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The Feasibility and Benefits of a 12-Week Yoga Intervention for Pediatric Cancer Out-Patients

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Background. Increasing rates of survival present a new set of psychosocial and physical challenges for children undergoing treatment for cancer. Physical activity (PA) has been shown to be a safe and effective strategy to mitigate the significant burden of cancer and its treatments, with yoga increasingly gaining recognition as a gentle alternative. The purpose of this study was to determine the feasibility and benefits of a 12-week community-based yoga intervention on health-related quality of life (HRQL), select physical fitness outcomes and PA levels (PAL). ***Procedure.*** Eight pediatric cancer out-patients (4 male; 4 female; $M_{age} = 11.88$, $SD = 4.26$) participated in the 12-week intervention consisting of supervised yoga sessions 2 times/week. Participants (patients and parent proxies) completed measures assessing HRQL, physical fitness and PAL at baseline and post-intervention. ***Results.*** Rates of recruitment, retention, attendance and adverse events indicated the program was feasible. Wilcoxon Signed Rank tests indicated significant improvements for patient ($P = 0.02$) and parent reported HRQL ($P = 0.03$), functional mobility ($P = 0.01$), hamstring flexibility (left, $P = 0.01$ and right $P = 0.02$), and total PAL ($P = 0.02$) pre to post intervention. ***Conclusion.*** This 12-week community-based yoga intervention was feasible and provides preliminary evidence for the benefits of yoga on HRQL, physical fitness and PAL in pediatric cancer out-patients. In a population where sedentary behavior and the associated co-morbidities are a growing concern, these results promote the continued exploration of yoga programming. Pediatr Blood Cancer 2014;61:1828–1834.

Key words: alternative medicine; pediatric oncology; physical fitness; psychosocial; quality of life; yoga

INTRODUCTION

Advances in treatment protocols over the last 30 years have resulted in improved survival rates in pediatric oncology [1]. Although imperative for recovery, many of these treatments are associated with a myriad of adverse psychosocial and physical side effects. These detrimental effects include: reduced health-related quality of life (HRQL), musculoskeletal impairments (limited functional mobility, flexibility, and range of motion (ROM)) and physical inactivity [2–11].

Seven recent reviews of the literature have investigated physical activity (PA) as a feasible, safe and effective strategy to promote HRQL, mitigate the effects of treatments, and enhance PA levels (PAL) in pediatric oncology [8,10,12–16]. These studies have examined PA in the form of mild to moderate aerobic and resistance training, leaving alternative types of PA, such as yoga, under explored [8,10,12–16]. Contemporary western yoga practice is defined as an alternative form of PA that combines physical practice, breath work and mindfulness/meditation [17,18]. In adult oncology, recent reviews suggest yoga may have a unique positive influence on psychosocial health outcomes [19]. Specifically, the literature reports positive effects for a variety of outcomes, including HRQL, mood, cancer-related distress, symptoms of fatigue, and sleep [18–20].

To date, there are three published studies providing preliminary evidence that yoga may offer psychosocial benefits for pediatric cancer patients [21–23]. This small body of literature necessitates continued exploration of key issues. First, no study has explored an intervention longer than five weeks. Second, the research has focused on hospital-based interventions leaving community-based unstudied. Third, none of the studies have explored the potential physical benefits of yoga.

Purpose

To begin to address these issues, the primary purpose of the present study was to examine the feasibility of a 12-week, community-based, yoga program for pediatric cancer out-patients (defined as those children receiving active cancer therapy day treatments) at the Alberta Children's Hospital (ACH). The secondary purpose was to explore the potential benefits of the yoga intervention on HRQL, select physical fitness outcomes (functional mobility, flexibility, and ROM), and PAL.

Hypotheses

Based on the literature, it was hypothesized that this intervention would be feasible as measured by recruitment, attendance, retention, and adverse events. Furthermore, it was hypothesized it would be beneficial as measured by improvements in HRQL, physical fitness outcomes and PAL.

METHODS

Participants

Inclusion criteria: (i) 5 years and older; (ii) out-patient; (iii) limited previous yoga experience; and (iv) not meeting the

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Canadian Society for Exercise Physiology (CSEP) PA guidelines. Ethics approval was obtained through the Conjoint Health Research Ethics Board. All participants and parents gave informed assent and consent for participation in the study and received medical clearance from their treating oncologist. Based on the limited data available and the feasibility nature of the study, no sample size was calculated.

Study Procedure

At baseline and post-intervention (within 2 weeks of completing the 12-week intervention) participants completed measures of HRQL, physical fitness outcomes and PAL. Parents completed measures of HRQL at baseline and 12-weeks. The intervention consisted of two supervised, group-based 1-hour yoga sessions/week at a location in the local community (Fig. 1).

