

# Impact of Exercise on Lower Activity Levels in Children with Acute Lymphoblastic Leukemia: A Randomized Controlled Trial from Turkey

Meltem Kurtuncu Tanir<sup>1</sup>, PhD & Sema Kuguoglu<sup>2</sup>, PhD

1 Assistant Professor in Zonguldak Karaelmas University, Zonguldak School of Nursing, Department of Pediatric Nursing, Zonguldak, Turkey

2 Professor of Pediatric Nursing in Emeritus Professor from Marmara University Health Science Faculty, Division of Nursing, Department of Pediatric Nursing, Istanbul, Turkey

## Keywords

children with ALL; exercise tolerance; muscle strength; quality of life.

## correspondenceTo

Meltem Kurtuncu Tanir, Assistant Professor in Zonguldak Karaelmas University, Zonguldak School of Nursing, Department of Pediatric Nursing, Zonguldak, Turkey.  
E-mail: meltemkurtuncu@yahoo.com.

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## Abstract

This randomized, controlled experimental study was carried out to determine the effects of an exercise program on both physical parameters and the quality of life of children with acute lymphoblastic leukemia (ALL). A total of 41 children with ALL (20 trial and 21 control cases) at two university hospitals were accepted into the study. Due to the demise of one of the children in the trial group, the study was completed with 19 trial and 21 control patients, a total of 40 children and their parents. Regular and systematic exercise regimens implemented by children with ALL have resulted in improved testing results, enhanced physical performance, and better laboratory results compared with a control group and to children's scores before the initiation of such a program.

## Introduction

Acute lymphoblastic leukemia (ALL) is the most common cancer seen in children and accounts for one-fourth of all childhood cancers. The highest incidence of ALL is observed in children aged 2–3 (Smith, Gloeckler Ries, Gurney & Ross, 2010). Male children display a 20% higher incidence than females. The recovery rate with treatment is 80% (Landolt, 2006; Pui & Evans, 2006).

Children with ALL exhibit body function disorders and activity limitations at an early stage. In one study, it was reported that in children taking Vincristine, peripheral neuropathy developed in the first month after the start of treatment. The first symptom of peripheral neuropathy is reduced deep tendon reflexes (Hartman, den Bos, Stijnen & Pieters, 2006). Other symptoms include parasthesia, pain, muscle cramps, muscle weakness, reduced ankle movement, decreased physical functions, and constipation (Wolin, Ruiz, Tuchman & Lucia, 2010). The literature reveals that children with ALL develop diminished functional mobility, weakened leg extension, and decreased ankle dorsiflexion

within the first year after the initiation of chemotherapy (Gocha, Chiarello & Lange, 2003; San Juan et al., 2008). Thus, it can be seen that as an outcome of the treatment of the chronic disease of cancer, children lose the physical functions they depend on in their everyday lives.

In response to the impact of the loss of physical functions, these children may suffer from various other problems such as social isolation, loss of independence, anxiety, and depression. Such physical and psycho-social changes have an adverse effect on the quality of life of children and their parents (Eiser, Eiser & Stride, 2005; Oral, 2000). Preventing, determining, or controlling disease- and procedure-related complications at an early stage can only be possible with symptom control after a program of rehabilitation (Bryant, 2003; Hooper, 2010). Ensuring that individuals with cancer live a quality life is dependent upon the quality of the rehabilitation program that is offered. Two important elements that are basic to cancer rehabilitation are aerobic exercise and educating children and their parents about the disease (Kearney & Richardson, 2006).

## Aim

This study was conducted with the aim of determining the effects of an exercise program on both physical parameters and on the quality of life of children with ALL.

## Method

### Design and Sample

All of the children at both university hospitals consented to work with the researchers and subsequently, 20 trial and 21 control patients, a total of 41 children, were accepted into the study. The two groups were formed by randomized selection. Due to the demise of one of the children in the trial group, the study was completed with 19 trial and 21 control patients, a total of 40 children and their parents.

The children in the sample group were chosen on the basis of the following criteria: (a) being in the age group 8–12, (b) being in remission (having received a diagnosis of ALL at least 1 year before the study), (c) being followed up as an outpatient, (d) not having participated in a regular exercise program in the last 6 months, (e) residing in Istanbul, (f) displaying a Grade 3 in motor strength (Hislop & Montgomery, 2006), (g) not having a previous history of cancer, (h) having no history of neurological disease or genetic disorder before the diagnosis of ALL, (i) having no cardiac, pulmonary, renal or hepatic dysfunction, and (j) having no problem with sight, hearing or perception.

To confirm subject eligibility, the child's psoas major and iliacus muscles were evaluated. The children's Psoas major and Iliacus muscles were evaluated for leg strength and found to be of average strength (Grade 3). In evaluating the muscles, the children were positioned on the edge of the table with their legs dangling down but fully supported on their thighs. Placing the hands on the knee joint, the children were instructed to lift their leg upward and keep it up. If the child was able to keep the leg up without resistance at the end of this test, the child was assessed as Grade 3 or above (Hislop & Montgomery, 2006; Figure 1).

### Setting

The study was conducted in the period September 2007–June 2008. The subjects were children registered at the Hematology-Oncology polyclinics of the Departments of Pediatrics of two university hospitals in Istanbul, Turkey. The implementation took place at the children's home and in the clinical environment. All of the children with

ALL who were being treated at the hospitals and their parents constituted the population of the research.

