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The effect of an interactive robot on children's post-operative anxiety, mobilization, and parents' satisfaction; randomized controlled study

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ABSTRACT

Purpose: To evaluate the effect of an interactive robot on Turkish children's post-operative anxiety, mobilization, and parents' satisfaction related to post-operative care.
Method: A randomized controlled study was conducted with 84 children who will undergo day surgery aged 5–10 years and their parents at a university hospital between June 2020–April 2022. The interactive robot was provided to accompany the children during the postoperative mobilization. Children in the control group received standard care during mobilization. Data were collected using the Personal Information Form, Children's State Anxiety (CSA), Parental Satisfaction Scale-Visual Analog Scale, and Mobilization Chart.
Results: It was determined that the CSA score of the children in the control group were higher than the intervention group before their first mobilization after surgery ($p = 0.005$). During the first ($p = 0.042$) and second ($p = 0.012$) mobilization, it was determined that the mobilization duration of children in the intervention group was longer than the children in the control group. It was found that the parents of the children in the intervention group had a high level of satisfaction.
Conclusion: It has been determined that interactive robots positively affect postoperative mobilization in children undergoing day surgery, reduce the anxiety level of children before mobilization, and increase the duration of mobilization. In addition, the use of interactive robots increased parents' satisfaction with post-operative mobilization care.
Practice implications: Using interactive robots to reduce the stress and anxiety of children during the perioperative process can be a promising approach to improve their recovery by providing early mobilization.

Introduction

In Turkey, approximately 5 million patients undergo surgery annually, and it is estimated that nearly half of them are children (Başara et al., 2021). Surgical interventions for children are very stressful processes (Bülbül & Arıkan, 2018; Suleiman-Martos et al., 2022;) and approximately 60–65% of children reported experiencing anxiety during the perioperative period (Gates et al., 2020; Suleiman-Martos et al., 2022). While anxiety experienced before surgical interventions can cause physical and psychological problems in children (Chow et al., 2016; Çiftçi et al., 2016), it can negatively affect the child and parents in the postoperative period by causing delays in the recovery process (Bülbül & Arıkan, 2018; Pomicino et al., 2018; Suleiman-Martos et al., 2022). It is emphasized that severe anxiety experienced due to surgical intervention may prevent children from participating in their care and negatively affect cooperation with healthcare professionals (Suleiman-Martos et al., 2022).

It has been documented that children are more vulnerable to anxiety due to their developmental characteristics, poor cognitive skills, lack of self-control, perception, and knowledge about surgery (Aytekin et al., 2016; Park & Kim, 2018). It is reported that anxiety that cannot be controlled during the perioperative process increases the use of anesthetic drugs during surgery and may cause negative consequences such as severe pain perception, increased analgesic use, delirium, and behavioral changes after surgery (Agbayani et al., 2020; Meletti et al., 2019). Anxiety in children caused by surgical intervention and cannot be managed effectively may last for 6–12 months after discharge. Despite all the

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information, it is known that the interventions to reduce the anxiety of children are generally applied in the preoperative period (Akgün Kostak et al., 2021; Jones et al., 2021; Meletti et al., 2019; Ryu et al., 2018), and the applications to reduce the pain are primarily applied in the postoperative period (Atak & Özyazıcıoğlu, 2021; Díaz-Rodríguez et al., 2021; Ünver et al., 2021).

The postoperative period is a process that starts with the child's transfer from the operating room and continues until discharge (Dolgun et al., 2017). Due to the anxiety experienced by the children in the post-operative period and the related negative effects, the mobilization desire of the children who underwent surgery decreases, the recovery processes are delayed, and the hospital stays are prolonged (Dehghan et al., 2017; Gonzalez-Mercado et al., 2017; Yun et al., 2015). The postoperative period aims to provide homeostatic balance, prevent surgery-related complications, and initiate mobilization as soon as possible (Bailey et al., 2019; Roberts et al., 2020; Rove et al., 2018). In studies conducted with children undergoing surgery, it is stated that early mobilization reduces postoperative complications, accelerates recovery, provides nutrition in the early period, and increases the patient's quality of life (Gao et al., 2019; Gather et al., 2018; Samuel et al., 2022). However, children perceive mobilization as a pain-causing practice and can cause anxiety in children (Schwab et al., 2020; Tadyanemhandu et al., 2018).

