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Effectiveness of a Virtual Reality Application on Mitigating Children's Pain and Anxiety throughout Phlebotomy

Doaa Bahig Anwr[1], Shimaa Hassan Khalf allah[2], Maha Mahmoud Saadoon[3], Dalia Mohamed Fathy Abdel Maksod[4], Nora Abdel Hamid Zaki[5] & Faten Fathi Ahmed Mahfoz[6]

1. Assistant Professor of Pediatric Nursing, Faculty of Nursing, Aswan University, Egypt.
2. Lecturer of Pediatric Nursing, Faculty of Nursing, Assuit University, Egypt.
3. Assistant Professor of Pediatric Nursing, Faculty of Nursing, Domietta University
4. Lecturer of Community Health Nursing, Faculty of Nursing, Kafrelsheikh University, Egypt North Private College of Nursing, Saudi Arabia
5. Assistant Professor of Pediatric Nursing, Faculty of Nursing, Assuit University, Egypt.
6. Assistant Professor of Pediatric Nursing, Faculty of Nursing, Suez Canal University, Northern Private College of Nursing, Saudi Arabia

Abstract:

Background: Virtual reality serves as a promising intervention for alleviating pain and anxiety in children. **Aim:** To evaluate the effectiveness of a virtual reality application on mitigating children's pain and anxiety throughout phlebotomy. This study employed a quasi-experimental research design. The investigation was conducted at the outpatient clinics and emergency pediatric department of Assiut University Children Hospital. **A purposive sample** of one hundred child was included in the study. **The instruments** were a structured interview questionnaire for children, a pain rating scale, and the Beck Anxiety Inventory scale. **The results** demonstrated statistically significant differences in pain and anxiety levels between the posttest and pretest. Moreover, children utilizing a virtual reality exhibited reduced pain and anxiety compared to those receiving conventional hospital treatment. **Conclusion:** The virtual reality application positively influenced pain and anxiety levels during phlebotomy. Consequently, it was **Recommended that** virtual reality applications be employed as conventional therapies for managing pain and anxiety during pediatric phlebotomy in clinical environments.

Keywords: Anxiety, Children, Pain, Phlebotomy &Virtual reality.

Introduction

Children undergoing medical procedures often experience pain, distress, and anxiety. This not only makes them less comfortable during the procedure but also raises the possibility of unfavorable outcomes such as attempts to escape, inadequate recovery, irregular sleep and feeding patterns, and signs of post-traumatic stress disorder **(Desai et al., 2023).** Pain is an unpleasant emotional and sensory experience associated with tissue damage. Children frequently show distinct signs of discomfort than adults do, and they experience greater levels of anxiety and agony throughout medical treatments. Their past experiences with pain and their recollection of it are strong predictors of their future reactions to pain **(Rivi et al., 2023).**

Pain is an uncomfortable mental, physical, and sensory state. All children experienced suffering for the first time when they were neonate, which unites them. As the fifth vital sign, pain should be monitored and managed by healthcare professionals when providing treatment to the pediatric patient **(Shahiri & Gélinas, 2023).**

Children may become nervous during phlebotomy and vein punctures because they are two of the most traumatic and unpleasant medical procedures. An adult who experienced trauma as a child may develop a needle phobia and avoid going to the doctor. Children's pain and anxiety during simple procedures such as venous blood drawing should be monitored and attempts should be made to reduce them **(Yilmaz & Canbulat., 2023).**

Repetitive procedures should worry parents and medical professionals since they may lead to conditioned anxiety and discomfort. Anticipatory anxiety reactions in children can manifest as behavioral shifts and physical symptoms. Virtual reality has become a promising technique in pediatric healthcare because of its realistic and entertaining environments that successfully divert children during medical procedures **(Ferraz-Torres et al., 2022).**

A potentially useful instrument in pediatric healthcare is virtual reality. Its ability to reduce anxiety and pain makes the experience smoother and less upsetting for children, especially those with persistent diseases that require multiple treatments. Virtual reality users can

feel completely immersed and as though they are in a virtual environment **(Zhang et al., 2022).** Because it directly targets pain and pays less attention to how pain is experienced, this absorption is important. Virtual reality is a particularly exciting technique for kids who want to play imaginatively **(Mantegazza et al., 2022).**

