

How to Cite:

Ayed, M. M. A., Mahmoud, N. F., & Amin, F. M. (2021). Effect of virtual reality application on preoperative anxiety level among children undergoing surgery. *International Journal of Health Sciences*, 5(S1), 597–610. <https://doi.org/10.53730/ijhs.v5nS1.13913>

Effect of virtual reality application on preoperative anxiety level among children undergoing surgery

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Abstract--Background: Children who undergo surgical operations may experience preoperative anxiety and they needed to both physical and psychological preparation. The aim: the study aimed to determine the effect of virtual reality application on preoperative anxiety levels among children undergoing surgery. Subject and Methods: Design: A quasi-experimental research design was utilized to achieve the study's aim. Setting: The study was applied in the General Pediatric Surgical Unit at Sohag University Hospital. Sample: A purposive sample of 100 children aged from 4-8 years was included, randomly assigned equally into a study and control group (The study group involved 50 children, who used virtual reality technology and 50 children in the control group using routine care only. Two tools were used to collect data: (I) Interview Structured Questionnaire developed by the researchers and (II) State-Trait Anxiety Inventory for Children. Results: The study result showed that preoperative anxiety scores were lower among children after the virtual reality application than among children in the control group. There were highly statistically significant differences detected between the total mean score of anxiety scores in the pretest and posttest before surgery ($P=0.000$). Conclusion: The study concluded that virtual reality application had a

more significant effect on reducing preoperative anxiety levels among children in the study group than those in the control group. Recommendations: The present study recommended using virtual reality application as a part of routine care among children undergoing Surgery.

Keywords---Children, Preoperative anxiety level, Virtual Reality application.

Introduction

Children who have surgery experience anxiety, which in most cases has severe consequences on their body and mind, leads to undesirable behaviors, increases pain scores, and manifests as rage, parental separation anguish, loss of control, new surroundings, and unknowable environmental conditions (Aytekin et al., 2016). Children may experience these emotions due to their limited cognitive abilities, experience deficiencies, need for others' support, inability to understand the significance of surgery from physical injury, pain, mutilation, or death, difficulty communicating with strangers when separated from their family, mistrust of adults, fear of the unknown, and/or insecurity about their abilities to control or limit things (Sekhavatpour et al., 2019).

There is evidence that non-pharmacological therapies can lessen preoperative anxiety (Markman, 2002). Anxious children tend to reject and refuse to participate in pre-and post-operative treatment. Therefore, one of the crucial nursing jobs is lowering children's anxiousness.

Preparing children physically, emotionally, and cognitively for care procedures and using virtual reality with preschoolers are both successful methods of reducing anxiety in children (El Sayed et al., 2019). Meanwhile, virtual reality software can help youngsters feel less anxious since it appeals to them, is suited to their needs in terms of cognitive development, growth, and mental health, and fosters a positive environment (Tunney and Boore, 2013).

Knowing how children cope with anxiety associated with surgery is crucial for nurses. Nurses must be aware of the meanings of fear and anxiety as well as how kids express their concerns to support children. Children can express their feelings in a variety of ways, such as by not talking much or by retreating, but they can also describe their anxieties in detail (van Dijk, 2017). All age groups of children worry before a medical operation, according to previous studies, but younger children worry more generally and feel uneasy (Aydin et al., 2016).

One of the most significant emerging technologies for helping children, especially those going through painful operations, to focus their attention is virtual reality. It's a tool that employs technology to draw a child's focus away from video animation and other cognitive and sensory stimulation. It does, however, limit their ability to focus their cognitive thinking away from sleep. Additionally, just

donning a head-mounted display enables kids to test out actual experiences that aid in their calmness and overcoming their anxiety (Kothgassner et al., 2019).

In addition, using virtual reality has been proven to be a successful way to get children to focus elsewhere. A helmet installed on the child's head gives them access to a real environment for sight and sound. The capacity to engage with virtual reality videos is provided, along with a high level of isolation from outside input. As a result of utilizing it, no adverse effects were noted (Sharar et al., 2016).