Yoga protocol. A 12-week pediatric yoga protocol was developed and modeled after a standardized yoga class. Each 60 minute class consisted of a warm-up, supine/seated/kneeling poses, standing poses, group activity, supine/seated/kneeling/prone poses, cool-down, and a final resting pose. Each element included in the protocol was designed to target an aspect of the outcome variables. All poses had available modifications and participants were instructed on these when necessary. Prior to being implemented, the protocol was reviewed by a team of yoga instructors, CSEP-Certified Exercise Physiologists (CEPs) and a physiotherapist from the hematology oncology transplant (HOT) program at the ACH, to enhance safety and ensure the protocol would adequately target both psychosocial and physical health outcomes. Instructors were required to hold yoga certifications and have complementary training in yoga for cancer populations and children.

Outcome Measures

Primary outcome: program feasibility. Recruitment, retention, attendance and adverse events were measures of program feasibility. As it was difficult to determine the total number of out-patients receiving treatment at the ACH who met study criteria, health care professional (HCP) assisted recruitment (via "consent to contact" forms) and self-referral were tracked. Recruitment was then defined as the number of eligible participants who enrolled in the program out of the number who self-referred or were recruited. Retention was defined as the number of participants completing the intervention and all scheduled assessments. Based on the literature, and previously published PA studies, a retention rate of >70% was considered feasible [21,24]. Attendance was defined as the number of group-based yoga sessions completed. Attendance rates averaging one class attended/week (>50%) was considered feasible [24]. Adverse events were defined as any negative outcomes during fitness testing and/or the 12-week yoga intervention.

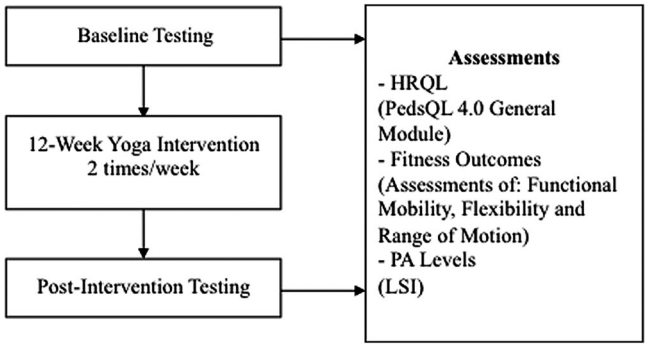

Fig. 1. Research flow. HRQL, health-related quality of life; LSI, leisure score index; PedsQL, pediatric quality of life inventory.

Secondary outcome: potential benefits. *Health-Related Quality of Life* was assessed by patient and parent-proxy reports on the Pediatric Quality of Life (PedsQL) 4.0 General Module. The PedsQL 4.0 (www.pedsql.org) is a 23-item likert-type response scale, with higher scores indicating better functioning [25]. It has good internal consistency reliability for the total score ($\alpha = 0.88$ self-report, 0.93 parent-proxy report), psychosocial summary scores ($\alpha = 0.83$ self-report, 0.86 parent-proxy report) and physical summary score ($\alpha = 0.80$ self-report, 0.88 parent-proxy report) [26]. It is comprised of four subscales including physical functioning, social functioning, emotional functioning, and school functioning. Validity has been demonstrated using the known-groups method. The minimal clinically important difference (MCID), defined as the smallest difference in a score that would mandate a change in the patient's care, has been determined to be a 4.40 change in patient-reported HRQL and a 4.50 change in parent-proxy reported HRQL [27,28].

Physical Fitness was assessed through a battery of assessments performed by one CEP. *Functional Mobility* refers to the capacity of children to do daily activities. It was assessed using the "Timed Up and Go" (TUG)-3m [4,29]. The test has been used previously in pediatric cancer populations [4,29,30]. *Flexibility* of the hamstrings was assessed by the Back-Saver Sit and Reach Test [31]. *Range of Motion* of the ankle was assessed using goniometry, measuring both passive and active dorsiflexion (DF)-ROM [32].

Physical Activity Levels were assessed subjectively using the Godin leisure score index (LSI) of the Godin Leisure Time Exercise Questionnaire (GLTEQ) [33,34]. The internal consistency for this scale has been reported to be 0.84 [35], and it has been used previously in pediatric cancer populations [24].

