Yoga for Children and Adolescents After Completing Cancer Treatment

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Abstract

Survivors of childhood cancer may experience persistent symptoms, including fatigue, sleep disturbance, and balance impairment. Yoga is a complementary therapy that improves fatigue, sleep, and quality of life in adult cancer survivors. Using a one group, repeated measures design, we evaluated the feasibility of a yoga program and assessed if cancer survivor participants ages 10 to 17 years (n = 13) had significantly less fatigue and anxiety, and better balance and sleep, after a 6-week yoga intervention compared with a 6-week pre-intervention wait period. Study recruitment was challenging with a 32% enrollment rate; yoga attendance was 90%. None of the scores for anxiety, fatigue, sleep, and balance had significant changes during the wait period. After the 6-week yoga program, children (n = 7) had a significant decrease in anxiety score (P = .04) while adolescent scores (n = 7) showed a decreasing trend (P = .10). Scores for fatigue, sleep, and balance remained stable post-intervention. Fatigue and balance scores were below norms for health children/adolescents while sleep and anxiety scores were similar to healthy peers.

Keywords

yoga, pediatric cancer, survivorship, symptoms

Introduction

Children and adolescents undergoing cancer treatment experience multiple distressing and prevalent symptoms related to the intensity of curative interventions (Hockenberry, 2004). Research has found that adult survivors of childhood cancer experience chronic symptoms, including fatigue, sleep disturbance, and balance impairment, that continue years after treatment completion. Research is emerging about the prevalence and intensity of symptoms at the end of therapy and the early years of survivorship (Rosen, Shor, & Geller, 2008; Varni, Burwinkle, Katz, Meeske, & Dickinson, 2002; Wright, Galea, & Barr, 2005). A recent study in the adult cancer population has demonstrated the benefit of yoga for improving fatigue, sleep, and quality of life in early cancer survivors (Mustian et al., 2010; Mustian et al., 2013).

In children and adolescents undergoing cancer treatment, fatigue has been reported as one of the most distressing and prevalent symptoms (Collins et al., 2000; Davies, Whitsee, Bruce, &McCarthy, 2002; Hockenberry-Eaton & Hinds, 2000). Fatigue is defined as a subjective symptom with physical, mental, and emotional components characterized by a lack of energy (Hockenberry-Eaton & Hinds, 2000). As treatment of childhood cancer advances, researchers have begun to identify fatigue as a persistent symptom in long-term survivors of the disease. Analysis of a large cohort of adult survivors of childhood cancer (n = 2645) from the Childhood Cancer Survivor study revealed that survivors reported significantly more fatigue than their siblings (Mulrooney et al., 2008). Meeske, Patel, Palmer, Nelson, and Parow (2007) studied children age 8 to 18 years who were cancer survivors and found that fatigue was associated with poorer physical and psychosocial functioning and was a powerful predictor of functional status and health related quality of life. When testing the PedsQL™ Multidimensional Total Fatigue Scale, Varni et al. (2002)

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found that children age 8 to 18 years who had completed treatment within the last 12 months (n = 41), had significantly more fatigue than healthy controls.

Balance is an integral component of functional motor ability that has been demonstrated to be decreased in survivors of childhood cancer. In a study of 99 children and adolescents at least 1 year off of treatment for acute lymphocytic leukemia (ALL), Wright et al. (2005) demonstrated that survivors have decreased balance control when compared with control subjects. The balance deficit primarily manifests itself in higher level motor tasks, such as standing with a narrowed base of support or with the eyes closed, and can lead to children having decreased feelings of adequacy in physical activity. De Luca et al. (2013) studied children who had completed treatment for ALL and found that in the cohort that was 13 to 24 months off treatment, 30% were below healthy norms for balance. Similar but more severe deficits have been found in survivors of childhood brain tumors (Ness et al., 2010). Because children who are survivors of ALL and other cancers are at risk for decreased levels of overall physical activity, increased levels of obesity, and cardiovascular risk factors (Chow, Pihoker, Hunt, Wilkinson, & Friedman, 2007), it may be important to improve their underlying balance impairment to address their overall health. Thus far, to our knowledge, no studies of interventions targeting balance impairments in survivors of childhood cancer have been reported.