Significance of the study

One of the procedures that youngsters fear the most is surgery. At least one hospital stay occurs in about 30% of children, and more than 5 million kids have surgery each year, of which 50% to 75% report significant anxiety before the procedure (Perry et al., 2012).

Many children undergoing surgery may experience anxiety during hospital admissions, which can have a significant impact on the children's physical, psychological, behavioral, cognitive, and academic development. Reducing the degree of anxiety in children having surgery can be viewed as an investment in the child's health to prevent long-term consequences.

Chow et al. (2015) demonstrated the effectiveness of audiovisual interventions in reducing preoperative anxiety in children undergoing elective surgery, and Aminabadi et al. (2011) demonstrated the statistically significant effect of virtual reality on reducing anxiety in children who visited the dentist. The purpose of the current study was to ascertain the impact of virtual reality application on preoperative anxiety levels in pediatric surgery patients because there aren't many studies that explore the significance of using virtual reality as a distraction tool for children having surgery.

Therefore, concentration distraction by using virtual reality technology reduces the child's perception which is associated with anxiety. Therefore, using virtual reality intervention for children is necessary to decrease anxiety. So, this study aimed to determine the effect of virtual reality application on preoperative anxiety levels among children undergoing surgery.

Operational definition

A virtual reality application is a tool that combines a head-mounted device and a mobile phone that produces a 3D real-time animation (Chan, 2017). This study refers to employing mobile technologies to access this created 3D environment. It consists of a head-mounted device (HMD) with 3D-capable eyewear, as well as input devices for the senses and headphones, which together produce a multisensory experience that can be utilized to occupy a child's attention.

Aim of the study

The study aimed to determine the effect of virtual reality application on preoperative anxiety levels among children undergoing surgery through:

- Assessing anxiety level among children undergoing surgery.
- Evaluate the effect of virtual reality application on preoperative anxiety levels among children undergoing surgery.

Research hypothesis

Children who applied virtual reality will experience a level of anxiety lower than those not exposed to storytelling.

Materials and Method**Research design**

A quasi-experimental research design was utilized to achieve the study's aim.

Setting

The study was applied in the General Pediatric Surgical Unit at Sohag University Hospital. The previous setting was selected because it is considered one of the largest public teaching hospitals in Egypt, with a high prevalence of children from various socio-economic and educational levels coming from all over regions to receive health care.

Subjects**Sample size:**

A purposive sample of 100 children aged from 4-8 years was included, randomly assigned equally into a study and control group (The study group involved 50 children, who used virtual reality application and 50 children in the control group using routine care only).

Sampling technique:

A purposive sample technique was used to collect data. The study sample was divided randomly into study and control groups. The coin was used in selecting the sample where the face of writing is selected for the virtual reality group and the face of the king is selected for the control group.

Inclusion criteria included:

- (1) Children aged from (4 – 8) years.
- (2) Conscious children.
- (3) Children in the preoperative period (theday before surgery).

Exclusion criteria included:

- (1) Children with chronic and neurological health problems.
- (2) Children with mental problems

Tools of data collection:

Tool I: An Interview Structured Questionnaire: was developed by the researchers after reviewing the related literature; it included two parts:

Part I: Demographic characteristics of the child as Age, gender, and residence.

Part II: Clinical data includes the child's diagnosis, medical history about surgery, and previous hospitalization.

Tool (II): State-Trait Anxiety Inventory for Children (STAIC): was developed by **Spielberger (1970)** to measure transitory anxiety state in children ages 6 to 14 years. The scale has 20 statements that ask kids how they are feeling at a specific moment. Five subscales are used to group scale assertions (sadness, worry, fear, uncertainty, and anxiety). Children were told to reply based on how they felt about their operations. Children answer the STAIC by choosing one of the three options (rarely, sometimes, and often). Three numbers—one, two, and three—were given to various response categories.

