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Research

The Effect of Virtual Reality Distraction and Fatigue Training on Anxiety and Fatigue Levels in Children with Cancer: A Randomized Controlled Study

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ABSTRACT

Objectives: This randomized controlled trial evaluated the effect of virtual reality (VR) distraction and fatigue training on anxiety and fatigue in children with cancer.
Methods: The sample of this parallel design randomized controlled trial consisted of 41 children aged 7 to 16 who were receiving chemotherapy treatment in the pediatric hematology and oncology wards of a university hospital. Data was collected with the Child Anxiety Scale-State, Child Fatigue Scale-24-Hours, and Visual Fatigue Scale in both groups before and during the first three days of chemotherapy treatment. All children admitted to the clinic during chemotherapy received fatigue education. On the first, second, and third days of chemotherapy treatment, children in the study group underwent a 15-minute VR distraction intervention following stratified randomization. Repeated measures analysis of variance was used to compare scale scores by group, time, and group-time interaction.
Results: Of the patients, 63.4% were male, and 39% had neuroblastoma. There was no difference between the groups in terms of diagnosis, age, duration of diagnosis, chemotherapy, or hemoglobin levels. A statistically significant difference was found between the mean scores of the anxiety and fatigue scores in the intervention and control groups in terms of group, time, and group-time interaction.
Conclusion: Applying VR distraction on the first, second, and third days of chemotherapy treatment was found to be useful in lowering anxiety and fatigue levels in addition to fatigue training.
Implications for Nursing Practice: Virtual reality distraction is an effective method for reducing anxiety and fatigue in this population.

Survival rates can reach 75% to 80% with significant advances in the treatment of childhood cancers. Treatments for childhood cancers can lead to the emergence of various symptoms in children. Especially, chemotherapy causes a series of symptoms in children. Symptoms associated with chemotherapy in children include anemia, nausea, vomiting, alopecia, cachexia, changes in excretion, mucositis, and fatigue.[1] Fatigue can seriously affect the lives of children with cancer.[2] In the literature, the incidence of fatigue in childhood cancers varies between 51 and 86%.[3–5]

Fatigue associated with childhood cancers is a strong state of weakness that is influenced by many factors and reduces the child's quality of life. Fatigue reduces the energy level of the child and causes various negative physical, mental, and emotional effects.[2] In childhood cancers, fatigue can be seen due to the side effects of treatment, chronic pain, surgical operation, physical and psychological symptoms, and the effects of medications given for other conditions. Due to fatigue, children experience negative conditions such as loss of energy, increased desire for rest, decreased interest in favorite activities, and problems in maintaining daily tasks.[2] The nursing interventions to support children trying to cope with this situation had positive results, reduce the level of fatigue, and improve the quality of life.[3] The management interventions for symptom control are effective in reducing the symptoms experienced by children. Starting

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Layperson Summary

What we investigated and why

We investigated the effect of virtual reality (VR) distraction and fatigue training on anxiety and fatigue in children with cancer. This was important as studies using VR distraction on symptoms in the pediatric cancer population are very limited.

How we did our research

We conducted a study with 43 hospitalized children aged 7 to 16. We gave a fatigue education and randomly assigned them to VR or control group. The VR group received virtual reality distraction for 15 minutes daily over three days. We assessed anxiety and fatigue symptoms.

What we have found

Virtual reality distraction reduced anxiety and fatigue compared to the control group.

What it means

Virtual reality distraction can be used for anxiety and fatigue at pediatric cancer patients undergoing chemotherapy.

reporting of symptoms regularly, non-pharmacological and integrative therapies for pain management, regular oral assessment, prophylactic and treatment algorithms for mucositis, comprehensive nutrition assessment, physical activity programs, and cognitive behavior therapy for fatigue can prevent exacerbation of symptoms.[6] The training about symptom management and identifying physical, mental, and emotional symptoms experienced during the treatment of childhood cancers enables children to cope with the symptoms they experience and improve their quality of life.[2,6] It is also emphasized that the distraction interventions applied in addition to the training provided for symptom management are effective in reducing symptoms. Distraction interventions, one of these methods, have been reported to reduce symptoms in children, especially by increasing psychological well-being.[7,8]

In addition to fatigue, anxiety is also a symptom that needs to be addressed in children with cancer. Anxiety is quite common in patients with cancer. Nonpharmacological methods are available to reduce anxiety.[9] Integrative interventions such as cognitive behavioral therapy, virtual reality games, music, and yoga can be applied to children with cancer.[10–13] Although standards have been developed for psychosocial care in pediatric oncology, anxiety-specific screening, and assessment guidelines are lacking in this population.[14] Anxiety in children with cancer should be regularly assessed and managed with appropriate interventions. The anxiety should be closely addressed by healthcare professionals during the treatment process.[15]

One of the most frequently used methods of distraction is virtual reality. Virtual reality (VR), a technology that allows children to immerse themselves in a virtual world, is used as a distraction method.[16] VR distraction is thought to affect various symptoms by blocking stimulation associated with the real environment and the external world with pain stimuli. VR is categorized into two main categories, immersive and non-immersive VR. Immersive VR influences the effects on the attention of users. Full immersion is reached by a head-mounted display, including the helmet which excludes sights and sounds from the environment. It is generally used in pain, anxiety, and distress management during chemotherapy treatment and needle-related procedural pain.[16–18] In the pediatric cancer population, VR is often used in the management of interventional pain.[19–21] VR technologies can support the management of pediatric cancers. The potential effects of VR have been shown to reduce pain and anxiety. The VR experience can be used as an accessible personal application during the patient's treatment process.[22]

It is emphasized that the combined application of various methods in the management of fatigue symptoms in childhood cancers is more effective in reducing the level of fatigue.[23] Identifying fatigue associated with childhood cancers as a problem in the clinical field and implementing intervention studies is a fairly new situation.[2,3,5] No studies were found in which both fatigue training and VR distraction were used together in childhood cancers.

