



## Systematic review of yoga for symptom management during conventional treatment of breast cancer patients

Pooja Selvan, Chloe Hriso, Julita Mitchell, Andrew Newberg\*

Department of Integrative Medicine and Nutritional Sciences, Thomas Jefferson University, Philadelphia, PA, 19107, USA

### ARTICLE INFO

#### Keywords:

Yoga  
Integrative medicine  
Breast cancer  
Quality of life

### ABSTRACT

**Introduction:** Breast cancer is one of the most commonly diagnosed cancers in women in the US, and its treatments have significant physical and psychological side effects and long-term complications causing significant morbidity and decreased quality of life. Integrative medicine modalities, such as Yoga, have been found to reduce side effects of conventional treatments without interfering with the treatment itself and improve quality of life. In this systematic review, we specifically explored Yoga as a potential option for symptomatic management in patients undergoing conventional breast cancer treatments.

**Methods:** We performed a literature search that was conducted to include the databases PubMed, PsychINFO, Cochrane Library, Scopus, and CINAHL, resulting in 28 randomized controlled trial (RCT) articles. We review the results of these trials regarding the impact of Yoga in this patient population.

**Results:** Overall, the majority of the RCT articles showed significant benefits of Yoga intervention in various aspects of quality of life, fatigue, nausea/vomiting, sleep quality, anxiety, depression, and distress. There are several studies that have explored the physiological mechanism behind the effects of Yoga and found that Yoga affects both the immune response and inflammation.

**Discussion:** These studies revealed that Yoga has a potential therapeutic role in the symptomatic management of breast cancer patients, enhancing quality of life during treatment as well as improving adherence to treatment. Future studies with more defined and consistent methodologies are necessary to fully understand the potential use of Yoga therapy in patients with breast cancer.

### 1. Introduction

Breast cancer (BC) is one of the most commonly diagnosed cancers in women in the US with 125 new cases reported for every 100,000 women (2012–2016) and is the second leading cancer to cause death in women [1]. Due to improvements in breast cancer screening, more cases are being diagnosed and treated earlier with more efficacious conventional treatments, such as adjuvant chemotherapy, hormonal therapy, radiotherapy, and surgical intervention, leading to decreases in mortality [2]. However, there are significant physical and psychological side effects, as well as long-term complications from these treatments, causing significant morbidity and decreased quality of life (QOL). This can even deter patients from completing treatment. Common complaints associated with treatment include fatigue, nausea, depression, and sleep issues among others [3]. After adjuvant treatments, QOL in patients has found to be impaired along with physical performance with increases in

depressive symptoms [4]. Increasingly, breast cancer patients (38–60%) have been using integrative medicine approaches as supportive therapies to reduce side effects and improve QOL during conventional treatment [5]. Therefore, some researchers have argued that appropriate integrative therapies should be encouraged routinely in breast cancer patients [6].

One complementary non-invasive therapy that is frequently utilized is Yoga, which incorporates physical postures (asanas), breathing exercises (pranayamas), meditation, chants, and relaxation (savasana). Multiple studies have found that Yoga improves aspects of physical, emotional, social, and psychological well-being in adult cancer patients and may be a supportive intervention for fatigue, depression, anxiety and sleep disturbances [7].

Physiologically, Yoga has been found to regulate the hypothalamic-pituitary-adrenal axis (HPAA), reduce circulating stress hormones, and improve parasympathetic function, which all aid in reducing stress and

\* Corresponding author. Department of Integrative Medicine and Nutritional Sciences, Thomas Jefferson University, 925 Chestnut Street, Suite 120, Philadelphia, PA, 19107, USA.

E-mail address: [Andrew.newberg@jefferson.edu](mailto:Andrew.newberg@jefferson.edu) (A. Newberg).

<https://doi.org/10.1016/j.ctcp.2022.101581>

Received 15 February 2022; Received in revised form 20 March 2022; Accepted 1 April 2022

Available online 6 April 2022

1744-3881/© 2022 Published by Elsevier Ltd.

modulating the stress response [8]. Yoga has been shown to alter activity in various brain structures that support improvements in mood and cognition [9]. Additionally, Yoga is associated with improved sensory awareness, regulation of autonomic input, and increases in parasympathetic activity [10]. Through recruitment of the insula, amygdala, and hippocampus in the brain, Yoga increases pain tolerance and reduces pain associated distress and anxiety [11].

In this systematic review, we specifically explored Yoga as a potential option for symptomatic management in patients undergoing conventional breast cancer treatments. We have summarized the current randomized controlled studies and critically evaluated their findings regarding the effectiveness of Yoga therapy during conventional treatment at improving QOL in breast cancer patients as well as other symptoms, such as fatigue, depression, and anxiety.

**2. Methods**

For this review, the search terms “Yoga” and “breast cancer” were used in the databases PubMed, PsychINFO, Cochrane Library, Scopus, and CINAHL. The search yielded a total of 1459 results. After removing exact and close duplicates, the search yielded 888 results. Screening for relevance and non-full articles i.e. titles or abstracts, resulted in the exclusion of 303 and 26 results respectively. Articles were then excluded due to not having a RCT design (225), no current breast cancer patients (146), Yoga not being the sole intervention (142), all or some participants not undergoing treatment during the study (16) and articles not in English (2). Allowable conventional cancer treatments included chemotherapy, radiation therapy and surgery. Studies of solely breast cancer were included. If a study included both breast cancer and other types of cancer, it was excluded. This resulted in 28 articles on 23 RCTs. We also evaluated each study for risk of bias using the Revised Cochrane risk-of-bias tool for randomized trials (RoB 2) [12].

The abbreviation of the groups compared in the studies were standardized to the following: YG = Yoga intervention group, STG = stretching/exercise/physiotherapy group, CG = control/standard care group (supportive counseling sessions). Please see Table 1 for further descriptions of the intervention(s) included in each RCT.