Scoring system

The total scores are a summation of the item scores; the total scores were 60. For statistical purposes, scores ranging from 20 to 30 were considered low anxiety, 30–40, indicating average; 40–50, indicating above average; and 50–60 suggesting a very high level of anxiety. The scale was translated into Arabic, and then back-translated into English. The translation was judged and tested for its content validity by nine experts in Pediatric Nursing and Psychiatric Nursing fields.

Tools validity and Reliability

Five pediatric nursing specialists with more than ten years of combined experience served as the panel to which the tools' content validity was tested. The panel's assessment of the tools' clarity in sentences, suitability of material, order of items, and accuracy in scoring and recording the items resulted in no changes to the tools. The first tool, Alpha Cronbach's test, yielded a result of 0.89, indicating good tool reliability; the reliability coefficient between-item STAIC reliability was 0.86. Internal consistency methods were used to verify the tools' reliability.

Pilot study

It was carried out on 10% of children (10 children) to test the clarity and applicability of the tools and estimate the time needed for data collection. Based on the result of the pilot study no modification was done to the tools, and the children in the pilot were included in the total sample.

Ethical considerations

Informed consent was obtained from the mothers of their children after the aim of the study was explained to the mothers and their children. The researcher informed the participants that, the study was voluntary, they were allowed to not participate and they had the right to withdraw from the study at any time.

Moreover, they were assured that their information would be confidential and used for research purposes only.

Data collection procedure

Fieldwork:

- At the beginning of the interview, the researchers introduced themselves to the mothers of the children and explained the goal of the study to reassure them that all information acquired was private. The researchers conducted interviews with the kids after getting their verbal consent for the data collection. During these interviews, the researchers fully explained each tool.
- The actual fieldwork was conducted between July 2019 and December 2019.
- The hospital's usual operations included data collection. The interview took place twice a week on weekdays between 9 and 11 am. The participants completed the questionnaire in roughly 25 to 30 minutes. The researchers employed Tool I both before and following the intervention.
- The data collection in the current study included two phases: preoperative assessment (pre-intervention) and the day of surgery before the operation (post-intervention before operation). On the day of the operation, the anxiety scores of children were collected; using the state anxiety level again were assessed before the operation.

In the intervention group:

Intervention: it included three stages:

Stage one: Pre-intervention stage:

- The researchers introduced themselves and described the study's purpose to the parents and kids.
- At the start of the study, assessments of the kids were made for both the study group and the control group.
- The researchers gathered and documented data on the demographics of the youngsters under study (pretest).
- Questionnaires from the State-Trait Anxiety Inventory were used to gauge the anxiety levels of children (pretest).

Stage two: Intervention Stage (Implementation):- it included:

1- Prepare the needed equipment:

- Virtual reality (VR) 3D glasses.
- VR selected videos according to children's age.
- Mobile with VR support system.

2-Children in the intervention group received training on the VR equipment to be familiar with the VR sets.



Virtual reality headset

- Virtual reality application one day before the surgery was received plus the routine care.
- Children are fully immersed in the VR concentration distraction method.
- Children engaged in 20 minutes of an immersive virtual reality environment one day before the surgery.
- Children reassessed for:

The anxiety level: was assessed by the researcher in the previously selected settings using State-Trait Anxiety Inventory. The questionnaires took roughly 15-20 minutes to complete.

Stage three: Post-intervention stage:

Children were reassessed by using State-Trait Anxiety Inventory (posttest) after the virtual reality application.

In the control group:

Children received routine information care, the day before surgery. It included pre and postoperative care and information regarding fasting time, hygiene, vital signs, control of losing teeth, dressing and wound care, and using analgesic drugs to relieve pain post-surgery and were assessed by the same previous tools.