Sleep is essential for healthy growth and development and cognitive functioning (Buckhalt, El-Sheikh, & Keller, 2007). Sleep in children with cancer may be influenced by the direct effects of cancer or the indirect effects of chemotherapy, radiation therapy, pain, brain injury, or fatigue (Rosen et al., 2008). The circadian and homeostatic systems may be affected by changes in the neurologic machinery of the brain or by disruptions in the sleep environment. In a study from the Childhood Cancer Survivor study, researchers found that adult cancer survivors reported significantly poorer sleep and greater daytime sleepiness than their siblings did (Mulrooney et al., 2008). Actigraphy measurement of children in the maintenance phase of outpatient treatment for acute lymphoblastic leukemia 3 weeks after a 5-day steroid pulse shows that their sleep efficiency is lower than the level considered acceptable for children (Hinds et al., 2007). However, little is known about the sleep quality of children in the first years after completing cancer treatment.

Researchers found little evidence for posttraumatic stress symptoms in children and adolescents, ages 8 to 19 years who had completed treatment for ALL a mean of 5.79 years previously, when compared with their healthy peers (Kazak et al., 1997). In the Childhood Cancer Survivor study, adult survivors of pediatric cancer and their siblings had levels of psychological distress that were within the range of population norms. However, survivors of childhood brain tumors have higher global distress than their healthy siblings (Zebrack et al., 2007). In their systematic review, researchers concluded that some studies show that pediatric patients who have recently completed cancer treatment experience positive psychosocial outcomes, including feelings of high self-worth and improved mental health, while other studies demonstrate that they can be at risk for lower levels of psychological well-being. Further research is needed to identify the unique needs of patients as they complete cancer treatment and transition to survivorship (Wakefield et al., 2010).

Yoga is the disciplined practice of breathing (*pranayama*), postures (*asana*), and meditation (*dhanya*); this creates an inner sense of peace with positive effects becoming visible over time. In healthy adults, the practice has been shown to lower the heart rate and blood pressure, while improving circulation and oxygenation, which all lead to improved cardiovascular endurance (Birkel & Edgren, 2000). Yoga has improved balance, flexibility, muscular strength (Evans, Sternlieb, Tsao, Zeltzer, 2009), and sleep, and can decrease levels of stress (Smith, Hancock, Blake-Mortimer, & Eckert, 2007). In healthy children, yoga has a positive influence on motor performance, ability to concentrate, cardiopulmonary functioning, and musculoskeletal functioning (Galantino, Galbavy, & Quinn, 2008). In a critical review of yoga studies for adults undergoing cancer treatment, DiStatio (2008) found that yoga decreased symptom distress including fatigue, insomnia, mood, and stress resulting in improved quality of life. In our earlier pilot study, we evaluated the impact of a single yoga session on a sense of well-being in children and adolescents with cancer, and parents of pediatric cancer patients. Using the State Anxiety Scale as the measurement, we found that parents and adolescents had a significant decrease in their self-report scores while children's scores were low both pre- and post-yoga and so did not change significantly (Thygeson, Hooke, Clapsaddle, Robbins, & Moquist, 2010). In a more recent study, researchers determined the feasibility and benefits of a 12-week, 2-session/week, community-based yoga intervention on quality of life, select physical fitness outcomes, and physical activity levels in a group of 8 children aged 8 to 17 years who were receiving cancer treatment. The children had a significant improvement in quality of life scores, flexibility, functional mobility, and physical activity scores (Wurz, Chamorro-Vina, Guilcher, Schulte, & Culos-Reed, 2014).

Adult oncology researchers recently completed a randomized clinical trial of 410 men and women who had completed cancer treatment within the last 2 to 24 months.

The study demonstrated that 4 weeks of yoga taken twice a week significantly improved self-reported sleep quality, fatigue, and quality of life compared with the control group (Mustian et al., 2010; Mustian et al., 2013). The methodology of this adult study was adapted for our study of a pediatric cancer survivors; an additional outcome, balance control, was added which is an important motor skill for ongoing development and physical functioning in survivorship.

In our exploratory study, we sought to explore the feasibility and benefits of a 6-session, weekly yoga intervention for pediatric cancer survivors who completed therapy in the past 2 to 24 months. The aim of the study was to determine if children and adolescents who were cancer survivors and participated in a 6-session, weekly yoga group had less fatigue, improved balance, improved sleep quality, and less psychological distress compared with baseline measurements.