**3. Results**

**3.1. Quality of life (QOL)**

Assessing a 12 week Dru Yoga intervention during neoadjuvant chemotherapy (CT), Jong et al. found that QOL assessed by the European Organization for Research in the Treatment of Cancer-Quality of Life C30 scale (EORTC QLQ C30) decreased in global health status, physical functioning, and role functioning at the end of CT in both the YG and CG. However, the YG had a significant improvement in emotional functioning at the end of CT (p = 0.045) and 3 months post-treatment (p = 0.001). Regarding the time taken to return to work, at 3 months post-treatment, 53% of the YG had returned to work compared to 23% of the CG [13].

During 6 weeks of daily adjuvant radiotherapy (RT), Ratcliff et al. found that Yoga may provide the best mental-health related QOL benefits for those experiencing pre-RT sleep disturbance and depressive symptoms. The YG (n = 53) patients with high baseline depressive symptoms reported marginally improved 3-month (post intervention) Mental Component Score (MCS) than their counterparts in the CG (n = 54, p = 0.11). The YG patients with high baseline sleep disturbances reported significantly improved post 3- (p < 0.01) and 6-months MCS compared to their counterparts in the CG (n = 54, p = 0.01) or STG (n = 56, p = 0.01). The YG had greater benefit finding (ability to find positive aspects out of challenging circumstances) than the STG and CG during follow-up (p = 0.01) [14].

Vadiraja et al. found that Yoga during 6 weeks of adjuvant RT post-surgery improved aspects of QOL. Compared to the CG (n = 33), the YG

**Table 1**  
Summary of the type of intervention(s) used in each reported trial.

Reference #	RCT	Risk of Bias	Type and Duration of Intervention(s)	
			YG	STG
12	Jong et al., 2018	High Risk	Dru yoga: Pranayama, energy block release, asanas, savasana; 1 session per week x 12 weeks	–
13	Ratcliff et al., 2016	Low Risk	Synchronized breathing, asanas, deep relaxation, pranayama, meditation; 1–3 sessions per week x 6 weeks	Recommended exercises during or after treatment for breast cancer; 1–3 sessions per week x 6 weeks
14,15,29	Vadiraja et al., 2009, 2009, 2009	Some Concern	Asanas, breathing exercises, pranayama, meditation, yogic relaxation; 18–24 sessions over 6 weeks	–
16	Siedentopf et al., 2013	Some Concern	Asanas, eye exercises, breathing exercises, relaxation; 2 sessions per week x 5 weeks	–
17	Lotzke et al., 2016	High Risk	Iyengar yoga: asanas and pranayama with the use of props, which help maintain the positions; 1 session per week x 12 weeks	Conventional physical exercise; 1 session per week x 12 weeks
18	Chandwani et al., 2014	Low Risk	Warm up with synchronized breathing, asanas, deep relaxation, pranayama, meditation; 1–3 sessions per week x 6 weeks	Recommended exercises during and after treatment for breast cancer; 1–3 sessions per week x 6 weeks
19	Raghavendra et al., 2007	Some Concern	Asanas, breathing exercises, pranayama, meditation, yogic relaxation; 3–6 h weekly over chemotherapy course (unspecified duration)	–
20, 33	Rao et al., 2017 & 2015	Some Concern	Asanas, breathing exercises, pranayama, meditation, yogic relaxation; 7 sessions per week x 24 weeks	–
21	Rao et al., 2008	Some Concern	Breathing exercises, pranayama, yogic relaxation;	Postoperative shoulder exercise rehabilitation; 4 hospital sessions

(continued on next page)

Table 1 (continued)

Reference #	RCT	Risk of Bias	Type and Duration of Intervention(s)	
			YG	STG
22	Chandwani et al., 2010	Some Concern	4 hospital sessions + unspecified duration of home practice over 4 weeks Patanjali's yoga tradition: warm up with synchronized breathing, asanas, deep relaxation, pranayama, meditation; 2 sessions per week x 6 weeks	+ unspecified duration of home practice over 4 weeks -
23	Eyigor et al., 2018	High Risk	Hatha yoga poses at a slow pace: standing poses, supine poses, savasana, and stretching and breathing exercises; 2 sessions per week x 10 weeks	-
24	Taso et al., 2014	Low Risk	Anusara yoga: warm up with meditation and breathing exercises, Anusara yoga asanas, gentle stretching, relaxation exercises; 2 sessions per week x 8 weeks	-
25	Chaoul et al., 2018	Some Concern	Tibetan yoga: mindfulness with meditation with breathing and visualization, breath retention exercise, Tsa Lung movements, compassion based meditation; 4 sessions over 4-12 weeks	Recommended exercises during and after treatment for breast cancer
26	Chakrabarty et al., 2015	Low Risk	Pranayama: Cycles of Nadi Sodhana, Sheetali, and Brahmari, involving various nostril breathing techniques and sitting poses; 5 sessions per week x 6 weeks	-
27	Vadiraja et al., 2017	Some Concern	Integrated yoga program: asana, pranayama, savasana, meditation, self-appraisal, and counseling; 24	-

Table 1 (continued)

