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# Energy efficiency training's effect on fatigue scores of children with a cancer diagnosis†

**Original Article**

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**Abstract:** **Objective:** Fatigue is the most common complication of cancer treatment procedure during chemotherapy, leading to limited daily activities, mood swings, and ultimately impaired functional status. This study aimed to determine the effect of energy efficiency training on the fatigue scores of children with a cancer diagnosis.

**Methods:** In the present clinical trial study, 30 children with a cancer diagnosis were randomly assigned variously to the control and testing groups. The cancer-related fatigue questionnaire for children with cancer was employed as the data collection tool. The intervention of the testing group was conducted in 4 sessions of 45–60 min of face-to-face interaction, group sessions, and question-and-answer sessions. Meanwhile, routine interventions were employed in the control group. Quantitative variables were reported as mean and standard deviation, and qualitative variables as frequency and percentage. Stata 11 statistical software and a change score approach were used to analyze the data.

**Results:** The mean fatigue score of the testing group increased from 72.12 to 77.53. There was a statistically significant difference between the mean fatigue scores of the testing group before and after the intervention ($P = 0.013$), and the children's fatigue score decreased. There was a statistically significant difference between the mean fatigue scores of the testing and control groups before and after the intervention ($P = 0.001$), and the fatigue score of the children in the testing group had decreased compared to the control group.

**Conclusions**: Energy efficiency techniques can be employed to increase energy and reduce fatigue during pediatric chemotherapy.

**Keywords:** *cancer • children • energy efficiency • fatigue • nursing*

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## 1. Introduction

Improving children's health provides them with the same opportunities and resources to access potential well-being; despite efforts made to control infectious diseases in children, the rate of non-infectious diseases including cancer has increased. Cancer is the uncontrolled growth of cells in an organ or tissue, which, eventually, leads to the formation of a mass or tumor.[1] Yet, childhood cancer accounts for approximately 0.5%–1%

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of cancer malignancies. An estimated 10,590 new cases of cancer in the United States in 2018 were estimated to occur in children aged 0–14 years.[2] Acute lymphoblastic leukemia (ALL) is the most common type of cancer in children. The annual prevalence is 4 cases per 100,000 Caucasian children, and it is more prevalent in boys than in girls, with a peak age of 2–5 years.[3] Furthermore, the emergence of new treatments in recent years has made cancer a chronic disease. Today, prominent research centers have determined that long-term survival rates in children with ALL diagnosis have reached 80%.[4] One of the most common treatments for cancer is chemotherapy, which uses cytotoxic substances to eliminate cancer cells and causes several side effects, including fatigue, nausea and vomiting, bone marrow suppression, and more.[5] Thus, although the number of patients undergoing treatment has increased, the negative effects of treatment or the disease itself have caused bothersome issues in children.[6,7] These issues include varying degrees of fatigue, pain, depression, nausea and vomiting, diarrhea, hair loss, weight loss, anemia, etc.[5] Fatigue is one of the most common complications of cancer[8,9] to the extent that 51%–86% of children with cancer diagnosis experience fatigue resulting from cancer and the associated treatments, which is a significant quantity.[10,11] Meanwhile, the effects of fatigue can be divided into 2 major groups: physical and psychosocial. The physical aspects of fatigue can be described as energy depletion, decreased performance compared to earlier activity, feeling exhausted, and increased need for sleep and rest. Psychosocial effects also include decreased motivation and feelings of discomfort and restlessness. Additionally, fatigue impairs cognitive functions including concentration and memory.[12] In general, fatigue has several negative effects on children's quality of life, daily activities, social interactions, academic performance, mood, and communication with other children. Despite fatigue being a sign of stress in children with cancer, it is easily overlooked by medical staff[13] and often goes untreated.[14]

Among the reasons for overlooking fatigue is that children, unlike adults, are not able to express their feelings of fatigue, the necessary training is not provided by health care personnel to combat fatigue and the associated side effects, and parents deem that only the treatment of the disease itself should be a priority. Accordingly, they dismiss the need to report fatigue.[2]