It is noteworthy that studies examining early postoperative mobilization and applications promoting mobilization, which is an essential element of postoperative accelerated recovery (ERAS) protocols in children, are limited (Abd-Elhamed et al., 2020; Gather et al., 2018; Samuel et al., 2022), and there is no literature investigating the role of anxiety in providing early postoperative mobilization of children. It has been reported that technology-based applications such as virtual reality glasses and robot use in children undergoing surgery are interventions that attract attention by children in relieving anxiety and pain, and interactive robots used in medical interventions have positive effects on recovery (Ali et al., 2021; Gates et al., 2020; Logan et al., 2019; Smakman et al., 2021; Suleiman-Martos et al., 2022). It is thought that interactive robots, which will be integrated into post-operative care, can attract children's attention, reduce their anxiety related to mobilization, and contribute to recovery by increasing children's participation in mobilization. It is thought that the benefits of mobilization for postoperative recovery may also positively affect parents' satisfaction with postoperative care. Considering these factors, this study aims to evaluate the effect of an interactive robot on children's post-operative anxiety, mobilization, and parents' satisfaction related to post-operative care.

The hypotheses of this study are

H1. The use of interactive robots in children would reduce post-operative anxiety.

H2. The use of interactive robots in children would increase the mobilization duration.

Method

Study design

This prospective and randomized controlled study aimed to evaluate the effect of an interactive robot on children's post-operative anxiety, mobilization, and parent satisfaction related to post-operative care. The study design and implementation were based on the principles in the CONSORT (Consolidated Standards of Reporting Trials) list (Moher, Schulz, Altman, and Consort Group,and CONSORT Group, 2001, Moher, Schulz, Altman, and Group, C., and Group, C, 2001). For the study, a clinical trial number was obtained from https://clinicaltrials.gov/ and registered in the system with the research data (Protocol ID- NCT05185830).

Study setting

The research was conducted between 01 June 2020 and 10 April 2022 at a University Hospital, Pediatric Surgery Clinic in northwestern Turkey. This hospital, one of the main centers for pediatric surgery patients in the Thrace Region, is also the only university hospital with a pediatric surgery clinic in northwestern Turkey.

Sample size

The study population consisted of pediatric surgery patients who will undergo day surgery aged 5–10 years and their parents at a University Hospital Pediatric Surgery Clinic. The reasons for including day surgery patients in the study were;

- Preventing the risk of bias in research results by the fact that children stay in the clinic for a short time after the surgery, and the probability of encountering the robot, especially in the control group, is reduced.
- Reducing the risk of prolonging the data collection process, with the difficulties that may be experienced in reaching the targeted sample size, where most surgical interventions are performed daily in the clinic where the research was conducted.

The G*Power software was used to analyze the sample size (Faul et al., 2007). Because there is no similar study, the effect size was purposed to be medium to calculate the sample size. In the sample calculation based on the moderate effect size (d: 0.60), 80% (1 – β error) power, and 95% (α error) confidence level, it was calculated that a total of 72 children, 36 children for each group. Taking into account the possible dropout, the sample size of each group was increased, and 42 children for each group (a total of 84) were included in the sample (G*Power 3.1.9.4) (Faul et al., 2007). After the research was completed, a post hoc power analysis was performed to determine the power of the study. The power of the study was found based on the effect size = 0.68, 80% (1 – β error) power, and 95% (α error) confidence level; the power of the study was found to be 88%.

Inclusion criteria of the study were; that they would undergo day surgery intervention, speak Turkish, volunteer to participate in the survey, are 5–10 years old, have no visual, auditory, or mental problems, and their parents agreed to participate in the study.

Exclusion criteria of the study were; will not undergo day surgery intervention, not being a volunteer to participate in the survey, and filling out the data collection forms incompletely were determined as the study's exclusion criteria.

Randomization

The study group was selected according to the inclusion and exclusion criteria. Eighty-four children and their parents who were scheduled for surgery in the pediatric surgery clinic were evaluated according to the inclusion/exclusion criteria of the study. The research was completed with 84 children and their parents, and no patient was excluded.

To eliminate selection bias and control variables that may affect the outcome measures, 84 children were randomly allocated to the intervention and control groups in the research. An independent statistician assigned the intervention and control groups, and a blind technique was applied to prevent bias and ensure confidentiality. Therefore, selection bias was controlled by randomized assignment and concealment of randomization.