Data Analysis

Given the exploratory nature of the study, a repeated measures within-subjects design was selected. Data were treated per-protocol, defined as those participants who completed assessments at baseline and post-intervention. Descriptive analyses were performed to check for normal distribution and to describe participant characteristics, recruitment, retention, and attendance rates. Non-parametric statistics were selected given the small sample size and violations to normality. Wilcoxon Signed-Rank tests were used to compare pre- and post-intervention HRQL, physical fitness, and PAL data. While it is recognized that the use of repeated tests increases the probability of Type I error, no statistical adjustment was made. All data were analyzed in SPSS 20 [36].

RESULTS

Participant Characteristics

Table I presents the characteristics and medical profiles of those who completed the intervention. Eight out-patients participated, ranging in age from 5 to 17 years ($M_{age} = 11.88$, $SD = 4.26$). Medical data revealed a mixed-cancer sample comprised of patients diagnosed with osteosarcoma ($n = 1$), central nervous system

TABLE I. Characteristics and Medical Profile of Study Participants

Participant	Gender	Age (y)	Diagnosis	Treatment protocol
1	M	14	Osteo	Chemo; Surg^{OnTx}
2	F	14	Lymph	Chemo^{OnTx}
3	F	5	CNS	Chemo^{OnTx}
4	F	14	ALL	Chemo; Rad^{OnTx}
5	M	8	CML	Chemo^{OnTx}
6	M	15	CNS	Chemo; Rad; SCT^{OffTx}
7	F	8	Mult	Chemo; Surg; Rad^{OffTx}
8	M	17	ALL	Chemo^{OnTx}
Total: N = 8	F: n = 4	Mage = 11.88	Osteo: n = 1	Chemo: n = 4
	M: n = 4	SD = 4.26	CNS: n = 2	MultMed: n = 4
			ALL: n = 2	
			CML: n = 1	
			Lymph: n = 1	
			Mult: n = 1	

F, female; M, male; y, years; N, total sample size; n, sample size; M, mean; ALL, acute lymphoblastic leukemia; CML, chronic myeloid leukemia; CNS, central nervous system tumor; Lymph, lymphoma; Mult, multiple diagnoses; Osteo, osteosarcoma; Chemo, chemotherapy; Surg, surgery; Rad, radiation; SCT, stem cell transplant; MultMed, multiple medical interventions; ^{OffTx}, off-treatment; ^{OnTx}, on-treatment.

tumours (n = 2), acute lymphoblastic leukemia (n = 2), chronic myeloid leukemia (1), lymphoma (n = 1), and multiple cancers (n = 1; neuroendocrine tumour and Burkitts lymphoma). Half of the sample was receiving chemotherapy alone (n = 4), while the other half was receiving (n = 2) or had received (n = 2) multiple medical interventions (i.e., surgery, chemotherapy, radiotherapy, stem cell transplant).

Primary Outcome: Feasibility

Recruitment data reported in Figure 2 are based on the number of families given a "consent to contact" form, or who contacted the research coordinator based on study advertisement they saw at the ACH or received through a local community foundation for pediatric cancer patients and their families. A total of 32 patients were referred or contacted the research coordinator and were assessed for eligibility. Of these, eight were ineligible (<5 years of age). Of the 24 eligible, 13 declined to participate. Reasons for not enrolling included schedule conflicts (n = 9) and worsening medical condition (n = 4). Eleven participants enrolled, resulting in a recruitment rate of 46% (11/24). Of the 11 out-patients enrolled, 73% (8/11) completed the 12-week program. Of the completers, 100% (8/8) completed all assessments, while 88% (7/8) of parents completed all parent-proxy reports. Non-completers (27%; 3/11) attended baseline assessments and an average of 1.67 classes before dropping out. Reasons for discontinuing included: not liking yoga (n = 1), returning to school (n = 1) and being too busy with appointments (n = 1). Attendance for intervention completers in the current study was 55%, ranging from a minimum of 42% (10/24 sessions attended) to a maximum of 88% (21/24 sessions attended). Main reasons for not attending included treatment schedule conflicts (i.e., being admitted as an in-patient), going on holiday, and not feeling well. No tracking of specific absence reasons were collected.

Secondary Outcome: Potential Benefits

Health-related quality of life. Changes in HRQL outcomes are shown in Table II. Both patients (n = 8) and parents (n = 7) completed HRQL assessments (with the exception of the School Functioning subscale; patients (n = 7) and parents (n = 6)). Patients reported significant improvements in total HRQL ($P = 0.02$) and approached significance on psychosocial HRQL ($P = 0.05$). Parents reported significant improvements in their child's total HRQL ($P = 0.03$), psychosocial ($P = 0.04$), physical ($P = 0.03$) and school ($P = 0.04$) HRQL. Table II highlights all mean difference scores for both patient and parent-proxy reports were greater than the pre-determined MCID of 4.40 and 4.50, respectively.

