

Effect of Virtual Reality on Alleviating Children's Fear and Pain during Painful Procedures

Gehan Mohammed Amin¹ & Samar Sobhi Abd Elkhair²

¹Lecturer of Pediatric Nursing, Faculty of Nursing, Cairo University, Egypt.

²Lecturer of Pediatric Nursing, Faculty of Nursing, Cairo University, Egypt.

Abstract

Background and aim: Venipuncture is scary aspect for hospitalized children. Virtual Reality (VR) is considered inventive distraction technique for controlling pain among children experiencing painful procedures. **The aim** of the study was to evaluate the effect of virtual reality on alleviating children's fear and pain during painful procedures. **Design:** One-group pre- posttest quasi experimental research design was utilized. **Sample:** A Purposive sample of 30 hospitalized children experiencing painful procedures were participated in the study. Data were collected within 6 month using socio demographic data tool that developed by the researchers, Wong-Baker faces pain rating scale (WBFPS) and children's fear scale (CFS). **Setting:** The study was carried out at Pediatric Inpatient Surgical Unit in Cairo University Specialized Pediatric Hospital (CUSPH) and Pediatric Inpatient Medicine Units in Elmonira Pediatric Hospital. **Results:** The majority of children felt severe pain and extreme fear during painful procedure pre-VR while most of children felt less pain and fear post-VR. There were a highly statistically significant difference between the total mean scores of pain and fear pre-VR and post-VR. **Conclusion:** Virtual reality has been to be effective in reduction of pain and fear during venipuncture among hospitalized children. **Recommendations:** It is suggested that VR could be integrated as adjunctive non-pharmacological therapy with the routine care during painful procedures for hospitalized children.

Keywords: Children, Fear, Pain, Painful procedures & Virtual reality.

Introduction

Pain is a chief health problem in children. Pain is well-defined as an unkind sensory and emotional experience that is accompanying with actual or potential tissue damage. Also, it is a compound of multidimensional and personal experience that involves biological, sensual, emotive, cognitive, and behavioral components (**International Association for the Study of Pain, 2021**).

Children of all ages, including preterm infants, experience pain because it is a universal experience. Numerous factors can produce pain such as disease processes, injuries, treatments, and surgical interventions. Children may lack the verbal capacity to explain their discomfort appropriately. In addition, there are general misconceptions regarding child pain among caregivers and medical professionals. The American Pain Society referred to pain as "the fifth vital sign" in 1995. The American Pain Society sought to convince medical personnel to consider pain whenever their patients' temperatures, pulses, respirations, and blood pressure were measured and to put pain management approaches into place (**Kyle & Carman, 2016**).

Insufficient pain control is related to various immediate and long-term undesirable consequences. Pain can cause many physiological problems such as perspiring, tachycardia, increased blood pressure and

if it is not managed timely can lead to chronic problems in the cardiovascular and respiratory systems and lengthier hospital stay. In addition, decreased memory, concentration and essential reduction in the level of self-confidence in children can result from psychological effects of pain. Children become agitated and irritable as result of pain, they will suffer from numerous conditions such as sleeplessness and malnourishment (**Shave, et al., 2018**).

Numerous studies have proposed non-pharmacological interferences of pain, such as distraction, procedural information provision, hypnosis, and cognitive behavioral therapy, to manage the pain and worry experienced by pediatric patients undergoing needle-related techniques. Distraction is the most effective non-pharmacological intervention for relieving the pain and anxiety by children experiencing needle-dependent techniques (**Davis, 2019**).

Conventional distraction techniques (e.g., reading books or listening to music) are some of the most common psychological methods for the lessening of procedural pain and anticipatory anxiety during venipuncture. Virtual Reality (VR) is considered one of the inventive distraction methods that can produce pain controlling among children experiencing needle related procedures. Moreover, virtual reality affords a

means of human/computer interaction, where in a child becomes dynamic contributor in a virtual environment created by a head-mounted display (HMD) (Atzori et al., 2018).

Moreover, while the child is using VR, he becomes immersed in a computer-created environment, wearing a head mounted display (HMD), or similar glasses, that block the child's view of the hospital treatment room and occlude sounds of the real environment. The child is deeply immersed and actively joined in the virtual environment as it changes in actual time with the child's activities. Virtual reality equipment has also become increasingly low-cost (Won, et al., 2017).

A great body of researches supports the effect of VR in reducing pain, anxiety, and fright among children. Study conducted by Gold and Mahrer (2017) and Also, Piskorz & Czub (2018) who studied the impact of VR using on children pain during blood draws in children, and they found that there was a significant decrease in pain during blood draws procedure.