A simple random sampling method was used for randomization. To prevent the children in the intervention and control groups from being affected by each other, the children were assigned to the control and intervention groups according to the weeks. Using the coin-flip method, weeks were determined as intervention or control groups. The coin-flip procedure was performed at the beginning of each week, the

children who underwent daily heads in the weeks of the 'Heads' were included in the intervention group, and the children who underwent day surgery in the weeks leading to the 'Tails' were included in the control group. In the study, participant and researcher blindness could not be performed. Blinding was impossible because the researcher followed the participants and parents daily and was aware of the intervention. The researcher encoded the data in the form of 'A' and 'B' and transferred them to the computer. In addition, an independent statistician analyzed the encoded data to avoid bias in the evaluation of the data.

It is recommended that all stages of randomized controlled trials be carried out according to Consolidated Standards of Reporting Trials (CONSORT). The study was carried out based on the CONSORT 2017 (Updated Guidelines for Reporting Randomized Parallel Group Studies) guidelines (Fig. 1).

Data collection tools

Data were collected using the Personal Information Form, Children's State Anxiety (CSA), Parental Satisfaction Scale-Visual Analog Scale, and Mobilization Chart.

Personal information form

This form was created by researchers in line with the literature, including the parent and child socio-demographic characteristics. It consists of 10 questions, such as mother-child age, child's gender, number of children, the status of chronic disease, the status of hospital experience, and the status of surgery experience (Dionigi et al., 2014; He et al., 2015).

Children's state anxiety (CSA)

The scale was developed by Ersig et al. (2013). The Turkish validity and reliability of the scale were performed by Özalp Gerçeker et al. (2018). The scale is in the form of a bulb at the bottom and a thermometer with horizontal lines at intervals going upwards. In this scale for children aged 4–10, children are explained, 'Imagine all your anxious or nervous feelings are on the bulb or the bottom of the thermometer.' 'If you're a little worried or nervous, your emotions may go up a little on the thermometer.' Emotions can be expressed at the highest point if you are 'very worried' or 'tense.' Children are asked to draw a line on the thermometer to show how worried or angry they are. To measure anxiety (CAS), the child is asked to mark what they are feeling 'right now. The score ranges from '0-10' (Ersig et al., 2013; Gerçeker et al., 2018).

Parental satisfaction scale-visual analog scale

After the intervention group had been mobilized, parent satisfaction scores were gathered using questionnaires from each child's parent. This was done as a feasibility test. The satisfaction surveys had ten items, each of which was evaluated on a scale ranging from 1 to 10,

