https://menj.journals.ekb.eg
Print ISSN: 2735-3974
Online ISSN: 2735-3982
DOI: 10.21608/menj.2024.378708

MNJ
Menoufia Nursing Journal
Faculty of Nursing
Menoufia University

Effect Of Virtual Reality on Pre-Operative Children`s Anxiety

Rehab Ibrahim Mostafa Radwan[1], Noha Mohamed Arafa[2], Maha Ebrahim Fouda[3]

[1]*Assistant professor, Pediatric Nursing, Faculty of Nursing, Damanhour University*

[2]*Assistant professor, Pediatric Nursing, Faculty of Nursing, Alexandria University*

[3]*Lecturer, Pediatric Nursing, Faculty of Nursing, Damanhour University*

Abstract: Background: Surgery in children is a challenging and stressful event. Preoperative anxiety is a potential threat for children and has negative consequences on children. Virtual reality may help children to reduce their anxiety through divert their attention. **Purpose:** to determine the effect of virtual reality on pre-operative children`s anxiety. **Design:** A Quasi-experimental research design was used to accomplish this study. **Settings:** The study was conducted at Surgical Unit (SU) in Alexandria University Children's Hospital (AUCH) at El-Shatby. Sampling: A convenience sampling of 60 children was included in the study. **Instrument:** One instrument was used for data collection namely; Yale Preoperative Anxiety Scale (YPAS). Characteristics and medical history of the children's assessment sheet was attached with the main instrument. Results: Children in the study group had lower mean (38.69±5.23) indicators of anxiety level than control group (81.72±6.52) during the second assessment (post intervention). Therefore, there were very highly statistically significant differences (P<0.001). **Conclusion:** it can be concluded that virtual reality applications had a valuable effect on reducing children's preoperative anxiety. **Recommendations:** Nurses should use virtual reality in their routine care for children undergoing surgery.

Keywords: *anxiety, children, pre-operative, virtual reality*

Introduction

Anxiety is uncomfortable feeling of apprehension or concern about something that is occurring or might happen in the future. Children during hospitalization experience anxiety for many reasons such as separation from their family and friends, unfamiliar faces, change of their routine, alarm sounds, and fear of unknown procedures. Children can express their anxiety in the form of regression in behaviors, aggression, lack of cooperation, and withdrawal (Alqudimat et al., 2021). Moreover, anxiety can be manifested as quick breathing, rapid heart rate, shivering,

tingling, muscle aches, dizziness, sweating, and fatigue. Anxiety during hospitalization is influenced by the age of the children, previous separation from their parents and hospitalization, and an available supportive system (Dehghan et al., 2019).

Surgery in children is a challenging and tense event. About 80% of children who are planned for surgery experience preoperative anxiety due to fear of pain, post-operative complications, and death. Such anxiety is a potential threat for children due to the changes that occur in their physiologic and psychological responses by releasing catecholamine and inducing cardiovascular reactions, such as tachycardia, arrhythmia, and hypertension which endanger children's health. It also has a negative effect on children by reducing the quality of anesthesia which can lead to prolonged duration of anesthesia and surgical complications. Moreover, increasing the demand for post-operative analgesics and also it can affect children physical growth and emotional development (Koo et al., 2020).

Unsuccessful management for preoperative anxiety may increase postoperative pain, analgesic consumption, difficulty sleeping, delirium and behavioral problems (Jabali et al., 2023). On the other hand, relieving children's preoperative anxiety can enhance recovery and pain tolerance, and decrease hospital stay which lead to the reduction of costs and complications after the surgery (Dehghan et al., 2019). Where, children have inadequate coping mechanisms for dealing with stressful situations. They are more probable than adults to have higher level of autonomic nervous system activity which leads to longer anesthesia duration. Therefore pediatric nurses should have a proactive role in reducing children's anxiety through active listening, effective communication, personal visits, music, medication, aromatherapy, and using distraction technology as virtual reality (Jabali et al., 2023).