### Ethical Issues

Permission for the study was obtained from the ethics boards as well as from the hematology/oncology departments of the two university hospitals (Reg. No. 2006-0091 and Reg. No. 2006-18108) where the research was to take place. Subsequently, the purpose of the study and information about the methodology were explained to the doctors, nurses, and other healthcare professionals working at the departments concerned and their cooperation was requested. The children who fulfilled the study criteria and their parents were informed about the purpose, plan and benefits of the research and then asked to sign a patient informed consent form. The questions of the children and parents in the control group were answered during the monitoring of the cases. The children and parents in the control group were given exercise pamphlets after the monitoring and then provided with 30–60 minute training sessions.

### Data Collection Process

The data collected on the children and their parents for this study were based on the results of information gathered from the following sources at the start of the study and later, after 3 months had elapsed: the Children's Identifying Information Form, the Pediatric Quality of Life Inventory (PedsQL 4.0), the Pediatric Quality of Life Inventory (PedsQL) 3.0 Cancer Module, the 9-Minute Walk Test, the Timed Up and Down Stairs Test, the Timed Up and Go Test, the Dynamometer and Goniometer tests; hematocrit, hemoglobin values were also evaluated.

### Measurement Instruments

*The Children's Identifying Information Form* was drawn up by the researchers based on the examples in the literature. The children's form included the variables of age, gender, educational status, ability to participate in activities, the means of transportation to school, how the disease was affecting the child's life, the child's thoughts about the disease, among others (Hicks, Bartholomew & Ward-Smith, 2003; Hockenberry & Wilson, 2007).

*PedsQL 4.0* is a quality of life measurement tool developed by Varni, Seid and Rode (1999) to assess the quality of life of children and adolescents between the ages 2 and 18 (Varni, Seid & Kurtin, 2001). As one of the general

quality-of-life inventories that are available today, PedsQL 4.0 is a 23-item quality-of-life inventory that is used in broad populations such as hospitals and schools to measure both healthy children and those with a particular condition (Eiser, Mohay & Morse, 2000; Eiser & Morse, 2001; Sönmez & Başbakkal, 2004; Varni et al., 2001). *PedsQL 3.0* was developed by Varni et al. (2001) and tested for validity and reliability.

The PedsQL 3.0 cancer module is a 27-item multidimensional inventory. The Cronbach's Alpha coefficients found in the validity and reliability studies of the inventory carried out in Turkey resulted in values of 0.602–0.982 for the subscales in the children's questionnaire and of 0.644–0.966 in the parents' questionnaire, indicating a high level of reliability (Kürtüncü Tanır & Kuğuoğlu, 2011).

It was concluded at the end of the study that the PedsQL 3.0 cancer module was a valid and reliable tool for assessing the quality of life of Turkish children, aged 8–12, diagnosed with cancer.

### Content Validity

To evaluate the face and content validity and reliability of the Turkish version of the scale items, 15 specialists in different fields were consulted. For the numerical assessment of content validity, the Content Validity Index (CVI) developed by Waltz and Bausell (1981) was used as an example, after which the researchers prepared gradation criteria that they submitted to the consultants (Erefe, 2002; Gözüm & Aksayan, 2003; LoBiondo-Wood & Haber, 2006). Changes were made in line with the recommendations of the specialists and the questionnaire was given its final form.

When a statistical analysis was made of the data that was collected with the help of the specialists, the CVI for the Pediatric Quality of Life Inventory Cancer Module (PedsQL 3.0) was found to demonstrate the high value of minimum 73%.

PedsQL 3.0 is a quality-of-life assessment tool used for children with cancer. PedsQL 4.0 is a general quality-of-life inventory. The two scales were used for comparative purposes.

*The 9-minute Walk Test* measures maximal functional capacity and cardio-respiratory endurance (Cilione et al., 2002; Cooper & Storer, 2003; Crapo et al., 2002; Enright, 2003; Zaino, Marchese & Westcott, 2004). This test is a submaximal test and may be applied at varying speeds depending upon the walking abilities of the patient. It requires no materials, only a distance measured accurately for length and a chronometer (Zaino et al., 2004). The

walking takes place for a distance of at least 30 m (100 feet) where traffic is minimal. Before the test, the purpose of the test is explained to the child, who is then asked to walk as long as he/she can between two points at his/her own speed, stopping to rest whenever the need arises. The test result is calculated in meters as the distance walked in the test (Cilione et al., 2002; Cooper & Storer, 2003; Crapo et al., 2002; Enright, 2003). *The Timed Up and Down Stairs Test* assesses the potential and functional mobility allowed by the neuromuscular and musculoskeletal systems that control posture (Zaino et al., 2004). It is believed that the time taken to go up and down stairs is related to the variations in developmental and functional mobility abilities. In measuring the time children take to go up and down stairs, they are asked to stand 30 cm away from the lowest step of a 14-step stair (stair height is 19.5 cm). They are then told to “climb the steps quickly but safely, to turn back on the last step and go down this time until both feet are on the last step.” The children are allowed to climb up and down the stairs any way they want. The variations may include running up, skipping steps, and others. The assessment is that the shorter the time, the better the functional abilities of the child (Zaino et al., 2004). *The Timed Up and Go Test* measures walking rate, functional mobility, and related components (Podsiadlo & Richardson, 1991). For the timing of the Up and Go test, the child sits in a chair of suitable height. The height of the seat is adjusted so that the hips and knees are in 90° flexion and the feet are firm on the floor. The test is carried out with bare feet. The child is given the command to “get up and go.” With the command “Go” the child gets up, walks 3 m, turns back, walks again and sits. The time that elapses between the child's getting up to the “Go” command and coming back to sit is recorded. If the participant runs during the test, the test is repeated. The assessment is that the shorter the time, the better the functional abilities of the child (Zaino et al., 2004). *The Dynamometer* provides an accurate and objective measurement of isometric muscle strength (Gocha, 2001; Saygin, Polat & Karacabey, 2005; Tamer, 2000). The measurement is carried out with back and leg dynamometry. After the child is given a determined time to warm up, the child's feet are arranged on the dynamometer bench while he is on his feet with legs bent. The arms are taut, the back straight and the body slightly leaning forward. In this position, the child grips the dynamometer bar vertically and uses the legs at a maximum, pulling the bar up. This is the point where the measurement is taken. This is repeated three times and the

