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Physical activity of pediatric patients with acute leukemia undergoing induction or consolidation chemotherapy

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ABSTRACT

This study aimed to assess the physical activity levels of pediatric patients with acute leukemia undergoing chemotherapy. Thirty-eight pediatric patients and matched controls, aged 3–12 years old, were measured for weight, height, and other anthropometric parameters. Physical activity was assessed using actical accelerometer and activity log book. Patients recorded significantly lower mean total activity counts (26.2 ± 30.2 cpm vs. 192.2 ± 68.8 cpm; $p < 0.01$) and spent more time in sedentary activities (1301 ± 121 min vs. 1020 ± 101 min; $p < 0.001$) compared to controls. They also achieved fewer 1–5-min bouts of moderate–vigorous physical activity (MVPA) compared to controls (1.50 ± 5.95 vs. 37.38 ± 40.36; $p < 0.001$). In conclusion, patients had lower physical activity level and intensity; and simple exercise intervention programs may be needed to minimize the detrimental effects of prolonged sedentary behaviors.

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1. Introduction

For the past decades, a combination of therapy has led to a higher survival rate of approximately 80% among leukemia patients, however, cancer and its treatment have severe implications for young patients [1]. The prolonged use of drugs may cause children to be prone to obesity, suffer growth hormones interruption, and may produce negative effects on bone density [2].

Almost all leukemia patients experience a reduction in their physical activity level, however, very little research has been conducted on this particular group of children [3], with the exception of few existing studies of long-term survivors of the disease [4,5] or patients undergoing chemotherapy in the maintenance phase [6,7], which is the later treatment cycle commonly conducted in an outpatient setting. To the best of our knowledge, there is only one study by Winter et al. [3] which has assessed the level of activity among pediatric cancer patient undergoing treatment in the early stages of induction and consolidation phases. The authors measured the level of physical activity among oncology patients during their in-patient stay for cancer treatment, as well as during home-stay without treatment. Thus, there remains a severe lack of data reporting the level of physical activity among pediatric patients, especially during in-patient treatments in the clinical setting.

Besides that, most studies on the level of physical activity use self-reports for measurement, which have been found to produce inconsistent results [8]. In contrast, accelerometry is known to be particularly useful for assessing physical activity because the technique provides an objective and non-obstructive measurement of the frequency, intensity and duration of

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physical activities. More importantly, accelerometers minimize errors related to the subjective recall of behavior, especially among children [9]. Accelerometers have been shown to be a valid instrument for measuring physical activity among children that add precision and credibility to the measurement results [10].

Therefore, the aim of this study is to assess the physical activity level and patterns of acute leukemia patients undergoing induction or consolidation chemotherapy in hospitals as compared to age-matched, healthy controls. We envisage the results of this study will facilitate in the development of appropriate and effective exercise intervention programmes tailored to the needs and conditions of individual patients in an attempt to support their recovery and well-being during their stay for in-patient treatment.

2. Methods

2.1. Study design and subjects

The present study was part of an on-going study on energy requirements of pediatric patients with acute leukemia. A total of 185 pediatric patients between the ages of 3 and 12 years old who were diagnosed with either acute lymphoblastic leukemia (ALL) or acute myelogenous leukemia (AML) and were undergoing chemotherapy treatments (in the induction or consolidation phase) as in-patients at the Paediatric Institute of Hospital Kuala Lumpur (HKL) and the Haematology and Oncology Paediatric Ward, Universiti Kebangsaan Malaysia Medical Centre (UKMMC) were identified from April 2009 to January 2011. A total of 127 patients between the ages of 3 and 12 years old were invited to enter the study; while 58 patients diagnosed with other forms of leukemia, receiving nutritional support via tube feeding or parenteral nutrition, constantly connected to an immobilized medical device, and presented with severe mobility difficulties or problems were excluded. In all, 56 patients were recruited, with 66 patients declining participation, while 5 were transferred to other hospitals for treatment. The main reason for non-participation was mainly because parental consent was very difficult to be obtained immediately post-diagnosis due to the emotional stress and anxiety of having to cope with the news of their child having cancer.

For the current analysis, 18 out of 56 patients were further excluded due to incomplete data on objectively measured physical activity, leaving a total of 38 patients (31 with acute lymphoblastic leukemia, 7 with acute myelogenous leukemia) that were evaluated. For comparison purposes, 38 healthy children were recruited from nurseries, kindergartens and primary schools around Kuala Lumpur to serve as controls. The control group was matched for gender, age (±12 months) and ethnicity.

Written informed consent was obtained from the parents or legal guardians of patients and controls prior to participation in the study. This study was approved by the Medical Research and Ethics Committee of Universiti Kebangsaan Malaysia and the Medical Research Ethics Committee (MREC) of the Ministry of Health Malaysia.

2.2. Anthropometric measurements

All anthropometric measurements were conducted according to the standard ISAK (International Society for the Advancement of Kinanthropometry) procedures [11]. Weight was determined to the nearest 0.1 kg, with subjects dressed in light clothing or ward gowns, using the SECA electronic scale Model 880 (SECA, Germany) after voiding. Height was measured to the nearest 0.1 cm without socks or shoes, using the SECA wall-mounted stadiometer Model 206 (SECA, Germany). Body mass index (BMI) was calculated using the standard formula of dividing body mass (in kg) by height squared (in meters).

