



# A feasibility study examining the impact of yoga on psychosocial health and symptoms in pediatric outpatients receiving chemotherapy

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## Abstract

**Purpose** Pediatric cancer patients experience symptoms that negatively impact quality of life; yoga may be an effective intervention. The primary objective was to determine the feasibility of a 10-week, weekly individualized yoga intervention for children and adolescents receiving outpatient cancer therapy primarily delivered remotely using Skype. Secondary objectives were to describe depression, anxiety, anger, fatigue, quality of life, and symptoms at 5 and 10 weeks after enrollment.

**Methods** We included English-speaking patients aged 10 to 18 years receiving outpatient chemotherapy for cancer. Weekly individualized yoga sessions were offered for 10 weeks. Weeks 1, 5, and 10 were in-hospital while the remaining sessions were delivered remotely using Skype. Twice weekly, homework was assigned between each session. The primary outcome was feasibility, defined as 80% of participants completing at least 60% of planned in-hospital or remote yoga sessions.

**Results** Between March and November 2017, 10 patients were enrolled. Two patients discontinued the study after one and two sessions. Only six participants achieved at least 60% of planned yoga sessions and thus, the study did not meet the a priori defined feasibility threshold. Among all participants, only one homework session was performed.

**Conclusions** A 10-week individualized in-person and remotely conducted yoga intervention was not feasible in children receiving cancer treatments because of failure to achieve the desired frequency of yoga sessions in a sufficient number of participants. Future research should identify approaches to improve compliance with remote yoga sessions and home practice.

**Trial registration** NCT03318068.

**Keywords** Pediatric oncology · Chemotherapy · Yoga therapy · Yoga · Symptoms

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## Background

The diagnosis and treatment of pediatric cancer is often associated with distress for patients and families.[1, 2]. More specifically, a subset of patients experience considerable negative psychological symptoms at diagnosis and during treatment, such as depression, anxiety, or anger [3–5]. These symptoms may persist throughout treatment, and possibly for years after diagnosis [4, 6]. Early identification and intervention for psychological symptoms may reduce their short- and long-term impacts.

Yoga has emerged as a potentially effective intervention to improve anxiety, mood, and fatigue in both adults and adolescents undergoing cancer therapy [7–9]. For example, exercise including yoga was effective at reducing fatigue in patients with cancer [10] and was recommended for children and adolescents with cancer and hematopoietic stem cell transplant (HSCT) recipients to manage fatigue [11]. While yoga may be effective at improving psychosocial symptoms, group-based yoga may not be feasible in children receiving cancer treatments due to scheduling and travel issues as well as variable ability to participate on a given day related to treatments and complications. Consequently, there may be greater interest in individualized yoga therapy where there is an ability to accommodate a patient's unique and changing needs [7, 9, 12]. However, individualized yoga therapy presents a challenge in terms of how to connect yoga instructors and patients for sessions. Since youth are among the most active users of technology [13], a web-based intervention might be an accessible and effective platform for intervention. Remote virtually delivered interventions, including yoga, may be able to provide a similar experience compared with in-person sessions [14].

A large randomized controlled trial would be required to determine whether individualized in-person and remotely conducted weekly yoga can improve depression, anxiety, anger, fatigue, quality of life, and symptoms in children receiving cancer therapies. However, prior to proceeding to a definitive randomized trial, it is important to establish the feasibility of the intervention. Consequently, our primary objective was to determine the feasibility of a 10-week, weekly individualized yoga intervention for children and adolescents receiving outpatient cancer therapy primarily delivered remotely using Skype. Secondary objectives were to describe depression, anxiety, anger, fatigue, quality of life, and symptoms at 5 and 10 weeks after enrollment.

## Methods

This pilot study was conducted at The Hospital for Sick Children (SickKids), Toronto, Canada. Research Ethics Board approval was obtained from SickKids and all

participants consented to participate. The study was registered with [ClinicalTrials.gov](https://clinicaltrials.gov) (NCT03318068).