Virtual reality -based therapies take children's attention away from active cognitive processing, potentially increasing their pain thresholds and tolerance. These methods also make it easier for kids to interact with virtual computing environments. More advanced virtual reality programs usually have a better pain-relieving effect because the human brain can only process so much information **(Arafat, 2022).** Distraction techniques as (virtual reality, deep breathing, visualization, drawing, and knitting, solving puzzles and listening to music) are quick and simple ways to take a child's attention away from uncomfortable stimuli and ease their suffering. Refocusing attention on pleasurable sensations can dramatically reduce discomfort, fear, and anxiety. It also elevates mood, which in turn causes the release of hormones that ease stress and eventually foster mental clarity. In order to assist patients feel less nervous and uncomfortable during invasive medical procedures, healthcare personnel can use distraction, a tactic that parents commonly do **(Yan et al., 2023).**

The Significant of the study

Many children between the ages of 6 and 18 years old who had phlebotomy reported feeling a great deal of pain and anxiety throughout the procedure, which can result in moderate to severe discomfort from phlebotomy as indicated by **Cáceres-Matos et al., (2024)** who indicated that a significant number of children report feeling pain during phlebotomy procedures. The level of pain experienced can vary based on factors such as age, previous experiences, and individual pain thresholds. It can be particularly difficult for certain persons to obtain blood sample collections from children. Safe and effective blood collection practices for pediatric patients require careful consideration of their mental and physical well-being **(Padoan et al., 2020).**

Non-pharmacological techniques are frequently employed as an inventive approach to lessen children's discomfort and anxiety during a painful procedures like phlebotomy (**Wong & Choi, 2023).** Since virtual reality offers a non-pharmacological means of reducing the pain and anxiety that are frequently associated with challenging medical procedures, its application has the potential to significantly impact nursing practice **(El Sharkawy et al., 2023).** Therefore, the purpose of this study was to evaluate the effectiveness of a virtual reality application on mitigating children's pain and anxiety throughout phlebotomy.

Aim of the Study

The aim of this study was to evaluate the effectiveness of a virtual reality application on mitigating children's pain and anxiety throughout phlebotomy.

Research hypothesis

It is anticipated that children who receiving a virtual reality application during phlebotomy will experience reduced pain and anxiety compared to those who do not receive such an application.

Null hypothesis

Virtual reality applications connected to pain score and anxiety are equally likely to be given to children undergoing phlebotomy as they are to those who do not.

Subjects and Method

Research design:

This study employed a quasi-experimental research design.

Study Setting:

The research was carried out in outpatient clinics and the emergency pediatric department at Assiut University Children Hospital, which is associated with the Ministry of Higher Education and Scientific Research. This setting located in the first floor in Assiut university children hospital and consisted of 8 room. Also this setting was suitable environment with specialized pediatric care, diverse patient population, access to resources and adherence to ethical standards all of which can contribute to the success and relevance of the research.

Subjects:

A purposeful sample of one hundred children, aged six to eighteen years, who accessed the previous mentioned setting and had phlebotomy performed throughout the study period was chosen. Children were divided into two groups using random assignment (by writing the children's' name on slips of paper, placing this paper in a bowl and randomly choosing the paper the first paper was in the study group and the second in the control group and so on), the study group, which comprised children who used virtual reality apps, and the control group, which consisted of children who had standard medical care according to the following criteria:

Inclusion criteria:

1. Children from 6-18 years.
2. Children and parents who agreed to participate in the study.
3. The score of pain and anxiety for children before phlebotomy was zero and had successful phlebotomy in the first attempt.

Exclusion criteria:

1. Children suffering from long-term illnesses.
2. Children suffering from vision problems.
3. Children who have sustained facial injuries.
4. Children with mental retardation or disability.
5. Children who have used analgesics during the past 24 hours.

