness, spirituality, and affect.



**TABLE 3.** Summary of Findings<sup>a</sup>

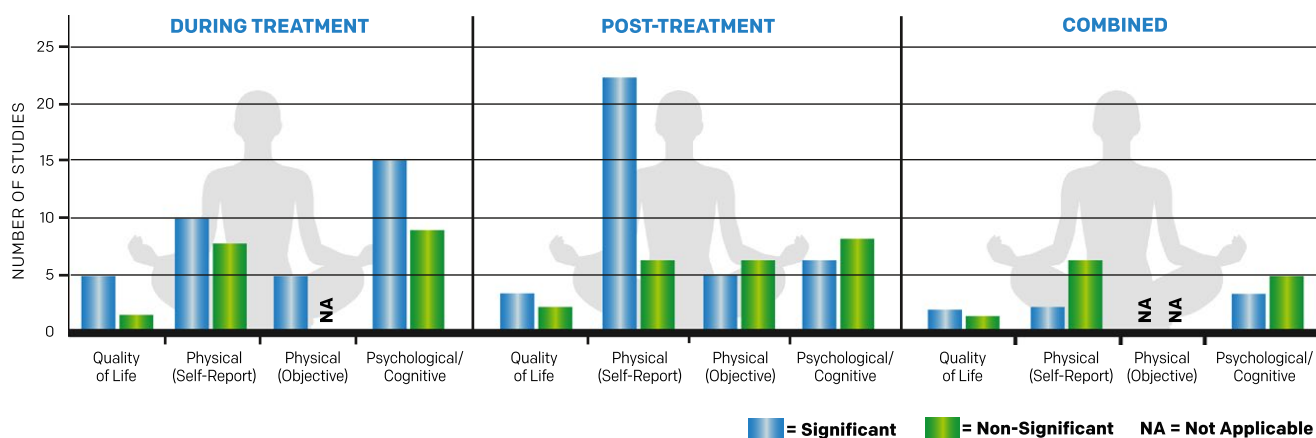
Outcome	No. of Studies					
	During Treatment		Post-Treatment		Combined	
	Significant	NS	Significant	NS	Significant	NS
Quality of life	5	1	3	2	2	1
Physical, self-reported						
Fatigue	5	3	7	3	0	4
Pain	1	0	2	1		NA
Sleep	2	2	4	2	2	1
Other <sup>b</sup>	2	2	9	0	0	1
Physical, objective						
Physical fitness		NA	1	4		NA
Actigraphy	1	0	1	0		NA
Biomarkers	4	0	3	2		NA
Psychological/cognitive						
Anxiety	4	4	0	1	1	1
Depression	3	4	2	3	2	1
Distress	2	0		NA	0	1
Perceived stress	3	0	1	3		NA
Other <sup>c</sup>	3	1	1	0	0	2
Cognition		NA	2	1		NA

Abbreviations: NA, not applicable (outcome not included), NS, nonsignificant.

<sup>a</sup>The table summarizes between-group main effects.

<sup>b</sup>The category “other” includes general symptoms (intensity/frequency), prostate symptoms, nausea/vomiting, dyspnea, menopausal symptoms, lymphedema, and vigor/vitality.

<sup>c</sup>The category “other” includes benefit-finding, intrusive/avoidant thoughts, life satisfaction, mindfulness, spirituality, and affect.



**Figure 2.** This is a summary of randomized controlled trials of yoga for oncology symptom management.

Other commonly assessed outcomes were QOL and depression (n = 5 studies each). QOL measures varied but commonly included cancer-specific measures, such as the Functional Assessment of Cancer Therapy (FACT) and European Organization for Research and Treatment of Cancer questionnaires. Of the 5 studies that examined QOL, 4 reported between-group improvements in various domains (global QOL,<sup>46</sup> emotional function [n = 2],<sup>46,60</sup> decreased diarrhea,<sup>46</sup> QOL subscale of symptoms,<sup>58</sup> FACT-Breast QOL total,<sup>60</sup> social,<sup>60</sup> and functional well being),<sup>60</sup> although 1 study (which examined breast

cancer-related QOL) was limited to a subgroup analysis based on attendance.<sup>23</sup> Of those 5 studies, nonsignificant findings also were reported for several QOL domains, including physical well being<sup>48,49</sup> or function,<sup>46</sup> social well being<sup>48,49</sup> or function,<sup>46</sup> emotional well being,<sup>48,49</sup> cognitive function,<sup>46</sup> role function,<sup>46</sup> and functional well being.<sup>48,49</sup>