Virtual reality (VR) is a computer based technology that offers an immersive experience in a three-dimensional simulated world by allowing individuals to interact with a virtual environment (Koo et al., 2020). Meanwhile, it is a non-invasive technique and one of the appealing methods for diverting children`s concentration from difficult situations. It helps to relax their fear, gain their cooperation during medical procedure, and reduce their physical and psychological discomforts (Keshvari et al., 2021; Jabali et al., 2023). The effect of virtual reality could be explained by two mechanisms: exposure to distraction as a child can visualize the operating room and experience the surgical environment in advance through VR which allow the child to become accustomed with fearful situations.

In addition, VR can provide attractive colors, pictures, and sounds that can divert a child's attention from stressful situations (Koo et al., 2020). The participants can move through the virtual world, they can see it from different dimensions, reach into it, grasp and redesign it (Agbayani et al., 2020).

The pediatric nurse should have a vital role in preparing child psychologically, physically and emotionally before the surgery. She also has a proactive role in using virtual reality as a modern technology that can help to distract a child's attention. Particularly VR is a safe, cost-effective, and not embarrassing intervention (Dehghan et al., 2019). Where, avoiding fearful situations may lead to continuity of fear, pediatric nurse should assist the child to cope with anxiety associated with surgery. Through VR child can imagine the operating room environment and understand the upcoming process before the operation to reduce his anxiety (Chen et al., 2023). Thus, the present study aimed to determine the effect of virtual reality on pre-operative children`s anxiety

Purpose:

To assess the effect of virtual reality on pre-operative children`s anxiety

Research Hypotheses

Children who are exposed to virtual reality (study group) are expected to exhibit less preoperative anxiety than those who are not exposed.

Methods:

Research Design

A Quasi-experimental research design (intervention and control groups) was used to accomplish this study.

Setting

The study was conducted at the Pediatric Surgical Unit (SU) in Alexandria University Children's Hospital (AUCH) at El-Shatby.

Sampling

A consecutive sampling of 60 children who fulfilled the following criteria comprised the study subjects:

- Child's age ranged from 4-10 years.
- Both sexes were included.
- The child did not receive any sedatives or analgesics.
- The child was hospitalized one day before surgery.

Study group:

Where children were exposed to virtual reality in addition to routine preoperative care.

Control group:

Where children received routine preoperative care.

Calculation of sample size:

- Epi-Info program was used to estimate the sample size using the following parameters:

Population size =100 children (representing the average number of children admitted to the previously mentioned setting in the last three months before data collection).

- Expected frequency = 50%.
- Acceptable error =5 %.
- Confidence coefficient =95%.
- Minimum sample size = 55 child.

Instruments

One instrument was used to collect the necessary data.

Part one:

Characteristics and medical history of the children's assessment sheet. It included data such as children's age, gender, birth order, and current diagnosis.

Part two: Yale Preoperative Anxiety Scale:

Yale Preoperative Anxiety Scale (YPAS) was developed in 1995 and then modified in 1997 (Jenkins et al., 2014). It was used to assess the anxiety experienced by children undergoing anesthesia and surgery. This instrument was adopted by the researchers. The YPAS consists of 5 items (activity, vocalizations, emotional expressivity, state of apparent arousal and use of parent).

Scoring system:

Each item was rated from 1 to 4 except for vocalization was rated from 1 to 6 (according to no. of sub items).The score of each item was calculated separately by division of the item rate by the highest possible rating.

Total scoring system was calculated by adding all the produced values then divide it by five (five is the no. of scale items), and multiply by 100.

Pilot study:

A pilot study was carried out on 6 children (10% of the total sample size) to test the applicability and clarity of the instruments. Those children were excluded from the study sample.

Reliability:

Reliability of instrument was determined by measuring the internal consistency of its items using Cronbach's Alpha coefficient test and the result was 0.917 which was accepted .

Validity

It was assessed by five experts (professors in the pediatric nursing). Recommended changes were done. The Content validity value was 92%.