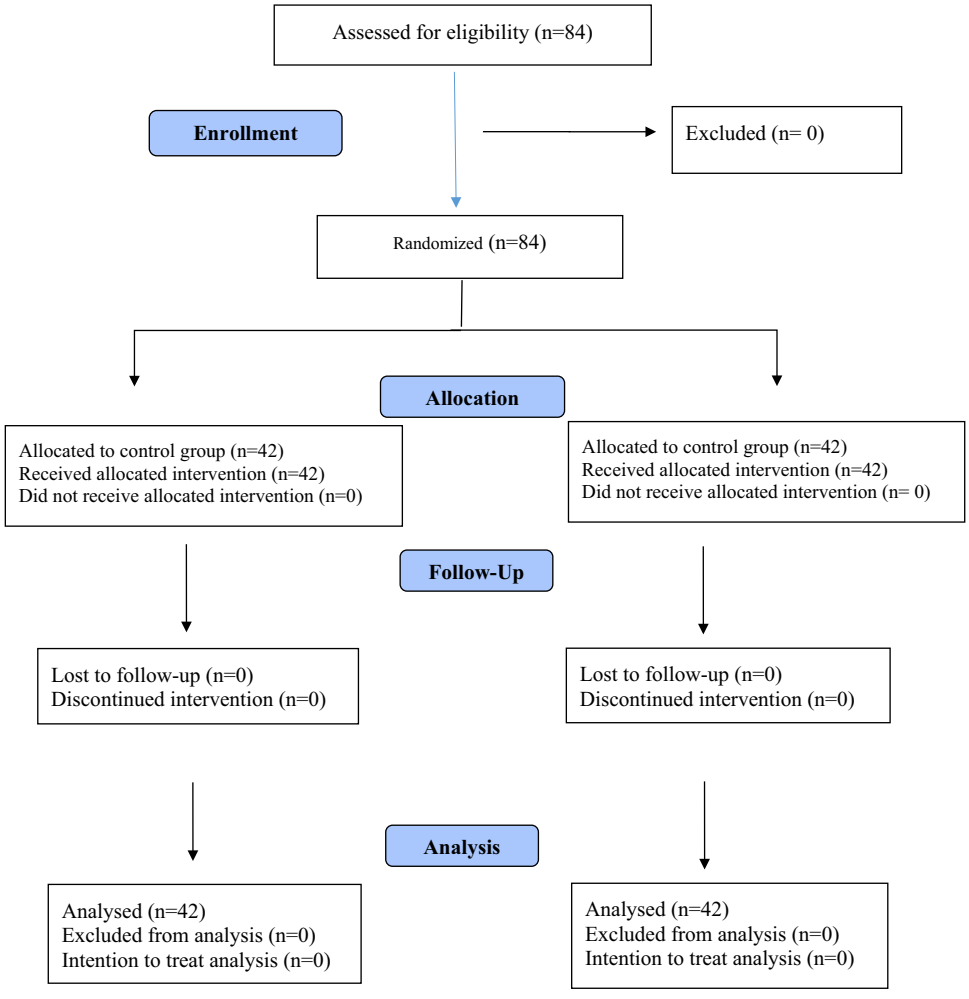

Fig. 1. Trial CONSORT flow diagram.

with '1' representing Strong Disagreement and '10' representing Strong Agreement. Questions were based on prior studies' parental satisfaction surveys (Lee et al., 2009; Williams et al., 2013). Parents of children in the intervention group are asked to mark 0–10′ on the line on the scale to assess their satisfaction with postoperative nursing care.

Mobilization chart

The researchers created the chart. The time the children were mobilized after the surgery and the standing/walking time at each mobilization were recorded by the researchers on the mobilization chart. A stopwatch was used to calculate the children's mobilization duration. The mobilization time was evaluated and registered by considering the time elapsed from the child's getting out of bed to returning to bed.

Interactive robot

An interactive robot named Silverlit Macrobot was used in the study (Fig. 2). Macrobot is an appealing robot that may help children get more interested in technology. The robot can record the movements, repeat them, and make fifty movements; It can record and repeat sounds, act with hand clapping movements, and make various movements. For example, when you clap your hand three times, it starts dancing; The robot also has a 'follow me' feature. By pressing a button on the remote control continuously, the robot can follow its user, and at the same time, it can carry small objects thanks to a small apparatus attached to it. When you guide the robot, it memorizes the path shown and can then go that path itself. It is also possible to program the macro b or via the controller. The robot is suitable for use by children aged five years and older.

Data collection process

The data were obtained from 84 children undergoing day surgery aged 5–10 years and their parents at a university hospital between June 2020–April 2022. The researchers informed the children and their parents about the purpose of the study. Written and verbal permission was obtained from parents who volunteered to participate in the study. Because the participants would be blind, no information regarding the groups was provided in the research. Children were assigned to groups based on the weeks they underwent surgery.

The mobilization of children in the study was performed by three nurses working in the pediatric surgery clinic and taking part in the study as researchers. Parents and children were informed about the study by the nurse. The descriptive characteristics of the child and parents were obtained through the *Personal Information Form* during a face-to-face interview immediately before mobilization. In the postoperative period, before the first mobilization, the children's anxiety levels toward mobilization were evaluated using the *Child Anxiety Scale*. The researchers recorded the frequency and duration of the child's mobilizations on the *Mobilization Chart*. Nursing care satisfaction toward mobilization of the parents in the intervention group was evaluated with the *Parental Satisfaction Scale-VAS* before discharge.

Fig. 2. Interactive robot.