Physical fitness outcomes. Changes in physical fitness outcomes are shown in Table III. *Functional Mobility:* There was significant improvement from baseline to post-intervention on the measure of functional mobility ($P = 0.01$), with participants taking significantly less time to complete the task. *Flexibility*: Participants left hamstring flexibility improved by 12.73 (SD = 7.79) ($P = 0.01$), while their right hamstring flexibility improved by 7.52 (SD = 12.57; $P = 0.02$). *Range of Motion*: There were no significant changes over the course of the intervention on DF-ROM.

Physical activity levels. Changes in PAL are shown in Table IV. There were no significant differences over the course of the intervention in the number of times/week participants engaged in PA (frequency). There were, however, significant increases in the number of minutes (duration) participants spent in PA. Participants reported significant increases in amount of time spent in mild ($P = 0.04$), moderate ($P = 0.03$) and strenuous ($P = 0.04$) PA. There was also a significant increase in total PA (metabolic equivalent (MET) hours/week) from baseline to post-intervention ($P = 0.02$). Moreover, there was a significant increase in total mild PA ($P = 0.04$).

DISCUSSION

The aim of this study was to examine the feasibility of a 12-week community-based yoga program for pediatric cancer out-patients and to explore the potential benefits of the yoga intervention on HRQL, select physical fitness outcomes, and PAL. Out-patients and their families were successfully recruited via "consent to contact" forms and self-referral, which was considered a significant marker

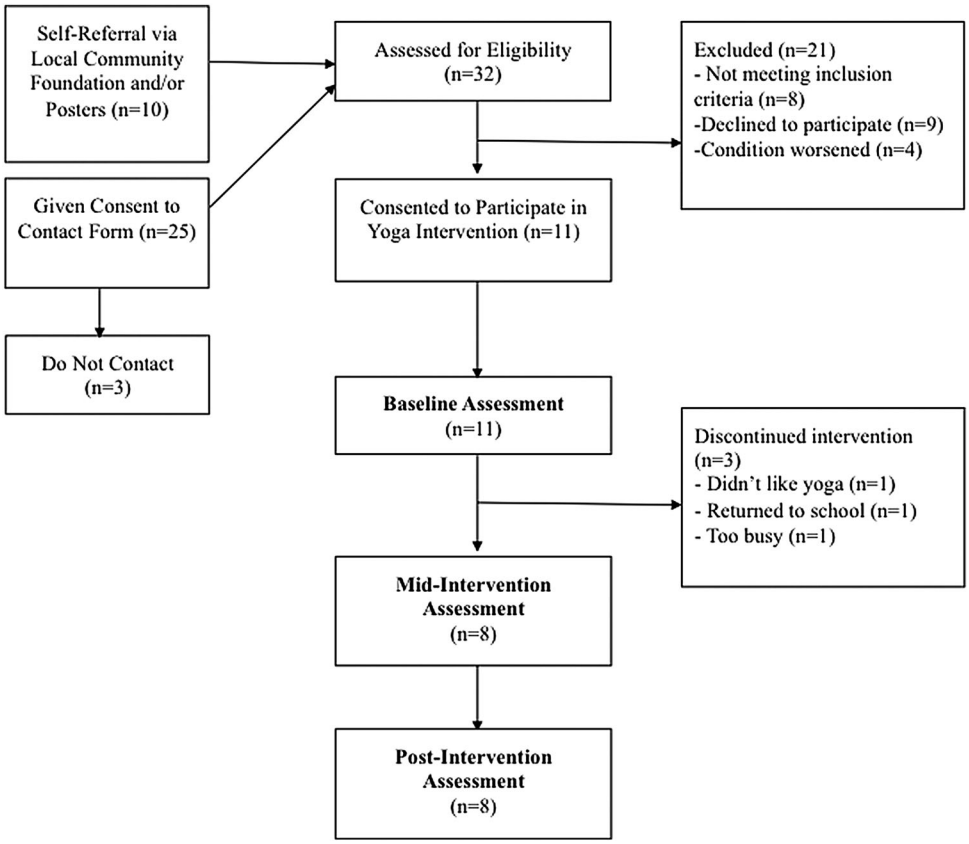

Fig. 2. Participant recruitment and retention.