This study was conducted to evaluate the effect of VR distraction and fatigue training on anxiety and fatigue levels in children with cancer.

Hypotheses of the Study

H1.1: The mean anxiety and fatigue scores of the children who received VR distraction and fatigue training (study group) were lower than those of the group who received only fatigue training (control group) in the inpatient unit.

H1.2: There is an interaction between time (Day 0, Days 1, 2, and 3 of chemotherapy treatment) and group (study/control) in terms of mean anxiety and fatigue scores of children in the inpatient unit.

Methods

Design

The study was a randomized, controlled, double-arm parallel design. This study was conducted in the pediatric hematology and oncology clinic of a university hospital between April 2022 and February 2023. This study was registered in the Clinical Trials Registry with the ID number NCT05774379.

Participants who were admitted to the clinic in the control and study groups received fatigue education. During a span of 3 days, the study group experienced a VR distraction intervention for 15 minutes once a day on days 1, 2, and 3 of chemotherapy treatment.

Participants

Inpatient pediatric patients aged 7 to 16 with cancer were included in the study. Pediatric patients under the age of 17 are monitored in the unit where the study is conducted.

In the GPOWER 3.1 statistical program, the total sample should be 36, based on 0.25 effect size, 80% power, 0.05 significance level, and four measurements in two groups, using analysis of variance in repeated measurements. It was decided that the total sample would be 40 children, considering the 10% loss. For the study, 54 children were evaluated, and the sample consisted of 41 children who met the inclusion criteria. The Consolidated Standards of Reporting Trials (CONSORT) checklist was used[24] (Fig. 1).

Inclusion Criteria

- Between the ages of 7 and 16.
- Inpatient chemotherapy treatment for more than 3 days.
- At least 4 weeks have passed since diagnosis (not in the induction phase).
- No need for transfusion of blood products (below 8 mg/dl for hematologic malignancies and below 7 mg/dL for oncologic malignancies).
- The child voluntarily agrees to participate in the study.

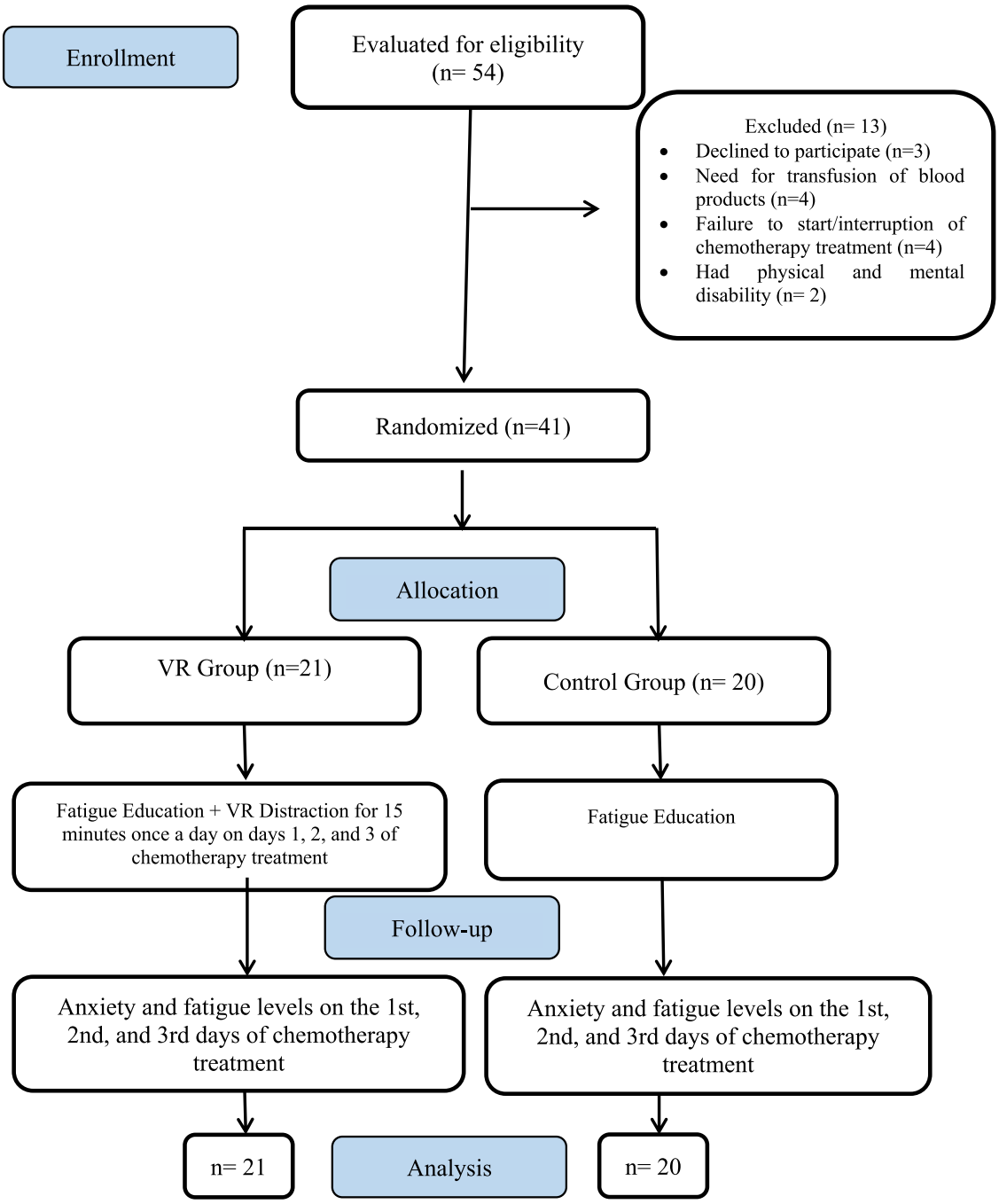

Fig. 1. Consolidated Standards of Reporting Trials (CONSORT) flow diagram.