best value in kg is recorded for each subject (Gocha, 2001; Saygin et al., 2005; Tamer, 2000). *The Goniometric* test is an objective method that allows the clinical assessment of normal joint movement (Otman, Demirel & Sade, 1998).

### Exercise Program for Children in Home

The first assessment of the children agreeing to participate in the research was carried out in the hospital. After dividing the children into trial and control groups, the researchers offered the children in the trial group their first session of training at a designated room in the hospital. One of each child's parents was admitted into the session to serve as a supporting and motivating force. In the session, the exercises that the children would be doing in the next 3 months were demonstrated. The workout comprised active range of motion (ROM), leg muscle strengthening and aerobic exercises.

A convenient time to meet at home for the next session in the week to follow was agreed upon with the parents. The home visits took place a total of two times, each visit lasting about 3 hours. The families were reminded a day in advance of their appointment. At the visit to the patient's home, in an effort to elicit a lasting approach to the exercises, the children were given an education pamphlet and a chart to log in their daily exercises. Phone calls were made to the children every 2 weeks in the first month and once each in the second and third months to inquire about whether they were continuing with their exercise program and if they had any problems with it in any way. No exercise was recommended to the patients in the control group over the course of the study. The children and parents in both groups were called into the hematology–oncology polyclinic 3 months after the first interview for final assessment.

The exercise program for children was planned as follows:

(1) *Active ROM exercises*; 5 days a week, 3 times a day, 20 times each repetition.

● Hip flexion	Lying on your back
● Extension of the knee	
● Flexion of the knee	
● Hip extension	
● Hip abduction and adduction	
● Foot dorsiflexion	
● Internal and external rotation of the foot	
● Hip extension Lying face down	Lying face down
● Flexion of the knee	

**Figure 1** Muscle Tests Manual Assessment Techniques. Hislop, H. J. & Montgomery, J. (2006).

(2) *Leg Exercises for strengthening the muscles*; 3 days a week, 3 times a day.

- Squatting and getting up movement (30 times)
- Walking on the heels (10 steps, 3 times, back and forth)
- Five-step stairs (up and down, 10 times)
- Leg abduction (Lying on one side and opening the legs to the side, 20 times).

(3) *Aerobic Exercises*, To be performed three times a week, once a day, for a half-hour. The children were told to choose one of the following suggested exercises:

- Step-dancing to the rhythm of music
- Jumping rope
- Riding a bicycle
- Running at a slow pace, in rhythm
- Walking quickly

It was explained to the children and parents that the children would have difficulties while doing these movements initially, but that as they put them into practice on a regular basis, they would benefit. The children were also given the researcher's phone number in case they needed to consult for any reason.

### Data Analysis

Research data were assessed with the Windows SPSS (Statistical Package for Social Sciences) 11.5 Program. Besides descriptive statistical methods (means, standard deviation), the one-way Anova test, the Tukey HDS, and the student's *t*-tests were also used in the analysis. The Kruskal-Wallis test and the Mann-Whitney U test were used for comparing the groups in terms of parameters that did not display normal distribution. The paired sample *t*-test was used for the intragroup comparison of parameters that displayed normal distribution and the Wilcoxon Signed Rank test was used for the intragroup comparison of parameters that did not display normal distribution. The chi-square and Fisher chi-square tests were also utilized. The internal consistency of the scale was calculated with Cronbach's Alpha coefficient. Results were assessed in a 95% confidence interval and significance was determined as  $p < .05$ .

### Results

#### Children's Identifying and Disease-Related Characteristics

The identifying and disease-related characteristics of the children in both the trial and the control group were dis-

**Table 1** Distribution and Comparison of Children's Identifying  $\bar{X}$  Characteristics ( $N = 40$ )

Characteristics		Trial ( $n = 19$ )		Control ( $n = 21$ )		Statistical Analysis
		$n$	%	$n$	%	
Gender	Girls	4	21.1	12	<b>57.1</b>	$\chi^2 = 6.078; p = .014^*$
	Boys	15	<b>78.9</b>	9	42.9	
Age	8–9 years	7	<b>36.8</b>	6	28.6	$\chi^2 = 0.862; p = .650$
	10–11 years	6	31.6	6	28.6	
	12 years	6	31.6	9	<b>42.8</b>	
School status	Elementary 1	1	5.3	4	19.0	$\chi^2 = 8.409; p = .135$
	Elementary 2	3	15.7	–	–	
	Elementary 3	4	21.1	2	9.5	
	Elementary 4	4	21.1	2	9.5	
	Elementary 5	2	10.5	3	14.3	
	Middle Sch. 1	5	<b>26.3</b>	10	<b>47.7</b>	
			$\bar{X} \pm SD$		$\bar{X} \pm SD$	
Age		10.21 $\pm$ 1.51		10.72 $\pm$ 1.51	$t = 1.089; p = .283$	
Weight (kg)		35.89 $\pm$ 10.70		34.18 $\pm$ 9.39	$t = 0.546; p = .588$	
Height (cm)		139.36 $\pm$ 11.58		137.63 $\pm$ 13.37	$t = 0.440; p = .663$	
Body mass index		18.10 $\pm$ 3.19		17.76 $\pm$ 2.90	$t = 0.366; p = .716$	

Note : Numbers in bold are statistically significant.