Statistical analysis:

Data entry and data analysis were done using SPSS version 19 (Statistical Package for Social Science). Data were presented as a number, percentage, mean, median, and standard deviation. The chi-square test and Fisher exact test were used to compare qualitative variables. Mann-Whitney test was used to compare quantitative variables between two groups. The P-value is considered statistically significant when $P < 0.05$.

Results

Table 1: Shows demographic data of virtual reality and control groups. Regarding age, more than half (52%) of children in the virtual reality group and 50% in the control group were aged 5>6 years with mean \pm SD (4.45 \pm 0.32 and 4.48 \pm 0.89 respectively). Boys were most prominent in virtual reality and control groups 52% and 54% respectively, 60% of them living in urban in the virtual reality group compared to 54% in the control group. There was no statistically significant difference between the virtual group and the control group in terms of age, gender, and residence ($p > 0.05$).

Table 2 illustrates that the highest percentage of the studied children (46%) in the virtual reality group were undergoing appendectomy, followed by those undergoing splenectomy (20%), cholecystectomy (20%), and renal stone removal (16%), while in the control group, the highest percentage of the studied children (44%) were undergoing an appendectomy. There was no statistically significant difference between the virtual group and the control group in terms of age, gender, and residence ($p > 0.05$).

Figure (1): Portrays that (68%) of the studied children in the virtual reality group had no history of previous hospitalization, while in the control group (70%) of the studied children had no history of previous hospitalization.

Table (3): shows that the total mean score of STAIC among the studied children before virtual reality was 46.4 \pm 2.0 and decreased to 24.7 \pm 1.2 in the virtual reality group compared to 39.82 \pm 5.04 in the control group after the virtual reality application. A highly statistically significant difference was detected between the total mean score of STAIC in the pre and post-virtual reality application in the virtual reality and control groups ($P=0.0001$).

Figure (2): Shows that 20% of the studied children in the pretest virtual reality group had high anxiety on STAIC, whereas the level became low anxiety level among 63% of them after the virtual reality application.

Table (1): Percentage distribution of the children in virtual reality and control groups regarding personal data (100)

	Virtual reality group (n= 50)		Control group (n= 50)		P-value
	No	%	No	%	
Age: (years)					
4 - < 5	4	(8.0%)	4	(8.0%)	0.517
5 - < 6	26	(52.0%)	25	(50.0%)	
6 - 8	20	(40.0%)	21	(42.0%)	
Mean \pm SD	4.45 \pm 0.32		4.48 \pm 0.89		0.322
Gender:					
Boys	26	(52.0%)	27	(54.0%)	0.665
Girls	24	(48.0%)	23	(46.0%)	
Residence:					
Urban	30	(60.0%)	27	(54.0%)	0.083
Rural	20	(40.0%)	23	(46.0%)	

Table (2): Percentage distribution of the children in virtual reality and control groups regarding medical diagnosis (100)

Medical diagnosis	Virtual reality group (n= 50)		Control group(n= 50)		P-value
	No	%	No	%	
Appendectomy	23	(46.0%)	22	(44.0%)	0.342
Splenectomy	10	(20.0%)	10	(20.0%)	0.087
Cholecystectomy	10	(20.0%)	11	(22.0%)	0.518
Renal stone removal	7	(14.0%)	7	(14.0%)	0.362