Exclusion Criteria

- The child does not have a physical, psychological, or cognitive deficit that would prevent him/her from wearing the glasses on his/her head to watch virtual reality.
- Failure to start/interruption of chemotherapy treatment.
- Being in the terminal period.
- Surgical operation.
- Unwillingness to participate in the study.
- Not participating in fatigue training.
- Having a history of vertigo (history of train or vehicle sickness).
- Failure to experience VR intervention for three consecutive days.

Randomization

Patients were distributed into groups by stratified randomization method. Patients were distributed into groups according to gender (male, female), age (7-9 years, 10-12 years, and 13-16 years) and malignancy type (hematologic, oncologic). The first patient in each block was assigned to the study or control group according to the order specified in the table.

Procedure

The written informed consent was obtained from parents after providing information to them about the study. A visually informed

form was prepared for the children and obtained assent from them. If the child is over 7 years old, written consent was also obtained from the child. When the patients were admitted to the clinic on the day before chemotherapy treatment started (day 0), fatigue education was given to all children included in the study by the same nurse researcher (PhD nurse who studies the field of cancer-related fatigue in children). Fatigue education was given on an individual basis. Formal education was implemented. Children's current knowledge and coping methods were questioned and the training was conducted interactively. No functional scale was used to evaluate fatigue management. Fatigue education included educational, game-playing, and stress-reducing activities about coping methods, energy conversation and activity, sleep quality, and stress management. Fatigue education is a fatigue-symptom-reducing approach with proven efficacy; therefore, all patients in the study received this standardized fatigue education. The fatigue education booklet used in this study is material that was previously used in another study and was structured with expert opinion.[3] The participants attended the educational activities and used role-playing, exercises, games, and display boards. Game-playing activities were organized during the educational activities. Stress-reducing activities were organized for the children with coloring books and materials (glue, crayons, felts, and activity books). Children were encouraged to use these materials to reduce their stress. The training and activities were conducted by the researcher. The training lasted one session, lasted 45 minutes on average, and the child and his/her parent participated in the training together. Role-play, exercise, games, coloring books, and activity materials were used during the training. The fatigue education booklet was given to the child after the training.

The primary variables of the study were anxiety and fatigue levels. Just before the training, the Child Anxiety Scale-State (CAS-S), Child Fatigue Scale-24-Hours, and Visual Fatigue Scale were evaluated by the child at 16.00 hours to determine how the child felt and the level of fatigue (pretest/ day 0). The scales were re-administered to the children on the 1st, 2nd, and 3rd days of chemotherapy treatment at 16.00 in the afternoon (post-tests / day 1, 2, 3).

In the study, data collection tools were administered to the children by a non-researcher. They were given a number and code number and delivered to the researcher. Thus, single-blind randomization is ensured. In the study group, patients knew which group they would be in since virtual reality would be applied, but the groups were not affected by each other.

Virtual Reality Intervention

Children's use of VR for a long time may cause various problems such as vision changes and nausea. Studies evaluating VR showed that VR is generally used during medical procedures.[8,12,16,19-22] Although VR usage times are not disclosed, it is understood that it is used for a short time. The VR usage time is limited to 15 minutes.

VR was applied for 3 consecutive days. Since children were not in the induction phase, treatment protocols, medications they receive, and treatment durations are often quite variable. However, this period was determined because the average length of stay in the unit is not less than 3 days.

According to the randomization scheme, children assigned to the study group experienced an immersive VR distraction intervention for 15 minutes once a day on days 1, 2, and 3 of chemotherapy treatment by the non-researcher. This intervention took place between 14.00 and 15.00 in the afternoon. In the afternoon, treatment is less frequent, and routine vital follow-ups are performed during the specified time interval. After follow-up and treatment, this time interval was determined so that the intervention could be applied more easily.

Virtual reality applications were selected by the patients in the study group. The Oculus Quest headset was used for viewing virtual reality images and sounds. The immersive VR is provided by an all-in-one VR headset with Oculus Quest 2. The images are changed when the child turns his/her head, for example by looking upwards, giving the child the feeling that he/she is moving in the video. The child advanced the images with the remote control of the VR headset. While the child was in a sitting position on the bed, he/she entered the VR world through the researcher's meta-account. While the child was in the VR world, the researcher could see which application the child was in from the phone. The meta-account profile had VR applications that children could play with. These were VR-rollercoaster, Ocean Rift, and yoga meditation. These apps were the ones used by children in previous VR-related research.[19,21] Patients selected the VR apps they wanted to experience through the remote controller.

Data Collection Tools

Sociodemographic Data Collection Form. It consists of questions about the sociodemographic and treatment-related characteristics of the children who participated in the study. It includes age, gender, diagnosis, date of diagnosis, relapse status, type of treatment, chemotherapy and other drug use, medications used, duration of hospitalization, steroid use, mucositis, nausea/vomiting, presence of a catheter, nutritional status, hemoglobin value, previous fatigue education, and invasive intervention status.