Reference #	RCT	Risk of Bias	Type and Duration of Intervention(s)	
			YG	STG
28	Anestin et al., 2017	High Risk	Bali Yoga Program – Breast Cancer (BYP-BC): Hatha yoga poses, frequent relaxation between poses, breathing techniques, meditation, visualization; 1 session per week x 8 weeks	-
30	Banerjee et al., 2007	Some Concern	Meditation, slow stretching, asanas, guided imagery with chanting, pranayama, deep relaxation with sound vibrations and guided imagery (yoga nidra); 6 week program	-
31	Rao et al., 2009	High Risk	Asanas, breathing exercises, pranayama, meditation, yogic relaxation techniques with imagery; Daily session x 6 weeks	-
32, 35, 36	Kovacic et al., 2013, 2011, 2011	Low Risk	Standard physiotherapy + relaxation training with Yoga in Daily Life (YIDL) system – asanas, breathing exercises, pranayama, relaxation techniques with yoga nidra, meditation techniques; 1 week program + daily relaxation session+ 3 weeks home practice	Standard physiotherapy (to facilitate recovery of shoulder post-surgery and limit development of secondary complications); 1 week program
34	Lanctot et al., 2016	Some Concern	BYP-BC – Hatha yoga asanas, relaxation, breathing techniques, meditation with chanting, visualization; 1 session per week x 8 weeks	-
37, 38	Rao et al., 2008, 2008	Low Risk	Asanas, pranayama, savasana with imagery; 4 weeks	-
39	Kumar et al., 2013	Some Concern	Sudarshan Kriya and Pranayam: breathing exercises; 18 h	-

(continued on next page)

Table 1 (continued)

Reference #	RCT	Risk of Bias	Type and Duration of Intervention(s)	
			YG	STG
			workshop over 3 days	

(n = 42) showed significant improvements in positive affect (p = 0.007), emotional function (p = 0.001), and cognitive function (p = 0.03), and a decrease in negative affect (p < 0.001) assessed by EORTC QLQ C30 functional scales and the Positive and Negative Affect Schedule (PANAS). There were significant positive correlations between positive affect and physical function (p = 0.002), emotional function (p < 0.001), cognitive function (p = 0.01), social function (p = 0.007) and global QOL (p < 0.001). These aspects (p = 0.004, p < 0.01, p = 0.001, p = 0.008, p = 0.001, respectively) were negatively correlated with negative affect [15].

Using EORTC QLQ C30 and Rotterdam Symptom Check List (RSCL), the YG (n = 44) had a significant decrease in psychological distress (p = 0.01), fatigue (p = 0.007), insomnia (p = 0.001), and appetite loss (p = 0.002) along with improved activity level (p = 0.02) compared to the CG (n = 44) [16].

Siedentopf et al. found that Yoga during the 5 week postoperative phase improved overall QOL (p = 0.002) and functional status (p = 0.005) in the YG (n = 49) post-intervention compared to the CG (n = 44) (EORTC QLQ-C30 and -BR23). Physical symptoms (fatigue, nausea and vomiting, pain, dyspnea, insomnia, appetite loss, and other gastrointestinal symptoms) were lower in the YG post-intervention compared to the CG 3 months later (p = 0.01). There were reductions in systemic treatment side effects, breast and arm pain, and distress due to hair loss. 86% of the YG and 59% of the CG (p = 0.04) confirmed a positive change in their physical activity through Yoga [17].

Lotzke et al. assessed a 12 week Iyengar Yoga intervention during neoadjuvant cytotoxic and endocrine therapy [18]. The YG (n = 45) had significant improvements in role (p = 0.013) and emotional functioning (p = 0.018) while the STG (n = 47) had a significant improvement in emotional functioning (p < 0.001) (EORTC). In both groups, dyspnea, appetite loss, constipation, and diarrhea were improved (p < 0.001) at 12 weeks and 3 months afterwards. At post 3 months, global health, role, and social functioning were significantly improved, indicating recovery of QOL, after CT for both groups. Chandwani et al. found that a 6 week Yoga intervention during RT improved the Physical Component Summary (PCS of SF-36) in the YG (n = 53) compared to the CG (n = 54) at 1 and 3 months post-RT (p = 0.01). At 1, 3, and 6 months post-RT, the YG had greater increases in physical functioning compared to the STG (n = 56) and CG (p < 0.05) [19]. However, the study was limited by a high dropout rate and inconsistent participation.

In early operable breast cancer patients undergoing 4–8 cycles of adjuvant CT, Raghavendra et al. found that there was improved QOL (p < 0.001) during CT in the YG (n = 28) compared to the CG (n = 34), using Functional Living Index for Cancer (FLIC) [20].

Rao et al. found that a Yoga intervention post-surgery over a 24 week period during RT, CT, or both, led to improvements in QOL (FLIC) following surgery (p = 0.01), during RT (p < 0.001), and CT (p < 0.001) in the YG compared to the CG. The YG had a reduced overall toxicity score compared to the CG (p = 0.01). Regular Yoga practice was related to decreased depression scores (p = 0.017, p = 0.04) and symptom severity (p = 0.003, p = 0.01) post-surgery and during RT. Following RT, there were decreases in depression scores (p = 0.03), symptom quantity (p = 0.03), distress (p = 0.004), and improvements in QOL (p = 0.02) [21].

In a 4 week Yoga intervention following surgery (lumpectomy or mastectomy), Rao, Nagendra et al. found that there was decrease in symptom severity (p = 0.01), distress (p < 0.01), and improvement in QOL (p = 0.01) using FLIC and symptom checklist in the YG (n = 33)

compared to the STG (n = 36) [22]. In a 6 week Yoga intervention during RT, Chandwani et al. showed the YG (n = 30) had better health perception (p = 0.005) and physical function scores (p = 0.04) 1 week post-RT (assessed by SF-36) compared to the CG (n = 31). The YG had a greater tendency to ruminate on (intrusion) or avoid thoughts about cancer-related stressors (avoidance) (Impact of Events Scale) at 1 month post RT (p = 0.01), and greater ability to find meaning in cancer (Benefit Finding Scale) 3 months post-RT (p = 0.01). The QOL subscales for fatigue, depression, or sleep showed no differences, suspected to be due to the timing of assessments missing the peaks of symptoms [23].

In a study evaluating the impacts of a 10-week Hatha yoga program on arm and shoulder pain, as a result of breast surgery, and QOL in breast cancer patients, Eyigor et al., 2018 found that the YG (n = 22) showed significantly improved pain severity in both arm pain (p = 0.01) and shoulder pain (p = 0.01) compared to the CG (n = 20) [24].

