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Comparison of Self-Reported Physical Activity in Children and Adolescents Before and During Cancer Treatment

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Background. Physical activities are important for the development of children and increasing evidence suggests beneficial effects of physical activity promotion during cancer treatment as well. The present study aimed at evaluating the current need of exercise interventions in pediatric cancer patients undergoing acute treatment and identifying risk factors for inactivity. ***Procedure.*** Data about self-reported physical activity before and during treatment was collected in a cross-sectional design with the physical activity questionnaire from the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) in a modified cancer specific version. ***Results.*** One hundred thirty pediatric cancer patients with various entities were questioned 3.0 ± 1.6 months since diagnosis. Patients' activity levels before diagnosis mainly matched reference values for healthy children in Germany. Reductions during treatment affected all dimensions of daily physical activities and minutes of exercise per week decreased significantly ($P < 0.001$). Largest reductions of physical activities during treatment were identified for bone tumor patients and in-patient stays. ***Conclusions.*** Due to the well known importance of physical activity during childhood and the identified risk of inactivity during cancer treatment, supervised exercise interventions should be implemented into acute treatment phase to enhance activity levels and ensure a continuously support by qualified exercise professionals. Pediatr Blood Cancer 2014;61:1023–1028. © 2013 Wiley Periodicals, Inc.

Key words: acute treatment; bone tumor; exercise; leukemia; pediatric cancer patients; physical activity

INTRODUCTION

Physical activity and physical fitness are essential for a healthy development of children and adolescents [1,2] and physical education is a compulsory subject at school. Furthermore, there is strong evidence for the relationship between physical activity and motor proficiency in children and adolescents [3,4] Pediatric cancer patients in Germany are isolated from school and their social environments for up to one year. This implicates a reduction of activities of daily living like walking to school and playing with friends and leads to decreased activity levels [5,6]. However, no physical activity promotion routine is implemented for pediatric cancer patients as a supportive care during cancer treatment. Several studies already analyzed the consequences of cancer disease, medical treatment and physical inactivity on physical fitness. Preliminary results indicate a reduction of muscle strength [7], impairments in fine and gross motor skills [8] and a low functional capacity [9]. Although functional impairments seem to be present, not even physiotherapy as a basic physical activity support is offered to all patients. Even patients with identified musculoskeletal complications often are not referred to physiotherapy treatment [10]. The importance of physical activities during childhood is accepted generally and increasing evidence suggests that physical activity promotion during cancer treatment may have beneficial effects on physical and psychosocial well being as well [11,12].

The purpose of this survey was to evaluate the current need for exercise interventions in children and adolescents during acute cancer treatment. Therefore we compared physical activity levels before and during cancer diagnosis by self-reports. Furthermore we referred the patients' activity levels to corresponding reference values and analyzed different entities and treatment phases. This paper describes intra-individual changes of physical activity levels in different types of pediatric cancer and provides information about specific risk factors for inactivity.

METHODS

Recruitment and Study Design

This cross-sectional study included patients who were treated at the Department for Pediatric Hematology and Oncology at University Hospital Muenster between February 2011 and July 2013. Inclusion criteria were regular in-patient stays at the pediatric cancer ward during this defined time period, age between 4 and 23 years and no survey during initial therapy for patients who have a relapse. The survey was administered at a standardized date 3 months post diagnosis in order to assess leukemia patients during consolidation and bone tumor patients during neo-adjuvant therapy. An exclusion criterion was the inability to fill in the questionnaire due to lack of understanding the German language or cognitive impairments. All patients and their legal guardians were informed orally and in writing about the study design that ensured pseudonymization of patients and data and they were asked to provide written consent for participating. The local ethics committee had approved this study. For several years, the pediatric cancer ward in Muenster has been offering a supervised exercise program and all patients of the present study had the possibility to take part voluntarily in this sport pedagogical program during their in-patient treatment phases. However, the underlying research question did not focus on assessing effects of this program.

Physical Activity Questionnaire

Data about physical activity before and during treatment was collected with a modified version of the physical activity questionnaire from the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) of the Robert Koch Institute [13,14]. Therefore, results of activity levels before

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diagnosis could be compared with a reference population of 4,529 healthy children and adolescents in Germany. Questions about physical activity were applied verbatim to determine activity levels before treatment and slight linguistic modifications were made to ascertain actual activity levels during treatment for in-patient and home stays. Physical activity before diagnosis was assessed retrospectively referring to a typical week in the past, when no signs of illness were present yet. In this context, physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure and includes exercise as a subcategory of activities that are more planned, structured and repetitive [15,16]. One additionally supplemented question asked for the daily time spent out of bed during in-patient and home stays. Different versions for younger children (4–6 years of age/kindergarten) and older children (school age) were used that only differed in one question regarding levels of physical activity at school or in kindergarten before diagnosis. While adolescent patients answered the questions independently, children received help either from their parents or the research assistant and time to complete the questionnaire was about 10–15 minutes.