Child Anxiety Scale-State (CAS-S). The CAS-S is shaped like a thermometer with a bulb at the bottom and horizontal lines at intervals going upwards. “Imagine that all your anxious or nervous feelings are at the bulb or bottom of the thermometer,” the children instructed. “If you are a little worried or nervous, the emotions may go up a little on the thermometer. If you are very, very anxious or nervous, emotions can go all the way to the top. Put a line on the thermometer showing how anxious or nervous you are”. To measure state anxiety (CAS-D), the child is asked to mark how they feel “right now”.[25] The score can range from 0 to 10 and can be administered to children aged 4 to 12 years.[26] Its psychometric properties in the Turkish population were examined by Gerçeker et al.[27] The CAS-D was also used in the cancer population by Gerçeker et al.[19]

Child Fatigue Scale-24 Hours (CFS-24 Hours). It consists of 10 items related to the perception of fatigue in children with cancer. The items in the scale include self-reports of the child between the ages of 7 and 12, indicating their experience of fatigue-related symptoms in the last 24 hours. The items are organized on a Likert scale from “not at all (1)” to “very much (5).” Scale scores range from 10 (no fatigue symptoms) to 50 (high fatigue). High scores indicate that the child perceives the fatigue symptom too much. Cronbach's Alpha reliability coefficient is between 0.64 and 0.72.[28,29] The Turkish reliability and validity of the scale was conducted by Ozalp Gerçeker and Bal Yılmaz,[30] Cronbach's Alpha value was found to be 0.83 for the 24-hour scale.

Visual Fatigue Scale (VFS). The “Visual Fatigue Scale” is a measurement tool that visually assesses fatigue. It is scored between “1” and “5” and an increase in the scale score indicates an increase in the child's fatigue level.[31]

Ethics

The study was approved by the ethics committee of the university where the study was conducted with code 5776GOA and number 03-42. Informed written consent was obtained from the child and parents.

Data Analysis

The data of the study were analyzed using the IBM SPSS 25.0 package program. Number, mean, and percentage calculations were used for descriptive data. The normal distribution of the data was calculated according to skewness and steepness, and the skewness and

steepness values were between -2 and +2. It was determined that the data had a normal distribution. The significance test of the difference between the two means was used to compare the scores of the VR and control groups on days 0, 1, 2, and 3. In comparisons according to time, group, and group*time interaction, repeated measures analysis of variance were used. The change within groups according to time was also compared by one-way analysis of variance. The Bonferroni adjusted t-test was used for post-hoc analysis. The significance level was accepted as .05 in the study.

Results

Demographic and Clinical Variables

The mean age of the patients in the VR group was 9.7 ± 3.6 years, and 9.6 ± 3.7 years in the control group. It found that 66.7% of the patients in the VR group and 60% of the patients in the control group were male, 19% of the patients in the VR group and 25% of the patients in the control group were diagnosed with ALL, 42.9% of the patients in the VR group and 65% of the patients in the control group were diagnosed in less than 6 months. It determined that 33.3% of the VR group and 20% of the control group relapsed; alkalizing agents were frequently used as chemotherapy in both groups, and steroid use was low in both groups (Table 1).

It was observed that there was no difference in hemoglobin levels on day 0 (pretest) and days 1, 2, and 3 of chemotherapy treatment, and it was generally 10 mg/dL. Few patients had mucositis (VR = 9.5%, Control = 20%), almost half of the patients had nausea/vomiting (VR = 47.6%, Control = 55%), most of them had port catheters (VR = 57.1%, Control = 75%), and there was no difference in terms of invasive interventions on day 0 and days 1, 2 and 3 of chemotherapy treatment (Table 1).

Anxiety Levels

There was no difference between the groups on Day 0 (pretest), while there was a difference between days 1, 2, and 3 of chemotherapy treatment. As a result of the analysis, there was a statistically significant difference between the mean anxiety scores in terms of group ($F = 39.946$, $p = .000$), time ($F = 8.890$, $p = .000$), and group*time ($F = 8.975$, $p = .000$) interaction (Table 2).

In terms of time, there was a difference in anxiety levels between day 0 and days 1, 2, and 3. There was also a difference between day 1 and day 3 ($p = .003$), but no difference was found between Day 2 and Day 3. When the change in anxiety levels within the groups according to time was analyzed, a significant difference was found in the VR group ($F = 17.632$, $p = .000$), while no difference was found in the control group ($F = 1.433$, $p = .268$). In the VR group, there was a difference in anxiety levels in terms of time between day 0 and days 1, 2, and 3, and between day 1 and day 3, while there was no difference in anxiety between the other days (day 1, day 2, and day 3).

Fatigue Levels

There was no difference between the groups on Day 0, but there was a difference between days 1, 2, and 3. As a result of the analysis, there was a statistically significant difference between the mean fatigue scores in terms of group ($F = 23.763$, $p = .000$), time ($F = 13.810$, $p = .000$), and group*time ($F = 8.454$, $p = .000$) interaction (Table 2).

In terms of time, there was a difference in fatigue levels between day 0 and days 1, 2, and 3. No difference was found between the other days. When the change in fatigue levels within the groups according to time was analyzed, a significant difference was found in the VR group ($F = 54.282$, $p = .000$), while no difference was found in the control group ($F = .238$, $p = .869$). In the VR group, there was a

Table 1
Demographic and Clinical Variables of the Patients ($n = 41$)