### 3.2. Fatigue

With an 8 week Anusara Yoga intervention during adjuvant CT, Taso et al. found reductions in fatigue (p < 0.001) and the interference of fatigue in daily life (p < 0.001) in the YG (n = 30) at 8 weeks and post-4 weeks (p < 0.05), while the CG (n = 30) had increases in both (p < 0.001). At 4 weeks, Yoga reduced the fatigue levels and influence of fatigue on daily life in participants with lower baseline scores (p < 0.05) and negatively affected participants with higher baseline scores (p < 0.05). At 8 weeks, there were significant reductions in the YG's fatigue levels and the influence of fatigue on daily life (~75%) with moderate starting baseline values (p < 0.05) [25]. Using the Brief Fatigue Inventory Chandwani et al. found that the YG and STG had significant reductions in fatigue (p < 0.05) at the end of 6 weeks of RT [18]. During 12 week of CT, Chaoul et al. found no significant differences in fatigue over time between the YG (n = 74), STG (n = 68), and CG (n = 85). However, they only held 4–90 min sessions rather than weekly and were limited by low participation rate (56%), individual classes that lacked group support, non-blinded randomization, and non-adherence to intent-to-treat principle [26].

In the above mentioned study by Jong et al. there was an increase in general fatigue (p < 0.006) at the end of the intervention in the CG, but not in the YG. Further, the higher the patient's age, the higher the MFI scores in: physical fatigue (p = 0.03), reduced activity (p = 0.001), and reduced motivation (p = 0.001) [12]. Similarly, Chakrabarty et al., 2015 showed in that in BC patients undergoing radiation therapy, the YG (n = 80) receiving pranayama intervention over a period of 6 weeks had reduced fatigue compared the CG (p = 0.001) [27].

For patients in more advanced breast cancer stages, Vadiraja et al., 2017 found that in an integrated yoga program over a period of 12 weeks, the YG (n = 46) showed significant reductions in fatigue severity (p < 0.001), fatigue frequency (p < 0.001), and fatigue interference (p < 0.001) compared to the CG (n = 45) receiving supportive therapy and education. Furthermore, in this YG, perceived stress was also reduced by 32.6% (p = 0.001) compared to the CG. This study also showed a measurable positive correlation between fatigue severity changes and cortisol levels measured at 9a.m., suggesting the potential for a yoga-based intervention to effectively reduce fatigue and stress concurrently in breast cancer patients [28].

### 3.3. Nausea/vomiting

Raghavendra et al. found that in early operable breast cancer patients undergoing adjuvant CT, Yoga led to decreases in CT-induced nausea frequency (p = 0.01) and severity (p = 0.01) assessed by Morrow Assessment of Nausea and Emesis (MANE) after the 4th CT cycle. The YG had reduced anticipatory nausea frequency (p = 0.05) and severity (p = 0.003), vomiting severity (p = 0.04), and toxicity scores (p < 0.001) compared to the CG. CT-related nausea frequency and severity, and vomiting frequency and severity correlated significantly and

positively with anxiety, depression, toxicity, and distress, and inversely with QOL. Those in the YG, who did not receive anxiolytics (65%), had reduced CT-related nausea frequency ( $p = 0.05$ ) and severity ( $p = 0.002$ ), vomiting frequency ( $p = 0.03$ ) and severity ( $p = 0.002$ ), anticipatory nausea severity ( $p = 0.02$ ), and anticipatory vomiting severity ( $p = 0.01$ ) [19].

Using the EORTC symptom scales, Jong et al. found that during 12 week of neoadjuvant CT, the YG ( $n = 47$ ) reported less nausea and vomiting compared to the CG ( $n = 36$ ) at 3 months post-CT ( $p = 0.004$ ), but not at the end of CT, emphasizing the long-term effects of Yoga [12].

Using an 8 week BYP-BC (Bali Yoga Program – Breast Cancer) yoga intervention during CT, Anestin et al. found that there were no differences in frequency, duration, or intensity of nausea and vomiting in both the YG ( $n = 52$ ) and CG ( $n = 30$ ) assessed by MANE. The lack of significant results may be due to baseline adequate symptom management with patients already equipped with coping strategies, physical activities, and psychotherapy. Further limitations include MANE being a self-report survey leading to underestimated symptoms, and inconsistent class attendance and home practice [29].

### 3.4. Anxiety and depression

Using the Hospital Anxiety and Depression Scale (HADS) to assess a 12 week Dru Yoga intervention during neoadjuvant CT, Jong et al. found that the YG had worse anxiety and depression levels at baseline compared to the CG, but both improved at the end of CT ( $p = 0.011$  and  $p = 0.03$ , respectively) with anxiety further improving at 3 months post-CT ( $p = 0.014$ ) [12]. With a 6 week Yoga intervention during adjuvant RT, Vadiraja et al. found decreases in anxiety ( $p < 0.001$ ) and depression ( $p = 0.002$ ) in the YG ( $n = 44$ ) compared to the CG ( $n = 44$ ). Following intervention in the CG, there was a decrease in anxiety ( $p = 0.04$ ) [30]. Banerjee et al. found that in recently operated breast cancer patients undergoing 6 weeks of RT, anxiety and depression decreased in the YG ( $n = 35$ ) and increased in the CG ( $n = 33$ ) at the end of RT with significant differences between the groups ( $p < 0.001$ ) [31].