TABLE II. Pre and Post Changes in Health-Related Quality of Life Outcomes Across the 12-week Intervention

	Baseline Mean (SD)	Post-program Mean (SD)	Mean diff.	Neg. MR	Pos. MR	Wilcox. Z	Probability
PedsQL 4.0							
Total							
Patient	65.08 (14.74)	75.57 (17.06)	10.49[T]	0.00	4.00	2.37	0.02*
Parent	56.67 (20.21)	79.19 (17.45)	22.52[T]	1.00	4.50	2.20	0.03*
Psychosocial sum.							
Patient	64.83 (12.30)	76.25 (17.97)	11.42[T]	1.00	4.00	2.00	0.05
Parent	57.71 (20.39)	77.86 (19.50)	20.15[T]	2.00	4.33	2.03	0.04*
Physical sum.							
Patient	65.91 (24.78)	75.00 (23.27)	9.09[T]	8.00	4.00	1.41	0.16
Parent	55.63 (26.71)	81.70 (17.62)	26.07[T]	1.00	4.50	2.20	0.03*
Emotional							
Patient	67.50 (18.90)	78.13 (22.51)	10.63[T]	1.50	4.50	1.58	0.11
Parent	58.57 (24.10)	81.43 (17.01)	22.86[T]	2.00	4.80	1.71	0.09
Social							
Patient	77.50 (16.90)	84.38 (17.00)	6.88[T]	0.00	2.50	1.84	0.07
Parent	67.14 (17.76)	87.86 (14.68)	20.72[T]	1.00	4.00	2.00	0.05
School							
Patient	50.00 (29.30)	64.29 (27.45)	14.29[T]	1.50	3.50	0.73	0.47
Parent	30.83 (34.70)	60.83 (34.56)	30.00[T]	0.00	3.00	2.02	0.04*

HRQL, health-related quality of life; Psychosocial Summ., psychosocial summary score; Physical Summ., physical summary score; Mean Diff., mean difference; Neg. MR, negative mean rank; Pos. MR, positive mean rank; PedsQL 4.0, Pediatric Quality of Life Inventory 4.0 General Module; SD, standard deviation; Wilcox. Z, Wilcoxon's Z score. *Significant at $P < .05$; [T]MCID difference.

TABLE III. Changes in Physical Fitness Outcomes Across the 12-week Intervention

	Baseline Mean (SD)	Post-program Mean (SD)	Neg. MR	Pos. MR	Wilcox. Z	Probability
Functional mobility						
TUG (s)	5.70 (1.24)	4.74 (0.42)	4.50	0.00	2.52	0.01*
Flexibility						
BSSR (cm)						
Left leg	8.97 (5.78)	21.70 (11.32)	0.00	4.50	2.52	0.01*
Right leg	11.75 (5.25)	24.32 (10.37)	0.00	4.00	2.36	0.02*
DF-ROM (degrees)						
LA	6.63 (15.19)	7.38 (7.21)	5.33	4.00	0.28	0.78
LP	14.00 (15.06)	11.25 (9.29)	3.00	3.00	1.22	0.22
RA	5.88 (15.42)	2.38 (10.45)	4.88	2.83	0.93	0.35
RP	13.00 (15.59)	9.75 (11.68)	5.40	3.00	1.26	0.21

TUG, timed up and go; s, seconds; BSSR, back saver sit and reach; cm, centimeters; LA, left active; LP, left passive; RA, right active; RP, right passive; Neg. MR, negative mean rank; Pos. MR, positive mean rank; SD, standard deviation; Wilcox. Z, Wilcoxon's Z score. *Significant at $P < 0.05$.

of feasibility. Seventy three percent of participants were retained exceeding our pre-determined minimum of 70% to declare feasibility. Moreover, participants attended close to 55% of classes, exceeding our minimum of 50% attendance to be considered feasible. Future research should consider modifying intervention designs to take into account patients and survivors unique treatment schedules. For example, interventions could explore combinations of in- and out-patient yoga, as well as home-based alternatives. Comparing these feasibility data to the literature is difficult, as the three previous yoga studies were short in duration [21–23]. Looking at the greater PA and pediatric oncology literature, a comparable 16-week community-based PA intervention reported 81.5% attendance to one weekly session, concluding their intervention was feasible, although no hypothetical definition of feasibility was given [24]. More research is needed to determine the optimal frequency and durations of community-based interventions. No participant experienced adverse reactions to the yoga program. This provides support for the assertion that yoga is a safe PA for pediatric cancer out-patients. Moreover, it addresses concerns about holding an intervention for patients in a community setting.