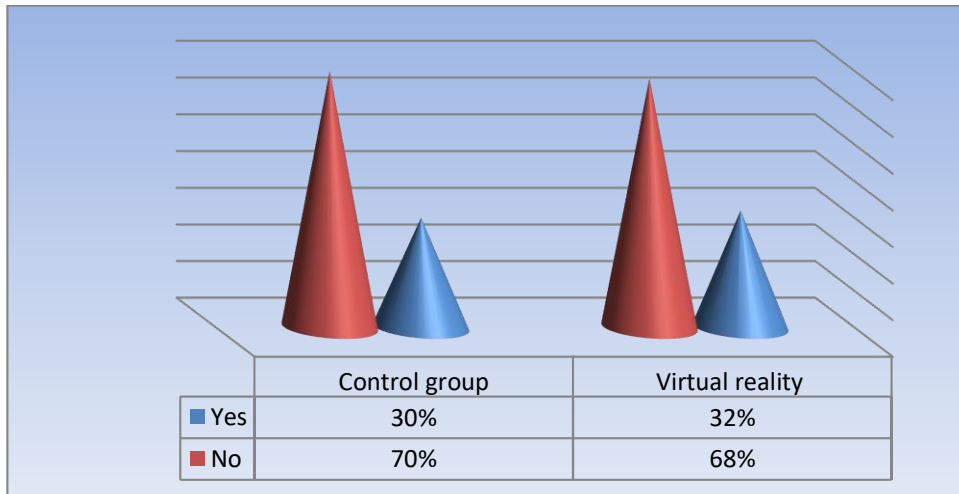


Figure (1): Percentage distribution of the children in virtual reality and control groups regarding previous hospitalization

Table (3): Comparison of mean anxiety scores in the virtual reality and control groups' pre and post-virtual reality application

State-Trait Anxiety Inventory	Virtual reality group (50)	The control group (50)	P-value
The total mean score of STAIC before virtual reality	46.4±2.0	45.09±3.33	P<0.001**
The total mean score of STAIC after virtual reality	24.7±1.2	39.82±5.04	

* (**) statistically significant at $p < 0.0001$ **

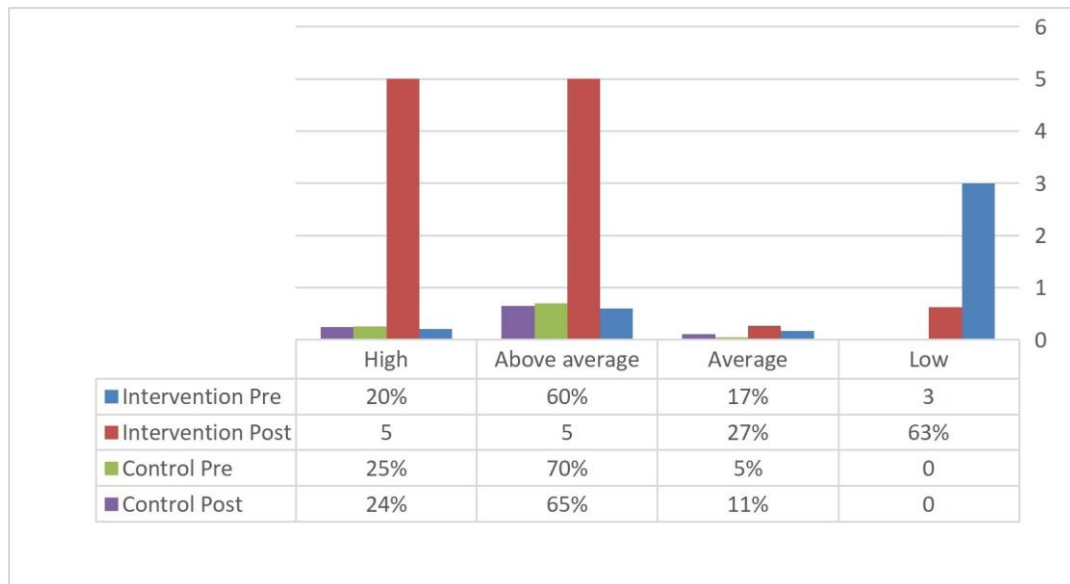


Figure (2): Percentage distribution of anxiety among children in virtual reality and control groups pre and post-virtual reality application

Discussion

Before surgery, interventions to lower anxiety and adverse psychological consequences in children and their parents are crucial. Prescription of a sedative before surgery, provision of psychological support and a suitable educational preparation program, and parental presence throughout the entirety of the surgical and anesthetic procedures were some of these interventions (Kain et al, 2007). The purpose of the study was to ascertain how the use of virtual reality affected the level of preoperative anxiety in young patients.