Statistical Analysis

Commercial software (IBM SPSS Statistics, version 21.0) was used for the statistical analyses. Frequency distribution of physical activity between patients and reference population as well as activity levels before and during treatment were compared with the Chi-squared test. Fisher's exact test was used for differences between leukemia and bone tumor patients. The extent of exercise activities (minutes per week) between different time points was analyzed with the Wilcoxon test as a non-parametric test for paired groups. Differences in sport activities between leukemia and bone tumor patients were assessed with the Mann–Whitney *U*-test. The level of statistical significance was set at $P < 0.05$ (significant), $P < 0.01$ (high significant), and $P < 0.001$ (highly significant) and all tests were two-tailed. *P*-values were not adjusted for multiple comparisons.

RESULTS

Sample

Data from 130 patients with various entities (Table I) out of 163 patients who met inclusion criteria was available for analysis during the study period (Fig. 1). Frequency distribution of entities in this patient group mainly met incidences of pediatric cancer, with exception of fewer brain tumor patients that were not treated at the pediatric cancer ward when chemotherapy was not part of their treatment regimen and higher numbers of bone tumor patients. The quantity of bone tumor patients is a characteristic of the University Hospital Muenster because the study central of Ewing sarcoma is located there as well as a specialized department for limb-salvage tumor surgery.

Physical Activity Anamnesis Before Treatment

Results of physical activity levels before treatment were matched to reference values of the KiGGS study in order to assess whether the patients showed normal levels of physical activity before their diagnosis. No significant differences were seen between short and medium daily walking distances, frequency of playing outside, frequency of an active way to school (walking or by bicycle), interest in sport, number of physical education lessons at school, and percentage of participation in sport clubs and sport in leisure-time. In few single categories the patients indicated higher levels of activities than the reference population, regarding frequency of participation in elective physical activities at school (24% vs. 10%, $P < 0.001$), percentage of meeting physical activity recommendation of >60 minutes moderate to vigorous physical activity per day (24% vs. 15%, $P = 0.01$) and frequency of walking more than 6km per day (20% vs. 10%, $P < 0.001$). Furthermore, patients engaged more minutes per week in sport clubs (222 minutes vs. 175 minutes) and did less sport in leisure-time (131 minutes vs. 219 minutes) although both groups indicated the same frequency of participation in sport clubs and sport in leisure-time.

TABLE I. Characteristics of the Study Participants (n = 130)

Characteristics	N (%)	Mean ± SD
Age (years)		12.2 ± 4.7
BMI (kg/m^2)		19.0 ± 4.7
Gender		
Male	79 (61)	
Female	51 (39)	
Months since diagnosis		3.0 ± 1.6
Cancer type and age (years)		
Leukemia	44 (34)	11.0 ± 4.5
Bone tumor	37 (28)	15.0 ± 3.1
Lower limb	23 (62)	
Trunk/upper limb	14 (38)	
Lymphoma	14 (11)	11.6 ± 5.0
Brain tumor	8 (6)	13.0 ± 6.7
Other solid tumor	27 (21)	10.6 ± 4.5

Mean and standard deviation (SD), n (number).

Physical Activity Before and During Treatment

Patients more often mentioned low or very low interest in sport during treatment than before and frequency of playing outdoors decreased. Percentage of meeting physical activity recommendation and daily walking distance were reduced highly significant during in-patient stays. Patients indicated to walk more during home stays, but still less than before their diagnosis (Table II).

The question about daily time spent out of bed revealed that home stays were characterized by much less bed rest than stays at the ward. While 50% of the patients during hospital stays left their bed for <1hour/day and only 2% for >10 hours/day the situation at home was exactly opposite with only 9% of patients leaving bed for <1-hour/day and 44% for >10 hours/day.