In addition to feasibility, results suggest the 12-week program was beneficial. Improvements for patient and parent-proxy reported HRQL are consistent with previous PA interventions reporting on HRQL in pediatric oncology [21,24,29,30,37–40]. Moreover, in the current study, HRQL changes met the MCID. This is an important finding as MCID are patient derived scores reflecting meaningful changes for the patient [27]. The results from the current study, in conjunction with the literature, suggest the potential for yoga to improve HRQL in pediatric oncology out-patients.

Improved physical fitness outcomes in the present study are an important addition to the current yoga and PA literature. Functional mobility was significantly improved, with participants completing the TUG-3m significantly faster post-intervention. San Juan et al. [30,41] found the same improvements with their supervised 16-week (three times/week), aerobic and resistance training intervention. There were substantial improvements in left and right hamstring flexibility. One PA intervention to date has explored this dimension of physical fitness and found significant (but smaller $\sim$0.05 cm) improvements [24]. Measures of DF-ROM did not improve significantly, with the majority of scores staying relatively

TABLE IV. Changes in Physical Activity Levels Across the 12-Week Intervention

	Baseline Mean (SD)	Post-program Mean (SD)	Neg. MR	Pos. MR	Wilcox. Z	Probability
Frequency (times/week)						
Mild	3.36 (2.56)	3.79 (3.34)	3.33	2.50	0.68	0.50
Moderate	5.31 (6.78)	3.93 (3.12)	3.50	3.50	0.74	0.46
Strenuous	0.88 (1.80)	2.43 (1.95)	3.50	2.88	1.09	0.28
Duration (min)						
Mild	15.00 (15.48)	45.00 (22.91)	0.00	3.00	2.02	0.04*
Moderate	12.81 (10.13)	36.25 (22.00)	0.00	3.50	2.20	0.03*
Strenuous	5.31 (10.39)	28.44 (21.67)	0.00	3.00	2.03	0.04*
METs (hr/week)						
Total MET	7.87 (10.69)	18.57 (22.72)	0.00	4.00	2.37	0.02*
Mild MET	1.89 (2.72)	3.34 (4.05)	0.00	3.00	2.02	0.04*
Moderate MET	4.18 (7.14)	7.47 (10.18)	2.00	5.50	1.35	0.18
Strenuous MET	1.79 (5.55)	7.57 (10.80)	1.00	4.00	1.99	0.05

MET, metabolic equivalent; Neg. MR, negative mean rank; Pos. MR, positive mean rank; SD, standard deviation. *Significant at $P < 0.05$.

the same or declining non-significantly. Similarly, Hartman et al. [42] and San Juan et al. [30,41] found no improvements after their 16-week and 2-year PA interventions. Conversely, Marchese et al. [29] and Wright et al. [43] found small significant improvements in their 4-month and 2-year interventions respectively. Notably, the studies that have reported significant improvements have focused on DF-ROM exercises in their intervention. Therefore, the lack of change observed in the current intervention may be due to the yoga protocol, which did not focus on DF-ROM. Additionally, it could be due to the variability in goniometry measurement [32] or the well-documented declines in DF-ROM during treatment [7,44–47]. Future work should focus on larger multisite randomized controlled trials to determine the cause-effect relationship between yoga and various physical health outcomes (i.e., fatigue, sleep quality, pain, physical functioning).

The CSEP PA Guidelines for Children and Youth suggest 60 minutes of moderate-vigorous PA 7 days/week. Data from the current study demonstrated that participants improved their PAL over the course of the intervention, however, were still not meeting the recommendations. This is comparable to other studies reporting PAL below recommendations despite significant improvements [11,24,48]. Although preliminary, the findings suggest yoga may be a valuable addition. As Geyer et al. [21] suggested, there is the potential for yoga to be easily implemented in conjunction with more traditional PA programs, 1–2 times per week, in an effort to enhance overall PAL.

Given the current study's small sample size, the results reported are preliminary and should be interpreted with caution. A major limitation in the present study relates to response bias (selection bias), which can create systematic differences between the sample and the larger population. Although recruitment criteria were stringent (required low PA and limited previous yoga participation), it is likely that a more motivated group of out-patients, whose experiences and attitudes may vary significantly from those who are more reluctant to participate, volunteered for the study. Moreover, given the scope of the current study and lack of a randomly assigned control condition, it is not possible to determine the causative influence of yoga or the potential influence of other confounding factors. Continued research with larger sample sizes and control groups will elucidate the effects of yoga in pediatric oncology.

CONCLUSION

The significant acute and late effects of treatments in pediatric oncology necessitates further research into yoga programming, which aims to enhance HRQL, improve select physical fitness outcomes and improve PAL in a population where sedentary behavior, and the associated co-morbidities are a growing concern. This 12-week community-based yoga intervention was feasible and provides preliminary evidence for the benefits of yoga on HRQL, physical fitness and PAL in pediatric cancer out-patients. This study continues building the foundation for yoga in pediatric oncology, contributing uniquely to the literature.