## Subjects

Eligibility criteria were as follows: (1) aged 10 to 18 years with any cancer diagnosis, (2) planned to receive cancer therapy within 21 days of enrollment and expected to be still receiving treatment for 10 weeks, (3) able to attend three in-person yoga sessions (baseline, week  $5 \pm 1$  and week  $10 \pm 1$ ), and (4) availability of an electronic device capable of accessing Skype at home. Exclusion criteria were as follows: (1) cognitive impairment or cardiopulmonary symptoms that precluded conduct of yoga according to the primary healthcare team, (2) did not understand English, (3) planned major surgery within 10 weeks of enrollment, and (4) planned admission for  $> 25\%$  of the next 10 weeks (which would preclude conduct of remote yoga sessions).

## Study procedure

After enrollment, baseline demographics were collected from the participant and the participant's health records. The intervention consisted of 45-min yoga sessions administered weekly for 10 consecutive weeks and homework between sessions. Yoga was conducted in-person for three sessions (baseline, week  $5 \pm 1$ , and week  $10 \pm 1$ ), and remotely using Skype for the remaining sessions. Patient-reported outcomes to be used as primary and secondary endpoints in a future randomized trial were collected concurrent with the in-person yoga sessions (baseline, week 5, and week 10).

The yoga protocol aimed to improve range of motion, flexibility, and strength. The sessions were delivered one-on-one and were adapted to accommodate the patient's specific needs while considering safety and logistical limitations of conducting yoga remotely. The session structure included the following components: (1) breathing exercises, (2) warm-up exercises, (3) standing, seated, and supine postures, and (4) final relaxation. Yoga session content was selected at the discretion of the instructor based on how the patient was feeling. Homework consisted of relaxation and breathing exercises to be performed at least twice between each of the weekly sessions; a reminder to complete homework was given at the beginning of each yoga session and participants were given a calendar to track their home practice.

All yoga instructors were certified yoga teachers and received research and study-specific yoga training. The in-person sessions were conducted by a clinical research assistant (ES) while the ambulatory sessions were conducted by two volunteer yoga instructors or two study co-authors (ES or UK). Safety of the remote yoga sessions was emphasized and included the following requirements: an adult was required to be at home throughout the session, with the adult's

presence being visually confirmed by the instructor at the beginning of each session; standing postures, including balancing, and transitions to the floor were conducted proximal to a chair, wall, or other supportive structure; backbends were excluded for patients who had a central venous line; and participants were asked to take off their socks during standing postures to minimize the risk of slipping or falling.

As an additional approach to ensure safety, the remote yoga sessions were video recorded and audited. We planned to record two sessions per participant using Movavi Screen Capture Studio software [15]. Each recording was reviewed by two research assistants and feedback was to be given to the instructor before the next scheduled yoga session. Each research assistant completed our previously developed 32-item standardized yoga session quality control and safety checklist [7]. The checklist includes the following categories: safety, adherence to the yoga intervention and overall quality of the session. The checklist also captured qualitative positive, constructive, and overall feedback about the session. Each session was given a score for the overall quality and safety on a 5-point Likert scale ranging from 1 (worst possible) to 5 (best possible) [7].

## Outcomes

The primary outcome was feasibility of the intervention as defined as the enrollment of at least 10 patients over 1 year and completion of at least 60% ( $n = 6$ ) of planned yoga sessions in at least 80% of participants. Establishing thresholds for success of a feasibility study a priori is important [16].

All patient-reported outcomes were administered on paper just before the in-person yoga sessions (baseline, week 5, and week 10) in the presence of a research assistant. Self-report anxiety, depression, anger, and fatigue were measured using the Patient-Reported Outcomes Measurement Information System (PROMIS) short forms [17–20]. The PROMIS measures use 5-point Likert scales and capture symptoms over the past 7 days. Scores are presented as a standardized  $T$  score with a mean of 50 and a standard deviation of 1. A higher PROMIS  $T$  score represents more of the construct being measured. These measures are valid in children aged 8 to 17 years receiving active cancer treatment [17] and are reliable in healthy and chronically ill children 8 to 17 years of age [19, 20].

Fatigue was also measured using the self-report Pediatric Quality of Life (PedsQL) Multidimensional Fatigue Scale (MFS). The PedsQL MFS is an 18-item instrument that assesses general fatigue, sleep/rest fatigue, and cognitive fatigue. Higher scores indicate less fatigue. It is reliable, valid, and responsive in children ages 5 to 15 with cancer [21].