Physical exercise has been assessed in minutes/week. Without splitting sport activities into sport club and leisure-time activities, patients reported extents of physical exercise for on average 209 minutes/week before diagnosis. While on treatment patients had a 91% reduction of physical exercise during in-patient stays (18 minutes/week, $P < 0.001$) and a 74% reduction during home stays (55 minutes/week, $P < 0.001$). Figure 2 shows this reduction of physical exercise during treatment in relation to exercise levels before diagnosis and a direct comparison between in-patient and home stays with significantly higher levels during home stays ($P < 0.001$). Dividing the patient group into children (4–13 years,

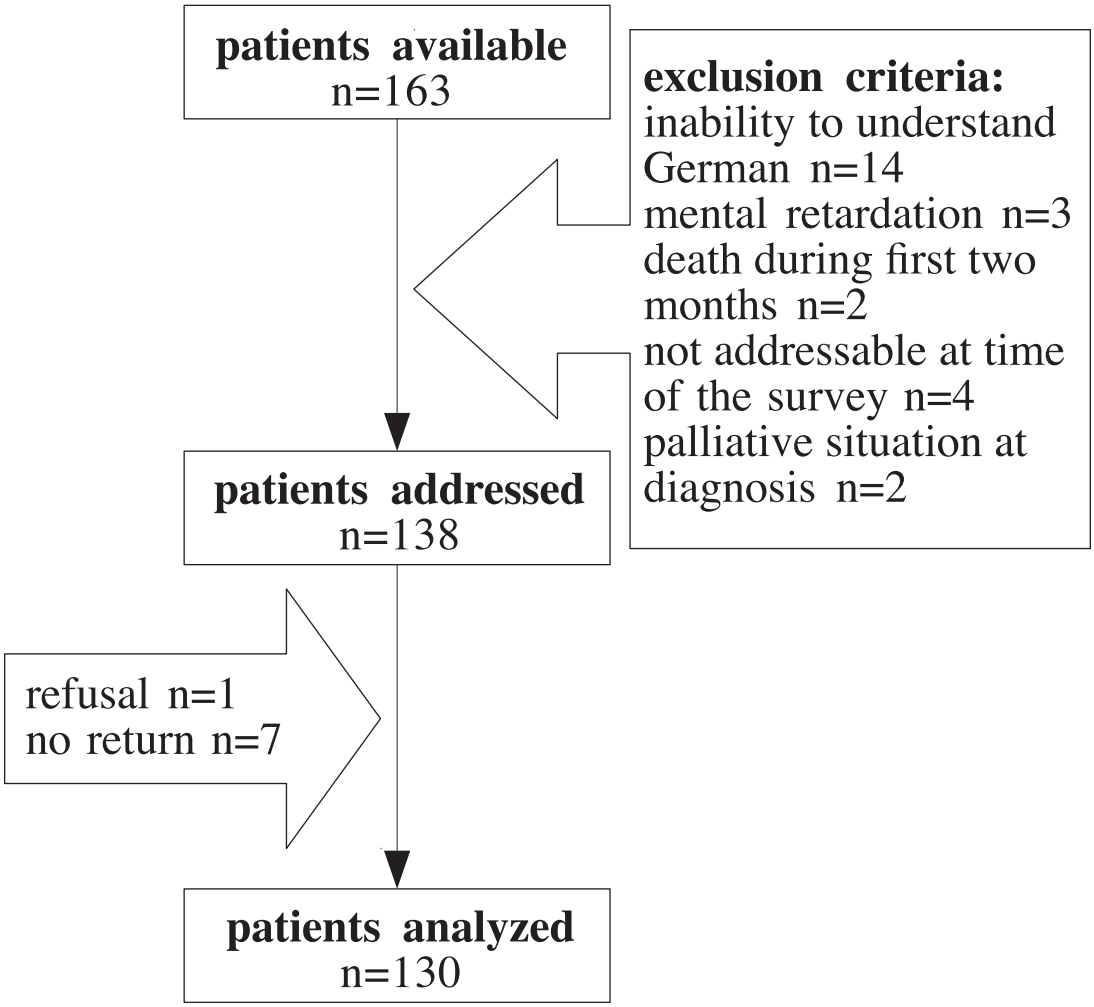

Fig. 1. Flow diagram of patient recruitment through the study period. Number (n).

n = 64) and adolescents (≥14 years, n = 66) could reveal larger reductions of physical exercise for adolescents during in-patient stays (87% reduction in children vs. 95% in adolescents) and home stays (64% reduction in children vs. 83% in adolescents). Self-reported physical activities during in-patient stays almost exclusively included contents of the local exercise program and 83% of study participants stated to be physically active in supervised interventions with the physiotherapist or sport therapist.