Consequently, given the importance of this issue, National Comprehensive Cancer Network's (NCCN) guideline suggests that all children over 5 years of age with a cancer diagnosis should be routinely screened and evaluated for cancer-related fatigue.[5,15] Specialists in diagnosing and confirming cancer-resulting fatigue (CRF) have identified 4 features: decreased or no energy for at least 2 weeks, discomfort, and dysfunction in performance, along with clinical evidence of CRF following cancer or relevant treatments and the lack of underlying psychiatric conditions such as depression.[16]

Therefore, due to the prevalence of fatigue in children with a cancer diagnosis and the negative effects on children's lives, today there are various strategies to subdue the fatigue in cancer patients, one of which is to develop practicing energy efficiency strategies.[17] The energy efficiency strategy is one of the means to allocate energy and strength for all daily tasks by saving energy and distribution. The most significant strategy to employ in these patients to manage their fatigue is to reduce activity and increase rest.[18] The purpose of energy efficiency is to strike a balance between rest and activity times during the illness-related fatigue period and to acknowledge the value of rest along with the self-care program during the day. Educational interventions based on the instructions of the NCCN could be related to regulating daily activities, sleep correction, social–psychological support (individual and group), sports (aerobic, resistance), and so on. Energy efficiency strategies will assist the client in identifying the peak hours of their energy and plan their main tasks to take place during these hours.[19] Since nighttime sleep deprivation is a factor in increasing children's fatigue during the day, these strategies may attempt to reduce the length and frequency of their naps and ensure adequate sleep length and quality during the night (striving to develop a regular sleep schedule by darkening rooms and reducing daytime nap lengths), as well as stress management and coping training (measures undertaken for increasing self-confidence, including stress reduction activities based on the level of development and the age group, such as using coloring books, doing crafts with craft paper, and engagement in other similar activities). Similarly, keeping children active and involved has a positive effect on their fatigue; so, it is possible to sustain activities based on their level of development and interest.[15]

In the meantime, pediatric nurses have an ideal opportunity to educate patients since education is considered one of the nursing functions in all areas where nurses serve, and this role is approved by the American Nurses Association's standards for clinical nursing.[3] All nursing activities focus on promoting, maintaining, and restoring health, preventing diseases, and assisting people to adapt to the diseases and make optimal use of their outstanding abilities.[11]

Given that fatigue is one of the inevitable complications of cancer and the associated treatments, and interferes with children's daily lives, it is necessary to conduct studies that examine the relationship between

educational interventions and fatigue control to improve energy and function levels in children with a cancer diagnosis for achieving better reactions as much as possible. Accordingly, the present study was conducted to determine the effect of education related to energy efficiency on the fatigue of children with inpatient cancer in hospitals in Hamadan.

# 2. Methods

## 2.1. Participants and settings

The present study is quasi-experimental (including an intervention group and a control group) with a pre-test and post-test approach. In this study, the subjects were 60 children, aged 6–16 years, who were admitted to the hematology department of Besat Hospital affiliated to Hamadan University of Medical Sciences, Iran, with their parents, who met the criteria to participate in the study; the criteria included an age range of 10–16 years, no physical or mental illness, no physical or mental illness in parents, and consent to participate in the study. The subjects were selected by available sampling and invited to participate in the study. The samples were then assigned to the intervention and control groups by simple random sampling. Among these, the most relevant criteria for leaving the study were noted as severe deterioration of the child's health, child's death, change of residence, and unwillingness to continue participating in the study.

At the beginning of the study, participants in both groups completed a demographic information questionnaire and a cancer-related fatigue questionnaire for children with cancer. The intervention group was trained for 1 week in 4 training sessions, each 45–60 min long, with 1 d between sessions (the sessions taking place on even days of the week). In the first session of the training, the trainers embarked on communication with the child and the parents; they introduced themselves, explained the purpose of the research, and obtained the parent consent form. On the first day, cancer and its complications were explained with more emphasis on fatigue, and the fatigue and its symptoms and complications were explained to the child. In the second session, the focus shifted toward energy efficiency strategies, and several aspects were discussed including planning for daily activities and sports (encouraging children to do daily tasks at the peak of their energy, resting between activities, doing activities while they are in a seated posture, and performing easy exercises such as walking). In the third session, the children were taught about adequate and relevant sleep strategies (recommendations for improving and increasing nighttime sleep, such as reducing daytime nap lengths, setting a specific time to fall asleep, using favorite blankets and pillows, and cuddling stuffed animals). In the fourth session, multiple methods of coping with stress (such as talking and interacting with peers, playing with friends in the playing area, having positive thoughts, and reading books) were taught. The control group received routine care. One week after the intervention, the fatigue questionnaire was completed again by the caregiver in both groups.