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REFERENCES

1. Siegel R, DeSantis C, Virgo K, et al. Cancer treatment and survivorship statistics 2012. CA Cancer J Clin 2012;62:220–241.
2. Diller L, Chow EJ, Gurney JG, et al. Chronic disease in the Childhood Cancer Survivor Study cohort: a review of published findings. J Clin Oncol 2009;27:2339–2355.
3. Hudson MM, Ness KK, Gurney JG, et al. Clinical ascertainment of health outcomes among adults treated for childhood cancer. JAMA 2013;309:2371–2381.
4. Marchese VG, Chiarello LA, Lange BJ. Strength and functional mobility in children with acute lymphoblastic leukemia. Med Pediatr Oncol 2003;40:230–232.
5. Nightingale CL, Quinn GP, Shenkman EA, et al. Health-related quality of life of young adult survivors of childhood cancer: A review of qualitative studies. J Adolesc Young Adult Oncol 2011;1:124–132.
6. Oeffinger KC, Mertens AC, Sklar CA, et al. Chronic health conditions in adult survivors of childhood cancer. N Engl J Med 2006;355:1572–1582.
7. San Juan AF, Chamorro-Vina C, Mate-Munoz JL, et al. Functional capacity of children with leukemia. Int J Sports Med 2008;29:163–167.
8. San Juan AF, Wolin K, Lucia A. Physical activity and pediatric cancer survivorship. Recent Results Cancer Res 2011;186:319–347.
9. van Brussel M, Takken T, Lucia A, et al. Is physical fitness decreased in survivors of childhood leukemia? A systematic review. Leukemia 2005;19:13–17.
10. Winter C, Muller C, Hoffmann C, et al. Physical activity and childhood cancer. Pediatr Blood Cancer 2010;54:501–510.
11. Sharkey AM, Carey AB, Heise CT, et al. Cardiac rehabilitation after cancer therapy in children and young adults. Am J Cardiol 1993;71:1488–1490.
12. Baumann FT, Bloch W, Beulertz J. Clinical exercise interventions in pediatric oncology: a systematic review. Pediatr Res 2013;74:366–374.
13. Huang TT, Ness KK. Exercise interventions in children with cancer: a review. Int J Pediatr 2011;461512:27.
14. Soares-Miranda L, Fiuza-Luces C, Lassaletta A, et al. Physical Activity in Pediatric Cancer patients with solid tumors (PAPEC): trial rationale and design. Contemp Clin Trials 2013;36:106–115.
15. Stolley MR, Restrepo J, Sharp LK. Diet and physical activity in childhood cancer survivors: a review of the literature. Ann Behav Med 2010;39:232–249.
16. Wolin KY, Ruiz JR, Tuchman H, et al. Exercise in adult and pediatric hematological cancer survivors: an intervention review. Leukemia 2010;24:1113–1120.
17. Feuerstein G. The shambhala guide to yoga. Boston: Shambhala Publications, Incorporated; 1996.
18. Smith KB, Pukall CF. An evidence-based review of yoga as a complementary intervention for patients with cancer. Psychooncology 2009;18:465–475.
19. Culos-Reed SN, Mackenzie MJ, Sohl SJ, et al. Yoga & cancer interventions: a review of the clinical significance of patient reported outcomes for cancer survivors. Evid Based Complement Alternat Med 2012;2012:642576.
20. Lin KY, Tsauo JY. Effects of yoga on the quality of life in cancer patients. Evid Based Complement Alternat Med 2013;4:127–151.
21. Geyer R, Lyons A, Amazeen L, et al. Feasibility study: the effect of therapeutic yoga on quality of life in children hospitalized with cancer. Pediatr Phys Ther 2011;23:375–379.
22. Moody K, Daswani D, Abrahams B, et al. Yoga for pain and anxiety in pediatric hematology-oncology patients: Case series and review of the literature. J Soc Integr Oncol 2010;8:95–105.
23. Thygeson MV, Hooke MC, Clapsaddle J, et al. Peaceful play yoga: serenity and balance for children with cancer and their parents. J Pediatr Oncol Nurs 2010;27:276–284.
24. Keats MR, Culos-Reed SN. A community-based physical activity program for adolescents with cancer (project TREK): program feasibility and preliminary findings. J Pediatr Hematol Oncol 2008;30: 272–280.
25. Varni JW, Seid M, Rode CA. The PedsQL: measurement model for the pediatric quality of life inventory. Med Care 1999;37:126–139.
26. Varni JW, Burwinkle TM, Katz ER, et al. The PedsQL in pediatric cancer: reliability and validity of the Pediatric Quality of Life Inventory Generic Core Scales, Multidimensional Fatigue Scale, and Cancer Module. Cancer 2002;94:2090–2106.
27. Jaeschke R, Singer J, Guyatt GH. Measurement of health status. Ascertaining the minimal clinically important difference. Control Clin Trials 1989;10:407–415.
28. Varni JW, Burwinkle TM, Seid M, et al. The PedsQL 4.0 as a pediatric population health measure: feasibility, reliability, and validity. Ambul Pediatr 2003;3:329–341.
29. Marchese VG, Chiarello LA, Lange BJ. Effects of physical therapy intervention for children with acute lymphoblastic leukemia. Pediatr Blood Cancer 2004;42:127–133.
30. San Juan AF, Fleck SJ, Chamorro-Vina C, et al. Effects of an intrahospital exercise program intervention for children with leukemia. Med Sci Sports Exerc 2007;39:13–21.
31. Kinetics H. FITNESSGRAM. Dallas: Cooper Institute; 2005.
32. Norkin CC, Joyce WD. Measurement of joint motion: A guide to goniometry. 3rd edn. Philadelphia: Davis Company; 2003.
33. Godin G, Jobin J, Bouillon J. Assessment of leisure time exercise behavior by self-report: A concurrent validity study. Can J Public Health 1986;77:359–362.