Cancer-specific quality of life and bothersome symptoms were measured using the self-report PedsQL 3.0 Acute Cancer Module [21] and Symptom Screening in Pediatrics Tool

(SSPedi) [22]. The PedsQL Acute Cancer Module measures the following eight dimensions: pain and hurt, nausea, procedural anxiety, treatment anxiety, worry, cognitive problems, perceived physical appearance, and communication [21]. It is reliable and valid in children ages 5 to 18 years with cancer [21]. SSPedi assesses how bothersome 15 symptoms were yesterday or today using 5-point Likert scales range from 0 (not bothered at all) to 4 (extremely bothered) [23–25]. The total score ranges from 0 to 60, with higher scores indicating more symptom burden. SSPedi is reliable, valid, and responsive in children 8 to 18 years of age receiving cancer treatments [26].

## Data management and statistical analysis

Study data including those obtained by the volunteer yoga instructors were collected using REDCap (Research Electronic Data Capture) [27] to enable a secure approach to remote data entry. Most statistical analyses, including whether the intervention was feasible according to the a priori established criteria, were descriptive. We compared characteristics of those who did and did not agree to participate using Fisher's exact test. Data analysis was conducted using SAS Version 9.4 (SAS Institute, Cary, NC, USA).

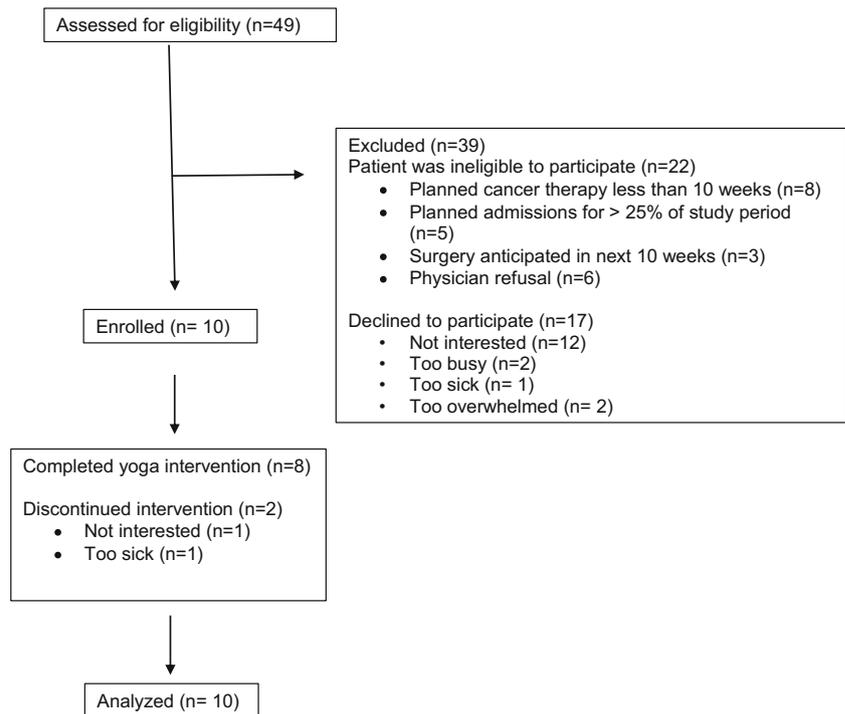
## Results

Between March and November 2017, 49 potential participants were assessed and 10 consented to participate. Fig. 1 shows the flow diagram of patient identification and their reasons for exclusion and study participation. There were no significant differences by age (10–15 vs 16–18 years,  $P = 0.12$ ), gender ( $P = 1.00$ ), and diagnosis (solid tumor vs not solid tumor,  $P = 1.00$ ) between those who did and did not agree to participate. Table 1 illustrates the demographics of the sample.

The median age was 15.1 years (range 11 to 18). In terms of exercise history, eight regularly participated in the following physical activities prior to diagnosis: team sports ( $n = 3$ ), swimming ( $n = 1$ ), walking ( $n = 1$ ), running ( $n = 1$ ), and other ( $n = 2$ ). Seven patients reported exercising since diagnosis with the following activities: team sports ( $n = 2$ ), walking ( $n = 4$ ), and other ( $n = 1$ ). Four had previous experience with yoga.