Variables	VR group		Control group		X^2/t	*P*
	M	*SD*	*M*	*SD*		
Age (year)	9.7	3.6	9.6	3.7	.003	.888
Age group	***n***	***%***	***n***	***%***		
7-9 years	10	47.6	9	45.0	.216	.897
10-12 years	6	28.6	7	35.0		
13-16 years	5	23.8	4	20.0		
Gender						
Girl	7	33.3	8	40.0	.196	.658
Boy	14	66.7	12	60.0		
Diagnosis						
Acute Lymphoblastic Leukemia	4	19.0	5	25.0	8.425	.675
Acute Myeloid Leukemia	1	4.8	1	5.0		
Lymphoma	2	9.6	3	15.0		
Noroblastoma	8	38.1	8	40.0		
Brain tumor	1	4.8	-	-		
Osteosarcoma	2	9.6	2	10.0		
Germ cell tumor	1	4.8	-	-		
Medulloblastoma	1	4.8	-	-		
Overial tumor	1	4.8	-	-		
Synovial sarcoma	-	-	1	5.0		
Diagnosis time						
<6 months	9	42.9	13	65.0	2.020	.155
>6-18 months	12	57.1	7	35.0		
Relapse status						
Yes	7	33.3	4	20.0	.928	.335
No	14	66.7	16	80.0		
Chemotherapy						
AntiGD2	-	-	4	20.0	20.321	.501
Azacidine	1	4.8	-	-		
Cyclophosphamide	3	15.0	4	20.0		
Etoposide and Cyclophosphamide	2	9.6	-	-		
Ifosfamide	2	9.6	2	10.0		
Ifosfamide and Cytarabine	-	-	2	10.0		
Irinotecan	2	9.6	1	5.0		
Irinotecan and Temozolamide	1	4.8	-	-		
Carboplatine and Paklitaksel	1	4.8	-	-		
Methotrexate	3	14.3	3	15.0		
Cyclophosphamide and Topotekan	1	4.8	-	-		
Cisplatin	-	-	1	5.0		
Cytarabine	1	4.8	2	10.0		
Cytarabine and Daunobicine	1	4.8	-	-		
Cytarabine and Etoposide	1	4.8	-	-		
Topotekan	1	4.8	1	5.0		
Vincristine	1	4.8	-	-		
Steroid receiving status						
Yes	4	19.0	6	30.0	.666	.414
No	17	81.0	14	70.0		
Hemoglobin value						
Day 0	10.6	1.2	9.9	1.6	3.609	.140
Day 1	10.7	1.2	10.0	1.6	3.264	.171
Day 2	10.6	1.1	10.2	1.6	2.953	.217
Day 3	10.2	1.2	10.1	1.3	.145	.721
Presence of mucositis						
Yes	2	9.5	4	20.0	.900	.343
No	19	90.5	16	80.0		
Presence of nausea/vomiting						
Yes	10	47.6	11	55.0	.223	.636
No	11	52.4	9	45.0		
Presence of port catheter						
Yes	12	57.1	15	75.0	1.453	.228
No	9	42.9	5	25.0		
Number of patients exposed to invasive intervention						
Day 0	13	61.9	10	50.0	.589	.443
Day 1	3	14.3	3	15.0	.004	.948
Day 2	12	57.1	9	45.0	.605	.437
Day 3	5	23.8	5	25.0	.008	.929

M=Mean, SD= Standard deviation.

Table 2
Comparison of Anxiety and Fatigue Scores According to Time, Group and Group*Time Interaction ($n = 41$)

	Time Group	Day 0 X±SS	Day 1 X±SS	Day 2 X±SS	Day 3 X±SS		*F*	*P*
Anxiety	**VR group**	2.8 ± 1.7	1.0 ± 1.2	0.4 ± 0.8	0.2 ± 0.5	Time, Group, Group*, Time	8.890, 39.946, 8.975	.000, .000, .000
	Control group	3.2 ± 1.0	3.6 ±1.8	3.7 ±2.0	3.9 ± 1.9			
	F	4.311	1.854	8.633	8.970			
	P	.091	.000	.000	.000			
Fatigue	**VR group**	26.4 ± 4.5	17.6 ± 3.5	15.8 ± 2.7	14.5± 2.9	Time, Group, Group*, Time	13.810, 23.763, 8.454	.000, .000, .000
	Control group	29.4 ± 6.3	28.6 ±10.0	28.4 ±10.5	28.0 ± 11.1			
	F	1.487	12.214	19.242	21.524			
	P	.093	.000	.000	.000			
Visual Fatigue Level	**VR group**	3.2 ± 0.7	2.0 ± 0.8	1.4 ± 0.6	1.2 ± 0.4	Time, Group, Group*, Time	17.941, 25.153, 12.735	.000, .000, .000
	Control group	3.3 ± 1.1	3.1 ±1.1	3.4 ±1.1	3.2 ± 1.3			
	F	4.393	7.447	14.264	36.690			
	P	.829	.001	.000	.000			

difference in fatigue levels in terms of time between day 0 and day 1, day 2, and day 3, day 1 and day 2, and day 1 and day 3, but there was no difference in fatigue between day 2 and day 3.

There was no difference between fatigue levels and age group, gender, diagnosis, treatment length, relapse status, chemotherapy treatment, and steroid use ($p > .05$).

Visual Fatigue Levels

There was no difference between the groups on Day 0, but there was a difference between Days 1, 2, and 3 according to VFS. As a result of the analysis, there was a statistically significant difference between the mean visual fatigue scores in terms of group ($F = 25.153$, $p = .000$), time ($F = 17.941$, $p = .000$), and group*time ($F = 12.735$, $p = .000$) interaction (Table 2).

There was a difference in visual fatigue levels between day 0 and days 1, 2, and 3. No difference was found between the other days. When the change in visual fatigue levels according to time within the groups was analyzed, a significant difference was found in the VR group ($F = 77.354$, $P = .000$), while no difference was found in the control group ($F = 1.620$, $P = .222$). In the VR group, there was a difference in visual fatigue levels in terms of time between day 0 and days 1, 2 and 3, day 1 and day 2, and day 1 and day 3, while there was no difference in fatigue between day 2 and day 3.

Discussion

The children in the study group received VR intervention, and all children received fatigue training as part of this investigation on the symptoms of anxiety and fatigue. Anxiety and fatigue levels were evaluated before chemotherapy treatment and on the 1st, 2nd, and 3rd days of chemotherapy treatment. Kudubeş et al.[3] found a difference in terms of fatigue and quality of life when 7 to 12-year-old pediatric oncology patients who were or were not given fatigue training. A difference was detected in terms of group, time, and group*-time interaction. It was determined that fatigue training reduced fatigue and increased the quality of life.[3] In a qualitative study, Antill Kenner[2] described parents' fatigue as "co-occurring not as a discrete entity of fatigue, accept the child's behavior as a new normal, recognize fatigue as a warning sign." Fatigue should be addressed from multiple perspectives and should be taken into consideration by health professionals. It should be detected early, regular screening should be performed, and appropriate interventions should be made.[32] Fatigue training is reported to be effective in reducing fatigue. Fatigue symptoms in children with cancer may continue after discharge.[33] Continuity of education and regular evaluation of fatigue are important for managing fatigue symptoms. Fatigue symptoms should also be included in discharge training. Nurses play an important role in the education of pediatric cancer patients and their families.[34] Mobile health tools are reported to be effective in managing chemotherapy-related symptoms in children with cancer.[35] With these innovative methods, health professionals can ensure continuity of education, strengthen communication with parents, and make symptom management more effective.