The next 7 studies used the Spielberger's State Trait Anxiety Inventory (STAI) and Beck's Depression Inventory (BDI). During 24 weeks of conventional treatment (surgery, adjuvant 6 weeks RT, 6 CT cycles), Rao et al. found decreases in state anxiety ( $p < 0.001$ ), trait anxiety ( $p = 0.005$ ), and symptom distress ( $p = 0.01$  using subjective symptom checklist) in the YG ( $n = 18$ ) compared to the CG ( $n = 20$ ). There was a positive correlation between anxiety states and traits with symptom severity and distress during treatment intervals [32]. Using Yoga in Daily Life (YDL) system, Kovacic et al. assessed anxiety during 1 week post-surgery as well as 3 weeks of adjuvant CT and RT. They found that the type of surgery ( $p = 0.019$ ,  $p = 0.008$ ) and the treatment ( $p < 0.0005$ ,  $p < 0.0005$ ) impacted outcomes of State-Anxiety scale (Y-1, transitory anxiety) and Trait-Anxiety scale (Y-2, general anxiety). There were decreases in Y-1 ( $p < 0.0005$ ) at 4 weeks and Y-2 ( $p < 0.0005$ ) at 1 week and 4 weeks in the YG ( $n = 16$ ), while STG ( $n = 16$ ) remained stable in both [33]. Using an 8 week BYP-BC intervention during CT, Anestin et al. found the YG had decreased anxiety post intervention ( $p < 0.001$ ) with a non-significant trend ( $p = 0.07$ ) compared to the CG [28]. In a 4 week Yoga intervention following surgery (lumpectomy or mastectomy), Rao, Nagendra et al. found a decrease in state ( $p = 0.04$ ) and trait ( $p = 0.004$ ) anxiety and depression ( $p = 0.01$ ) in the YG compared to the STG [21]. Rao et al. found that Yoga post-surgery over a 24 week period of RT, CT, or both, significantly decreased anxiety states following surgery ( $p = 0.04$ ), before RT ( $p = 0.005$ ), and during RT ( $p = 0.009$ ) in the YG compared to the CG. Following RT, there was a decrease in anxiety states ( $p < 0.001$ ) in the YG, which was maintained during CT ( $p < 0.001$ ). Depression scores significantly decreased following surgery ( $p = 0.01$ ), before RT ( $p = 0.007$ ), following RT ( $p < 0.001$ ), before CT ( $p = 0.01$ ), and after CT ( $p = 0.002$ ) in the YG compared to the CG [20]. Depression scores positively correlated with symptom severity and distress following surgery and during RT and CT

[34]. With an 8 week BYP-BC during CT, Lancot et al. found no changes in anxiety symptoms (STGAI-Y,  $p = 0.10$ ) due to low power and low baseline anxiety levels. Regarding depression symptoms (BDI II), there was an increase in the CG ( $n = 43$ ,  $p = 0.007$ ) at 8 weeks, no change in the YG ( $n = 58$ ), and a non-significant difference between the groups ( $p = 0.08$ ) [35].

### 3.5. Stress and self esteem

Using the YDL system, Kovacic et al. found improvements in the Rotterdam Symptom Checklist (RSCL) psychological distress subscale ( $p = 0.0005$ ) in the YG at 4 weeks post surgery/end of RT, with a non-significant worsening in the CG ( $p = 0.058$ ). The baseline mean Perceived Stress Scale (PSS) scores were high in both groups, but decreased at 4 weeks in the YG ( $p = 0.0005$ ) [36]. These results correlated with Vadiraja et al. and Banerjee et al., who both found significant decreases in perceived stress using PSS during 6 weeks of RT in the YG compared to the CG ( $p < 0.001$ ) [29,30]. In early operable breast cancer patients undergoing 4–8 cycles of adjuvant CT, Raghavendra et al. found a decrease in treatment-related distressful symptoms ( $p = 0.002$ ), symptom severity ( $p < 0.001$ ), and distress ( $p < 0.001$ ) in the YG compared to the CG, using a symptom checklist [19].

Using the YDL system, Kovacic et al. found that the YG ( $n = 16$ ) had improvements in Rosenberg Self Esteem Scale (RSE) scores compared to the CG ( $n = 16$ ) at 1 week post-surgery ( $p < 0.0005$ ) and 4 weeks post-surgery/end of RT ( $p < 0.0005$ ) while the CG's scores were unchanged [37].

### 3.6. Post-operative recovery

Rao et al. found that a 4 week Yoga intervention following surgery (lumpectomy or mastectomy) led to a decrease in duration of hospital stay ( $p = 0.003$ ), drain retention ( $p = 0.001$ ), and days until suture removal ( $p = 0.03$ ), in the YG ( $n = 33$ ) compared to the STG ( $n = 36$ ). Regression analysis on postoperative outcomes showed that Yoga affected the duration of drain retention and hospital stay [38].

### 3.7. Molecular level changes

Chandwani et al. found that at the end of 6 weeks of RT, the cortisol slope was steepest in the YG compared to the STG and the CG ( $p = 0.023$  and  $p = 0.008$ , respectively), maintaining 1 month after ( $p = 0.05$  and  $p = 0.04$ , respectively) [22]. Vadiraja et al. found that during 6 weeks of RT, the YG ( $n = 44$ ) had significant decreases in 6 a.m. salivary cortisol ( $p = 0.009$ ) and pooled mean cortisol ( $p = 0.03$ ) compared to the CG, with a positive correlation between 6 a.m. salivary cortisol level and anxiety ( $p < 0.05$ ) and depression ( $p < 0.01$ ) [29]. Banerjee et al. found that radiation-induced DNA damage was elevated in both the YG and CG after 6 weeks of RT, but 14.5% lower in the YG ( $p < 0.001$ ) [30].