According to the study's findings, there was no statistically significant difference in the demographic information between the virtual reality group and the control group. This highlighted how comparable the traits were between the virtual group and the control group.

In terms of diagnosis, the results of the current study showed that less than half of the analyzed youngsters in the virtual reality group were having appendicectomies. This outcome is consistent with a study conducted by Sabaq and El-Awady (2012) in Egypt to assess the impact of preoperative preparation activities and mothers' presence during induction on anxiety levels and behavioral changes in the majority of young patients undergoing elective surgery at Zagazig University Hospital. Both in the study group and the control group, they discovered that the majority of children had appendicitis. Hosseinpour and Ahmadi (2016), who conducted a study in Iran on emergency abdominal surgery in infants and children, revealed similar findings and noted that the differential diagnosis of the surgical acute abdomen from 6 to 11 years was appendicitis, cholecystitis, and pancreatitis.

In accordance with the findings of the current study, the majority of the analyzed youngsters in both the virtual reality group and the control group had no prior hospitalization history. These findings are in line with those of Potasz et al. (2013), who in a randomized clinical study with 53 hospitalized children in Brazil investigated the impact of play activities on stress and discovered that the majority of the children had never been hospitalized before.

According to the results of the current study, the STAIC total mean score for the children who were being studied before the virtual reality application was 46.42.0 and reduced to 24.71.2 compared to 39.825.04 in the control group after the virtual reality application. The efficiency of the virtual reality program, according to the researchers, is demonstrated by the fact that the anxiety scores of the children who were being studied for surgery in the virtual reality group decreased. It also demonstrated the significance, impact, and effectiveness of the use of virtual reality.

This research supports Chan et al., (2017) study, "Application of a virtual reality prototype for pain alleviation and decreasing anxiety of pediatric in Taiwan," which found a substantial change in the children's reported outcomes in the intervention group following the use of virtual reality.

The results of the current study showed that whereas more than three-fifths of the children in the virtual reality application group experienced modest levels of anxiety, one-fifth of the studied children in the pretest virtual reality group reported significant levels of anxiety on the STAIC. According to the researchers, this showed a reduction in the preoperative anxiety level of the kids in the virtual reality group.

This might be explained by the fact that virtual reality application might help children and their parents to calm down, feel less panicky, and spend less time in counseling. This finding is in line with findings from Fincher et al. (2012) and Ko et al. (2021), who found that it is thought that between 50 and 70 percent of hospitalized children feel extreme anxiety and anguish before surgery. A similar conclusion was made by Nisha and Umarani (2013), who focused on the fact that children are more susceptible to anxiety and examined the impact of play interventions on the alleviation of anxiety in preoperative children. They might not be in control or know the proper processes.

The findings of Miller et al. (2018), who claimed that the use of multi-model distraction virtual reality as a distraction tool in an outpatient burns clinic enhances sleep quality, are in agreement with our findings. Similarly, Demeter et al. (2015) investigated "Who can benefit from virtual reality to minimize experimental pain," and they discovered that virtual reality can be utilized as an efficient manipulation for enhancing children's sleep quality with efficient conditioned modulation.

According to the findings of Hatipoglu et al. (2018) and Cooper et al. (2019), giving children visual and auditory information before general anesthesia was very beneficial in lowering preoperative anxiety, which was still present one week after discharge. This might be a result of distraction tasks activating less

frequently in the areas of the brain where children's attention was responsible for the occurrence of nausea and vomiting such as the thalamus, insula, and anterior cingulate cortex (Martin, 2010).

Conclusion

Based on the findings of the present study and research hypothesis it concluded that virtual reality application had a more significant effect on reducing preoperative anxiety levels among children in the study group than those in the control group.

Recommendations:

The following recommendations were suggested based on the results of the present study:

- The present study recommended using virtual reality application as a part of the routine care among children undergoing surgery
- Further research is required on a larger sample of children to be generalized.

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