Physiological and psychological symptoms often occur together in the cancer population.[10] Pouraboli et al.[36] examined the effect of relaxation techniques on anxiety and fatigue and reported that the intervention reduced fatigue and anxiety. Nonpharmacological interventions are complementary to traditional treatment, and their use may improve fatigue and psychological stress in children and adolescents with cancer.[37] It is reported that there is a strong relationship between fatigue, pain, and anxiety, and supportive care should also be focused on healing children with cancer from the time of diagnosis.[38]

Studies evaluating the effect of VR on fatigue symptoms are limited.[39] Virtual reality can effectively reduce symptoms associated with cancer treatment. It is very valuable to investigate the effect of this intervention on the symptoms experienced by patients. Distraction is an effective symptom management, and since it arouses curiosity, it can be predicted that virtual reality, an emotion-focused distraction intervention, can reduce the severity of these symptoms. In a study evaluating the effectiveness of VR in the management of procedural pain in this population, it was found to reduce pain and distress. The study also monitored the heart rate and saturation of the patients, and the patients found the VR intervention entertaining and distracting.[40] It is reported that VR increases patients' emotional well-being and reduces cancer-related psychological symptoms.[16] It is effective on procedure-related pain and anxiety in this population.[17,19,21] VR is effective in the physical and mental health of pediatric oncology patients. In a study examining its effect on emotional moods, it was reported to be effective on anxiety.[41] Further studies examining VR applications are needed to support children's adaptation to hospitalization and cancer treatment.

Conclusion

Interventions may also lead to a reduction in fatigue and anxiety. In this study planned from this point, fatigue training and VR distraction, an intervention that has attracted attention in recent years, were discussed together. When the control group, which received only fatigue training, was compared with the study group that received VR distraction in addition to fatigue training, it was determined that there was a difference in anxiety and fatigue levels between the 1st, 2nd, and 3rd days of chemotherapy treatment. There was no difference between the groups in terms of anxiety, and fatigue scores of the children in the intervention and control groups before chemotherapy treatment. While there is no difference between the two groups on Day 0, anxiety and fatigue scores appear

to be in favor of the VR group. Since fatigue training is known to be an effective intervention, fatigue training was provided to the entire sample as there may be contamination between groups in terms of training. However, if there had been a group that was not trained, the results might have been different. As can be seen, since the maximum score is 50, it can be said that the fatigue scores on Day 0 are at an average level and do not increase during the chemotherapy treatments (days 1-3). A difference was found between anxiety and fatigue score averages in terms of group, time, and group*time interaction. While the anxiety level remained similar over the days in the control group, it was observed that anxiety gradually decreased in the VR group. While the fatigue levels were moderate before chemotherapy, it was determined that the fatigue level was lower in the VR group. VR distraction has been found to reduce fatigue and anxiety.

By considering fatigue and anxiety together, this study showed that VR may be effective not only on anxiety but also on fatigue in the pediatric oncology population. In this study without a single evaluation, the effectiveness of the sequential VR intervention was demonstrated on consecutive days. It has been shown that anxiety and fatigue can be reduced by adding VR distraction to the fatigue training applied as a standard approach.

Limitations

Fatigue training was given on the first day of hospitalization, and fatigue-related training and interventions were not continued in the following days. Interventions related to fatigue could have continued throughout the hospitalization. The effectiveness of the fatigue training could be evaluated with functional scales. VR applications were limited with VR-rollercoaster, Ocean Rift, and yoga meditation. VR applications could be chosen for adolescent patients according to their preferences, allowing them to be more free. The diagnosis and chemotherapies the patients received were quite different. Some patients received chemotherapy treatment for long days. In patients receiving chemotherapy for a long time, VR intervention could be continued and fatigue and anxiety levels could be continued to be evaluated.

Patients can be monitored on the days they receive chemotherapy treatment. The physiological parameters of the patients could also be monitored, and especially the physiological parameters during the VR distraction application could be shared. Children's fatigue scale -24 hours includes self-reports of the child between the ages of 7 and 12. In the study, the age group was kept wide due to sample limitations (7-16). Therefore, the Visual Fatigue Scale was also used to evaluate fatigue. In the study, the age group could have been limited. The study could have been conducted with a larger number of participants and patients receiving the same chemotherapy protocol.

Implications for Nursing Practice

Virtual reality technology can be used for symptom control in the child cancer population. During these difficult times, patients can watch many videos/applications, play games, meditate, or travel to any country or city they want with this distracting technology. In many studies on symptom control in the pediatric cancer population, practices such as education and diverting attention are used. This study reveals the usability of virtual reality technology in anxiety and fatigue symptom management in pediatric cancer patients.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Gülçin Özalp Gerçeker: Writing – original draft, Supervision, Software, Methodology, Data curation, Conceptualization. **Murat Bektaş:** Software, Methodology, Conceptualization. **Ayşe Önal:** Visualization, Investigation, Data curation. **Aslı Akdeniz Kudubeş:** Visualization, Investigation, Data curation. **Refik Emre Çeçen:** Visualization, Investigation, Data curation.