Waist circumference and mid-upper arm circumference (MUAC) were measured to the nearest 0.1 cm using a flexible, non-stretchable tape. Triceps skinfold thickness was measured to the nearest 0.1 mm using the Harpenden skinfold calipers (British Indicators, U.K.).

2.3. Physical activity assessment

Physical activity level was assessed using the actical accelerometer (model 198-0200-01, Mini Mitter, Co, Inc., USA). Actical is the smallest commercially available dual-mode accelerometer (capable of measuring both accelerometer counts and step counts) [12,13]. Actical is light, not obvious and very sensitive to the frequency and amplitude of movements [14]. This device is child-friendly and has been validated for measuring physical activity among children in free-living conditions [10]. A 15-s epoch (interval) was used, and total activity count was measured.

Once the actical was calibrated, the device was fastened to an elastic waist belt strap and worn on the subject's waist by mounting the belt around the waist circumference, with the actical device resting on the iliac crest of the hip in the correct orientation. For standardization purposes, all subjects wore their actical devices on their right hip, under their clothing. The subjects wore the acticals at all times, even during sleep. They only removed the acticals during bath time, swimming or any other water activity and immediately replaced the device after these activities.

Subjects were instructed to wear the actical for 5 days, including 3 weekdays and 2 weekend days. Upon completion of the 5-day study period, the actical was collected and the data recorded in the device were retrieved and stored using the ActiReader and actical 2.0 software. The stored data were then loaded into Microsoft Excel 2007 spreadsheets and saved for analysis.

Only data with a minimum of 10 registered hours per day of recording [15] on at least 3 full days (2 weekdays and 1 weekend day) were considered valid for analysis. The intensity of physical activity was described based on counts per minute (cpm) using cut-off points suggested by Puyau et al. [10] for subjects aged 7–12 years old and by Pfeiffer et al. [12] for subjects 3–6 years old. Sedentary activity was defined as <100 cpm for all age groups. For subjects in the 7–12 years group, the intensity of an activity count of 100–1499 cpm was considered light, 1500–6500 cpm was considered moderate and >6500 cpm was considered vigorous [10]. For subjects in the 3–6 years group, cut-off points of 100–2860 were considered light, >2860 cpm was considered moderate and >5644 cpm was considered vigorous [12]. Counts per minute (cpm) was defined by averaging the four 15-s epoch counts over each minute [12].

To assess physical activity patterns, parents or caretakers were instructed to record the child's physical activity on 2 weekdays and 1 weekend day in a 3-day physical activity log book concurrent with wearing the actical. Activities were recorded in a half-hourly manner throughout 24 h in a day. Activities that were most commonly and frequently done by patients, as recorded by parents or caregivers were collated into main activity groups and reported in the most appropriate manner.

Table 1
Anthropometric characteristics of leukemia patients and controls (mean ± SD).

Variables	Patients (n = 38)	Controls (n = 38)
Age (years)	7.0 ± 2.9	6.8 ± 2.8
Body weight (kg)	23.2 ± 10.0	21.5 ± 9.1
Height (cm)	117.5 ± 17.5	116.7 ± 15.4
BMI (kg/m^2)	16.1 ± 3.7	15.7 ± 2.9
Waist circumference (cm)	57.8 ± 10.5*	52.1 ± 8.3
MUAC (cm)	19.2 ± 3.8*	16.9 ± 2.7
Triceps skinfold thickness (mm)	14.3 ± 7.1*	9.6 ± 4.9

* Independent t-test showed significant difference between patients and controls at $p < 0.05$.

2.4. Statistical analysis

Data analysis was performed using the SPSS (Statistical Package for the Social Sciences) for Windows, version 18.0 (SPSS Inc., Chicago, USA). The Wilks–Shapiro normality test was used to check for the distribution of the data. Descriptive and statistical values were expressed as means ± SD. Median and interquartile range (IQR) were also reported for data that were not normally distributed. To compare anthropometric status between leukemia patients and their matched controls, independent t-test was used, while the Mann–Whitney test was used to compare the level of physical activity between patients and controls because the variables demonstrated skewed distributions. A p-value less than 0.05 was considered a measure of statistical significance.

3. Results

3.1. Anthropometry

Table 1 shows the comparison of anthropometric characteristics between leukemia patients and their sex, age and ethnicity-matched controls. Although all anthropometric measurements showed higher mean values in the patient group, significant differences between patients and controls were observed only in the measurements of waist circumference, MUAC and triceps skinfold thickness ($p < 0.05$).

3.2. Physical activity

The level of physical activity between patients and controls are compared in Table 2. The results show that leukemia patients had significantly lower levels of physical activity ($p < 0.01$), whether quantified as activity counts (expressed as counts per minute, cpm), total activity counts or total steps, compared to their healthy counterparts. The results also showed that leukemia patients spent

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