Ethical considerations

Permission from the Research Ethics Committee of the Faculty of Nursing, Alexandria University was obtained before conducting this study (no,AU-20-4-258.date13/2/2024.) Written informed consent of the children's parents was obtained after clarifying the purpose of the study. Parents had the right to decline the involvement of their children and to withdraw from the study at any time. Confidentiality of the acquired data was guaranteed, and participants' anonymity was ensured

Procedure

1) An official letter was sent from the Dean of the Faculty of Nursing, Alexandria University to the administrator of Alexandria University Hospital (El Shatby Pediatric surgical unit). It contained the purpose of the study and methods of data collection. Then, approval of the head of the department and head nurse was obtained.

2) Eligible children who fit the inclusion criteria were randomly divided into two equal groups, where one child was assigned to the study group, and the next child was assigned to the control group alternatively. Each group consisted of 30 children.

3) Data collection continued from March to May 2024. The researcher attended at morning shift 6 days /week for data gathering. Initially, data was collected about characteristics of

children, medical history of both groups (study and control) using part one of the instrument. All children in both groups were assessed first time on the morning day of surgery.

4) The children in the study group were exposed to the virtual reality intervention in addition to unit routine care as follows: children wore special three D eyeglasses and watched a cartoon movie through the researcher's smartphone for 10 minutes.
5) The children in the control group were left for the unit routine care without any intervention.
6) The second assessment was done by part two of the instrument for all children in both groups around an hour before surgery.

Statistical Analysis

An IBM computer was used for data entry. SPSS software program version twenty-five was used for data analysis. The mean and standard deviation of quantitative data were computed for categorical variables, groups' comparisons were evaluated using the Chi-square test (Monte Carlo). For quantitative normal distributed data, two groups were compared using the student t test. A paired sample t test was used to compare pre and post-program for normally distributed quantitative variables. F-test (ANOVA) was used for normally distributed quantitative variables, to compare between more than two categories. A statistical significant difference was considered if $P \leq 0.05$ A highly statistical significant difference was considered if $P \leq 0.01$. A very highly statistical significant difference was considered if $P \leq 0.001$.

Results:

Table 1 presents the characteristics and medical history of children in the study and control groups. As regards age, it was found that 70% of the children in both the study and control groups ranged from 5-10 years. In addition, 56.7 and 46.7% of the children had the first birth order in the study group and control groups respectively. The same table reveals that the current diagnosis was congenital defect repair for 40 % of children in the study group compared to 50% of children in the control group. While, 40.0% of the children in the study group were diagnosed with hernia repair compared to 33.3% of the children in the control group. No statistical significant difference was found between the two groups concerning their characteristics.

Table 2: Mean and standard deviation of anxiety level for children in the study and control groups during the initial and second assessments at the preoperative period.

Indicators of anxiety (activity, vocalization, emotional expressivity, state of apparent arousal and use of parents) showed lower means and standard deviations among children in the study group during. the second assessment (post intervention) than during the initial assessment. Therefore, there were very highly statistical significant differences $P \leq .001$. For the control group, means and standard deviations of indicators of anxiety were higher during the second assessment. There were very highly

statistical significant differences P=.001 between children in the control group (at first and second assessments)

Table 3 reveals mean and standard deviation of anxiety level between children in the study and control groups during the initial assessment at preoperative period. It was clear that mean indicators of anxiety level was almost equal between children in the study and control groups during the initial assessment at preoperative period.

Table 4 reveals mean and standard deviation of anxiety level between children in the study and control groups during the second assessment at preoperative period. Children in the control group had higher mean indicators of anxiety level than study group during the second assessment at preoperative period. Therefore, there were very highly statistically significant differences (P<0.001).

Table 5 presents the relation between children's age and their preoperative anxiety. It is observed from the table that the mean overall total score of the children less than five years old in the study group in first assessment was 65.11±11.51 compared to 73.90±8.05 in the children aged from 5- 10 years old. Statistically significant differences were found (p=0.023). Whereas, the mean overall total score of the children less than five years old in the study group in the second assessment was 34.33±5.67 compared to 40.55±3.82 in the children aged from 5- 10 years old. Very highly statistical significant differences were found (p=0.001). On the other side, the same table also points that the mean overall total score of the children less than five years old in the control group in the initial assessment was 64.76±7.39 compared to 75.27±9.53 in the children aged from 5- 10 years old. A significant statistical differences were found (p=0.006). Moreover, the mean overall total score of the children less than five years old in the control group in the second assessment was 86.44±8.34 compared to 79.70±4.41 in the children aged from 5- 10 years old. Statistically significant differences were found (p=0.045).