Study procedure

Standard care applied to all groups: In the pediatric surgery clinic where the research was conducted, day surgery is conducted due to diagnoses such as inguinal hernia, circumcision, hydrocele, undescended testicle, cystoscopy, or cord cyst. In the clinic, children who undergo the day surgery and their parents are informed about the surgery one day before the surgery and admitted to the clinic on the morning of the surgery. After the admission of children to the clinic, preoperative procedures are performed. After the surgery, the children are taken to the post-anesthesia care unit. Parents accompany the children in the post-anesthesia care unit, and after about half an hour, the children and parents are transferred to the clinic from the post-anesthesia care unit. When children admit to the clinic, vital signs are evaluated every 15 min in the first half hour, every 30 min in the next two hours, and once an hour in the following hours. Children's blood glucose levels are evaluated in the second hour after surgery, and a liquid diet is started. Nurses carry out the first postoperative mobilization in the second hour after surgery. Children are discharged 6–8 h after surgery if no complications occur. The clinic implements no pharmacological or nonpharmacological intervention to relieve children's preoperative and postoperative anxiety. Nurses use positive encouragement methods to reduce anxiety related to mobilization.

Intervention group

The nurse researcher went to the children's room two hours after the surgery and recorded the descriptive characteristics of the parents and children on the *Personal Information Form* by the face to face method. Half an hour before mobilization, the nurse explained to the children and their parents the importance of mobilization. They introduced to the children and their parents an interactive robot that would follow the children throughout the mobilization process. After the children and parents were informed about the robot's features, they were told that the robot would accompany the child's mobilization. One minute before the first mobilization, the children's anxiety levels toward mobilization were questioned with *Child Anxiety Scale* by the nurse researcher and chidren's self-report was recored. The first mobilization of the children was accompanied by a researcher nurse, an interactive robot, and a parent. The nurse attending the mobilization also measured the mobilization times of the children with a stopwatch and ensured that they were recorded. The time from getting up from the child's bed to returning to the bed was considered as the mobilization time. After the mobilization, the child was informed that when they wanted to stand up, the robot could accompany them and walk if they wanted. The nurse evaluated each mobilization with a stopwatch and recorded the frequency and duration of mobilization in the *Mobilization Chart*. Just before the discharge of children, the parents' satisfaction in terms of nursing care for postoperative mobilization was evaluated by the face to face method and recorded using the *Parent Satisfaction Scale- VAS*.

Control group

The nurse researcher went to the children's room two hours after the surgery and recorded the descriptive characteristics of the parents and children on the *Personal Information Form*. The nurses explained to the children and their parents the importance of mobilization. Before the nurses carried out the first mobilization, the children's anxiety levels for mobilization were evaluated and recorded with the *Child Anxiety Scale* scale. A nurse and a parent accompanied the first mobilization of

the child. The nurse attending the mobilization also measured the mobilization times of the children with a stopwatch and ensured that they were recorded. The nurses informed the children that they could walk as much as they wanted. The nurse accompanying the mobilization evaluated each mobilization with a stopwatch and recorded the frequency and duration of mobilization in the *Mobilization Chart*.

Ethical statement

IRB approval was obtained from Trakya University Faculty of Medicine Scientific Research Ethics Committee, and written permission was obtained from Trakya Health Research and Application Center, Department of Pediatric Surgery. Doctors and nurses working in Trakya University Health Research and Application Center, Pediatric Surgery clinic, were informed about the study. The purpose of the research was explained to the children and their parents. The *Informed Voluntary Consent Form* was read to the parents, and their verbal and written consent was obtained. It was explained to the participants that the received data would be reported without specifying their names and would be used only for scientific purposes. Participants were informed that they could leave the study at any time without giving a reason.

Data analysis

NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) program was used for statistical analysis. Descriptive statistical methods (mean, standard deviation, median, frequency, percentage, minimum, maximum) were used to evaluate the study data. The Shapiro-Wilk test and graphical examinations tested the conformity of quantitative data to normal distribution. Mann-Whitney *U* test was used in the comparison between the two groups of quantitative variables that did not show normal distribution. Wilcoxon signed-ranks test was used for intragroup comparisons of quantitative variables that did not show normal distribution. Pearson chi-square test, Fisher's exact test, and Fisher-Freeman-Halton exact test were used to compare qualitative data. The significance level was taken as $p < 0.05$.

Results

The distribution of children's descriptive characteristics according to groups is given in Table 1. More ($n = 36$; 85.7%) of the children in the intervention group and control group ($n = 35$; 83.3%) were male. The mean age of the children was 7.14 ± 1.67 years in the intervention group and 7.69 ± 1.70 years in the control group. More ($n = 41$; 97.6%) of the children in the intervention group and control group ($n = 40$; 95.2%) did not have a chronic disease. Most of the children had not previously undergone an operation (intervention group; $n = 30$; 71.4%; control group; $n = 31$;73.8%). It was determined that 41.7% ($n = 5$) of the children in the intervention group had undergone surgery two times, while 90.9% ($n = 10$) of the children in the control group had undergone surgery once. More than half of the children had hospital experience (intervention group; $n = 23$; 54.8%; control group: $n = 25$; 59.5%). The mean number of hospitalizations in the intervention group was 2.22 ± 2.28 times, and in the control group was 1.60 ± 1.08 times.