Finally, a range of additional outcomes improved after yoga, including cognition (eg, memory difficulties, cognitive disorganization, cognitive complaints), lymphedema, vitality/vigor, and biomarkers (eg, inflammation,

stress/cortisol). However, the findings were limited to 2 or 3 studies for each outcome. Unlike RCTs conducted during treatment, post-treatment studies rarely assessed anxiety.

### Combined samples

In studies that enrolled patients during the active phase of treatment and once treatment ended, again, fatigue was the most common outcome ( $n = 4$ ).<sup>66-69</sup> However, none of the RCTs reported a significant effect of yoga on fatigue. For QOL, sleep, and depression, 2 of 3 studies (for each outcome) reported significant effects of yoga. Indeed, for the 3 studies that measured QOL, there were significant group differences for mental health QOL in 1 study<sup>68</sup> and for general health-related QOL, social well being, emotional well being, functional well being, and physical well being in another study<sup>69</sup> for at least 1 time point. Two studies reported significant group differences for social well being.<sup>67,69</sup> In 2 studies, findings were nonsignificant for physical health QOL, general health-related QOL, and several QOL domains (emotional, functional, and physical well being)<sup>67,68</sup>; social well being was nonsignificant in 1 of those studies.<sup>68</sup> Other outcomes were less commonly studied in combined samples; indeed, none of the combined-sample RCTs assessed pain, perceived stress, or objectively measured physical outcomes.

### Adverse Event Reporting

Of the studies that were conducted during cancer treatment, 6 mentioned that there were no adverse events related to the study intervention, and 7 did not include adverse event reporting. Of the post-treatment studies, 7 mentioned adverse events or safety reporting. Of these, events likely attributed to the yoga interventions were described in 3 studies and included transient muscle soreness, unilateral hip pain, back spasms, and recurrence of chronic back and/or shoulder problems.<sup>50,56,60</sup> In addition, Mustian and colleagues systematically reported on all unexpected, serious, life-threatening, and fatal adverse events during the study period and did not attribute the single serious adverse event that occurred to the yoga intervention.<sup>52</sup> Of the combined studies, 2 included adverse event reporting, and 2 did not. One study stated that no adverse events were reported.<sup>68</sup> Cramer et al reported 7 total minor adverse events (eg, muscle soreness, minor vertigo), including 6 that recovered without treatment.<sup>60,69</sup> One patient who experienced hip pain recovered after treatment with analgesic drugs.

## DISCUSSION

The popularity of yoga with patients who have cancer is reflected in the existing evidence base and the number of trials that have examined the effects of yoga in oncology. Twenty-nine RCTs of yoga for adults with cancer were identified, including 13 conducted during cancer treatment, 12 conducted in patients who had completed cancer treatment, and 4 that included a combined sample. Results from RCTs conducted during and after treatment have consistently reported improvements in multiple domains of QOL, fatigue, sleep, psychological outcomes, and biomarkers. Studies of yoga after treatment also have reported benefits for a range of other self-reported outcomes. The 4 studies that included patients both on and off treatment had less consistent findings, with none reporting improvements in fatigue, and 2 each reporting improved QOL domains, sleep, and depression.