Methods

Participants

Participants for this study were recruited from 2 pediatric cancer centers in Minnesota. Eligible participants included children and adolescents age 10 to 18 years, who (*a*) spoke English; (*b*) had completed treatment in the past 2 to 24 months for a pediatric cancer (leukemia, lymphoma, solid tumor, and/or central nervous system [CNS] tumor); (*c*) received cancer treatment that included chemotherapy and/or radiation, or if a patient with a CNS tumor, treatment with surgery only were also eligible; (*d*) were able to stand and ambulate without assistance of a walker or wheelchair; (*e*) had not participated in a yoga class in the previous 3 months; (*f*) gave assent according to institutional guidelines; and (*g*) had parental consent to participate. Children and adolescents were excluded if they had an antecedent neurological, developmental, or genetic disorder before their cancer diagnosis.

The study was approved by the institutional review board at each of the participating sites. Potential participants and families were invited to the study during a standard clinic visit for follow-up care. These occur monthly during the first 6 months after cancer treatment. If a patient was not scheduled for a clinic visit within a 2-month period, they were contacted by mail with a recruitment letter and study information sheet with a phone call follow-up from one of the investigators. Photos of children and adolescents performing yoga were included with the assent form as an additional source of explanation on what yoga is. To encourage subject enrollment into a study that had an unfamiliar group, participants were informed that they could bring a friend, sibling, and/or parent to the class as co-attendees (partner). Co-attendees only participated in the yoga sessions and did not complete any study measurements. Parents were provided reimbursement for their fuel costs for the 8 study visits. Participants were given a $10 gift card after each set of study measurements to thank them for their time.

There were no published studies available that evaluate yoga on fatigue in children with cancer. We were therefore unable to estimate the sample size needed to detect a change in fatigue. This feasibility study will provide a foundation for developing future power estimations for measuring fatigue in yoga intervention studies.

Design and Procedures

A one-group, within-subject, repeated-measures design was used to evaluate if children and adolescent cancer survivors had significantly less fatigue, better balance, better sleep, and less stress after a 6-week yoga intervention compared with a 6-week pre-intervention wait period. Study measurements occurred 3 times: (*a*) Week 1 of the study (start of the pre-intervention wait period); (*b*) Week 6 (after wait period) and immediately before first yoga class; (*c*) Week 11 after the sixth yoga session was completed.

Yoga Intervention

The series of 6 weekly yoga classes was held at one of the study institutions, in a large conference room, cleared of furniture, with accessible wall space. Prior to initiating the yoga intervention, the physical therapist investigator reviewed the medical history of each participant and discussed any potential restrictions or modifications needed for the participants with the yoga instructor. The yoga instructor and one of the study investigators met the participants and their family members in the room before the start of each class. The yoga instructor engaged the participants in discussions about any current injuries, previous yoga experience, and so on. At the start of each class, the yoga instructor introduced the general structure of the class, based on the principles of hatha yoga, emphasized the importance of the breath in conjunction with physical movements, and encouraged participants to do only what was comfortable in their own bodies. The 45-minute yoga class followed a standard yoga class structure, starting with an opening seated meditation, followed by gentle stretching, then warm up poses, standing poses, balancing poses, seated and supine cool down stretches, and final resting pose. Modifications were taught as part of the class, providing different options at varying difficulty levels for many of the poses. The emphasis of the class was on the breath and on making the class an individual experience for each participant within the context of the group activity. Relaxing music and dimmed lighting were

part of that experience, with the instructor often playing the same music for consistency.

Yoga curriculum was developed by the instructor, who was a co-investigator on the study, in conjunction with the physical therapist coinvestigator to accommodate all levels and to avoid postures that may place too much stress on the post–chemotherapy body. The yoga intervention blended active and restorative (restful) poses, with each weekly class building on poses introduced in each of the previous yoga sessions. For example, after Warrior II was introduced in Week 3, Week 4 offered the opportunity to hold Warrior II for a longer time, and Week 5 built on the pose by adding the option to flow between Warrior II and extended side angle. The class was designed to increase awareness of the breath, increase strength and endurance, facilitate an improvement in balance, and to provide a peaceful experience for participants. In addition to attending the weekly yoga classes, the participants were given a DVD that featured the same yoga instructor and offered the same variations and modifications for the poses that were presented in class. The participants were instructed to use the DVD to practice yoga in the home setting twice a week. At the end of the class, refreshments were provided. Participants and the co-attendees that accompanied them stayed for 15 minutes for informal socialization.