Table 6 portrays the relation between children's gender and their preoperative anxiety. It is observed from the table that the mean overall total score of the male children in the study group in initial assessment was 69.93±10.41 compared to 73.27±9.15 in the female children. Whereas, the mean overall total score of male children in the study group in the second assessment was 38.97±6.52 compared to 38.27±2.46 in female children. No Statistically significant differences were found between both genders either in the initial or second assessment. On the other hand, it is revealed from the same table that the mean overall total score of the male children in the control group in the initial assessment was 73.02±10.70 compared to 71.51±9.92 in female children. While, the mean overall total score of the male children in the control group in the second assessment was 82.28±4.57 compared to 81.34±7.66 in female children. No statistical significant differences were found between both genders either in the initial or second assessment.

Table 1: Characteristics and Medical History of Children in the Study and Control Groups

Characteristics and Medical History	Study group (n=30)		Control group (n=30)		Test of significance	p
	No	%	No	%		
Age/year						
<5	9	30.0%	9	30.0%	χ^2=0.000	1.00
5-10	21	70.0%	21	70.0%		
Mean± SD	6.60±2.24		6.50±2.22		t=0.174	0.863
Gender						
Male	18	60.0%	12	40.0%	χ^2=2.400	0.121
Female	12	40.0%	18	60.0%		
Birth order						
First	17	56.7%	14	46.7%	χ^2=0.601	0.438
Second	13	43.3%	16	53.3%		
Number of Siblings						
Not present	6	20.0%	10	33.3%	χ^2= 1.364	0.506
1	18	60.0%	15	50.0%		
≥2	6	20.0%	5	16.7%		
Diagnosis						
Congenital Defect Repair	12	40.0%	15	50.0%	χ^2=0.606	0.436
Hernia repair	12	40.0%	10	33.3%	χ^2=0.287	0.592
Tonsillectomy	6	20.0%	5	16.7%	χ^2=0.111	0.739

χ^2: Chi square test, t: Student t-test

Table 2: Mean and standard deviation of anxiety level for children in the study and control groups during the initial and second assessments at the preoperative period

Anxiety Scale Items	Study group (n=30)		Control group (n=30)	
	Initial assessment	Second assessment (post-intervention)	Initial assessment	Second assessment
Activity	0.60±0.19	0.48±0.14	0.67±0.26	0.87±0.13
Test of significance $t_2(p_2)$	4.349* (<0.001*)		4.397* (<0.001*)	
Vocalization	0.61±0.24	0.27±0.08	0.66±0.23	0.75±0.17
Test of significance $t_2(p_2)$	10.229*(<0.001*)		1.239 (0.225)	
Emotional Expressivity	0.77±0.23	0.43±0.15	0.78±0.21	0.88±0.13
Test of significance $t_2(p_2)$	6.325* (<0.001*)		2.282* (0.030*)	
State of Apparent Arousal	0.87±0.18	0.41±0.12	0.85±0.19	0.79±0.15

Test of significance $t_2(p_2)$	9.845* (<0.001*)		2.249* (0.032*)	
Use of Parents	0.72±0.25	0.35±0.12	0.65±0.23	0.79±0.19
Test of significance $t_2(p_2)$	5.916* (<0.001*)		2.984* (0.006*)	
Overall total score	71.27±9.90	38.69±5.23	72.11±10.08	81.72±6.52
Test of significance $t_2(p_2)$	20.092* (<0.001*)		3.787* (0.001*)	

t_2,p_2: Paired sample t-test and p value for comparing pre and post program in each of control and study group

*: Statistically significant at $p \leq 0.05$

Table 3: Mean and standard deviation of anxiety level between children in the study and control groups during the initial assessment at preoperative period