Regarding the primary feasibility endpoint, among the 10 participants enrolled, two discontinued the study participation after the first and second yoga sessions because of being too busy and not being interested in yoga respectively. Neither provided any week 5 or 10 patient-reported outcomes. Over all 10 participants, only 6 (60%) completed at least 60% of the yoga sessions, which did not meet the a priori defined feasibility threshold for the study. The median number of completed yoga sessions was 6.5 (range 1 to 9). No adverse events

**Fig. 1** Flow diagram of patient identification and their reasons for exclusion and study participation



were attributed to the yoga sessions. In terms of other feasibility issues, resources to conduct the study and questionnaire completion were not problematic.

Table 2 shows the patient-reported outcomes collected at baseline, week 5, and week 10. Of the total potential number

of patient-reported outcomes at weeks 5 and 10, 16/20 were completed.

A summary of yoga session characteristics is presented in Table 3. A total of 61 yoga sessions were delivered; 25 (41%) were conducted in-person and 36 (59%) were conducted remotely by Skype. Median duration of all yoga sessions was 45 min (interquartile range 40 to 45). Of the in-person sessions, only one (4%) was missed due to feeling too sick. In comparison of the remote sessions, 23 (39%) were missed for the following reasons: no planned session due to scheduling issues ( $n = 5$ ), cancellation due to feeling too sick ( $n = 6$ ), failure to attend a planned session without cancellation ( $n = 6$ ), or not interested in session ( $n = 6$ ). In terms of the homework component that was requested to occur at least twice a week, only one participant did one session among all 10 enrolled participants. Table 3 also shows the highest intensity level achieved during the sessions, which was similar between the in-person vs remote sessions. Breathing and relaxation exercises were practiced during all yoga sessions. Discomfort in a yoga posture was expressed during 16 sessions because of hamstring tension ( $n = 9$ ) and restricted range of motion from a central venous line ( $n = 1$ ) or surgical site ( $n = 1$ ).

Of the eight participants who completed the study, all agreed with the statement “overall, I enjoyed participating in this study”, all agreed that the yoga program helped to manage their stress and anxiety, and all agreed that they would recommend this program to others. Participants expressed the following positive comments: “[sessions] were tailored to my specific needs”, “whenever I did yoga, it would help me forget about problems at school and homework and focus on my

**Table 1** Demographics of the study cohort ( $N = 10$ )

Characteristic	<i>n</i> (%)
Male	3 (30)
Age in years	
10–12	2 (20)
13–15	6 (60)
16–18	2 (20)
Diagnosis	
Solid tumor	5 (50)
Brain tumor	4 (40)
Leukemia or lymphoma	1 (10)
Months from diagnosis	
0 to 5	4 (40)
6 to 12	1 (10)
> 12	5 (50)
Extent disease	
Localized	8 (80)
Metastatic	2 (20)
Relapsed disease	1 (10)
Treatment type	
Chemotherapy	10 (100)

**Table 2** Patient-report outcomes

Measure	Baseline median (IQR) <i>N</i> = 10	Weeks 5 median (IQR) <i>N</i> = 8	Week 10 median (IQR) <i>N</i> = 8
<b>PROMIS</b>			
Depressive symptoms total score	57 (47 to 59)	51 (35 to 56)	46 (38 to 61)
Anxiety total score	55 (44 to 66)	53 (44 to 61)	47 (41 to 58)
Anger total score	48 (42 to 62)	43 (32 to 54)	42 (33 to 59)
Fatigue total score	58 (54 to 71)	63 (51 to 71)	53 (39 to 68)
<b>PedsQL Cancer Module</b>			
Pain and hurt	63 (50 to 100)	75 (50 to 81)	69 (38 to 81)
Nausea	61 (30 to 75)	55 (28 to 82)	58 (33 to 95)
Procedural anxiety	67 (33 to 83)	54 (50 to 83)	71 (50 to 88)
Treatment anxiety	71 (42 to 92)	75 (58 to 96)	75 (50 to 100)
Worry	50 (25 to 67)	46 (33 to 67)	58 (33 to 79)
Cognitive problems	71 (25 to 92)	67 (33 to 92)	58 (50 to 92)
Perceived physical appearance	83 (67 to 92)	83 (58 to 96)	71 (63 to 92)
Communication	60 (45 to 80)	58 (43 to 75)	50 (40 to 78)
<b>PedsQL Multidimensional Fatigue Scale</b>			
General fatigue	54 (33 to 58)	33 (25 to 71)	67 (19 to 79)
Sleep rest fatigue	38 (29 to 50)	35 (21 to 52)	52 (27 to 71)
Cognitive fatigue	63 (38 to 75)	58 (42 to 83)	71 (44 to 94)
Symptom Screening in Pediatrics Tool total score	14 (8 to 28)	16 (7 to 30)	10 (4 to 28)