$t$ , student  $t$ -test

$\chi^2$ , Chi-square test

\* $p < .05$

tributed and the groups were compared in terms of these characteristics.

As seen in Table 1, a comparison of the identifying characteristics of the groups showed that the trial group consisted of 78.9% boys while the control group comprised 57.1% girls. Distributions according to gender thus displayed a significant difference ( $p = .014$ ). In the comparison of the age range of the children in the trial and control groups, it was observed that a distribution of mean ages did not show a statistically significant difference; both groups were homogeneous in terms of age ( $p = .283$ ). There was no significant difference between the groups in terms of school status, weight, height, or body mass index ( $p = .135, p = .588, p = .663, p = .716$ ).

When the children were asked about their feelings and thoughts about their sickness, the responses of "I feel scared

and worried" ( $p = .121$ ) and "I am worried about the diagnosis and the methods of treatment" ( $p = .233$ ) were more frequently encountered in the control group (50% and 50%, respectively) as compared with the trial group. No significant difference was seen between the two groups.

### Findings Related to Quality of Life

As can be seen in Table 2, the scores for pain and hurt (Initial measurement:  $p = .219$ , Last measurement:  $p = .170$ ), nausea (Initial measurement:  $p = .167$ , Last measurement:  $p = .091$ ), procedure-related anxiety (Initial measurement:  $p = .064$ , Last measurement:  $p = .871$ ) on the initial and on the final measurement at the end of 3 months did not show a significant difference in the children in the trial and control groups. In the intragroup assessment, however, it

**Table 2** Comparison of the Change in the Mean Scores on the PedsQL 3.0 Cancer Module Children's Form from the First to the Last Measurement ( $N = 40$ )

Measurement Areas	Time of Measurement	Trial ( $n = 19$ )	Control ( $n = 21$ )	Test value; <sup>a</sup> $p$
		$\bar{X} \pm SD$	$\bar{X} \pm SD$	
Pain and hurt	Initial measurement	73.68 $\pm$ 17.62	66.07 $\pm$ 24.41	$t = 1.248$ ; $p = .219$
	Last measurement	90.13 $\pm$ 11.47	83.33 $\pm$ 18.68	$t = 1.401$ ; $p = .170$
	Test value: <sup>a</sup> $p$	<b><math>t = 4.050</math>; <math>p = .001^{**}</math></b>	<b><math>t = 2.904</math>; <math>p = .009^{**}</math></b>	
Nausea	Initial measurement	71.31 $\pm$ 22.35	63.09 $\pm$ 21.76	$t = 1.408$ ; $p = .167$
	Last measurement	93.68 $\pm$ 1.11	84.76 $\pm$ 20.82	$t = 1.749$ ; $p = .091$
	Test value: <sup>a</sup> $p$	<b><math>t = 4.1751</math>; <math>p = .001^{**}</math></b>	<b><math>t = 3.434</math>; <math>p = .003^{**}</math></b>	
Procedural anxiety	Initial measurement	59.64 $\pm$ 30.71	42.06 $\pm$ 31.34	$t = 1.906$ ; $p = .064$
	Last measurement	74.12 $\pm$ 23.05	73.01 $\pm$ 19.34	$t = 0.164$ ; $p = .871$
	Test value: <sup>a</sup> $p$	<b><math>t = 2.799</math>; <math>p = .012^*</math></b>	<b><math>t = 4.994</math>; <math>p = .001^{**}</math></b>	
Treatment anxiety	Initial measurement	79.82 $\pm$ 31.34	54.36 $\pm$ 30.80	<b><math>t = 2.803</math>; <math>p = .008^{**}</math></b>
	Last measurement	85.96 $\pm$ 23.74	80.95 $\pm$ 12.67	$t = 0.821$ ; $p = .419$
	Test value: <sup>a</sup> $p$	$t = 0.907$ ; $p = .376$	<b><math>t = 3.818</math>; <math>p = .001^{**}</math></b>	
Worry	Initial measurement	85.52 $\pm$ 15.17	78.96 $\pm$ 22.76	$t = 1.060$ ; $p = .296$
	Last measurement	90.78 $\pm$ 16.17	78.96 $\pm$ 16.37	<b><math>t = 2.293</math>; <math>p = .027^*</math></b>
	Test value: <sup>a</sup> $p$	$t = 1.023$ ; $p = .320$	$t = 0.00$ ; $p = 1.00$	
Cognitive problems	Initial measurement	70.26 $\pm$ 22.26	71.66 $\pm$ 19.19	$t = 0.065$ ; $p = .949$
	Last measurement	81.84 $\pm$ 22.37	66.90 $\pm$ 34.18	$t = 1.650$ ; $p = .108$
	Test value: <sup>a</sup> $p$	<b><math>t = 2.432</math>; <math>p = .026^*</math></b>	$t = 0.559$ ; $p = .556$	
Perceived physical appearance	Initial measurement	67.54 $\pm$ 18.40	58.73 $\pm$ 19.27	$t = 1.446$ ; $p = .156$
	Last measurement	70.61 $\pm$ 20.10	72.61 $\pm$ 22.69	$t = 0.294$ ; $p = .770$
	Test value: <sup>a</sup> $p$	$t = 0.459$ ; $p = .652$	<b><math>t = 2.55</math>; <math>p = .019^*</math></b>	
Communication	Initial measurement	74.12 $\pm$ 28.17	63.88 $\pm$ 34.59	$t = 1.229$ ; $p = .226$
	Last measurement	78.50 $\pm$ 27.68	78.57 $\pm$ 17.59	$t = 0.009$ ; $p = .993$
	Test value: <sup>a</sup> $p$	$t = 0.589$ ; $p = .563$	<b><math>t = 2.351</math>; <math>p = .029^*</math></b>	