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Supplementary materials

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References

1. Rodgers C, Hooke MC, Ward J, Linder LA. Symptom clusters in children and adolescents with cancer. *Semin Oncol Nurs*. 2016;32(4):394–404.
2. Antill Keener T. Childhood cancer-related fatigue and day-to-day quality of life. *J Pediatr Oncol Nurs*. 2019;36(2):74–85. https://doi.org/10.1177/1043454218818062.
3. Kudubes AA, Bektas M, Mutafoğlu K. The effect of fatigue-related education on pediatric oncology patients' fatigue and quality of life. *J Cancer Educ*. 2019;34(6):1130–1141. https://doi.org/10.1007/s13187-018-1419-4.
4. Van Dijk-Lokkart EM, Steur LMH, Braam KI, et al. Longitudinal development of cancer-related fatigue and physical activity in childhood cancer patients. *Pediatr Blood Cancer*. 2019;66(12):e27949. https://doi.org/10.1002/pbc.27949.
5. Walter LM, Nixon GM, Davey MJ, Downie PA, Horne RSC. Sleep and fatigue in pediatric oncology: a review of the literature. *Sleep Med Rev*. 2015;24:71–82. https://doi.org/10.1016/j.smrv.2015.01.001.
6. McCulloch R, Hemsley J, Kelly P. Symptom management during chemotherapy. *Paediatr Child Health (Oxford)*. 2018;28(4):189–195. https://doi.org/10.1016/j.paed.2018.02.003.
7. Bukola IM, Paula D. The effectiveness of distraction as procedural pain management technique in pediatric oncology patients: a meta-analysis and systematic review. *J Pain Symptom Manage*. 2017;54(4):589–600. https://doi.org/10.1016/j.jpainsymman.2017.07.006. e1.
8. Indovina P, Barone D, Gallo L, Chirico A, De Pietro G, Giordano A. Virtual Reality as a Distraction Intervention to Relieve Pain and Distress during Medical Procedures. *Clin J Pain*. 2018;34(9):858–877. https://doi.org/10.1097/AJP.0000000000000599.
9. Chen PY, Liu YM, Chen ML. The effect of hypnosis on anxiety in patients with cancer: a meta-analysis. *Worldviews Evid-Based Nurs*. 2017;14(3):223–236. https://doi.org/10.1111/wvn.12215.
10. Bradt J, Dileo C, Magill L, Teague A. Music interventions for improving psychological and physical outcomes in cancer patients. *Cochrane Database Syst Rev*. 2016;2016(8): CD006911. https://doi.org/10.1002/14651858.CD006911.pub3.
11. Danhauer SC, Addington EL, Sohl SJ, Chaoul A, Cohen L. Review of yoga therapy during cancer treatment. *Support Care Cancer*. 2017;25(4):1357–1372. https://doi.org/10.1007/s00520-016-3556-9.
12. Li A, Montaño Z, Chen VJ, Gold JI. Virtual reality and pain management: current trends and future directions. *Pain Manag*. 2011;1(2):147–157. https://doi.org/10.2217/pmt.10.15.
13. Zhang P, Mo L, Torres J, Huang X. Effects of cognitive behavioral therapy on psychological adjustment in Chinese pediatric cancer patients receiving chemotherapy: a randomized trial. *Medicine (Baltimore)*. 2019;98(27):e16319. https://doi.org/10.1097/MD.0000000000016319.
14. Wiener L, Kazak AE, Noll RB, Patenaude AF, Kupst MJ. Standards for the psychosocial care of children with cancer and their families: an introduction to the special issue. *Pediatr Blood Cancer*. 2015;62(5):S419–S424. https://doi.org/10.1002/pbc.25675. Suppl.
15. Trentacosta CJ, Harper FWK, Albrecht TL, Taub JW, Phipps S, Penner LA. Pediatric cancer patients' treatment-related distress and longer-term anxiety: an individual differences perspective. *J Dev Behav Pediatr*. 2016;37(9):753–761. https://doi.org/10.1097/DBP.0000000000000327.
16. Chirico A, Lucidi F, De Laurentiis M, Milanese C, Napoli A, Giordano A. Virtual reality in health system: beyond entertainment. a mini-review on the efficacy of VR during cancer treatment. *J Cell Physiol*. 2016;231(2):275–287. https://doi.org/10.1002/jcp.25117.
17. Birnie KA, Noel M, Chambers CT, Uman LS, Parker JA. Psychological interventions for needle-related procedural pain and distress in children and adolescents. *Cochrane database Syst Rev*. 2018;10(10): CD005179. https://doi.org/10.1002/14651858.CD005179.PUB4.
18. Flujas-Contreras JM, Ruiz-Castañeda D, Gómez I. Promoting emotional well-being in hospitalized children and adolescents with virtual reality. *CIN Comput*