Furthermore, Atzori, et al., (2018) who studied the efficacy of Virtual as a distraction method for handling pain in children and adolescents experiencing venipuncture and they proved that during VR, children reported significant decreases in time consumed thinking about pain, and children also reported significantly more entertaining during VR, and stated a strong sense of going inside the computer-made world" during VR and no side effects were informed.

Significance of the study

The pain resulted from medical procedures is one of the worrying and frightening experiences for children. The most common sources of pain in hospitalized children are invasive procedures. Invasive procedures the most hurting intervention usually applied to children and regularly associated by pain, fear, and anxiety (Pancekauskaitė & Jankauskaitė, 2018).

The frightening practices that children encounter during hospitalization including intravenous cannulation (IV), IV drug administration, blood drawing, and wound care. They are stressful for children and their caregivers. Children who are subjected to this type of procedure repeatedly show resistance and can remain in a continuous state of alert, trying to anticipate its approach. This situation produces anxiety, fear and insecurity. To reduce the undesirable influence on the child, the use of distraction techniques are suggested to provide humanized, a traumatic care as part of current practices in caring of pediatric patients (Friedrichsdorfa & Goubert, 2019).

Immersive VR is engaging intervention that might help to decline pain and anxiety for children

experiencing aching techniques and suffering from severe pain. Using VR as a diversion technique eases interventions by health professionals. Also, it can assist children to face this undetermined situation, express their feelings and concerns, feel calmer and safer, and become familiar with medical procedures. Similarly, VR facilitates communication and promotes the development and recovery of the children (Nordgard & Lag, 2021).

Methods

Aim of the study:

The purpose of the present study was to evaluate effect of virtual reality on alleviating children's fear and pain during painful procedures.

Research Hypotheses:

To fulfill the aim of the study, the following research hypotheses are formulated:

1. After use of virtual reality children are expected to have less pain and fear during painful procedures than before using VR.
2. Virtual reality is expected to be an effective distractor for children pain during painful procedures.

Research Design:

One group pre- posttest quasi experimental research design was used to attain the aim of the study.

Setting:

The study was carried out at Pediatric Inpatient Surgical Unit which is located at the fourth floor in Cairo University Specialized Pediatric Hospital and Pediatric Inpatient Medicine Unit in the fifth and sixth floor at Elmonuria Pediatric Hospital which received children affected with numerous disorders either congenital or acquired at a excessive rate.

Participants:

A purposive sample of 30 children undergoing blood drawing or cannulation in hospital was participated in the study during 6 months.

Inclusion criteria:

Children aged from 6 to 12 years

Exclusion Criteria:

- Children with motor and/or cognitive disorder.
- Children experiencing urgent painful techniques (due to an unsteady hemodynamic status, life-threatening medical illnesses or worsening clinical status).
- Use of additional pharmacological or non-pharmacological pain relief strategies.
- Children who suffering from pain due to other causes than painful procedures.

Data collection tools

The data was collected by the next tools, which were developed by the researchers after comprehensive review of related literature

Tool (I): Children's bio demographic characteristics: it is developed by the researchers and included 16 items. It divided into three parts:

Part (1): Included 7 questions related to child's personal data as age, gender, rank in the family and presence of computer at home or mobile.

Part (2): Incorporated 4 questions about child's past and present medical history, as reason of previous and current admission.

Part (3): It contained 5 questions about pain and pain relief measures such as previous using of pharmacological or non-pharmacological pain relief and types of painful procedures.

Tool (II) Wong-Baker FACES pain rating scale (WBFPS):

This scale measures the grades of pain experienced by the children. The scale comprises six cartoon expressions with pain scores of (0 -10), with 0 demonstrating no pain (no hurts) and 10 demonstrating extreme pain (hurts worst). The first face explains a pain score of 0, and shows "no hurt". The second expression illustrates a pain score of 2, and point out "hurts a little bit." The third face show a pain score of 4, and point out "hurts a little more". The fourth face explains a pain score of 6, and displays "hurts even more". The fifth face shows a pain score of 8, and indicates "hurts a whole lot"; the sixth face represents a pain score of 10, and point out "hurts worst." The WBFPS scale is extensively utilized with children ages three and older. The children will requested to handpick the faces that best describe the degree of pain experienced by the children who undergoing painful procedure. The pain levels were then transformed into numerical values. The scale is available online at: <https://wongbakerfaces.org>.