34. Godin G, Shephard RJ. A simple method to assess exercise behavior in the community. Can J Appl Sport Sci 1985;10:141–146.
35. Sallis JF, Buono MJ, Roby JJ, et al. Seven-day recall and other physical activity self-reports in children and adolescents. Med Sci Sports Exerc 1993;25:99–108.
36. Corp I. IBM SPSS Statistics for Windows Version 20.0. Armonk, NY: IBM Corp; 2011.
37. Gohar SF, Comito M, Price J, et al. Feasibility and parent satisfaction of a physical therapy intervention program for children with acute lymphoblastic leukemia in the first 6 months of medical treatment. Pediatr Blood Cancer 2011;56:799–804.
38. Rosenhagen A, Bernhorster M, Vogt L, et al. Implementation of structured physical activity in the pediatric stem cell transplantation. Klin Padiatr 2011;223:147–151.
39. San Juan AF, Chamorro-Vina C, Moral S, et al. Benefits of intrahospital exercise training after pediatric bone marrow transplantation. Int J Sports Med 2008;29:439–446.
40. Speyer E, Herbinet A, Vuillemin A, et al. Effect of adapted physical activity sessions in the hospital on health-related quality of life for children with cancer: a cross-over randomized trial. Pediatr Blood Cancer 2010;55:1160–1166.
41. San Juan AF, Fleck SJ, Chamorro-Vina C, et al. Early-phase adaptations to intrahospital training in strength and functional mobility of children with leukemia. J Strength Cond Res 2007;21:173–177.
42. Hartman A, te Winkel ML, van Beek RD, et al. A randomized trial investigating an exercise program to prevent reduction of bone mineral density and impairment of motor performance during treatment for childhood acute lymphoblastic leukemia. Pediatr Blood Cancer 2009;53: 64–71.
43. Wright MJ, Hanna SE, Halton JM, et al. Maintenance of ankle range of motion in children treated for acute lymphoblastic leukemia. Pediatr Phys Ther 2003;15:146–152.
44. Hartman A, Pieters R, van den Bos C, et al. Perceived and actual motor competence of children treated for cancer with vincristine containing chemotherapy. Pediatr Blood Cancer 2008;51:306–307.
45. Gocha Marchese V, Chiarello LA, Lange BJ. Strength and functional mobility in children with acute lymphoblastic leukemia. Med Pediatr Oncol 2003;40:230–232.
46. Wright MJ, Halton JM, Barr RD. Limitation of ankle range of motion in survivors of acute lymphoblastic leukemia: a cross-sectional study. Med Pediatr Oncol 1999;32:279–282.
47. Wright MJ, Halton JM, Martin RF, et al. Long-term gross motor performance following treatment for acute lymphoblastic leukemia. Med Pediatr Oncol 1998;31:86–90.
48. Moyer-Mileur LJ, Ransdell L, Bruggers CS. Fitness of children with standard-risk acute lymphoblastic leukemia during maintenance therapy: response to a home-based exercise and nutrition program. J Pediatr Hematol Oncol 2009;31:259–266.