Examining the number of positive versus negative outcomes for patients receiving cancer treatment reveals clear benefits in terms of QOL, fatigue, and perceived stress, with less consistent but supportive evidence for other psychosocial outcomes like benefit finding and spirituality. There were mixed findings for sleep, anxiety, and depression. Four of 4 studies also reported improvements in biomarkers that included cortisol regulation and inflammatory markers. One of the limitations in these studies is that they do not necessarily target 1 symptom at the start of the trial. Rather, they tend to focus more on a buffering model, diminishing the onset of multiple symptoms associated with treatment. Many patients will go through treatment experiencing few side effects, whereas others will struggle from the outset. If studies conducted in patients who were receiving treatment used a population expected to develop more symptoms or patients who had already developed side effects, perhaps the benefits of yoga would be magnified.

Post-treatment studies demonstrated consistent support for yoga in improving fatigue, sleep, and multiple QOL domains as well as several biomarkers. Additional measures assessed physical fitness/functional ability outcomes, which were unique to the post-treatment studies. Given the opportunity for the body physiologically to “make gains” post-treatment, and the American Cancer Society’s recommendation for continued physical activity and fitness post-treatment, the potential for yoga as a type of physical activity that improves fitness outcomes, such as aerobic capacity, strength, and flexibility, is important.<sup>46,59,61,70,71</sup> In addition, given the prevalence of comorbidities, (eg, heart disease) in cancer survivorship,

understanding the benefits of yoga as a “body-mind medicine” should be further explored.

Despite the well established correlation between cancer diagnosis and distress, which frequently persists after treatment, post-treatment studies did not have a substantial focus on psychosocial well being.<sup>72,73</sup> Two studies reported improvements in depression, whereas only 1 study demonstrated an improvement in anxiety.<sup>60,72,73</sup> Finally, the association between physical and psychological outcomes is often captured with global QOL measures. Overall, the issue of using QOL measures to understand specific constructs (physical or psychological) is a potential limitation. It is done to provide a comprehensive measure that reduces patient burden; however, the use of a global QOL measure may obscure important nuances that would be captured using a more symptom-specific measure. In addition, for the most part, these studies did not target specific elevated symptoms, with the exception of some studies that examined chronic fatigue and sleep disturbances. Similar to the studies of patients undergoing active treatment, examining the benefits of yoga to treat a specific condition will yield greater understanding of the specificity of yoga at treating targeted conditions.

Studies that evaluated yoga interventions in a sample that combined those who were currently receiving treatment *and* those who had finished treatment reported less robust findings compared with studies that included a more homogeneous sample. These weaker findings are likely because of the increased heterogeneity of the outcomes at study entry, making significant between-group findings more difficult. Indeed, when Moadel et al conducted subanalyses of their sample focusing only on women who were *not* on treatment at the start of the trial, the findings were clearly stronger.<sup>67</sup> This suggests that future efficacy studies should focus on specific populations and times during the cancer care trajectory.

Measures used in the studies conducted during and after treatment were quite varied, making comparison across measures difficult. Use of the Patient-Reported Outcomes Measurement Information System (PROMIS) in future trials would greatly facilitate comparisons and also would lend toward comparison with legacy measures using Prosetta Stone.<sup>74</sup> Furthermore, many of the measures used in these studies rely on self-report, which can capture important subjective responses to the intervention. However, increasing the use of objective measures, such as physical fitness, costs and health care utilization, and biologic outcomes, is important to improve the reliability of the data and our understanding of the breadth

of changes that result from yoga participation. It is noteworthy that several clinical trials assessed biomarkers, with findings suggesting that yoga may improve outcomes like stress hormone regulation, inflammation, and immune function.

It is noteworthy that none of the trials documented any serious adverse events associated with yoga, and only some minor adverse events were reported (eg, muscle soreness).<sup>50,56,60</sup> Minor adverse events were reported by only 3 post-treatment trials and by 1 trial that combined active and post-treatment patients. One way these adverse events may be mitigated in future studies could be by reducing the intensity of movements taught during active treatment. Other studies specifically reported that there were no adverse events related to the intervention, although it was not clear in many publications whether there were no adverse events or whether adverse events simply were not assessed. It is important for future trials to systematically assess and report on all adverse events, because relying on spontaneous reports from participants may highly underestimate the frequency of these events.