Tool (III) Children's fear scale (CFS):

The degrees of fear of children were measured by the Children's Fear Scale (CFS). The scale involves five cartoon faces with fear scores of (0– 4), with 0 illustrating 'no fear' and 4 representing 'extreme fear. These faces are displaying numerous amounts of being scared (McMurtry et al., 2019). The first face is not scared at all (score 0), the second face is a little bit more scared (score 1), the third face is a bit more scared (score 2), the fourth face is more scared, the fifth face is the extreme scared (score 4). The children will requested to look at these faces and select the one that displays amount of anxiety they felt throughout hurting procedure. The fear levels were later transformed into numerical values. Scale and guidelines are accessible at <http://pphc.psy.uoguelph.ca/index.php>.

Scoring system:

Wong-Baker faces pain rating scale: The scale included six cartoon expressions with pain ratings of

(0 -10). The child score is based on the face which is selected by the child or the caregiver from (0-10)

Children's fear scale:

The scale consisted of five cartoon expressions with fear ratings of (0-4). The child score is based on the face which is picked by the child or the caregiver from (0-4)

Validity and Reliability

Tool (1): Structured interview form which is developed after comprehensive revising of literature. The tool is revised by three experts in Pediatric Nursing to check the content validity of the tools. Reliability of tool was performed to approve its consistency using Cronbach's alpha and the results was 0.75.

Tool (2): Wong-Baker faces pain rating scale is adopted, the internal reliability coefficients for the WBFPS was determined to be 0.82-0.92, and the test and retest reliability was 0.90 (McMurtry, et al, 2019).

Tool (3): Children's fear scale is adopted. The CFS has revealed good evidence of test-retest ($r_s = 0.76$, $p < 0.001$) reliability in addition to construct validity among children (McMurtry, et al, 2019).

Procedure:

An Official permissions was attained from the manager of CUSPH and from the superiors of pediatric surgical and medical departments. The researchers presented themselves to children and their mothers who fulfill the inclusion criteria. In the first visit a written formal consent were attained after clarification of the purpose of the study. The researchers met each mother at special quiet room in the surgical or medical department in order to fill the study's tools. The researchers filled tool (I) children's biosociodemographic sheet, tool (II) WBFPS and tool (III) CFS before the painful procedure to assess baseline child pain and fear level without using VR. The second visit; the researchers explained the game briefly that would be played and the VR equipment to child and mother. The researchers wear the child the head mounted display and began the game for 5 minutes before the beginning of painful procedure. The child continued VR play throughout the painful procedure during which pain and fear were observed by the researchers. After ending the procedure the researchers assess pain and fear.

Pilot study

The pilot study will be achieved on 5 children who are hospitalized and undergoing painful procedure to assess the possibility, objectivity, applicability, clearness, and competence, of the study tools and time needed to accomplish them and to detect any probable problems in methodological technique or

instrument. The results of the pilot study will be used to check the suggested statistical and data analysis approaches. Participants in the pilot study included or excluded from the study sample.

Ethical Considerations

A principal agreement was acquired from the research ethics committee in the Faculty of Nursing, Cairo University. A written informed consent was attained from children's mothers by the researchers after comprehensive explanation of the purpose and nature of the study in order to get their acceptance as well as to gain their cooperation. Children and their mothers were informed that involvement in the study was elective; mothers and children had the right to not complete the study at any time without

providing any purpose and without any influence on the care of their children. Confidentiality was assured to children and their mothers.

Statistical analysis

The collected data was coded, classified, arranged, and examined using the Statistical Package for Social Science (SPSS) program version 21. Descriptive data will be displayed as mean and standard deviation. Qualitative data was illustrated as frequency and percentage. Comparison of means was made using paired sample t-test. Association among variables was made by Pearson correlation coefficient. Level of significance was set at $P < 0.05$, 0.001 was used as the cut of value for statistical significance.

Results

Table (1): Percentage Distribution of Children' Personal Characteristics (n=30)

Item	No	%
Age/ years:		
6 < 8	7	23.3
8 < 10	18	60
10 ≤ 12	5	16.7
X ± SD	8.5 ± 1.5 years	
Gender:		
Male	19	63.3
Female	11	36.7
Rank :		
1	11	36.7
2	14	46.7
3+	5	16.3
X ± SD	1.9 ± 0.8	
Siblings:		
Yes	19	63.3
No	11	36.7

Table (2): Percentage Distribution of Childs' previous and current medical history (n=30)

Variable	N	%
Previous admission:		
Yes	12	40
No	18	60
No of previous admission: n=12		
Once	9	75
Twice	3	25
Previous admission cause: n=12		
Operation	4	33.3
Illness	5	41.7
Complications	3	25
Current admission cause:		
Operation	11	36.7
Illness	15	50
Complications	4	13.3

Table (3): Percentage Distribution of non-pharmacological methods used by studied children and types of procedures done (n=30)

Variable	N	%
Using non-pharmacological methods during procedures:		
Yes	0	0
No	30	100
Using virtual reality previously:		
Yes	0	0
No	30	100
Type of painful procedure that is done:		
Blood drawing	17	56.7
Cannulation	13	43.3

Table (4): Percentage distribution of children's pain pre and post using of VR (n=30).