Table 1
Comparison of descriptive characteristics of children.

		Intervention ($n = 42$)	Control ($n = 42$)	p
Gender	Female	6 (14.3)	7 (16.7)	[a]0.763
	Male	36 (85.7)	35 (83.3)	
Age	*Mean ± SD*	7.14 ± 1.67	7.69 ± 1.70	[b]0.167
	Median (Min-Max)	7 (5–10)	8 (5–10)	
Chronic disease	Yes	1 (2.4)	2 (4.8)	[c]1.000
	No	41 (97.6)	40 (95.2)	
Surgery experience	Yes	12 (28.6)	11 (26.2)	[a]0.807
	No	30 (71.4)	31 (73.8)	
Number of surgery	1 time	4 (33.3)	10 (90.9)	**[d]0.021***
	2 times	5 (41.7)	1 (9.1)	
	≥3 times	3 (25.0)	0 (0)	
Hospital experience	Yes	23 (54.8)	25 (59.5)	[a]0.659
	No	19 (45.2)	17 (40.5)	
Number of hospitalizations	*Mean ± SD*	2.22 ± 2.28	1.60 ± 1.08	[b]0.498
	Median (Min-Max)	1 (1−10)	1 (1–5)	

*Pearson Chi-Square Test; Mann Whitney-U Test; Fischer Exact Test;Fischer Freeman Halton Test; *p < 0.05.*

Table 2
Comparison of Child Anxiety Scale score according to the groups.

		Intervention (n = 42)	Control (n = 42)	p
Child Anxiety Scale	*Mean ± SD*	2.74 ± 2.60	4.50 ± 2.96	***0.005*** **
	Median (Min-Max)	2 (0–9)	4.5 (0–9)	

*Mann Whitney-U Test; **p < 0.01.*

The descriptive characteristics of children were compared according to the groups; they were homogeneous in terms of gender, age, chronic disease, surgical experience, hospital experience, and the number of hospitalizations ($p > 0.05$). Within the scope of the number of surgical experiences, there was a statistically significant difference between the groups ($t = 9.244$; $p = 0.023$). The number of one surgery in the control group is higher than in the intervention group. The experience of 3 or more surgeries in the experimental group was higher than in the control group.

The comparison of the Child Anxiety Scale score according to the groups is presented in Table 2. The *Child Anxiety Scale* scores (4.50 ± 2.96) of the children in the control group were statistically significantly higher than those in the intervention group (2.74 ± 2.60) ($p = 0.005$).

The Parental Satisfaction Scale-VAS score of the parents in the intervention group for postoperative nursing care was 9.52 ± 0.83. It was determined that the *Parental Satisfaction Scale* scores of parents for mobilization care were high (Fig. 3).

The comparison of the mobilization duration of the children according to the group and the time interaction of the intervention and control groups is presented in Table 3. Children in the intervention group walked in the first mobilization for 6.80 ± 2.51 min; control group walked for 3.33 ± 2.33 min (Mean difference 3.46 ± 1.46, 95% CI (0.15–6.77). Children in the intervention group walked in the second mobilization for 7.50 ± 2.34 min; the control group walked for 3.33 ± 1.36 min (Mean difference 4.16 ± 1.13, 95% CI (1.61–6.72). Children in the intervention group walked in the third mobilization for 6.00 ± 2.55 min; the control group walked for 6.67 ± 4.93 min (Mean difference −0.66 ± 2.44, 95% CI (−6.21–4.88).

When the differences between the groups according to the mobilization duration follow-ups were examined, it was determined that there was a significant difference between the mobilization duration (minutes) in the first mobilization ($p = 0.042$) and the second mobilization ($p = 0.012$) according to the groups. There was no significant difference in the third mobilization ($p = 0.792$). In the first and second mobilizations, it was determined that the children in the intervention group had more mobilization (walking) durations of time. This result indicated that children in the intervention group who mobilized with the robot walked longer during the first and second-time mobilization than children in the control group.