Note: Numbers in bold are statistically significant.

$t$ , student  $t$ -test

<sup>a</sup>paired sample  $t$ -test

\* $p < .05$

\*\* $p < .01$

was found that there was a strikingly significant rise in pain and hurt scores (Trial group  $p = .001$ ; Control group  $p = .009$ ), nausea (Trial group  $p = .001$ ; Control group  $p = .003$ ), and procedure-related anxiety (Trial group  $p = .012$ , Control group  $p = .001$ ) from the initial measurement to the time of the measurement made at the end of the 3-month period in the trial and control groups.

It was found that the treatment anxiety scores of the trial group of children in the initial measurement were significantly high ( $p = .008$ ); at the 3-month point, the mean scores for treatment anxiety did not display a significant difference between the groups ( $p = .419$ ). The intragroup assessment showed that in the trial group, although treatment anxiety scores had increased in the final measurement compared with the initial assessment, the difference was not significant ( $p = .376$ ); in the control group, however, the increase in the treatment

anxiety scores represented a significant increase over the initial measurement ( $p = .001$ ).

While mean worry scores in the initial measurement did not display a significant difference between the groups ( $p = .296$ ), the subjects in the trial group 3 months later showed a significant increase in their worry scores ( $p = .027$ ). The intragroup assessment revealed an increase in the worry ( $p = .320$ ) scores of the trial group, but no significant change between the first measurement and the last in the control group ( $p = 1.00$ ).

The mean scores for cognitive problems in the initial measurement and the measurement taken 3 months later did not indicate a significant difference between the groups (Initial measurement:  $p = .949$ , Last measurement:  $p = .108$ ). In the intragroup assessment, however, the trial group revealed a significant increase in scores in the last measurement compared to the initial data ( $p = .026$ ).

**Table 3** Distribution and Comparison of Mean Scores of Children on Initial and Last Measurements on the PedsQL 3.0 Cancer Module and the PedsQL 4.0 in Terms of Children's Gender ( $N = 40$ )

		Girls ( $n = 16$ ) $\bar{X} \pm SD$	Boys ( $n = 24$ ) $\bar{X} \pm SD$	Statistical Analysis
<i>PedsQL 3.0 Cancer Module</i>				
Pain and hurt	Initial measurement	63.97 $\pm$ 24.55	72.91 $\pm$ 18.67	$t = 1.326; p = .193$
	Last measurement	84.37 $\pm$ 17.96	88.02 $\pm$ 14.50	$t = 0.708; p = .0488$
Nausea	Initial measurement	65.00 $\pm$ 24.74	66.66 $\pm$ 21.90	$t = 0.227; p = .821$
	Last measurement	83.75 $\pm$ 21.48	92.50 $\pm$ 12.59	$t = 1.625; p = .112$
Procedural anxiety	Initial measurement	45.09 $\pm$ 33.34	53.12 $\pm$ 30.87	$t = 0.794; p = .432$
	Last measurement	71.35 $\pm$ 22.56	75.00 $\pm$ 20.11	$t = 0.535; p = .596$
Treatment anxiety	Initial measurement	49.50 $\pm$ 30.40	75.69 $\pm$ 33.50	<b><math>t = 2.560; p = .014^*</math></b>
	Last measurement	80.72 $\pm$ 16.58	85.06 $\pm$ 20.11	$t = 0.715; p = .479$
Worry	Initial measurement	76.47 $\pm$ 29.79	82.63 $\pm$ 17.36	$t = 0.836; p = .408$
	Last measurement	81.25 $\pm$ 18.88	86.80 $\pm$ 15.90	$t = 1.004; p = .322$
Cognitive problems	Initial measurement	69.70 $\pm$ 22.18	71.04 $\pm$ 19.61	$t = 0.203; p = .840$
	Last measurement	71.87 $\pm$ 34.24	75.41 $\pm$ 27.10	$t = 0.364; p = .718$
Perceived physical appearance	Initial measurement	55.39 $\pm$ 20.61	68.40 $\pm$ 15.92	<b><math>t = 2.281; p = .028^*</math></b>
	Last measurement	69.27 $\pm$ 26.47	73.26 $\pm$ 17.37	$t = 0.577; p = .567$
Communication	Initial measurement	60.78 $\pm$ 34.58	72.22 $\pm$ 30.56	$t = 1.118; p = .270$
	Last measurement	77.60 $\pm$ 18.43	79.16 $\pm$ 24.41	$t = 0.211; p = .834$
<i>PedsQL 4.0</i>				
Physical functioning	Initial measurement	49.08 $\pm$ 21.14	55.59 $\pm$ 18.24	$t = 0.862; p = .397$
	Last measurement	73.63 $\pm$ 20.53	74.60 $\pm$ 13.39	$t = 0.182; p = .856$
Emotional functioning	Initial measurement	59.11 $\pm$ 25.69	69.58 $\pm$ 18.58	$t = 1.516; p = .138$
	Last measurement	79.06 $\pm$ 20.83	81.87 $\pm$ 15.38	$t = 0.491; p = .626$
Social functioning	Initial measurement	81.76 $\pm$ 13.80	82.29 $\pm$ 14.06	$t = 0.119; p = .906$
	Last measurement	86.87 $\pm$ 15.37	89.16 $\pm$ 12.21	$t = 0.524; p = .603$
School-related problems	Initial measurement	60.29 $\pm$ 21.89	63.54 $\pm$ 20.71	$t = 0.483; p = .632$
	Last measurement	68.43 $\pm$ 31.02	72.50 $\pm$ 25.28	$t = 0.455; p = .652$
Total scores	Initial measurement	68.05 $\pm$ 15.42	71.80 $\pm$ 12.67	$t = 1.080; p = .287$
	Last measurement	77.00 $\pm$ 20.56	79.53 $\pm$ 14.75	$t = 0.455; p = .652$