Sample size calculation

Using G Power Software 3.1.9.7, the required sample size for the investigation was determined. The experiment involved a one-way ANOVA test with fixed effects, with an actual power (1-β) = 0.75, an α error of 0.05, and an effect size (f): 0.40. According to the findings, in order to guarantee sufficient statistical power, at least 100 children were necessary.

Tools of data collection:

The data for this study was collected using the following three tools.

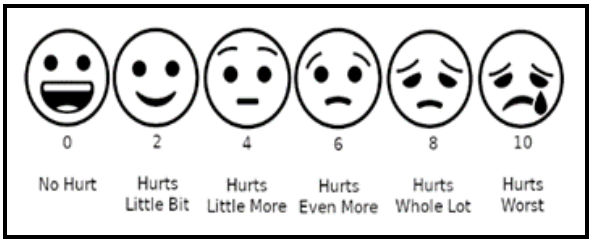
Tool I: A structured interviewing questionnaire which developed after studying relevant literature. To better fit the study sample, it was written in Arabic. There were two sections to the questionnaire:

Part 1: Characteristics of the child, such as gender, age, child ranking, level of education, and residence.

Part 2: A medical history for the children. The researchers created this method to gather information on each child, such as their medical diagnosis, length of stay in the hospital, and indication of phlebotomy.

Tool II: Pain rating scale: It included two parts:

Part 1: Wong-Baker Faces Pain Rating Scale. This pain intensity measure for children was adapted from **(Wong et al., 2012).** The scale consists of a series of six faces, each depicting a different facial expression ranging from a smiling face "no hurt" (0 - no pain) to a tearful face "hurts worst." (10 - Sever pain). Researcher point to the face that best represents their current level of child pain.



Scoring system:

Four levels of pain were distinguished using a scoring system as follows:

1. No pain = 0 point.
2. Mild pain= 1:3 points.
3. Moderate pain = 4:6 points.
4. Severe pain=7:10 points.

Part 2: Behavioral rating scale

This scale was derived from **(Hjermstad et al., 2011).**The behavioral rating scale encompassed four pain behaviors: crying, movement of limbs, agitation, and verbalization. Every behavior category was evaluated on a scale from 0 to 2. The cumulative pain score varied from 0 to 10.

Tool III: **Beck Anxiety Inventory (BAI) scale:** which adapted from **(Beck et al., 1988).** This scale is a self-report measure of anxiety and consisted from 21 items. It had a maximum score of 63 and was intended to assess children's anxiety. As follows was the computation of the mean scores for the various anxiety levels: not at all (score of zero), mildly, but it didn't bother me much (score of 1), moderately – it wasn't pleasant at times (score of 2) and severely – it bothered me a lot (score of 3).

System of scoring:

The overall score is determined by summing the 21 items.

Score of 0-21 = low anxiety

Score of 22-35 = moderate anxiety

Score of 36 and above = potentially concerning levels of anxiety (sever anxiety)

Method of Data Collection

Official permission was acquired from the Assiut University Children Hospital administration to conduct the study. Five expert juries in the disciplines of pediatrics and pediatric nursing assessed the contents validity index of tools in order to determine its validity. After informing parents of the purpose and design of the study, parents provided written constant for their children to participate. In earlier studies, the validity and reliability of tool two (Cronbach's a=0.95, 0.88), and (Cronbach's a=0.92, 0.51) for tool three.

Pilot study:

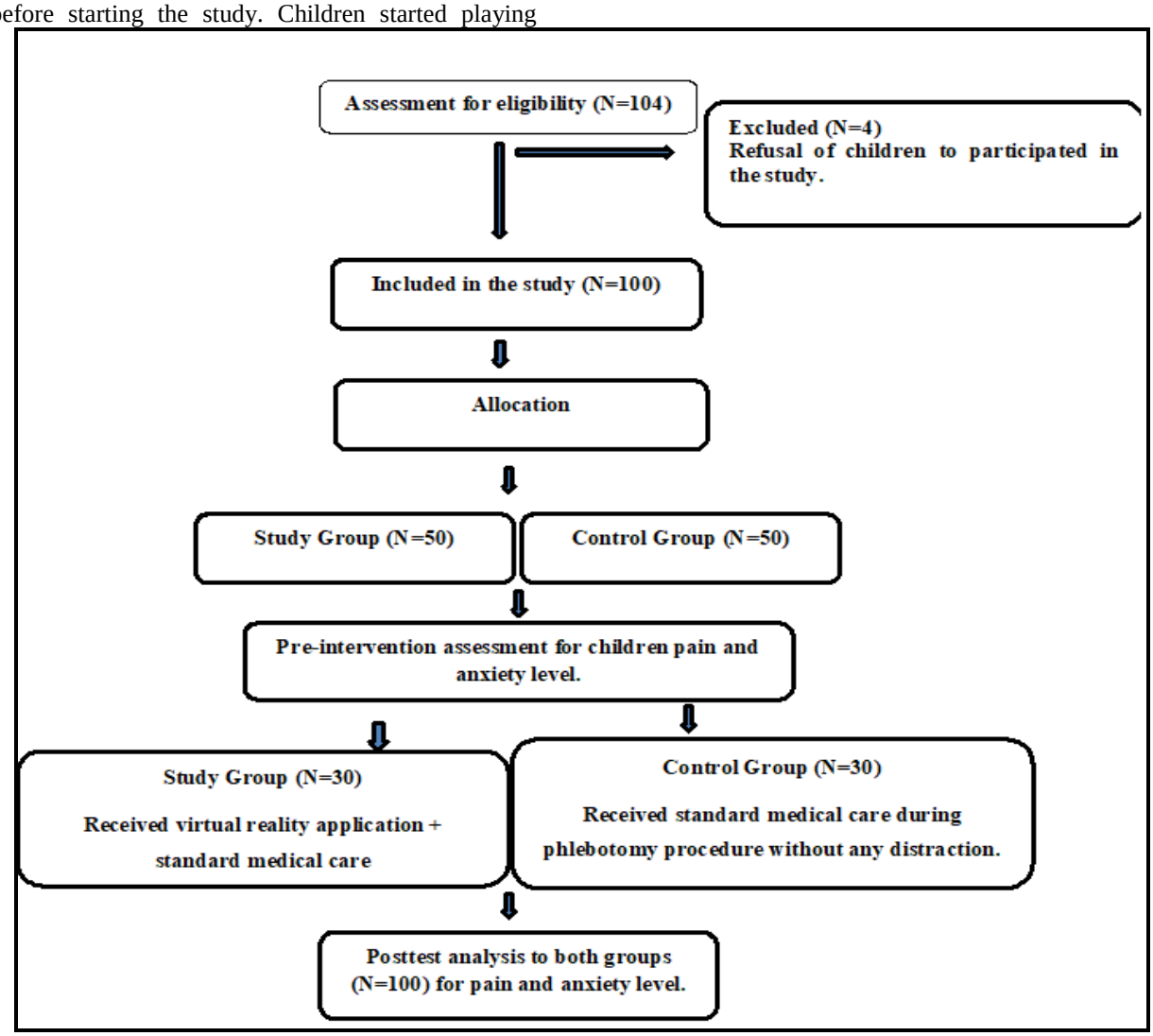
Ten percent of children took part in this preliminary investigation. It was done to determine how complete and clear the tools were, as well as to estimate how much time would be needed. No modifications were made, and the children that took part in the pilot study were incorporated into the research.

Field of study:

The study was conducted from the beginning of March 2024 until the end of April 2024.The study tools were utilized to gather data. Throughout the process, all parents were instructed to wait with their kids. The researcher assessed and noted the child's pain and anxiety. Utilizing tool one (pre-test), the characteristics of the study group and the control group were evaluated. Children were selected according to their inclusion and exclusion criteria. Then they sent to the nursing room for starting the phlebotomy procedure as requested. The nurse started the phlebotomy procedure as requested. During the procedure (children in both the study and the control groups) were assessed using tools two and three (pre-test). Children in the control group received only standard medical care during phlebotomy procedure without any distraction.