Physical Activity in Leukemia and Bone Tumor Patients

Group comparisons were only made between the two largest patient groups that were leukemia and bone tumor patients. By comparing their self-reported physical activity levels, greater reductions were usually seen for bone tumor patients. 69% of bone tumor patients did not leave the bed for >23 hours/day during in-patient stays, while 20% even admitted to leave bed for <15 minutes/day. Only 40% Leukemia patients stated to leave the bed for <1-hour/day (69% vs. 40%; $P = 0.013$). However, no differences regarding time out of bed were seen between the two entities during home stays. Regarding daily walking distances during in-patient stays, more bone tumor patients almost never walked as compared to leukemia patients (34% vs. 7% of leukemia patients; $P = 0.003$) but once again no significant differences could be seen for home stays. However, playing outside during home stays was less frequent in bone tumor patients (0.6 vs. 2.7 days/week in leukemia patients, $P < 0.001$), as well as the number of days of meeting physical activity recommendation (1.9 vs. 3.5 days/week in leukemia patients, $P = 0.007$). Minutes of physical exercise per week were significantly reduced in both entities compared to levels before diagnosis ($P < 0.001$, Fig. 3). While leukemia patients more than doubled their exercise levels during home stays (25 minutes vs. 64 minutes during home stays, $P < 0.001$), bone tumor patients remained as inactive during home stays as during in-patient stays (17 minutes vs. 16 minutes, $P = 0.959$). Interest in sports tended to be slightly higher in bone tumor patients, because 53% stated high or very high interest during treatment (vs. 42% of leukemia patients, $P = 0.372$).

DISCUSSION

The present study revealed in extent to which levels of physical activity changed due to cancer treatment. The patients represented a typical collective of children in Germany because they generally

TABLE II. Physical Activities Before Diagnosis and During Treatment

Physical activities	Before diagnosis	During treatment	*P*-value
Interest in sport			
High or very high	67.7	47.2	0.001
Moderate	26.2	26.0	1.000
Low or very low	6.2	26.8	<0.001
Playing outdoors			
Daily	33.8	18.5	0.007
4–6 (days/week)	29.2	8.1	<0.001
<1–3 (days/week)	33.8	37.9	0.515
Never	3.1	35.5	<0.001

Daily walking distance	Before diagnosis	In-patient	*P*-value	Home	*P*-value
<1 km	10.1	78.5	<0.001	25.1	0.002
1–5 km	69.8	21.5	<0.001	53.5	0.010
>6 km	20.2	0	<0.001	21.3	0.878
Meeting recommendations	23.8	1.6	<0.001	21.4	0.657

All results are given in percentages (%). *P*-value is always based on statistical differences in relation to results before diagnosis.

met reference values for healthy children and adolescents before their diagnosis, except for some categories in which the patients indicated a physical activity behavior above average. Physical activity levels decreased significantly during treatment and the most pronounced reductions were seen for in-patient stays where more than 50% of patients stayed in bed for more than 23 hours/day. Underlying cause could be the common habit to carry out all activities of daily living like eating, playing and watching TV in bed due to the lack of other recreational facilities and space. However, this high amount of bed rest time may result in typical consequences of inactivity like skeletal muscle atrophy and weakness, joint contractures, thromboembolic disease, systemic inflammation [17], and a decline in physical function [18]. Sedentary behavior has recently been described as a health risk for adult cancer patients that is independent from physical inactivity and may contribute to an increased risk of cancer progression, comorbidities and chronic diseases [19]. Due to these negative impacts of sedentary behavior and bed rest, the patients should be motivated to leave their hospital bed more often by implementing enjoyable offers for all ages and establishing allocated areas for adolescent patients to relax and study [20].