Note : Numbers in bold are statistically significant.

$t$ , student  $t$ -test

\* $p < .05$

There was no statistically significant change in the scores for cognitive problems from initial to last measurement in the control group ( $p = .556$ ).

The mean scores for perceived physical appearance (Initial measurement:  $p = .156$ , Last measurement:  $p = .770$ ) and communication (Initial measurement:  $p = .226$ , Last measurement:  $p = .993$ ) in the initial measurement and in the measurement taken at the end of 3 months did not show a significant difference between the groups. In the intragroup assessment, the trial group displayed an increase in perceived physical appearance ( $p = .652$ ) and communication ( $p = .563$ ) scores on the last measurement compared with the initial one, but this change was not statistically significant. In the control group, however, there

was a statistically significant increase in scores on the first and last measurements with regard to perceived physical appearance ( $p = .019$ ) and communication ( $p = .029$ ).

As can be seen in Table 3, in a comparison of the mean scores of the children at the initial and last measurements of the PedsQL 3.0 cancer module and the PedsQL 4.0 in terms of gender, it was found that while the initial treatment anxiety mean scores were significantly higher in boys ( $p = .014$ ), at the final measurement, treatment anxiety scores did not display a significant difference according to gender ( $p = .479$ ). In the initial survey, physical appearance mean scores were significantly lower in girls ( $p = .028$ ), but at the last survey, there was no difference according to gender ( $p = .567$ ).

**Table 4** Distribution and Comparison of Children's Physical Parameters in the Trial and Control Groups ( $N = 40$ )

		Trial ( $n = 19$ ) $\bar{X} \pm SD$	Control ( $n = 21$ ) $\bar{X} \pm SD$	Test value: <sup>a</sup> $p$
Distance on 9-minute walk test (number of cycles)	Initial measurement	27.05 $\pm$ 6.59	26.27 $\pm$ 9.28	$t = 0.190; p = .850$
	Last measurement	35.89 $\pm$ 8.46	26.76 $\pm$ 10.57	<b><math>t = 2.995; p = .005^{**}</math></b>
	Test value: <sup>a</sup> $p$	<b><math>t = 6.058; p = .001^{**}</math></b>	<b><math>t = 0.277; p = .785</math></b>	
Up and down-stairs (sec)	Initial measurement	8.78 $\pm$ 1.93	9.22 $\pm$ 1.50	$t = 0.814; p = .421$
	Last measurement	7.26 $\pm$ 1.79	9.04 $\pm$ 1.20	<b><math>t = 3.666; p = .001^{**}</math></b>
	Test value: <sup>a</sup> $p$	<b><math>t = 4.657; p = .001^{**}</math></b>	$t = 0.623; p = .540$	
Up and go time (sec)	Initial measurement	8.31 $\pm$ 1.60	8.77 $\pm$ 1.60	$t = 0.911; p = .368$
	Last measurement	6.57 $\pm$ 1.34	8.33 $\pm$ 1.62	<b><math>t = 3.998; p = .001^{**}</math></b>
	Test value: <sup>b</sup> $p$	<b><math>t = 6.105; p = .001^{**}</math></b>	$t = 1.673; p = .110$	
Dynamometer	Initial measurement	50.52 $\pm$ 27.38	39.09 $\pm$ 13.85	$Z = 1.558; p = .119$
	Last measurement	75.52 $\pm$ 30.22	40.71 $\pm$ 17.19	<b><math>Z = 3.967; p = .001^{**}</math></b>
	Test value: <sup>b</sup> $p$	<b><math>Z = 3.731; p = .001^{**}</math></b>	$Z = 2.828; p = .055$	
Goniometer	Initial measurement	1.42 $\pm$ 0.50	1.81 $\pm$ 0.39	<b><math>Z = 2.600; p = .009^{**}</math></b>
	Last measurement	1.00 $\pm$ 0.00	1.76 $\pm$ 0.43	<b><math>Z = 4.850; p = .001^{**}</math></b>
	Test value: <sup>a</sup> $p$	$Z = 0.508; p = .611$	$Z = 1.414; p = .157$	
Hemoglobin	Initial measurement	12.40 $\pm$ 1.13	12.36 $\pm$ 0.77	$t = 0.141; p = .889$
	Last measurement	12.94 $\pm$ 0.69	12.60 $\pm$ 0.63	$t = 1.567; p = .126$
	Test value: <sup>a</sup> $p$	<b><math>t = 3.690; p = .002^{**}</math></b>	$t = 1.711; p = .103$	
Hematocrit	Initial measurement	37.58 $\pm$ 3.14	38.94 $\pm$ 2.61	$t = 1.496; p = .143$
	Last measurement	39.22 $\pm$ 2.16	39.80 $\pm$ 2.11	$t = 0.832; p = .411$
	Test value: <sup>a</sup> $p$	<b><math>t = 3.673; p = .002^{**}</math></b>	$t = 0.813; p = .085$	

Note : Numbers in bold are statistically significant.