Informatics, Nurs. 2020;38(2):99–107. https://doi.org/10.1097/CIN.0000000000000586.
19. Gerçeker GÖ, Bektaş M, Aydınok Y, Ören H, Ellidokuz H, Olgun N. The effect of virtual reality on pain, fear, and anxiety during access of a port with huber needle in pediatric hematology-oncology patients: randomized controlled trial. *Eur J Oncol Nurs*. 2021;50:101886. https://doi.org/10.1016/j.ejon.2020.101886.
20. Loeffen EAH, Mulder RL, Font-Gonzalez A, et al. Reducing pain and distress related to needle procedures in children with cancer: a clinical practice guideline. *Eur J Cancer*. 2020;131:53–67. https://doi.org/10.1016/j.ejca.2020.02.039.
21. Kanad N, Özalp Gerçeker G, Eker İ, Şen Susam H. The effect of virtual reality on pain, fear and emotional appearance during blood draw in pediatric patients at the hematology-oncology outpatient clinic: a randomized controlled study. *Eur J Oncol Nurs*. 2024;68:102495. https://doi.org/10.1016/j.ejon.2023.102495.
22. Yap KYL, Koh DWH, Lee VSJ, Wong LL. Use of virtual reality in the supportive care management of paediatric patients with cancer. *Lancet Child Adolesc Heal*. 2020;4(12):899–908. https://doi.org/10.1016/S2352-4642(20)30240-6.
23. Robinson PD, Oberoi S, Tomlinson D, et al. Management of fatigue in children and adolescents with cancer and in paediatric recipients of haemopoietic stem-cell transplants: a clinical practice guideline. *Lancet Child Adolesc Heal*. 2018;2(5):371–378. https://doi.org/10.1016/S2352-4642(18)30059-2.
24. Schulz KF, Altman DG, Moher D, Group the CONSORT. CONSORT 2010 statement: updated guidelines for reporting parallel group randomized trials. *Obstet Gynecol*. 2010;115(5):1063–1070. https://doi.org/10.1097/AOG.0b013e3181d9d421.
25. Kleiber C, Mccarthy AM. Evaluating instruments for a study on children's responses to a painful procedure when parents are distraction coaches. *J Pediatr Nurs*. 2006;21(2):99–107. https://doi.org/10.1016/j.pedn.2005.06.008.
26. Ersig AL, Kleiber C, McCarthy AM, Hanrahan K. Validation of a clinically useful measure of children's state anxiety before medical procedures. *J Spec Pediatr Nurs*. 2013;18(4):311–319. https://doi.org/10.1111/jspn.12042.
27. Gerçeker G, Ayar D, Özdemir E, Bektaş M. Gaining of children's state anxiety and children's fear scale to Turkish language. *Dokuz Eylül Üniversitesi Hemşirelik Fakültesi Elektron Derg*. 2018;11(1):9–13.
28. Hinds PS, Hockenberry M, Rai SN, et al. Clinical field testing of an enhanced-activity intervention in hospitalized children with cancer. *J Pain Symptom Manage*. 2007;33(6):686–697. https://doi.org/10.1016/j.jpainsymman.2006.09.025.
29. Hockenberry MJ, Hinds PS, Barrera P, et al. Three instruments to assess fatigue in children with cancer: the child, parent and staff perspectives. *J Pain Symptom Manage*. 2003;25(4):319–328. https://doi.org/10.1016/S0885-3924(02)00680-2.
30. Gerçeker GÖ, Yilmaz HB. Reliability and validity of turkish versions of the child, parent and staff cancer fatigue scales. *Asian Pacific J Cancer Prev*. 2012;13(7):3135–3141. https://doi.org/10.7314/APJCP.2012.13.7.3135.
31. Piper BF, Borneman T, Sun VCY, et al. Cancer-related fatigue: role of oncology nurses in translating national comprehensive cancer network assessment guidelines into practice. *Clin J Oncol Nurs*. 2008;12:37–47. https://doi.org/10.1188/08.CJON.S2.37-47.
32. Christen S, Roser K, Mulder RL, et al. Recommendations for the surveillance of cancer-related fatigue in childhood, adolescent, and young adult cancer survivors: a report from the International Late Effects of Childhood Cancer Guideline Harmonization Group. *J Cancer Surviv*. 2020;14(6):923–938. https://doi.org/10.1007/S11764-020-00904-9.
33. Nunes MDR, Jacob E, Adlard K, Secola R, Nascimento LC. Fatigue and sleep experiences at home in children and adolescents with cancer. *Oncol Nurs Forum*. 2015;42(5):498–506. https://doi.org/10.1188/15.ONF.498-506.
34. Hockenberry M, Haugen M, Slaven A, et al. Pediatric education discharge support strategies for newly diagnosed children with cancer. *Cancer Nurs*. 2021;44(6):E520–E530. https://doi.org/10.1097/NCC.0000000000000947.
35. Novrianda D, Herini ES, Haryanti F, Supriyadi E, Lazuardi L. Chemo assist for children mobile health application to manage chemotherapy-related symptoms in acute leukemia in Indonesia: a user-centered design approach. *BMC Pediatr*. 2023;23(1):274. https://doi.org/10.1186/S12887-023-04076-0.
36. Pouraboli B, Poodineh Z, Jahani Y. the effect of relaxation techniques on anxiety, fatigue and sleep quality of parents of children with leukemia under chemotherapy in south east iran. *asian pac j cancer Prev*. 2019;20(10):2903–2908. https://doi.org/10.31557/APJCP.2019.20.10.2903.
37. Lopes-Júnior LC, Bomfim EO, Nascimento LC, Nunes MDR, Pereira-da-Silva G, Lima RAG. Non-pharmacological interventions to manage fatigue and psychological stress in children and adolescents with cancer: an integrative review. *Eur J Cancer Care (Engl)*. 2016;25(6):921–935. https://doi.org/10.1111/ECC.12381.
38. Weaver MS, Wang J, Greenzang KA, McFatrich M, Hinds PS. The predictive trifecta? Fatigue, pain, and anxiety severity forecast the suffering profile of children with cancer. *Support care cancer*. 2022;30(3):2081–2089. https://doi.org/10.1007/S00520-021-06622-X.
39. Ioannou A, Papastavrou E, Avraamides MN, Charalambous A. Virtual reality and symptoms management of anxiety, depression, fatigue, and pain: a systematic review. *SAGE Open Nurs*. 2020;6: 2377960820936163. https://doi.org/10.1177/2377960820936163.
40. Nilsson S, Finnström B, Kokinsky E, Enskär K. The use of Virtual Reality for needle-related procedural pain and distress in children and adolescents in a paediatric oncology unit. *Eur J Oncol Nurs*. 2009;13(2):102–109. https://doi.org/10.1016/j.ejon.2009.01.003.
41. Tennant M, Youssef GJ, McGillivray J, Clark TJ, McMillan L, McCarthy MC. Exploring the use of Immersive Virtual Reality to enhance Psychological Well-Being in Pediatric Oncology: a pilot randomized controlled trial. *Eur J Oncol Nurs*. 2020:48. https://doi.org/10.1016/j.ejon.2020.101804.