Three different cohorts of participants completed the yoga measurements and 6-week sessions. Each cohort had 4 to 5 participants. With family or friends accompanying the participant, each session had 10 to 12 attendees.

Measurement

Feasibility was determined by how many patients met the eligibility criteria but lived greater than an hour away from the institution where the weekly classes were held, making study participation burdensome and impractical. The overall study consent rate was tracked as was attendance, and the number of times the participants used the yoga DVD at home. Study participants were encouraged to bring a friend, sibling, and/or parent to class with them and the co-attendee's relationship to the participant was also recorded.

The PedsQL Multidimensional Fatigue Scale was used to measure the subject's level of fatigue (Varni et al., 2002). The 18-item scale includes three 6-item subscales, which include (*a*) general fatigue, (*b*) sleep/rest fatigue, and (*c*) cognitive fatigue. This scale was selected because it has been tested in children and adolescents, ages 5 to 18 years, who have completed treatment within the past 12 months as well as pediatric cancer survivors 12 to 24 months posttreatment (n = 95). A 5-point Likert-type scale is used across the self-report scale; items are reverse scored and linearly transformed to a 0 to 100 scale with 0 = 100, 1 = 75, 2 = 50, 3 = 25, 4 = 0, so that higher scores indicate less fatigue. Estimates for the internal consistency for the total fatigue score were 0.88 for 8 to 12 year olds and 0.92 for 13 to 18 year olds (Cronbach's α). The scale detected significant differences in total fatigue between subjects who had been off cancer treatment less than 12 months and healthy controls ($P < .05$) (Varni et al., 2002) .

The Adolescent Sleep-Wake Scale (ASWS) is a 28-item self-report scale that assesses sleep quality in children and adolescents (LeBourgeois, Giannotti, Cortesi, Wolfson, & Harsh, 2005). The respondent is asked to indicate the frequency of sleep behaviors using a 6-point scale ("always," "frequently-if not always," "quite often," "sometimes," "once in a while," and "never"). Sleep is measured along 5 behavioral dimensions including going to bed (5 items), falling asleep (6 items), maintaining sleep (6 items), going back to sleep (6 items), and returning to wakefulness (5 items). Mean subscale scores for each dimension and a full-scale sleep-quality score (ASWS total; mean of 5 subscales) can be calculated. Higher scores indicate better sleep quality. In a sample of 572 American children and adolescents ages 12 to 18 years, the estimate for the internal consistency for the full scale (ASWS total) was 0.86 (Cronbach's α) (LeBourgeois et al., 2005).

The Bruininks-Oseretsky Test of Motor Proficiency (BOT-2) Balance Subtest is a functional capacity measure used to assess the motor skill of children and adolescents. The BOT-2 balance subtest is designed to assess children with mild to moderate balance instability. Test items include skills such as standing with one foot in front of the other on a low balance beam and standing on one leg with eyes open and closed. Interrater reliability, test–retest reliability, and a standard error of measurement were established for each subtest and age group (Bruininks & Bruininks, 2005). Participants were scored for the subtest, with an age and gender normalized mean of 15 and standard deviation of 5. The balance subtest specifically has interrater reliability above 0.9 (Bruininks & Bruininks, 2005).

Spielberger State Trait Anxiety Inventory (STAI) was used to measure psychological distress and the general sense of well-being. The adult version of the STAI was used for adolescents ages 13 to 18 years (Spielberger, Gorsch, Lushene, Vagg, & Jacobs, 1983), while the child version, STAIC, was used for children ages 7 to 12 years (Spielberger, Gorsch, Lushene, Vagg, & Jacobs, 1973). The STAI and STAIC are composed of 2 separate report scales that measure state and trait anxiety. Trait anxiety refers to the relatively stable individual differences in anxiety proneness. In this study, only the State (S-Anxiety) scale was be used as a measurement of the

participants' current feelings. The STAI has 20 items and the participant rates the feeling for each on a 4-point scale with responses choices being "not at all," "somewhat," "moderately so," or "very much so." Possible scores range from 20 to 80. The internal consistency estimate for the STAI ranges from 0.90 to 0.94 (Cronbach's α) (Spielberger et al., 1983). The STAIC also has 20-item instruments. Each question begins with the words "I feel" followed by a 3-point rating scale. Possible scores range from 20 to 60. The internal consistency estimate for the STAIC is 0.82 to 0.87 (Cronbach's α) (Spielberger et al., 1973). Both the adult and child versions of this scale have been previously used in the pediatric oncology population.