In a 4 week Yoga intervention following surgery (lumpectomy or mastectomy), Rao, Nagendra et al. found a decrease in CD56% ( $p = 0.02$ ) in the YG ( $n = 33$ ) compared to the STG ( $n = 36$ ) [21]. During a 32 week period of surgery followed by RT and CT, Rao et al. found a decrease in NK cell % in CG ( $n = 21$ ) from pre-surgery to post-surgery (4 weeks,  $p < 0.05$ ) and from pre-surgery to post-CT (32 week,  $p < 0.001$ ). There was no decrease in the YG ( $n = 16$ ) with a higher NK cell % in the YG post-CT compared to the CG ( $p < 0.05$ ) [39].

Rao et al. found that a 4 week Yoga intervention following surgery (lumpectomy or mastectomy) led to decreases in plasma TNF alpha ( $p < 0.001$ ) and IgA ( $p = 0.001$ ) levels following surgery in the YG compared to the STG. Regression analysis on postoperative outcomes confirmed that the Yoga intervention affected TNF alpha levels [37].

Similarly, Kumar et al., 2013 showed that a YG ( $n = 78$ ) receiving the yoga intervention showed significantly different levels of blood cortisol ( $p \leq 0.002$ ) after 3 months and 6 months of the intervention compared to the CG ( $n = 69$ ) [40].



#### 4. Discussion/conclusion

Most of the literature on yoga for breast cancer to date has focused on a combination of cancer patients and survivors. This review of articles aimed to contribute to the literature by focusing on the potential benefits of yoga during cancer treatment. Overall, the majority of the RCTs showed significant benefits of Yoga intervention in QOL, fatigue, nausea/vomiting, sleep quality, anxiety, depression, stress, and wound healing. Several studies explored the physiological effects of Yoga on the immune response and inflammation. They found that Yoga leads to better cortisol regulation, less immune suppression and better wound healing. These mechanisms still need to be further explored. As highlighted, the studies that did not show improvements were limited by various reasons. These included low baseline values due to adequate baseline coping strategies, low study power, emphasis of yoga intervention on physical vs. mental health, inconsistent participation, design of the study (individual vs. group classes and variable class frequency), type of assessment(s) used, and non-adherence to intent-to-treat principle.

The RCTs used varying Yoga interventions in terms of type of Yoga (such as Tibetan, Anusara, Dru, and Bali), duration and frequency of Yoga intervention, individual, group, and/or home practice sessions, and when and how the outcomes were assessed (during chemotherapy, radiotherapy, and/or post-surgery). However, the Yoga interventions included four common aspects: asanas (postures), pranayama (nostril breathing), breathing exercises, and relaxation techniques/meditation. The variations in Yoga interventions used presented a major methodological challenge and limitation in summing and comparing the results. Furthermore, forming a standardized Yoga regimen for breast cancer patients that could also be individualized per patient should be explored. This would enable Yoga to become a more standardized intervention that physicians can recommend to their patients. In addition, there was some concern for, or a high risk of, bias in most studies. Only six studies were regarded as low risk of bias. It should be noted that a common issue had to do with developing an appropriate control group since subjects will know if they are performing Yoga practices versus other types of interventions. Thus, the overall risk of bias in the presented studies suggests that additional studies will be needed, with improved methods, to determine how useful Yoga can be in patients with breast cancer.

In conclusion, this systematic review of RCT's emphasizes the potential therapeutic role of Yoga in the symptomatic management of breast cancer patients, enhancing QOL during treatment as well as improving adherence to treatment. The findings suggest that yoga can be a feasible supportive intervention in patients undergoing treatment for breast cancer, with significant physical, emotional, social and psychological benefits. Future studies with more defined and consistent methodologies are necessary to fully understand the potential use of Yoga therapy in breast cancer patients.

#### Author Contribution statement

PS was involved with conceptualization, methodology, formal analysis, and writing the article; CH was involved with methodology, formal analysis, and writing the article; JM was involved with methodology, formal analysis, and writing and editing the article; AN was involved with conceptualization, methodology, formal analysis, writing the article, study supervision, and project administration.

#### Author Disclosure statement

Each author declares that he/she has no conflict of interest regarding the contents of this article.

#### Funding statement

No funding was obtained for the work performed on this article.

#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ctcp.2022.101581>.