Anxiety Scale Items	Study group (n= 30) initial assessment (pre intervention)	Control group (n= 30) initial assessment	Test of significance t_1	p_1
Activity	0.60±0.19	0.67±0.26	1.137	0.260
Vocalization	0.61±0.24	0.66±0.23	0.838	0.406
Emotional Expressivity	0.77±0.23	0.78±0.21	0.147	0.883
State of Apparent Arousal	0.87±0.18	0.85±0.19	0.344	0.732
Use of Parents	0.72±0.25	0.65±0.23	1.064	0.292
Overall total score	71.27±9.90	72.11±10.08	0.328	0.744

t_1, p_1: Student t-test and p value for comparing control and study group in each of pre and post program

*: Statistically significant at $p \leq 0.05$

Table 4: Mean and standard deviation of anxiety level between children in the study and control groups during the second assessment at preoperative period

Anxiety Scale Items	Study group (n= 30) second assessment (post intervention)	Control group (n= 30) second assessment	Test of significance t_1	p_1
Activity	0.48±0.14	0.87±0.13	11.493*	<0.001*
Vocalization	0.27±0.08	0.75±0.17	13.766*	<0.001*
Emotional Expressivity	0.43±0.15	0.88±0.13	12.752*	<0.001*
State of Apparent Arousal	0.41±0.12	0.79±0.15	10.926*	<0.001*
Use of Parents	0.35±0.12	0.79±0.19	10.780*	<0.001*
Overall total score	38.69±5.23	81.72±6.52	28.205	<0.001*

* $P < 0.05$ (significant)

t_1, p_1: Student t-test and p value for comparing control and study group in each of pre and post program

Table 5: Relation between children's age and their preoperative anxiety in the study and control groups

Anxiety Scale Items	Age /years							
	Study group (n=30)				Control group (n=30)			
	Initial Assessment		Second Assessment		Initial Assessment		Second Assessment	
	<5 (n = 9)	5-10 (n = 21)	<5 (n = 9)	5-10 (n = 21)	<5 (n = 9)	5-10 (n = 21)	<5 (n = 9)	5-10 (n = 21)
Activity	0.56±0.17	0.62±0.20	0.42±0.13	0.50±0.14	0.53±0.23	0.73±0.25	0.86±0.13	0.87±0.13
Test of significance t(p)	0.823(0.417)		1.565(0.129)		2.048(0.051)		0.154(0.878)	
Vocalization	0.48±0.19	0.67±0.23	0.22±0.09	0.29±0.07	0.46±0.14	0.75±0.21	0.91±0.09	0.69±0.16
Test of significance t(p)	2.183*(0.038*)		2.362*(0.025*)		3.827*(0.001*)		3.815*(0.001*)	
Emotional Expressivity	0.67±0.33	0.81±0.16	0.47±0.15	0.42±0.14	0.69±0.27	0.81±0.18	1.00±0.0	0.83±0.12
Test of significance t(p)	1.238(0.245)		0.955(0.348)		1.389(0.176)		6.325*(<0.001*)	
State of Apparent Arousal	0.89±0.18	0.86±0.19	0.28±0.08	0.46±0.09	0.94±0.11	0.81±0.21	0.86±0.13	0.76±0.15
Test of significance t(p)	0.430(0.669)		5.327*(<0.001*)		2.312*(0.029)		1.740(0.093)	
Use of Parents	0.67±0.25	0.74±0.26	0.33±0.13	0.36±0.13	0.61±0.22	0.67±0.24	0.69±0.11	0.83±0.20
Test of significance t(p)	0.712(0.487)		0.473(0.640)		0.592(0.559)		2.442*(0.022*)	
Overall total score	65.11±11.51	73.90±8.05	34.33±5.67	40.55±3.82	64.76±7.39	75.27±9.53	86.44±8.34	79.70±4.41
Test of significance t(p)	2.406*(0.023*)		3.526*(0.001*)		2.941*(0.006*)		2.293*(0.045*)	

t, p: Student t-test and p value for comparing between the two age categories
*: Statistically significant at $p \leq 0.05$