Discussion

Anxiety management of children undergoing surgery in the postoperative and preoperative periods is a critical care intervention for nurses (Pestana-Santos et al., 2022; Ünver et al., 2021). To reduce children's anxiety during the postoperative period, it is recommended to prepare children for the perioperative process with their parents, inform them about the perioperative process, use therapeutic communication with

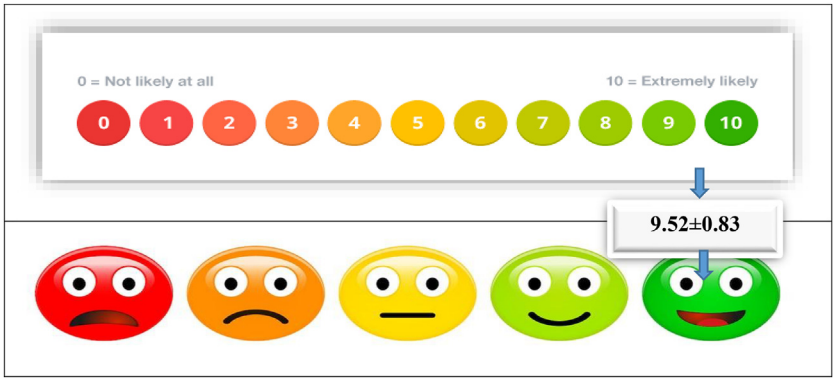

Fig. 3. Parental Satisfaction Scale scores of the parents.

health professionals to establish a confidential relationship, and use non-pharmacological methods such as distraction methods (Agbayani et al., 2020; Karataş & Çalışır, 2019; Lööf & Lönnqvist, 2022). This study aimed to evaluate the effect of an interactive robot on children's post-operative anxiety, mobilization, and parents' satisfaction related to post-operative care. As a result of the study, it was determined that the use of interactive robots in the mobilization process reduced the anxiety of children, increased the mobilization duration, and increased parents' satisfaction toward post-operative care.

Mobilization is one of the most critical situations that can cause anxiety in children in the postoperative period. Anxiety that the children would experience trauma due to mobilization can lead to prejudice toward mobilization in children and this anxiety could prevent children from standing up in the early period. In this study, to reduce children's anxiety toward mobilization, children were introduced to the interactive robot before mobilization and were informed that the robot would accompany them during mobilization. It was determined that the score of the children in the intervention group who knew that they would be mobilized with the robot was lower than the children in the control group during the first mobilization. Jeong et al. (2015) used robots to reduce the anxiety, fear, and pain level of hospitalized children related to medical care, and it was found that children were more willing to connect emotionally and be physically active with a robot rather than a virtual character (Jeong et al., 2015). Similarly, Farrier et al. determined that using a humanoid robot programmed with psychological strategies to support use of humanoid robots is increasing to strengthen coping skills in children was effective in reducing children's fear and pain levels toward care (Farrier et al., 2019). In line with this information, it is recommended to use robots in pediatric surgery clinics to reduce children's anxiety about mobilization. In addition, it is recommended to emphasize the importance of mobilization to the child and family and to provide information explaining that mobilization reduces the duration of hospital stay and hospital costs with its effects on the prevention of postoperative complications and faster recovery (Abd-Elhamed et al., 2020; Bailey et al., 2019; Gao et al., 2019).

Postoperative mobilization modulates breathing, promotes intestinal peristalsis, improves gastrointestinal system functions, decreases abdominal distension, strengthens the muscular contraction, promotes the venous return to the extremities, and reduces the risk of thrombophlebitis (Cuello-Garcia et al., 2018; Dolgun et al., 2017; Owens & Tapley, 2018; Tsuboi et al., 2019). In this framework, it is essential to ensure that children are mobilized after surgery and to enhance mobilization durations. One of the most notable outcomes of this research was that the children in the intervention group who utilized the interactive robot had longer first and second mobilization durations than the children in the control group. According to the findings of this study, the interactive robot is a beneficial source of positive reinforcement for children's mobilization and provides psychological support by reducing their anxiety levels. Similarly, Jibb et al. (2018) found that the interactive MEDIPORT robot used by pediatric oncology patients during subcutaneous port needle interventions reduced the negative effects on children due to needle interventions and increased their quality of life (Jibb et al., 2018). The use of humanoid robots has been used to strengthen and support hospitalized children psychosocially (Ali et al., 2021; Jeong et al., 2015; Jibb et al., 2018; Kanda et al., 2004). Consequently, it is recommended that interactive robots be used in the postpostoperativeiod to support the mobilization of children and increase the mobilization duration.