#### References

- [1] U.S. Cancer Statistics Working Group, U.S. Cancer, Statistics Data Visualizations Tool, Based on November 2018 Submission Data (1999–2016), U.S. Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute, June 2019. [www.cdc.gov/cancer/dataviz](http://www.cdc.gov/cancer/dataviz).
- [2] C.E. DeSantis, J. Ma, A. Goding Sauer, L.A. Newman, A. Jemal, Breast cancer statistics, 2017, racial disparity in mortality by state, CA A Cancer J. Clin. 67 (6) (2017) 439–448.
- [3] T.G. Odle, Adverse effects of breast cancer treatment, Radiol. Technol. 85 (3) (2014) 297M–319M.
- [4] H.M. Penttinen, T. Saarto, P. Kellokumpu-Lehtinen, et al., Quality of life and physical performance and activity of breast cancer patients after adjuvant treatments, Psycho Oncol. 20 (2011) 1211–1220.
- [5] M. Horneber, G. Bueschel, G. Dennert, D. Less, E. Ritter, M. Zwahlen, How many cancer patients use complementary and alternative medicine: a systematic review and meta-analysis, Integr. Cancer Ther. 11 (2012) 187–203.
- [6] C.C. Hack, J. Hackl, N.B.M. Hüttner, H. Langemann, J. Schwitulla, S. Dietzel-Drentwett, P.A. Fasching, M.W. Beckmann, A.K. Theuser, Self-reported improvement in side effects and quality of life with integrative medicine in breast cancer patients, Integr. Cancer Ther. 17 (3) (2018) 941–951.
- [7] J. Langhorst, G.J. Dobos, Yoga for improving health-related quality of life, mental health and cancer-related symptoms in women diagnosed with breast cancer, Cochrane Database Syst. Rev. 1 (1) (2017) Jan 3).
- [8] R.M. Rao, R. Amritanshu, H.T. Vinutha, S. Vaishnaruby, S. Deepashree, M. Megha, R. Geetha, B.S. Ajaikumar, Role of yoga in cancer patients: expectations, benefits, and risks: a review, Indian J. Palliat. Care 23 (3) (2017) 225–230.
- [9] N.P. Gothe, I. Khan, J. Hayes, E. Erlenbach, J.S. Damoiseaux, Yoga effects on brain health: a systematic review of the current literature, Brain Plast. 5 (1) (2019) 105–122.
- [10] P. Sengupta, Health impacts of yoga and pranayama: a state-of-the-art review, Int. J. Prev. Med. 3 (7) (2012) 444–458.
- [11] E. Rivest-Gadbois, M.H. Boudrias, What are the known effects of yoga on the brain in relation to motor performances, body awareness and pain? A narrative review, Compl. Ther. Med. 44 (2019) 129–142.
- [12] Higgins JPT, Savović J, Page MJ, Elbers RG, Sterne JAC. Chapter 8: assessing risk of bias in a randomized trial. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 6.3 (updated February 2022).
- [13] M.C. Jong, I. Boers, A.P. Schouten van der Velden, S.V. Meij, E. Göker, A.N.J. H. Timmer-Bonte, H.A. van Wietmarschen, A randomized study of yoga for fatigue and quality of life in women with breast cancer undergoing (neo) adjuvant chemotherapy, J. Alternative Compl. Med. 24 (9–10) (2018) 942–953.
- [14] C.G. Ratcliff, K. Milbury, K.D. Chandwani, A. Chaoul, G. Perkins, R. Nagarathna, R. Haddad, H.R. Nagendra, N.V. Raghuram, A. Spelman, B. Arun, Q. Wei, L. Cohen, Examining mediators and moderators of yoga for women with breast cancer undergoing radiotherapy, Integr. Cancer Ther. 15 (3) (2016) 250–262.
- [15] H.S. Vadiraja, M.R. Rao, R. Nagarathna, H.R. Nagendra, M. Rekha, N. Vanitha, K. S. Gopinath, B.S. Srinath, M.S. Vishweshwara, Y.S. Madhavi, B.S. Ajaikumar, S. R. Bilimagga, N. Rao, Effects of Yoga program on quality of life and affect in early breast cancer patients undergoing adjuvant radiotherapy: a randomized controlled trial, Compl. Ther. Med. 17 (5–6) (2009) 274–280.
- [16] S.H. Vadiraja, M.R. Rao, R.H. Nagendra, R. Nagarathna, M. Rekha, N. Vanitha, S. K. Gopinath, B. Srinath, M. Vishweshwara, Y. Madhavi, S. Ajaikumar, B. S. Ramesh, N. Rao, Effects of Yoga on symptom management in breast cancer patients: a randomized controlled trial, Int. J. Yoga 2 (2) (2009) 73–79.
- [17] F. Siedentopf, I. Utz-Billing, S. Gairing, W. Schoenegg, H. Ketenich, I. Kollak, Yoga for patients with early breast cancer and its impact on quality of life – a randomized controlled trial, Geburtshilfe Frauenheilkd 73 (4) (2013) 311–317.
- [18] D. Lötze, F. Wiedemann, D. Rodrigues Recchia, T. Ostermann, D. Sattler, J. Ettl, M. Kiechle, A. Büssing, Iyengar-yoga compared to exercise as a therapeutic intervention during (Neo)adjuvant therapy in women with stage I-iii breast cancer: health-related quality of life, mindfulness, spirituality, life satisfaction, and cancer-related fatigue, Evid Based Complement Alternat Med 2016 (2016) 5931816.
- [19] K.D. Chandwani, G. Perkins, H.R. Nagendra, N.V. Raghuram, A. Spelman, R. Nagarathna, K. Johnson, A. Fortier, B. Arun, Q. Wei, C. Kirschbaum, R. Haddad, G.S. Morris, J. Scheetz, A. Chaoul, L. Cohen, Randomized, controlled trial of Yoga in women with breast cancer undergoing radiotherapy, J. Clin. Oncol. 32 (10) (2014) 1058–1065.
- [20] R.M. Raghavendra, R. Nagarathna, H.R. Nagendra, K.S. Gopinath, B.S. Srinath, B. D. Ravi, S. Patil, B.S. Ramesh, R. Nalini, Effects of an integrated Yoga programme on chemotherapy-induced nausea and emesis in breast cancer patients, Eur. J. Cancer Care 16 (6) (2007) 462–474.