## 2.2. Data analysis

The data collection tool in this study was a cancer-related fatigue questionnaire for children with a cancer diagnosis, aged between 4 years and 18 years, designed and developed by Momayyezi et al.[20] The questionnaire contained 25 questions, and its composition is the following: 3 dimensions of daily activities, 11 general issues questions (questions 1 to 11), 9 sleep difficulties questions (questions 12 to 20), and 5 mental and emotional state questions (questions 21 to 25), with a 4-choice Likert scale (never = 4; sometimes = 3; usually = 2; and always = 1). The highest intensity of fatigue is given to a score of 25 and the lowest intensity of fatigue is given to a score of 100. Therefore, the higher the score, the greater the intensity of fatigue. To determine the scientific validity of the questionnaire, content validity was applied by providing the questionnaire to 10 esteemed faculty members of Yazd University to enable them to express their opinions. Statistical Package for Social Sciences (SPSS) software (version 16) was used for data analysis. In preparing and designing this questionnaire for children with cancer diagnosis, 101 children between the ages of 4 years and 18 years were selected. Cronbach's alpha was 90% for daily activities and general issues, 87% for sleep issues, and 89% for mental and emotional states. Reliability was confirmed at 93% with Cronbach's alpha and a test–retest method.[8]

The study of Kudubes et al.[10] was considered in the calculation of sample size.[2] The first type of error level was considered to be 0.05 and the test power was considered to be 90%.

Therefore, in each group, 31 subjects were needed, and during the research, due to the death of 2 subjects

$$n = \frac{(Z^2_{1-\alpha/2} + Z_{1-\beta})^2 \times [{\sigma_1}^2 + {\sigma_2}^2]}{(\mu_1 - \mu_2)^2} = \frac{(1.96 + 0.842)^2 \times [11.34^2 + 16.50^2]}{(10)^2} = 31$$

and their withdrawal from the research, finally 60 subjects remained.

After obtaining the necessary permits from Hamadan University of Medical Sciences and presenting them to the pertinent authorities, the study's main objects were explained to the participants and their main caregivers, and legal guardians. Written and oral consent of adults in charge of subjects was obtained. To prevent the exchange of information between patients, the control group was first sampled and the before and after the questionnaire was completed by the main caregiver of the subject 1 month apart from those of the intervention group. In the control group, routine interventions were conducted and no training was provided for them. On the contrary, training sessions were provided for the intervention group in addition to routine care. The training consisted of 1 week's worth of sessions and was provided in the form of 4 training sessions, each having a duration of 45–60 min, with 1 d apart between each session (sessions on even days of the week); 2 weeks after the completion of the training interventions, the post-test questionnaire was completed by the child's main caregiver. To ensure the understanding of the content of the intervention by all the children participating in the study, the training was in the form of visuals using photos and, if necessary, videos; and an attempt was made to ensure the understanding of the content of the intervention by the participants through their engagement in group discussion. For younger children, when it was assumed that the content of the intervention was not well understood, an attempt was made to solve the problem by face-to-face teaching and by using photos and necessary explanations.

### 2.3. Content of training sessions

In the first session of the training, the trainers embarked on a process of communication with the child and the parents: they introduced themselves, explained the purpose of the research, and obtained the parent consent form. On the first day, cancer and its complications were explained with more emphasis on fatigue, and the fatigue and its symptoms and complications were explained to the child. In the second session, the focus shifted toward energy efficiency strategies, and various measures were discussed, including planning for daily activities and sports (encouraging children to do daily tasks at the peak of their energy, resting between activities, doing activities while they are in a seated posture, and performing easy exercises such as walking). In the third session, the children were taught about adequate and relevant sleep strategies (recommendations for improving and increasing nighttime sleep, such as reducing daytime nap lengths, setting a specific time to fall asleep, using favorite blankets and pillows, and cuddling stuffed animals). In the fourth session, the methods of coping with stress (such as talking and interacting with peers, playing with friends in the playing area, having positive thoughts, and reading books) were taught. The control group received routine care. One week after the intervention, the fatigue questionnaire was completed again by the caregiver in both groups.