$T$ , student  $t$ -test

$Z$ , Mann Whitney  $U$  test

<sup>a</sup>Paired Samples  $t$ -test

<sup>b</sup>Wilcoxon Signed rank test

**\*\* $p < .01$**

### Characteristics of the Impact of the Three-Month Exercise Program on Physical Parameters

In this section, a comparison has been made between the groups in terms of the distribution of the scores of the children in the trial and control groups at the end of the 3-month exercise program. It was seen that all of the children in the trial group had performed the exercises regularly and had marked their progress on the exercise worksheet.

The distribution and comparison of the physical parameters in the initial and final survey is given in Table 4. In the trial group, the increase in the distance on the 9-minute walk test at the final as compared with the initial measurement was found to be highly significant ( $p = .001$ ). In the control group, however, the change seen in the final measurement of the distance covered in the 9-minute walk test was not found to be statistically significant as compared with the initial scores ( $p = .785$ ).

In the trial group, significant decreases were seen in up and down stairs climbing ( $p = .001$ ) and in up and go times ( $p = .001$ ) in the final measurement as compared with the initial scores. The control group, on the other hand, did not display any significant changes in the timed up and down stairs test from the initial to the last measurement ( $p = .540$ ).

Looking into dynamometer measurements, a markedly significant increase was seen in the results of the trial group from initial to final testing ( $p = .001$ ). In the control group, no significant change was observed from the initial to the final reading ( $p = .055$ ).

The initial and final hemoglobin and hematocrit test results showed that the trial group showed a markedly significant increase ( $p = .002$ ) but that the control group displayed no significant change from the initial measurement to the final reading ( $p = .103$ ).

## Discussion

### A Discussion of the Findings on the Children's Identifying and Disease-Related Characteristics

The study found that in the control group of children, 42.8% were 12 years old, but that the ages of the trial group were more concentrated in the 8–9 age group (36.8%). It was determined that mean ages ( $10.72 \pm 1.51$  in the control group and  $10.21 \pm 1.51$  in the trial group) were close in the two groups and therefore the statistical analysis showed that there was no significant difference between the groups in terms of mean age ( $t = 1.089$ ;  $p > .05$ ) (Table 1).

The literature points to a negligible ALL risk in children under the age of 15 and it is reported that the risk peaks at ages 2–5 (Lanzkowsky, 2005). The findings of the present study are similar to the results reported in studies on ALL in Turkey and abroad. The fact that no significant difference was found between the control and trial groups indicates a similarity between the groups.

In terms of gender, 78.9% of the children in the trial group were boys, while the majority of 57.1% was made up of girls in the control group. There is no significant difference, then, in distribution according to gender ( $p < .05$ ) (Table 1).

In a study in which Gocha (2001) explores the impact of physical therapy on the body functions and activity of children with ALL, it was found that 20 of the children with ALL in the 4–17 age group in the study were boys and 6 were girls, a finding that is consistent with the results of the present study.

The children in the control group were of a mean height of  $137.63 \pm 13.37$  cm, with a mean weight of  $34.18 \pm 9.39$  kg. The mean height of the children in the trial group was  $139.36 \pm 11.58$  cm and mean weight was  $35.89 \pm 10.70$  kg. The statistical analysis determined that there was no significant difference between the groups in terms of height ( $t = 0.440$ ;  $p > .05$ ), weight ( $t = 0.546$ ;  $p > .05$ ) or body mass index (BMI) ( $t = 0.366$ ;  $p > .05$ ). It was, however, found that the weight of 55% and the height of 65% of the children were below the 50th percentile.

In Kezer's (2006) study on the endocrinal complications of leukemia therapy, it was found that the height of 57.1% of 21 children with leukemia was below the 50th percentile. Similarly, Gocha's (2001) determined that the height of more than 50% of the children with ALL was below the 25<sup>th</sup> percentile.

### Discussion of Findings Related to Quality of Life

The statistical analysis shows that the 3-month exercise program resulted in decidedly significant increases in

both the trial and control groups at the final measurement as compared with the initial scores in the subscales of pain and hurt, nausea and procedure-related anxiety on the *PedsQL 3.0 Cancer Module Children's Form* ( $p < .01$ ) (Table 2).

In Gocha's study (2001), no significant difference was found in either of the PedsQL inventory forms between initial and last measurement in the trial and control groups. It can be seen that the results of Gocha's study and the present research are not consistent.

Although the researchers took measures to prevent the interaction of the trial and control groups, it was observed that the children and their families who were subjects of the study did interact, forming loyalties and relationships in a social environment. For this reason, when it is considered that the children and families who received the exercise training had the opportunity to share their knowledge and practices with the control group, we believe that our findings might be the result of this interaction process.