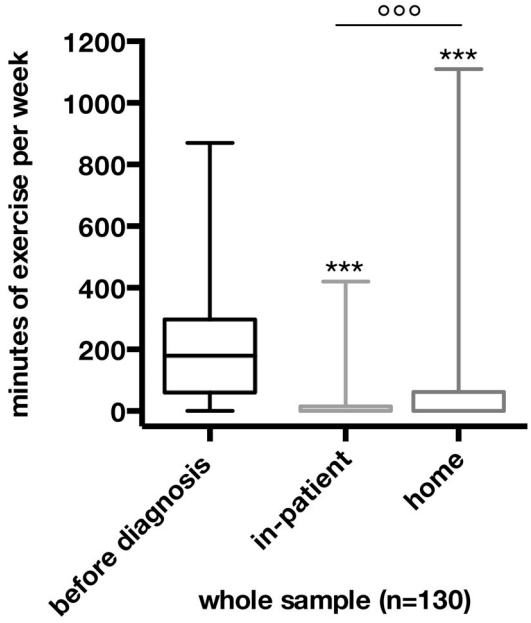

Fig. 2. Extent of physical exercise before diagnosis, during in-patient and home stays in the whole patient collective. Asterisks symbolize statistical differences in relation to time before diagnosis ($P < 0.001$); dots symbolize statistical differences between in-patient and home stays ($P < 0.001$); whiskers represent minimum and maximum of the data; number (n).

Exercise activities have been identified as highly reduced during in-patient stays which could be explained by the various cancer and treatment-specific problems like side effects of chemotherapy, limitations of loading tumor-affected extremities or permanent restrictions by the infusion stands. Levels of exercise were low in the patient group, although all children and adolescents had the possibility to participate in a supervised exercise program voluntarily during in-patients stays. This on the one hand suggests even lower levels of exercise for patients treated in other hospitals without any sport incentives. On the other hand, the listed exercise activities at the ward were almost exclusively limited to contents of the supervised exercise intervention and the patients accepted this offer gladly. This underlines the importance of exercise programs to at least ensure a continuously support of physical activities and shows us to even intensify the exercise program. The presence of qualified therapists seems to be an important aspect as well, because the majority of patients mentioned to be physically active with the exercise professional during in-patient stays.

Daily walking distances were larger at home than during in-patients stays. This result supports the findings of a previous investigation about the daily level of activity during cancer treatment from Winter et al. [5]. An explanation might be that some patients compensated reduced exercise levels and frequencies of playing outdoors by more walking activities. Interest in sport was reduced during treatment but almost half of the patients still quoted high or very high interest. Exercise has already been identified as an important aspect for young adults with cancer and the present study confirms these findings of Gupta et al. [21] for children and adolescents as well.