- [21] R.M. Rao, N. Raghuram, H.R. Nagendra, G.S. Kodaganur, R.S. Bilimagga, H. P. Shashidhara, R.B. Diwakar, S. Patil, N. Rao, Effects of a yoga program on mood states, quality of life, and toxicity in breast cancer patients receiving conventional treatment: a randomized controlled trial, *Indian J. Palliat. Care* 23 (3) (2017) 237–246.
- [22] R.M. Rao, H.R. Nagendra, N. Raghuram, C. Vinay, S. Chandrashekara, K. S. Gopinath, B.S. Srinath, Influence of Yoga on mood states, distress, quality of life and immune outcomes in early stage breast cancer patients undergoing surgery, *Int. J. Yoga* 1 (1) (2008) 11–20.
- [23] K.D. Chandwani, B. Thornton, G.H. Perkins, B. Arun, N.V. Raghuram, H. R. Nagendra, Q. Wei, L. Cohen, Yoga improves quality of life and benefit finding in women undergoing radiotherapy for breast cancer, *J. Soc. Integr. Oncol.* 8 (2) (2010) 43–55.
- [24] S. Eyigor, R. Uslu, S. Apaydin, I. Caramat, H. Yesil, Can yoga have any effect on shoulder and arm pain and quality of life in patients with breast cancer? A randomized, controlled, single-blind trial, *Compl. Ther. Clin. Pract.* 32 (2018) 40–45.
- [25] C.J. Taso, H.S. Lin, W.L. Lin, S.M. Chen, W.T. Huang, S.W. Chen, The effect of Yoga exercise on improving depression, anxiety, and fatigue in women with breast cancer: a randomized controlled trial, *J. Nurs. Res.* 22 (3) (2014) 155–164.
- [26] A. Chaoul, K. Milbury, A. Spelman, K. Basen-Engquist, M.H. Hall, Q. Wei, Y.T. Shih, B. Arun, V. Valero, G.H. Perkins, G.V. Babiera, T. Wangyal, R. Engle, C.A. Harrison, Y. Li, L. Cohen, Randomized trial of Tibetan Yoga in patients with breast cancer undergoing chemotherapy, *Cancer* 124 (1) (2018) 36–45.
- [27] J. Chakrabarty, M. Vidyasagar, D. Fernandes, G. Joisa, P. Varghese, S. Mayya, Effectiveness of pranayama on cancer-related fatigue in breast cancer patients undergoing radiation therapy: a randomized controlled trial, *Int. J. Yoga* 8 (1) (2015) 47–53.
- [28] H.S. Vadiraja, R.M. Rao, R. Nagarathna, H.R. Nagendra, S. Patil, R.B. Diwakar, et al., Effects of yoga in managing fatigue in breast cancer patients: a randomized controlled trial, *Indian J. Palliat. Care* 23 (3) (2017) 247–252.
- [29] A.S. Anestin, G. Dupuis, D. Lanctôt, M. Bali, The effects of the Bali yoga program for breast cancer patients on chemotherapy-induced nausea and vomiting: results of a partially randomized and blinded controlled trial, *J. Evid. Based. Complementary. Altern. Med.* 22 (4) (2017) 721–730.
- [30] H.S. Vadiraja, R.M. Raghavendra, R. Nagarathna, H.R. Nagendra, M. Rekha, N. Vanitha, K.S. Gopinath, B.S. Srinath, M.S. Vishweshwara, Y.S. Madhavi, B. S. Ajaikumar, B.S. Ramesh, R. Nalini, V. Kumar, Effects of a Yoga program on cortisol rhythm and mood states in early breast cancer patients undergoing adjuvant radiotherapy: a randomized controlled trial, *Integr. Cancer Ther.* 8 (1) (2009) 37–46.
- [31] B. Banerjee, H.S. Vadiraj, A. Ram, R. Rao, M. Jayapal, K.S. Gopinath, B.S. Ramesh, N. Rao, A. Kumar, N. Raghuram, S. Hegde, H.R. Nagendra, M. Prakash Hande, Effects of an integrated Yoga program in modulating psychological stress and radiation-induced genotoxic stress in breast cancer patients undergoing radiotherapy, *Integr. Cancer Ther.* 6 (3) (2007) 242–250.
- [32] M.R. Rao, N. Raghuram, H.R. Nagendra, K.S. Gopinath, B.S. Srinath, R.B. Diwakar, S. Patil, S.R. Bilimagga, N. Rao, S. Varambally, Anxiolytic effects of a Yoga program in early breast cancer patients undergoing conventional treatment: a randomized controlled trial, *Compl. Ther. Med.* 17 (1) (2009) 1–8.
- [33] T. Kovačić, M. Zagoričnik, M. Kovačić, Impact of relaxation training according to the Yoga in Daily Life® system on anxiety after breast cancer surgery, *J. Compl. Integr. Med.* 10 (1) (2013) 153–164.
- [34] R.M. Rao, N. Raghuram, H.R. Nagendra, M.R. Usharani, K.S. Gopinath, R. B. Diwakar, S. Patil, R.S. Bilimagga, N. Rao, Effects of an integrated yoga program on self-reported depression scores in breast cancer patients undergoing conventional treatment: a randomized controlled trial, *Indian J. Palliat. Care* 21 (2) (2015) 174–181.
- [35] D. Lanctôt, G. Dupuis, R. Marcaurell, A.S. Anestin, M. Bali, The effects of the Bali Yoga Program (BYP-BC) on reducing psychological symptoms in breast cancer patients receiving chemotherapy: results of a randomized, partially blinded, controlled trial, *J. Compl. Integr. Med.* 13 (4) (2016) 405–412.
- [36] T. Kovačić, M. Kovačić, Impact of relaxation training according to Yoga in Daily Life® system on perceived stress after breast cancer surgery, *Integr. Cancer Ther.* 10 (1) (2011) 16–26.
- [37] T. Kovačić, M. Kovačić, Impact of relaxation training according to Yoga in Daily Life® system on self-esteem after breast cancer surgery, *J. Alternative Compl. Med.* 17 (12) (2011) 1157–1164.
- [38] R.M. Rao, H.R. Nagendra, N. Raghuram, C. Vinay, S. Chandrashekara, K. S. Gopinath, B.S. Srinath, Influence of Yoga on postoperative outcomes and wound healing in early operable breast cancer patients undergoing surgery, *Int. J. Yoga* 1 (1) (2008) 33–41.
- [39] R.M. Rao, S. Telles, H.R. Nagendra, R. Nagarathna, K. Gopinath, S. Srinath, C. Chandrashekara, Effects of Yoga on natural killer cell counts in early breast cancer patients undergoing conventional treatment, *Med. Sci. Mon. Int. Med. J. Exp. Clin. Res.* 14 (2) (2008) LE3–4.
- [40] N. Kumar, S. Bhatnagar, T. Velpandian, S. Patnaik, G. Menon, M. Mehta, et al., Randomized controlled trial in advance stage breast cancer patients for the effectiveness on stress marker and pain through sudarshan kriya and pranayam, *Indian J. Palliat. Care* 19 (3) (2013) 180–185.