Table 6: Relation between children's gender and their preoperative anxiety in the study and control groups

Anxiety Scale Items	Gender							
	Study group (n=30)				Control group (n=30)			
	Initial Assessment		Second Assessment		Initial Assessment		Second Assessment	
	Male (n = 18)	Female (n = 12)	Male (n = 18)	Female (n = 12)	Male (n = 12)	Female (n = 18)	Male (n = 12)	Female (n = 18)
Activity	0.58±0.17	0.63±0.23	0.50±0.15	0.44±0.11	0.63±0.33	0.69±0.20	0.83±0.12	0.89±0.13
Test of significance t(p)	0.574(0.571)		1.236(0.227)		0.654(0.522)		1.183(0.247)	
Vocalization	0.55±0.26	0.71±0.18	0.23±0.09	0.33±0.0	0.65±0.23	0.67±0.24	0.76±0.15	0.75±0.19
Test of significance t(p)	1.936(0.063)		5.169*(<0.001*)		0.250(0.804)		0.185(0.854)	
Emotional Expressivity	0.74±0.25	0.81±0.19	0.51±0.10	0.31±0.11	0.83±0.12	0.74±0.25	0.88±0.13	0.89±0.13
Test of significance t(p)	0.901(0.375)		5.018*(<0.001*)		1.247(0.223)		0.289(0.775)	
State of Apparent Arousal	0.85±0.21	0.90±0.13	0.42±0.12	0.40±0.13	0.83±0.22	0.86±0.18	0.77±0.20	0.81±0.11
Test of significance t(p)	0.708(0.485)		0.450(0.656)		0.381(0.706)		0.623(0.538)	
Use of Parents	0.78±0.26	0.63±0.23	0.29±0.10	0.44±0.11	0.71±0.26	0.61±0.21	0.88±0.13	0.74±0.20
Test of significance t(p)	1.677(0.105)		3.800*(0.001*)		1.083(0.292)		2.112*(0.044*)	
Overall total score	69.93±10.41	73.27±9.15	38.97±6.52	38.27±2.46	73.02±10.70	71.51±9.92	82.28±4.57	81.34±7.66
Test of significance t(p)	0.900(0.376)		0.414(0.683)		0.389(0.701)		0.381(0.706)	

t, p: Student t-test and p value for comparing between males and females
*: Statistically significant at $p \leq 0.05$

Discussion

Surgery is a challenging and worrying event causing stress for both children and their families which has adverse effect on children. This stress is reflected in anxiety, fear, and anger. The identification and management of these clinical phenomena are valuable to prevent both psychological and physiological side effects (Aytekin et al., 2016). It is essential to assess anxiety early during the day of surgery to intervene and take action before anxiety increases. Virtual reality is one of the non-pharmacological interventions that can be used preoperatively to decrease children's anxiety (Jenkins et al., 2014).

The findings of the current study clarified that in the initial assessment, the total score of anxiety level was high in both the study and control groups and remained high in the control group in the second assessment. It could be due to the stress of surgery and the waiting period before. Moreover, preoperative anxiety rises up at the day of operation. These findings are in accordance with results presented by Fincher et al. (2012) and Ko et al. (2021), who discovered that more than half of hospitalized children suffered from anxiety before surgery. In addition, these findings are consistent with previous studies done by Uğraş et al. (2018), Üzümcü et al. (2018), Gezer and Arslan (2019), and Al-Nerabieah et al. (2020) who reported the same findings.

Heightened anxiety could expose children to major adverse consequences like behavioral alterations, increased incidence of emergence delirium and the need for higher dose of postoperative analgesic (Ayed et al., 2021). Hence, it is vital, to perfectly assess a child's anxiety before surgery to lower adverse psychological consequences in children either preoperatively or postoperatively (Hatipoglu et al., 2018).