An examination of the effect of gender on the quality of life, revealed that while boys displayed higher procedure-related anxiety scores, girls' perceived physical appearance scores were lower (Table 3). One of the more frequently seen side effects of cancer therapy is loss of hair (Aranda & Hayman-White, 2001; Çavuşoğlu, 2011; Scott-Findlay & Chalmers, 2001). The change in physical appearance may incite a fear of rejection by peers (Ağaoğlu & Nogay, 1999). It can be said that girls are more susceptible to this anxiety than boys. In many studies, it has been shown that boys display higher quality-of-life scores (Bastiaansen, Koot, Bongers, Varni & Verhulst, 2004; Baydur, Saatli, Özyurt & Eser, 2004; Rydström, Dalheim-Englund, Holritz-Rasmussen, Möller & Sandman, 2005).

### A Discussion of the Findings Regarding the Impact of a Three-Month Exercise Program on Physical Parameters

One of the hypotheses of this study was that "Specific assessment of levels of activity and body functions would improve in children with ALL after a program of physical exercise was implemented at home." This hypothesis was verified with a significant increase in exercise performance and body functions (Table 4).

When the trial group was assessed in terms of mean scores for the distance walked in the 9-minute walk test, up and downstairs climbing times, up and go times, leg muscle strength measurement, and hemoglobin and hemotocrit levels, it was found that the children in the trial group had shown more improvement in all parameters

after the 3-month exercise period compared with their control group counterparts. In particular, the distance walked in the 9-minute walk, up and go times, leg muscle strength and hemoglobin and hematocrit values of the trial group displayed a strikingly significant increase ( $p < .05$ ;  $p < .001$ ) (Table 4). The study with children with ALL conducted by San Juan et al. (2007) exhibits results similar to the present findings.

In a study by Gocha (2001), a significant difference was seen in ankle dorsiflexion and leg muscle strength of the trial group compared with the control group. No significant difference was observed between the two groups, however, in hemoglobin or in 9-minute walk distances.

Shore and Shepard (1999), in a study where the impact of aerobic exercises on children with ALL was evaluated, 6 children with ALL were compared with 11 healthy children, with no significant difference found between the exercise performances of the two groups. This outcome may have stemmed from the limited number in the group sample.

In a study by Marchese, Chiarello and Lange (2004), where the effects of physical exercise on children with ALL, ages 4–15, were assessed, trial and control groups were evaluated 4 months later, at which point it was discovered that the trial group displayed a significant increase in leg muscle strength.

Marchese et al. (2006), in their study of children and adolescents with cancer, reported up and downstairs climbing results that were similar to those of the present study. Shore and Shepard's study (1999) of children with cancer revealed improvements in both blood counts and in exercise capacity following a 12-week exercise regimen.

The literature emphasizes that there is a significantly high positive impact of aerobic exercise on physical performance and the cardiovascular system in cancer patients undergoing chemotherapy (Dimeo, Fetscher, Lange, Mertelmann & Keul, 1997; Moyer-Mileur, Ransdell & Bruggers, 2009).

Another study researching the physical and psychological effects of a 12-week exercise program on 3 children, ages 13–14, all of whom had been successfully treated for lymphoblastic leukemia, reported in particular a drop in  $VO_2$  and improvements in weight gain scores and in anxiety scores on psychological tests. Exercise regimens are recommended for children with cancer in view of the benefits they provide in the posttherapy management period (Bar-Or & Rowland, 2004).

### Limitations of the Study

The education sessions for the children and their parents took place in subjects' homes as the physical environment

## Key Practice Points

- Especially in the first year after the start of chemotherapy treatment in children with ALL functional mobility, strength and extension of the legs can lead to a decrease in ankle dorsiflexion strength.
- Intensive therapy in children with ALL, depending on the rate of 15–29% of the treatment caused a reduction in bone mineral density, fatigue and lack of energy due to decreased physical activity due to the increased risk of osteoporosis in these children.
- Physical and psychosocial changes that are adversely affecting the quality of life for children and families in both.
- ALL in survival rate reaches 80%. Survival rate and increased incidence of side effects caused by longer duration of treatment and late effects of treatment is becoming increasingly important.

of the hospital was considered unsuitable for purposes of education.

### Application to the Practice

When regular and systematic exercises are implemented in rehabilitation programs, nurses can take on the task of providing information and education to children with ALL and their parents. The nurse should describe the program of exercise to the child and parents before discharge from the hospital. An explanation of the purpose and importance of the program as well as written materials should be provided. At each home visit and clinical check-up, the nurse should evaluate the child's behavior and adjustment to the program. An inquiry should be made as to whether any problems are being experienced and if there are problems, necessary modifications should be made. At the same time, the nurse can have the hospitalized child with ALL do the exercises in bed while watching TV. For example, hip extension and knee flexion can be practiced while the child is laying face-down; hip flexion, knee extension, knee flexion, hip abduction and adduction can be performed while the child is laying supine. In the case of children who feel good enough to get out of bed, the child can be made to do squat down-and-rise and walk-on-heels exercises. To sum up, the research team concludes that an exercise program is beneficial to children with ALL and recommends the implementation of such a program. Nurses can play an active role in sustaining the physical well-being of the children with ALL.

## Conclusion

Regular and systematic exercise regimens implemented by children with ALL have resulted in improved testing results, enhanced physical performance, and better laboratory results compared with a control group and with children's scores before the initiation of such a program. To generalize the results gathered in this study of children with ALL and their parents, it is recommended that more studies be carried out with larger sample sizes with longer and more repeated monitoring periods.

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