Pain scale	Pre-VR		Post-VR		X ²	P-value
	N	%	N	%		
No hurts	0	0	0	0	60	0.001**
Hurts a little bit	0	0	4	13.3		
Hurts a little more	0	0	21	70		
Hurts even more	3	10	5	16.7		
Hurts a whole lot	20	66.7	0	0		
Hurts worst	7	23.30	0	0		

Table (5): Total mean \pm SD of children's pain pre and post use of VR during painful procedure

Pain score	X \pm SD	t	P-value
Pre-VR	3.93 \pm 0.36	59	0.001**
Post-VR			

Statistically significant difference * $p < 0.05$

Table (6): Percentage distribution of children's fear pre and post using of VR (n=30)

Children Fear scale	Pre-VR		Post-VR		X ²	P-value
	N	%	N	%		
Not scared	0	0	0	0	60	0.001**
A little bit more scared	0	0	26	86.7		
A bit more scared	0	0	4	13.3		
More scared	3	10	0	0		
Extreme scared	27	90	0	0		

Statistically significant difference * $p < 0.05$

Table (7): Total mean \pm SD of children's fear pre and post use of VR during painful procedure

Fear score	X \pm SD	t	P-value
Pre-VR	2.76 \pm 0.45	35.2	0.001**
Post-VR			

Statistically significant difference * $p < 0.05$

Table (8): Correlations between pain and fear with Personal Characteristics of Children and their Mothers.

Personal characteristics	Children pain		Children fear	
	r	P	R	P
Child age	-0.91	0.001**	-0.41	0.02*
Mothers' age	0.31	0.09	0.18	0.32
Childs' rank	0.030	0.87	0.099	0.60
Number of previous admission	-0.47	0.008**	-0.44	0.01*

Statistically significant difference * $p < 0.05$



Figure (1): Wong-Baker Faces Pain Rating Scale.

Table (1): Revealed that 23.3% of children their age ranged between 6-8 years followed by 16.7% their age ranged between 10 and 12 years with the $X \pm SD$ of 8.5 ± 1.5 years. In relation to children gender, 63.3% were males, and 46.7% ranked as the 2nd child.

Table (2): Shows that, 60% of children did not admit to hospital previously while 40% previously admitted. Three quarters of children (75%) previously admitted only once. as regard to previous admission cause, more than two fifth of children (41.7%) admitted with illness followed by 33.3% admitted for operation and 50% currently admitted with illness.

Table (3): Illustrates that, all children (100%) use neither non pharmacological methods nor virtual reality during procedures. As regard to type of painful procedure, blood drawing was done for 56.7% of children.

In relation to pain scale, **table (4):** Proves that, 66.7% of children hurt a whole lot during procedure pre-VR while 70% hurts a little more post-VR. There were highly statistically significant difference between percentages of pain scale items before and after virtual reality ($X^2= 60$, $p=0.00$, $P=0.001$)

It is evident from **table (5):** That there were a highly statistically significant difference between the total mean scores of pain scale pre-VR and post-VR ($t = 59$, $p = 0.001$).

As regard to fear scale, **table (6):** verifies that, the majority of children 90% were extremely scared during procedure pre-VR while 86.7% were a little bit more scared post-VR. There were highly statistically significant difference between percentages of fear scale items pre and post-VR ($X^2=60$, $p=0.001$)

It is obvious from **table (7):** That there were a highly statistically significant difference between the total mean scores of fear scale pre-VR and post-VR ($t = 35.2$, $p = 0.001$).

Table (8): Revealed that, there were a statistically significant negative correlations between children age with their pain and fear ($r=-0.91$, $p=0.001$, $r=- 0.41$, $p=0.02$) respectively. Moreover, there were highly statistically significant negative correlations between number of children previous admission with their pain and fear ($r= - 0.47$, $p=0.008$, $r=- 0.44$, $p=0.01$) respectively.