*IQR* interquartile range, *PROMIS* the Patient-Reported Outcomes Measurement Information System, *PedsQL* Pediatric Quality of Life

breathing”, and “I loved the Skype sessions because I was in the comfort of my own home, so I felt more comfortable doing yoga”.

Eleven of the 16 remote sessions scheduled for auditing were recorded and reviewed. Reasons for failure to record the five missed session were as follows: session canceled due to feeling too sick ( $n = 1$ ), failure to attend a planned session without cancelation ( $n = 2$ ), and technical difficulties with the software ( $n = 2$ ). The median overall quality and safety of the sessions was 5 (range 4 to 5). No safety issues were identified during session auditing.

## Discussion

In this 10-week pilot study of a weekly, individualized in-person and remotely conducted yoga intervention for children receiving cancer treatments, we found that this approach was not feasible due to inability to deliver the planned frequency of yoga sessions in a sufficient proportion of children. However, among those who completed the protocol, all provided mid-study and end-of-study outcomes and qualitative comments were favorable. A system of volunteer yoga-teacher-driven remote sessions could be performed safely. No adverse events resulted from the yoga sessions.

In contrast to our results, a recent pediatric pilot trial demonstrated that an individualized daily yoga intervention is feasible in pediatric inpatients receiving intensive chemotherapy or HSCT recipients [28]. The difference may be related to the captive nature of inpatients, which improves their adherence to scheduled individualized yoga sessions. As distinct from inpatients, outpatients are still engaged in their day-to-day activities such as school, homework, and extracurricular events, which likely reduces their ability to participate in scheduled yoga sessions.

While we hypothesized that group-based yoga interventions would not be feasible for outpatient pediatric cancer patients, Wurz et al. found that among pediatric oncology outpatients aged 5 to 17 years, a 12-week, twice weekly group-based intervention held in the community was feasible although their threshold for feasibility was less stringent than ours (retention rate > 70% and attendance averaging > 50%). Feasibility of group-based sessions may differ based upon geographic considerations and the catchment area of patients for a given center.

Last minute cancelations due to feeling too sick and failure to attend planned sessions without communicating with the instructor reflect some of the challenges of working with this clinical population. While some of these issues may affect healthy populations, pediatric cancer patients can become highly symptomatic from treatment-related toxicities [22, 23,