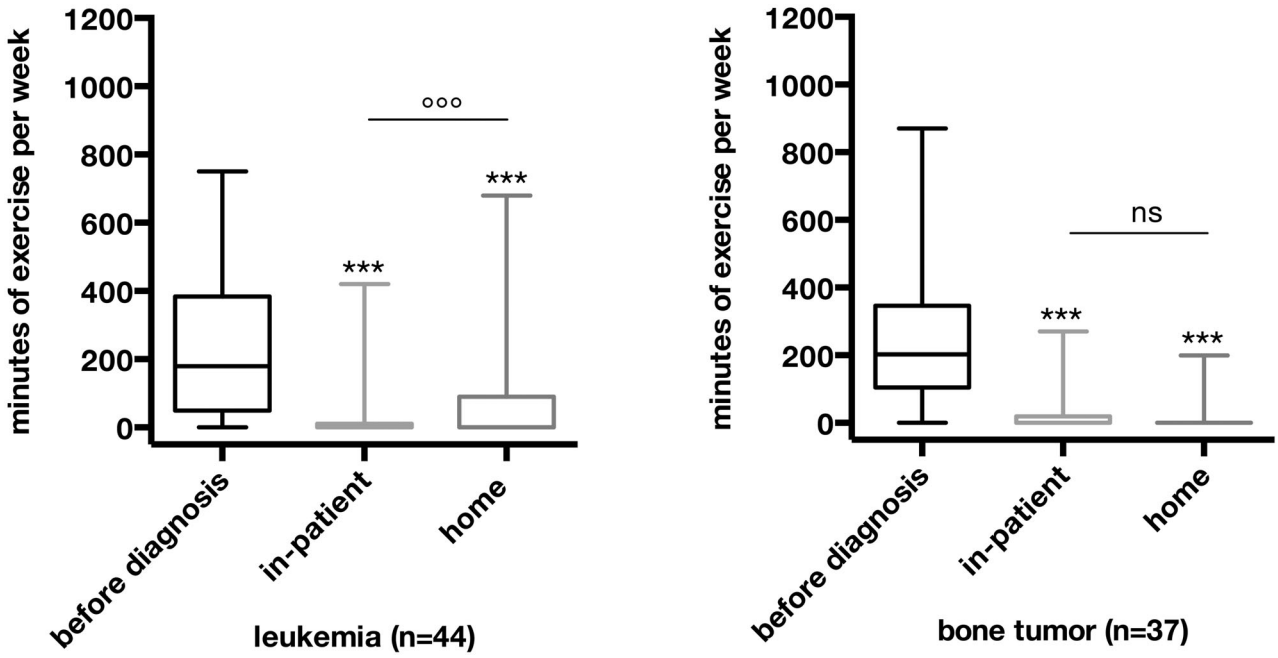

Fig. 3. Extent of physical exercise before diagnosis, during in-patient and home stays in leukemia and bone tumor patients. Asterisks symbolize statistical differences in relation to time before diagnosis ($P < 0.001$); dots symbolize statistical differences between in-patient and home stays; ($P < 0.001$) for leukemia patients; not significant (ns, $P = 0.959$) for bone tumor patients; whiskers represent minimum and maximum of the data; number (n).

The overall lower physical activity level of bone tumor patients in comparison with leukemia and lymphoma patients supports the findings of Winter et al. [5]. Surprisingly, the self-reported walking distances during home stays and bed rest times during home stays in the present survey did not differ between tumor entities. Therefore, it appears that patients with bone tumors are mostly capable to walk and be physically active but other obstacles drastically limit their physical activities in the hospital. These barriers could be the permanent restriction by the infusion stand in addition to wheel chairs or forearm crutches or the older age of bone tumor patients, because age-dependent analysis showed greater reductions of exercise levels in older patients. Adolescents with cancer have to face additional issues during cancer treatment because the severe illness occurs during their main developmental stages towards adulthood with all accompanying pubertal problems of emotional changes and the discrepancies between individuality and dependency [22,23] and the identified inactivity of bone tumor patients during in-patient stays may be due to the overall negative impact of being hospitalized, isolated from peers and dependent on parents [24,25]. Furthermore, some bone tumor patients may have lost their motivation to exercise, because endoprosthetic replacement or amputations limit their ability to resume their former type of sport after treatment. Implementing help to find new exercise perspectives already during intensive treatment may also help to motivate the patients to be more physically active during treatment.

The limitations of this study include the determination of physical activity by self-reports that have been shown to be less valid than objective methods like accelerometry [26]. Further research should compare self-reports and objective accelerometry and verify the cancer patients' ability of self-assessment of physical activity levels and intensity during treatment. However, this method was the most suitable method to assess former levels of physical activity, although it may have led to recall bias. Furthermore, it has to be noted that results cannot be generalized to the whole population of pediatric cancer patients due to the single-center design of this study. However, the present patient group shows a representative cross-section of our department because the majority of available patients could be questioned and response rates were high. Other strengths are the inclusion of physical activity levels before treatment to determine intra-individual changes and the inclusion of a large sample of various cancer entities because most previous research about this topic focused on leukemia and lymphoma patients [12,27].

Based on the present findings and the experience with the local exercise program we recommend the following organizational aspects when promoting exercise during hospital stays: Exercise interventions should always be supervised by sport therapists and offer diversified sport activities adapted to (1) patients' interests; (2) physical and psychological conditions; and (3) recommendations of the sport therapist based on motor abilities and impairments. To respect medical and psychosocial aspects and physical limitations, the sport therapist should cooperate intensely with the medical and psychosocial staff and the physiotherapists. Furthermore, he should involve exercise counseling and extensive discussion of wishes, fears and individual problems of the patients and parents in relation to physical activities and sports. We recommend carrying out frequent interventions with short duration (20–30 minutes) to lower the inhibition threshold to participate, and a gradual load increase for new diagnosed children to avoid negative experiences like sore muscles or strong exhaustion at the beginning. Contents should include training of sensorimotor function, strength, coordination, flexibility, and endurance in a playful manner. Wherever possible, the sport therapist should consider the former type of sport as well as contents of age-related physical education guidelines in the

exercise program. To minimize organizational barriers to exercise like conflicts with medical examinations and other therapies and to respect varying physical form over the day, the sport offer should be scheduled flexibly.

In summary, this study highlighted significant reductions of physical activities in a large sample of pediatric cancer patients during acute treatment and identified the diagnosis of bone tumors, being at older age and in-patient stays as specific risk factors for inactivity. Further research should focus on individual patient-related barriers and motivations to be physically active. The presence of specialized therapists seems to be important for patients to exercise. Therefore, exercise professionals should continuously provide support for children and adolescents with cancer and help to overcome individual barriers and problems. Based on the present findings, implementing supervised exercise programs at pediatric cancer wards are needed to enhance activity levels and support an active disease management.

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