Discussion

Virtual reality is a remarkably influential method to divert child attention from painful or frightening stimuli. It is a effective and attractive technique to reduce fear and pain of children experiencing painful procedures. Thus, this study aimed to evaluate the effect of virtual reality on relieving pain and fear among hospitalized children. The current study results emphasized that VR led to significant improvements of pain during venipuncture in children. This finding was congruent with the study that done by **Atzori et al., (2018)** who predicting the effect of virtual reality during venipuncture in children with onco-hematological disorders and **Lluesma Vidal et al., (2022)** who studied the influence of virtual reality on pain and fear during procedures concerning needles in pediatrics and they revealed in their study that the use of virtual reality was effective in reducing pain in children during procedures involving needles and it can be considered an effective distraction technique for children and adolescents' pain management during venipuncture. Similarly, **Smith et al., (2022)** who studied the impact of virtual reality technology on pain and anxiety in children with burn support the current findings and they reported that the levels of pain and anxiety in the active virtual reality group was reduced as compared to the standard care group, with significant differences observed in pain intensity. Also, the current study findings were in align with **Hashimoto et al., (2020)** who evaluate the effect of video glasses in reducing preoperative anxiety compared with portable multimedia player in children as they found that there were significantly lower pain and anxiety scores during procedures in the virtual reality group compared to the control group. From the researchers points of view that VR was effective in improving pain of children during venipuncture because VR using result in attraction of children attention physically and intellectually to another world away from the uncomfortable environment of the painful situation.

The current study results highlighted that using of VR resulted in significant reduction of children fear

during venipuncture. This finding is consistent with **Wang, et al., (2022)** who applied VR on pain, fright, and worry during needle-related procedures in children and teenagers and **Gerceker et al., (2018)** who assessing the effect of virtual reality on hurt, fright and worry during blood sample drawing in children aged 5–12 years old and they stated that VR reduced the degree of fright during blood drawing experienced by the 7–12 years old children. Furthermore, VR produce positive emotions, more than other traditional distraction techniques.

Additionally, the study results were in line with **Abdel-Salam et al., (2023)** who evaluate the influence of virtual reality eyeglasses on decreasing pain and anxiety of children with chemotherapy and they reported in their study that less than two-thirds of the studied children had severe anxiety levels pre-VR intervention while less than half of them had low anxiety levels during and after VR. Also, **Atzori et al., (2018)** support these results as they stated in their study that VR elicit positive emotions, more than traditional distraction techniques.

The researchers think that when children play VR game or watch VR movie, they totally become immersed in new situation which affect their perception of emotional distress like anxiety or fear.

As regard to characteristics of children, the current study findings proved that three fifth of children, their age between 8 and 10 years old with the mean age of 8.5 ± 1.5 years. These results were congruent with **Ferraz-Torres et al., (2022)** who evaluate the effect of passive or active virtual reality on pain and anxiety in pediatric patients and they proved that the average age of the pediatric patients was 8.4 years. Additionally, these study results was agree with the findings of **Aydin & Ozyazicioglu (2019)** who studied the impact of virtual reality headset on pain felt during a venipuncture in children and they reported that 80% of children in their study were between the ages of 6 to 10 years.

In relation to children gender, the present study results reported that more than three fifth of children were males. These findings were agree with **Semerci et al., (2021)** who evaluate the effects of virtual reality on pain reduction during venous port access in children with oncology and they reported that more than half of studied children were males. Moreover, These results was consistent with **Tennant et al., (2020)** who explored the effect of immersive virtual reality to enhance psychological wellbeing in pediatric oncology and they stated in their study that more than half of studied children were boys.

The current study results stated that there were highly statistically significant negative correlations between number of children previous admission with their pain and fear. From the researchers points of view

that frequent hospital admission of children might lead to those children become more familiar with painful procedures than other children who had not previously admitted.

Conclusion

The current study findings concluded that virtual reality has been to be effective in reduction of pain and fear during venipuncture among hospitalized children. Moreover, there were highly statistically significant correlation between children age with their pain and fear.

Recommendations

It is suggested that VR could be integrated as adjunctive non-pharmacological therapy with the routine care during painful procedures for hospitalized children; this could help children handle venipuncture in a non-stressful manner. Moreover, educational training programs should be given for enhancing nurses awareness and performance regarding using of virtual reality as a diversion method during painful procedures among children.

Conflict of Interest:

The authors announce that the research was conducted in the absence of any commercial or financial relationships that could be interpreted as a possible conflict of interest.

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