Administration of Study Measurements

The first set of measurements was performed on Week 1 of the study. The participants then had a 6-week pre-intervention waiting period. On Week 6, the participants returned to the study site, repeated the measurements, and then started the yoga intervention. The yoga session intervention was held weekly for 6 weeks on the same day. The third and last set of measurements was performed after the sixth yoga session.

Self-report instruments were read to subjects ages 12 years and less, and for subjects who have a learning disability documented in their medical history. The fatigue instrument was administered first to assure that fatigue was reported from the previous week and not related to fatigue from completing study measurements. All subjects were directed to think about how they felt during the past week. The BOT-2 Balance Subtest was administered by a physical therapist, a coinvestigator on the study. At each yoga session, participants were asked individually if they used the DVD to perform yoga at home and if they answered yes, the number of times.

Analysis

Using descriptive statistics, feasibility was assessed by the percentage of patients and families who assented/consented, attended at least 4 of the 6 sessions, practiced yoga at home, and completed all the study measurements. SPSS software version 20.0 was used. Because of the small sample size, the nonparametric Wilcoxon signed rank test with a 0.05 2-sided significance level was used to compare group medians to evaluate if there was a significant change in Week 1 and Week 6 pre-intervention measurement scores due to passage of time since completing treatment. The Wilcoxon signed rank test was also performed to determine if there was a significant change in the scores between the Week 6 pre-intervention measurement and the Week 11 post-intervention measurement.

Results

Feasibility

Ninety patients were screened and determined to meet the eligibility criteria; however, 37 of these patients lived an hour or more away from the institution and were therefore not recruited to the study. Fifty-three patients and families were invited to the study with 30 refusing right away during the discussion citing lack of interest, burden of extra trips to institution, or time limitations. Five 18 year olds expressed interest but were leaving the area for college during the study time period. Eighteen participants were consented for an enrollment rate of 34%. Two survivors were removed from the study due to relapse during their enrollment period; 3 adolescents consented but dropped out of the first cohort before the intervention was started. Thirteen of the 18 enrolled participants (72%) completed study. The yoga class attendance rate was 90% with 69% reported practicing yoga at home with DVD at least once a week. Eight-five percent of participants had a parent participate in yoga classes with them and an additional 54% also brought a sibling or friend to class.

Sample

The sample characteristics of the 13 participants who completed the study are provided in Table 1. Seventy-seven percent of the participants were female and 84% were Caucasian. This racial predominance is reflective of the pediatric cancer population in the state of Minnesota. Children and adolescents who had been treated for CNS tumors made up the largest diagnostic group with those treated for leukemia or lymphoma second. The 2 participants who were in the solid tumor group had completed treatment for cancers that had permanently affected their walking gait and balance. The types of cancer treatment administered included single or combination approaches of chemotherapy, surgery, and/or radiation.

Change in Symptoms

During the pre-intervention, 6-week wait period, total fatigue median scores remained stable as did the median subscores for general fatigue and sleep/rest fatigue (Table 2). Median subscores for cognitive fatigue showed a significant decrease ($P = .05$) indicating a worsening symptom. Median total scores and subscores on the Adolescent Sleep-Wake scale evidenced little change during the wait period (Table 3) and balance measurements also remained relatively stable (Table 4). Median scores for anxiety/sense of wellness evidenced little change (Table 5).

After the 6 weekly yoga sessions, self-reports of fatigue and sleep pre- and post-yoga intervention remained stable (Tables 2 and 3, respectively). Balance

Table 1. Patient Demographic Characteristics (N = 13).