After completion of the questionnaire by the control group's caretakers and complete data collection, pamphlets and brochures were also provided to the control group.

Quantitative variables were reported as mean and standard deviation whereas qualitative variables were reported as frequency and percentage. The *t* test was employed to compare the mean fatigue score between the intervention and control groups. Since there was a correlation score above 0.5 between the fatigue scores before and after the intervention in the groups, the change score approach was used to analyze the data. In this method, first, the mean difference between the 2 groups was calculated before and after, and in the next step, this mean difference was compared between the 2 groups. The approach was to analyze the intention to treat. Results were reported at a significance level of 0.05. Stata 11 statistical software was employed to analyze the data.

## 3. Results

According to the demographic specification tables, male sex accounted for the highest percentage of subjects in both the intervention (66.7%) and control (53.3%) groups, while ALL cancer accounted for the highest percentage of disease in both the intervention (46.7%) and control (76.7%) groups. ALL is the most common type of cancer in children and is more common in boys than girls. The highest percentage of parents in the intervention (76.7%) and control (63.3%) groups had received an undergraduate education.

| Age (years) | Intervention | | Control | | Test statistics | *P* value |
|---|---|---|---|---|---|---|
| | N | % | N | % | | |
| 6–11 | 15 | 50 | 15 | 50 | | |
| 12–16 | 15 | 50 | 15 | 50 | | |
| Total | 30 | 100 | 30 | 100 | T = 0/74<br>df = 10 | 1 |

**Table 1.** Absolute and relative frequency distribution of studied children according to age.

Table 1 shows that in both the test and control groups, 50% of children were in the age group of 6–11 years and 50% were in the age group of 12–16 years. The paired *t* test did not show a significant difference in terms of age between the 2 test and control groups. Therefore, the 2 groups were similar in terms of children's age (Table 1).

A comparison of the mean scores of the research units between the pre-intervention and post-intervention test groups has generally shown that the intervention is significant, and the average scores have generally increased from 72.17 to 77.53. In general, training in the intervention group has been able to improve children's fatigue and their energy levels (Table 2).

A general comparison of the mean scores of the research units in the control group, before (78.06) and after (75.33) the study, revealed that during the study, subjects' fatigue score has generally worsened and their fatigue has increased. Statistically, this difference is significant (0.039) (Table 3).

Comparison of mean scores of research units in the test and control groups before and after the intervention, in terms of daily activities ($P$ = 0.002), sleep ($P$ = 0.007), and mental and emotional status ($P$ = 0.032), revealed that the training and interventions performed in the intervention group had a statistically significant difference compared to the control group in reducing the fatigue scores of children with cancer in the mentioned areas (0.001) (Table 4).

# 4. Discussion

Regarding determining the degree of fatigue in children with cancer in the control group before and after the study, the findings of the present study revealed that between the mean fatigue scores of the control group, there was a statistically significant difference (0.039) in general before (78.66) and after the study (75.33). It was concluded that in the children of the control group who had not received training after being hospitalized in terms of activity, sleep, and emotional and mental status, average fatigue scores had decreased compared to the first few days of hospitalization, and their fatigue had worsened. This finding was consistent with the results of the studies authored by Dehkordi,[21] Kudubes,[10] and Barwick.[22] The studies confirmed that fatigue occurs during chemotherapy and increases over time, and among patients receiving chemotherapy, fatigue peaks within a few days of hospitalization. Dehkordi,[20] aiming to determine the effect of energy efficiency training on the fatigue of cancer patients in his study, observed that fatigue increased in the control group subjects who did not receive training.