For the study group, the total score of anxiety level decreased in the second assessment after the VR application compared to the total score before the application. This might be clarified by the fact that the combination of auditory and visual senses in VR triggers the parasympathetic nervous system, helps children to relax and reduce anxiety. Consequently, virtual reality applications might help children to calm down and feel less panicky (Riches et al., 2021). The findings of the current study were consistent withGanry et al., 2018; Yang et al., 2019; Hendricks et al., 2020; Sahin & Basak, 2020. In addition, these findings were supported by Li et al., 2016; Saharan, 2017; Hendricks et al., 2020. The studies showed that children who received distracting interventions as play exhibited lower levels of anxiety than those who didn't.

It is exciting to note the great worth of VR application on preoperative anxiety level. The present study revealed that the anxiety scores of children who were exposed to virtual reality decreased and there were very highly statistical differences between preoperative anxiety level between children in the study and control groups especially after the second

assessment (after the application of VR), Some researchers explained that virtual reality application (e.g. watching cartoon movies) leads to endorphin secretion and thus, can modify emotions, increase children's comfort, and reduce pain, fear, and anxiety (Kazemi et al., 2012). This result could also be justified by wearing eyeglasses could help in taking their mind off the real situation. Consequently, watching cartoon movies would remind these children with a secure environment at home and feel more quietness. This result is in harmony with Hatipoglu et al. (2018) and Cooper et al. (2019) who confirmed in their studies that, visual and auditory stimulations for children before general anesthesia was very valuable in lowering their preoperative anxiety.

However, the result of the current study is also consistent with Erdogan and Aytekin Ozdemir (2021) who conducted a randomized controlled study about the effect of three different methods on venipuncture pain and anxiety in children, one of them was virtual reality. They reported that, the difference in anxiety scores between the study and control groups was statistically significant. Furthermore, this result was consistent with Goldman and Behboudi (2021) who mentioned that, it was reported by children in the study group (virtual reality) that, the level of anxiety is lower after the utilization of VR than before. Moreover, this result was in line with Mohanasundari et al. (2021) who found that, children who received VR therapy perceived less anxiety compared to the control group.

In contrast, a study conducted by Yıldırım and Gerçeker (2023) illustrated that there were no differences in post-procedural anxiety scores between the study and control groups.

Concerning the relation between children's gender and their preoperative anxiety, the findings in the present study demonstrated that, no statistical significant differences were found between both genders either in the initial or second assessment. The results of the current study were congruent with findings have been done by Ryu et al. (2017) who stated that, there was no relation between children's anxiety and their characteristics, including sex. On the contrary, Rema et al. (2016) found that, the boy's group presented higher anxiety scores in comparison to the girl’s group.

The level of preoperative anxiety severely differs with age. The present study findings showed that younger children below 5 years old had lower anxiety levels than older children aged from 5- 10 years in the study group in the second assessment (after the application of VR). This could reflect that there were positive correlations between age and anxiety level. From the researchers' point of view, these results might be due to younger children feeling calmness in the presence of their caregivers. Moreover, according to their level of cognitive and emotional development, their attention easily gets distracted with cartoon movies, which creates a cheerful environment for them. While older children might be fear of post-operative pain and could be more

aware of the possible risks of the operation.

Amazingly, the level of anxiety is higher in children below 5 years old than in children aged from 5- 10 years in the control group in the second assessment. This could reflect that there were negative correlations between age and anxiety level. It could be due to younger children's fear of unfamiliar environments and limited coping mechanisms for resolving stressful situations. On the other hand, older children better accept separation anxiety (Abu-Elenen et al., 2018). This result was consistent with Kaluza et al. (2021) who clarified that, younger children reported more anxiety and pain. The present study contradicts the study done by Nordgård (2020), who declared that there was no relationship between the mean age of participants and the efficiency of VR.

Conclusion

Based on the findings of the current study, it can be concluded virtual reality applications had a significant effect on decreasing children's preoperative anxiety.

Recommendations:

The present study findings led to the following recommendations to be suggested:

- Nurses should use virtual reality applications in pediatric surgical units as a routine care for children undergoing surgery.
- Educational training programs are important for pediatric nurses about anxiety assessment and management strategies before children undergo surgery.
- Further researches related to utilization of virtual reality glasses for a larger number of children having pain and anxiety or other health problems are required to be generalized.

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