Characteristic	n	Percentage
Gender		
Male	3	23
Female	10	77
Race or origin		
Caucasian	11	84
Hispanic Latino	1	8
Asian	1	8
Diagnostic group		
Leukemia/lymphoma	5	38
Solid tumor	2	15
CNS tumor	6	46
Cancer treatment		
Chemotherapy only	5	38
Chemotherapy & radiation	2	15
Chemotherapy & surgery	2	15
Radiation only	1	8
Surgery & radiation	1	8
Surgery only (CNS)	2	15
	Mean	SD
Age	12.92	2.68
Months off treatment	10.5	5.73

Table 2. Change in Median Scores for Fatigue.

	Pre-Intervention Wait Period			Intervention		
The PedsQL Fatigue Scale	Week 1 (Pre-Wait)	Week 6 (Post-Wait/Pre-Yoga)	*P*	Week 6 (Post-Wait/Pre-Yoga)	Week 11 (Post-Yoga)	*P*
Total score	68.66	66.02	.17	66.02	68.57	.30
General fatigue	79.17	75	.68	75	75	.43
Sleep/rest fatigue	75	66.6	.11	66.6	70.83	.21
Cognitive fatigue	70.83	62.5	.05*	62.5	66.67	.65

*Significant difference.

Table 3. Change in Median Scores for Sleep.

	Pre-Intervention Wait Period			Intervention		
Adolescent Sleep–Wake Scale	Week 1 (Pre-Wait)	Week 6 (Post-Wait/Pre-Yoga)	*P*	Week 6 (Post-Wait/Pre-Yoga)	Week 11 (Post-Yoga)	*P*
Total score	4.54	4.59	.70	4.59	4.67	.16
Going to bed	4.20	3.80	.22	3.80	4.90	.38
Falling asleep	4.33	4.83	.13	4.83	5.00	.72
Maintaining sleep	5.50	5.33	.50	5.33	5.00	.50
Going back to sleep	5.00	5.50	.82	5.50	5.33	.90
Returning to being awake	3.60	3.60	.42	3.60	4.00	.32

after the 6 weeks of yoga also remained unchanged compared with the post-wait/pre-yoga measurements (Table 4). Children (n = 7) had a significant decrease in their anxiety/wellness scores (P = .04) compared with their scores post-wait period/pre-yoga (Table 5). The median adolescent scores (n = 6) on the State Anxiety scale

Table 4. Change in Median Scores for Balance.

	Pre-Intervention Wait Period			Intervention		
	Week 1 (Pre-Wait)	Week 6 (Post-Wait/Pre-Yoga)	*P*	Week 6 (Post-Wait/Pre-Yoga)	Week 11 (Post-Yoga)	*P*
BOT-2 Balance Subtest	7.0	8.0	.18	8.0	8.0	.14

Table 5. Change in Median Scores for Anxiety/Sense of Wellness.

		Pre-Intervention Wait Period			Intervention		
Cohort	n	Week 1 (Pre-Wait)	Week 6 (Post-Wait/Pre-Yoga)	*P*	Week 6 (Post-Wait/Pre-Yoga)	Week 11 (Post-Yoga)	*P*
Child (STAIC)	7	26	28	.916	28	22	.04*
Adolescent (STAI)	6	29	32	.50	32	24.5	.10

*Significant difference.

trended toward a decrease ($P = .10$) after the yoga intervention (Table 5).

Healthy Norms

When compared with their healthy child and adolescent peers, cancer survivors' self-report scores for sleep and anxiety were similar. However, fatigue and balance scores were below those of healthy norms at all the measurements. Each of the 13 participants completed 3 time points for a total of 39 measurements. Seventy-four percent of the total fatigue scores were below the mean for healthy children with 46% of the total scores being lower than 1 SD below the mean. In the subscale of general fatigue, 77% were below the healthy mean with 28% lower than 1 SD below the mean. Sleep fatigue subscale scores were closer to healthy children with 54% below the mean and 28% lower than 1 SD below their healthy peers. The subscale scores for cognitive fatigue were the lowest of the fatigue subscores compared with healthy children with 90% of participants scoring below the mean and 51% below 1 SD. Among the balance scores, 66% of participants were more than 1 SD below age- and gender-matched normal values.