The results of the present study for determining fatigue scores in children with cancer in the pre- and post-intervention screening groups indicated that there was a statistically significant difference (0.013) between the mean scores of children's fatigue in the intervention group, generally before (72.12) and after the intervention

| | Mean score | Standard deviation | 95% Confidence interval | | *P* value |
|---|---|---|---|---|---|
| Pre-intervention | 72.12 | 9.91 | 68.39 | 75.80 | 0.013 |
| Post-intervention | 77.53 | 7.71 | 74.65 | 80.41 | |

**Table 2.** Comparison of average scores of research units in general in the test group before and after the intervention.

| | Mean score | Standard deviation | 95% Confidence interval | | *P* value |
|---|---|---|---|---|---|
| Pre-intervention | 78.06 | 1.98 | 74.00 | 82.12 | 0.394 |
| Post-intervention | 75.33 | 11.29 | 71.11 | 79.55 | |

**Table 3.** Comparison of average scores in research units in general in the control group before and after the study.

| | T statistic | Degree of freedom | Mean score difference | Standard deviation difference | Confidence interval | | *P* value |
|---|---|---|---|---|---|---|---|
| Daily activity | 3.26 | 58.00 | 4.50 | 1.37 | 1.74 | 7.25 | 0.002 |
| Sleep | 2.83 | 46.24 | 2.20 | 0.77 | 0.64 | 3.76 | 0.007 |
| Stress | 2.19 | 58.00 | 1.46 | 0.67 | 0.13 | 2.80 | 0.032 |
| Total | 3.38 | 48.23 | 8.16 | 2.41 | 3.31 | 13.02 | 0.001 |

**Table 4.** Comparison of the average scores of the fatigue questionnaire dimensions of the research units between the test and control groups before and after the intervention.

(77.53). It was concluded that the subjects' average scores increased after the hospitalization in terms of activity, sleep, and emotional and mental status and their fatigue rate decreased compared to the first few days of hospitalization. This finding was consistent with the findings of Kudubes,[10] Ekti Genc,[23] and Nunes et al.[24] Kudubes, who conducted a study aimed at determining the impact of training related to fatigue control on the life quality of children with a cancer diagnosis, concluded that 5 sessions of training related to fatigue control could reduce the fatigue of children with cancer and improve their life quality. Ekti Genc,[23] who conducted a study to determine the effect of nursing interventions on the fatigue syndrome of children with leukemia under chemotherapy, concluded that children who were trained in techniques to reduce fatigue, including measures aimed at improving sleep and activity levels, observed that their fatigue was significantly reduced.

The results of the present study to compare the fatigue scores of children with cancer in the intervention and control groups before and after the intervention revealed that the average fatigue scores of the intervention group compared to the control group before and after the intervention, in terms of activity, sleep, and mental and emotional state increased, and their fatigue decreased compared to the beginning of the study. The intervention has caused a statistically significant difference (0.001), and has thus been proven to be effective. This finding was consistent with the findings of studies authored by Kudubes,[10] Nunes,[24] Barwick,[22] Aghayosefi,[25] TalaKoob,[26] and Moghadam Tabrizi.[12] In the study of Tabrizi et al., which was conducted to determine the effect of energy efficiency strategies on cancer-related fatigue, the intervention to teach energy efficiency techniques during 6 individual, group, and via-text sessions reduced the fatigue of cancer patients. Statistically, there was a significant difference between the intervention and control groups after the intervention, and the fatigue of the intervention group was reduced. In a study by Talakoob et al.[26] to determine the effect of painting on fatigue and depression in children with a cancer diagnosis and undergoing chemotherapy, children in the intervention group who performed 6 free painting sessions were significantly less likely to experience fatigue and depression.

The findings of the present study showed that energy efficiency training has generally been effective on the fatigue score in children with cancer and has improved energy levels and reduced fatigue in children with cancer. Among the mean fatigue scores of children with cancer in the intervention group compared to the control group in terms of daily activities, sleep, and mental and emotional status, there was a statistically significant difference after the intervention (0.001). The research hypothesis that energy efficiency training affects fatigue in children with cancer has been confirmed.

## 5. Conclusions

Developing energy efficiency strategies can be effective in managing cancer-related fatigue in children with the disease, and so it is recommended that children and their parents, as well as medical staff, pay attention to energy efficiency strategies for the betterment of children with cancer.

## Limitation

The small number of samples was one of the limitations of this study. Therefore, it is not possible to generalize the results of this study to the patient population with high confidence. Therefore, it is recommended that this limitation be suitably addressed in future studies.

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## Ethical approval

Ethical issues are not involved in this paper.

## Conflicts of interest

All contributing authors declare no conflicts of interest.

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