**Table 3** Summary of yoga session components and participation

Yoga components	Total	In-person yoga sessions	Skype sessions
Total planned sessions	85	26	59
Total sessions conducted, <i>n</i> (%)	61 (72)	25 (96)	36 (61)
Total missed sessions, <i>n</i> (%)	24 (28)	1 (4)	23 (39)
Reasons for missed session, <i>n</i>			
Scheduling issues	5	0	5
Feeling too sick	7	1	6
Failure to attend a planned session without cancelation	6	0	6
Not interested in session	6	0	6
Median duration of session in minutes (IQR)	45 (40 to 45)	45 (40 to 45)	45 (40 to 45)
Other family member participated, <i>n</i> (%)	14 (23)	7 (28)	7 (19)
Highest intensity level during session, <i>n</i> (%)			
Breathing and relaxation	2 (3)	1 (4)	1 (3)
Restorative yoga	14 (23)	7 (28)	7 (19)
Low intensity postures	10 (16)	3 (12)	7 (19)
Moderate intensity postures	35 (57)	14 (56)	21 (58)
Session location*, <i>n</i> (%)			
Mat	49 (80)	16 (64)	33 (92)
Chair	6 (10)	3 (12)	3 (8)
Bed	13 (21)	9 (36)	4 (11)
Other	3 (5)	1 (4)	2 (6)
Breathing exercises*, <i>n</i> (%)			
Breath awareness	61 (100)	25 (100)	36 (100)
Yogic breathing	60 (98)	24 (96)	36 (100)
Alternate nostril breathing	10 (16)	2 (8)	8 (22)
Left nostril breathing	4 (7)	4 (16)	0 (0)
Kapalabhati	1 (2)	1 (4)	0 (0)
Warm-up exercises*, <i>n</i> (%)			
Range of motion movements	58 (95)	23 (92)	35 (97)
Sun salutations	10 (16)	6 (24)	4 (11)
Postures, <i>n</i> (%)			
Seated	56 (92)	22 (88)	34 (94)
Standing	41 (67)	13 (52)	28 (78)
Downward dog	20 (33)	11 (44)	9 (25)
Backbends	9 (15)	4 (16)	5 (14)
Final relaxation	61 (100)	25 (100)	36 (100)

IQR interquartile range

\*Participants could be in multiple locations or participate in multiple breathing and warm-up exercises during each session

26] that can result in hospitalizations. These events likely contributed to failure to attend some sessions. We also found that assigning yoga homework was not successful in our study. This finding is in contrast to adult outpatient studies, which were successful at achieving compliance with yoga homework [29, 30]. Failure to have homework completed may reflect the pediatric age of our participants, phase of treatment, or how we requested homework to be completed. Providing

more resources for home practice such as yoga manual with photos, descriptions of safe routines, and access to instructional online yoga videos, and a process of submitting homework weekly may improve compliance with yoga homework. Future qualitative research interviewing those who did and did not comply with yoga homework could provide insight into reasons for lack of adherence and how to increase completion rates in future studies working with this population.

While the number of patients in our study was too small to conduct statistical analysis, the median scores were similar to publications of general pediatric oncology populations for PROMIS measures [17], PedsQL 3.0 Acute Cancer Module scales and SSPedi symptom scores [22]. In contrast, the PedsQL MFS scores were worse, with median general fatigue scores of 33 to 67 across time points, in comparison to a general oncology population, which had a mean score of 75 [21].

The strengths of this study are its pilot nature, which is important prior to proceeding to a definitive randomized trial [16]. The evaluation of individualized, remote yoga sessions conducted in the home for pediatric cancer patients is a novel contribution to the literature. Additionally, using volunteer yoga instructors to carry out the remote sessions was another innovative component as this model may be a more sustainable approach when resources are constrained. Finally, another strength is the high level of satisfaction among those who did complete the study. This finding suggests that the program itself was designed well from a user-acceptability perspective and that if we could identify a mechanism to increase the number of sessions delivered, then this study may be feasible to evaluate in a randomized trial.

The study's weaknesses include its conduct at a single institution and limitation to older children 10 to 18 years of age who were English-speaking. While using volunteers was considered an innovative approach, we do not know whether session adherence would have been better or worse, had we remunerated instructors for conducted sessions. Finally, our approach to yoga homework was not effective and we do not know whether session adherence may have been better had homework been performed between sessions.

In conclusion, a 10-week individualized in-person and remotely conducted yoga intervention was not feasible in children receiving cancer treatments because of failure to achieve the desired frequency of yoga sessions in a sufficient number of participants. Future research should identify approaches to improve compliance with remote yoga sessions as well as home practice.

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## Compliance with ethical standards

**Ethical approval** Research Ethics Board approval was obtained from SickKids (REB#1000054681). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institution and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

**Conflicts of interest** There are no financial or non-financial conflicts of interest for any of the authors involved in this study.

**Abbreviations** PROMIS, the Patient-Reported Outcomes Measurement Information System; PedsQL, Pediatric Quality of Life; MFS, Multidimensional Fatigue Scale; SSPedi, Symptom Screening in Pediatrics Tool; REDCap, Research Electronic Data Capture; SAS, Statistical Analysis Software; IQR, Interquartile range

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