Adverse events are an extremely important consideration, because any side effects or risk profiles need to be weighed against the possible benefits. In the case of yoga, the high safety profile combined with benefits for both subjective and objective outcomes and the relatively low cost suggest it is appropriate to encourage patients to participate in yoga programs to reduce symptoms and improve multiple aspects of QOL during and after treatment. However, even if cost is not a barrier, for many patients, accessing yoga classes can be a challenge.

Investigators have explored the feasibility of methodological innovations to increase the reach of yoga to more heterogeneous populations (eg, other cancer types, rural residence). Some of these new methods include incorporating caregivers, implementing yoga in the clinical setting, offering yoga in community settings, and using technology.<sup>75-79</sup> The use of these approaches could address barriers to participation, such as accessibility, travel distance, and dissemination (eg, increased treatment fidelity).<sup>80</sup> Because there is now evidence supporting the efficacy of yoga, it is increasingly important to investigate the effectiveness of these approaches and other intervention elements that may facilitate the eventual translation of yoga to practice (eg, low cost, takes limited time, is manualized, self-sustaining).<sup>81</sup> Furthermore, future research could also examine whether programs that place a greater



emphasis on relaxation and meditation during active treatment may lead to greater improvements in mental health and sleep disturbances.<sup>45</sup>

### Limitations

Several limitations arise when examining yoga and cancer research. As with other areas of research, a “file-drawer” effect, in which negative trials tend to not get published, may occur. However, as indicated in Table 3, several trials published nonsignificant findings. Because many of these trials had small sample sizes, they may have been underpowered, and future large-scale trials are needed. Furthermore, the current review was heavily weighted with studies of yoga for patients with breast cancer and for generally high-functioning populations. However, trials are emerging of yoga for participants with other types of cancers, including ovarian, prostate, colorectal, brain, and blood cancers and advanced lung cancer, and the findings may be different for a more heterogeneous group of cancer survivors.<sup>69,75-77,82,83</sup> Another inherent challenge is that most studies used different kinds of yoga. Although there may be consistency in the components, such as incorporating movements, breathing exercises, and relaxation and meditation practices, the specific practices, intensity, frequency, and duration often vary substantially. Reporting yoga protocols, similar to published reports of clinical trial protocols in exercise, for example, would further our understanding of the effects of yoga. Unfortunately, most studies also did not report the details on their teacher training and whether teachers had experience specifically in oncology populations. However, a well trained yoga therapist, for which there is now an accreditation (available at: <http://www.iayt.org/>, Accessed August 14, 2018), should be able to work with vulnerable patients to ensure utmost safety and efficacy. In addition, the “dose” of yoga varied tremendously between studies, including the number of classes, the length of each class, and the frequency of practice. A methodological limitation was that most studies did not include active control groups, making it a challenge to determine whether it was yoga per se that conferred the benefits. However, the studies that did include active control groups, such as stretching or exercise, did report outcomes favoring the yoga group. Future work comparing the efficacy and/or non-inferiority of yoga with other active interventions, such as traditional physical activity, also would be beneficial and could be examined within practical behavioral trial frameworks. Finally, treatment fidelity is often missing

from studies, making it difficult to know whether what was supposed to be taught to the patients actually was taught. More recent trials (especially studies with financial support) include quality-control procedures to ensure the appropriate delivery of all components.

### Conclusion

Despite these limitations, there is sufficient evidence to support the benefits of yoga for patients while they are undergoing cancer treatment and when they move out of the medical setting and into survivorship. Yoga improves multiple aspects of QOL, cancer-specific symptoms, psychological outcomes, and important biomarkers, such as stress hormone regulation, immune function, and inflammatory markers. As a low-cost and safe intervention, yoga should be provided alongside the standard of care to help improve multiple aspects of patients’ adjustment to cancer and its treatment. In many trials, the evidence supports what we would expect: that outcomes are best for those who engage in yoga more often.<sup>25,56,67</sup> Future research should focus on better understanding the factors that facilitate engaging in yoga and strategies for overcoming the barriers.

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The authors made no disclosures.

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