Limitations

The study's small sample size limited the analysis of the data and study results. The decrease in anxiety must be interpreted cautiously due to the size of the child (n = 7) and adolescent (n = 6) subgroups created based on the instrument age specifications. Although we were assertive and committed in our recruitment efforts, we had limited success enrolling participants. Study results will provide guidance in determining a sample size for future yoga intervention studies however. The small sample size also limited the exploration of variables such as gender, diagnosis, or treatment methods that may have influenced symptoms. Research on pediatric cancer symptoms during and/or after treatment is challenging at one or two institutions in focused geographic areas due to small numbers of specific types of cancer and potential patients at different points in the treatment trajectory. For example, conducting a yoga program for pediatric patients with a specific diagnosis who are at similar points in treatment or survivorship would not be feasible. Although the study was done in a major metropolitan area in the Midwest, many of the patients who met the age, diagnosis, and treatment eligibility criteria lived considerable distance away and returning to the treatment institution posed an unreasonable burden.

There may have been a selection bias in the sample for this study. Several parents commented that they were continually watching for opportunities for their child to be physically active because they were aware of their child's risk of obesity as a cancer survivor. Patients and families that committed to the study may have been more active and functional at baseline with less distressing symptoms than other survivor families. Also, when asked about their patterns of performing the yoga intervention at home using the study DVD, participants may have reported that they practiced in an effort to please the researchers, when in fact they had not performed yoga between the weekly sessions.

Discussion

Although enrollment rates for the study were low at 35%, the yoga intervention proved feasible for those patients and families who committed to participating with a 90%

attendance rate. Participants reported a rate of 69% for practicing yoga at home at least once a week using a DVD but also discussed that they did not enjoy the home sessions as they did the "in person" class. Most patients brought a parent who also took the yoga class and many brought siblings or friends. Researchers planning yoga studies in the future should consider including these supportive co-attendees in their study designs. All the participants and their co-attendees commented on how much they enjoyed the social part of the experience. Several parents shared that they wished yoga had been offered to them early in their child's treatment trajectory. In reflecting back, they recognized that they should have done more self-care and now, in their child's survivorship, were dealing with their own health concerns with weight gain and poor fitness.

Future researchers will also face the challenge of recruiting enough participants to a study group for receiving the yoga intervention simultaneously. Returning to the treating institution is burdensome but holding interventions sessions at outside locations presents its own set of geographic and logistical difficulties in a large metropolitan area. In our study, the physical therapist with expertise in pediatric oncology late effects consulted with the yoga instructor to ensure the yoga intervention was safe and adapted to any ongoing effects of treatment or disease. If multiple community yoga instructors were used, this safety adaptation would be difficult to assure.

During the study pre-intervention 6-week wait period, most of the symptoms measured did not change with the passage of time. The subscores for cognitive fatigue showed a significant increase. It is not known why these scores would change other than the second measurements at the end of the wait period were taken immediately before the first yoga session when the participant may have been overly focused about a starting a new experience with yoga.

The yoga intervention did result in a significant decrease in the 6- to 12-year-old children's anxiety/wellness scores and the 13- to 17-year-old adolescent scores trended toward a decrease. The pre-intervention scores were already within the norm for healthy children and adolescents but still decreased even lower. This is consistent with our previous research that showed a decrease in these scores in adolescents measured pre and post a single yoga session. We do not know if our results reflect a cumulative effect of 6 weeks of yoga or were due to the benefits of a single session. The study intervention did not affect the participant' sleep self-report scores; however, the scores were similar to norms of health children and adolescents and followed similar patterns with "returning to wake" having the lowest scores. Both fatigue and balance scores were lower than healthy norms and did not improve significantly with yoga. A yoga intervention that was administered over a longer period than 6 weeks, had more frequent meetings during the week, and/or longer class sessions with more time devoted to challenging balance and restorative poses, may have resulted in different outcomes and should be considered for future research.

Conclusion

Recruiting pediatric cancer survivors to a yoga intervention study over a multi-week time period is challenging with potential participants reporting lack of interest due to the burden of returning to the institution after treatment has been completed. Those who did participate were engaged with excellent attendance with their family and friends. Self-report scores for anxiety/sense of wellness decreased but scores for other symptoms were not affected by the yoga intervention. Future studies should consider intervention intensity and length as well as approaches to decrease participant burden.

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