In the literature, it is reported that the parents' perception of care significantly affects the children's emotional states. It is stated that the higher the physical and emotional support perceived by the parents, the lower the children's anxiety and the higher the parental satisfaction (Pomicino et al., 2018). It is emphasized that, in addition to preoperative education for children and their families, the implementation of a few elements of the ERAS protocols, such as early postoperative mobilization, can increase the comfort of pediatric patients and the satisfaction of their parents and reduce the length of hospital stay (Roberts et al., 2020). In this study, it was determined that the parents of the children in the intervention group using interactive robots had a high level of care satisfaction regarding post-operative nursing care. It is thought that interactive robots help children relax by reducing their anxiety level, providing emotional support for them to cope with their current illness or situation, and contributing to recovery by increasing the well-being of children. All these effects also increase their parent's

Table 3
Comparison of children's mobilization duration by groups.

Mobilization duration (minutes)	Intervention group	Control group	Mean difference	p	95% CI	
					Lower	Upper
	Mean ± SD	Mean ± SD	Mean ± SD			
First mobilization	6.80 ± 2.51	3.33 ± 2.33	3.46 ± 1.46	**0.042***	0.15	6.77
Second mobilization	7.50 ± 2.34	3.33 ± 1.36	4.16 ± 1.13	**0.012***	1.61	6.72
Third mobilization	6.00 ± 2.55	6.67 ± 4.93	−0.66 ± 2.44	0.792	−6.21	4.88

CI: Confidence Interval.

satisfaction with post-operative care (Jibb et al., 2018; Moerman et al., 2019; Moerman & Jansens, 2021).

Practice implications

In recent years, the use of interactive robots has become widespread to improve the coping strategies for hospitalized children, ensure their well-being, reduce children's fears and anxiety about interventional procedures, and provide emotional support. In this context, it is recommended to use interactive robots by nurses in pediatric surgery clinics to reduce children's anxiety, accelerate their recovery and improve their quality of life during the perioperative process, which is a stressful period for children.

Limitations

In addition to the strengths of this research, there are some limitations. Firstly, blinding could not be performed because the children, parents, and nurses were aware of the intervention. Parental satisfaction assessments may have been affected by no blinding. In addition, the nurses accompanying the children in the intervention and control groups may have encouraged them at different levels while they were mobilized. This may have affected the walking time of the children. Secondly, in this study, anxiety assessment was evaluated before mobilization. The effect of the robot on the level of anxiety that may occur in subsequent mobilizations was not assessed in the second and third mobilizations. It is recommended that future studies conduct an anxiety assessment before each mobilization. Thirdly, situations such as the experience of surgery, the number of surgeries, and hospital experience may cause anxiety about mobilization in children. When the sociodemographic characteristics of the groups were compared, it was determined that the groups did not have similar characteristics in terms of the number of surgeries. It is thought that this factor may have affected the results in the control group. It is recommended that future studies use block randomization methods that can control confounding factors.

Conclusion

In this study, which examined the effects of the interactive robot on children's post-operative anxiety, mobilization, and parents' satisfaction related to post-operative care, it was found that interactive robots positively affected the mobilization of children. After the study, it was revealed that interactive robots were beneficial in reducing children's anxiety before mobilization and increasing mobilization duration. One of the essential results of the research is that interactive robots increase parental satisfaction with post-operative care. Considering the negative effects of the experiences during the perioperative period on children, it is recommended that interactive robots be utilized in the postoperative mobilization phase to relax and provide psychological support.

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CRediT authorship contribution statement

Sacide Yildizeli Topçu: Conceptualization, Data curation, Investigation, Methodology, Project administration, Resources, Software, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Remziye Semerci:** Conceptualization, Data curation, Investigation, Methodology, Project administration, Resources, Software, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Melahat Akgün Kostak:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Özlem Güray:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Senem Sert:** Conceptualization, Data curation, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Gözde Yavuz:** Conceptualization, Data curation, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors have no conflicts of interest to disclose.

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