Intervention

The researcher prepared the needed virtual reality equipment (Samsung Gear headset, virtual reality selected video and Samsung smartphone with virtual reality support system) for children in the study group. Then performed hand hygiene and wore appropriate personal protective equipment (gloves & mask) and wiped the lens and removed any foam areas from the headset with a dry microfiber cloth. The researcher cleaned the virtual reality face plate with alcohol swabs and make sure that the residue from alcohol swaps completely dries as it can be a bit harsh on some children's skin and put cover over child's hair (eg, bouffant cloth surgical cap). The researcher operated the supported mobile with virtual reality video, placed it in the virtual reality goggle and the goggle was put on the child eyes and secured around the child's head. The researcher trained each child individually for 5-7 minutes on utilization of virtual reality goggle and playing games through it before starting the study. Children started playing with virtual reality goggle just one minute before the phlebotomy procedure to be immersed in the virtual reality game. The nurse was asked to start the phlebotomy procedure while the child was using the virtual reality goggle. The researcher removed the virtual reality goggle after finishing the procedure and placed on a clean disposable pad and cleaned all visibly soiled areas with disposable wipes or paper towels. The researcher disinfected the virtual reality headset and allowed it to dry and stored the device in a dry space physically separated from non-disinfected devices. Also removed personal protective equipment and performed hand hygiene. Finally the researcher assessed the feasibility of the virtual reality experience after using the virtual reality goggle during the phlebotomy for the study group by using tools two and three (post-test).



Research flow chart

Ethical considerations

The research proposal was approved by the local Ethics Committee at Assiut University's Faculty of Nursing with No. (1120240767) before the start of the trial. Each child who took part in the study had their parents provide written informed consent, with the understanding that the information gathered would only be used for research, to guarantee the participants' privacy. When the study was being applied, there was no risk to the study subjects. Parents of children have explained the purpose and design of the study. The parents of the children were informed that they had the option to decline their participation in the study.

Statistical Analysis

Data was formatted and coded uniquely so that it could be entered into a computer. Version 23 of the SPSS (Statistical Package for the Social Sciences) was utilized for data entry and analysis. Graphics were generated using Excel software. Quantitative data were presented as mean and standard deviation (X ±SD) for comparison among different groups and analyzed using the Chi-square test for categorical variables. The Fisher's exact test was additionally employed.

Results

Table (1): Distribution of studied children regarding to their personal data (n=100)

Items	Study group (n=50)		Control group (n=50)		Chi – Square	
	n	%	n	%	X^2	P
Age (Years)						
6 < 12	37	74.0	34	68.0		
12 – 18	13	26.0	16	32.0	0.437	0.508
Mean ±SD	13 ±1.3		13±1.5		0.712	0.477
Gender						
Male	27	54.0	25	50.0		
Female	23	46.0	25	50.0	0.160	0.688
Child education						
Primary	37	74.0	34	68.0		
Preparatory	7	14.0	10	20.0	0.198	0.656
Secondary	6	12.0	6	12.0		
Child's rank						
First	7	14.0	8	16.0		
Second	17	34.0	16	32.0		
Third	20	40.0	22	44.0		
Only child	6	14.0	4	8.0	1.001	0.801
Child residence						
Rural	38	76.0	36	72.0		
Urban	12	24.0	14	28.0	0.207	0.648

Chi Square test.

Table (2): Distribution of studied children regarding to their medical data (n=100)

Items	Study group (n=50)		Control group (n=50)		Chi – Square	
	n	%	n	%	X^2	P
Length of hospitalization (Days)						
1 – 5	10	20.0	12	24.0		
6 – 10	26	52.0	23	46.0		
More than 10	14	28.0	15	30.0	0.399	0.818
Phlebotomy site						
Basilic vein	14	28	15	30		
Cephalic vein	12	24	10	20		
Dorsal metacarpal vein	16	32	14	28		
Median cubital vein	6	12	8	16		
Radial vein	2	4	3	6	2.140	0.949
Indication of Phlebotomy						
Blood draw.	39	78	37	74		
Cannula insertion	11	22	13	26	3.120	0.894
Phlebotomy try:						
Successful on the first try	48	96	49	98		
Repeated	2	4	1	2	1.360	0.756

Chi Square test.

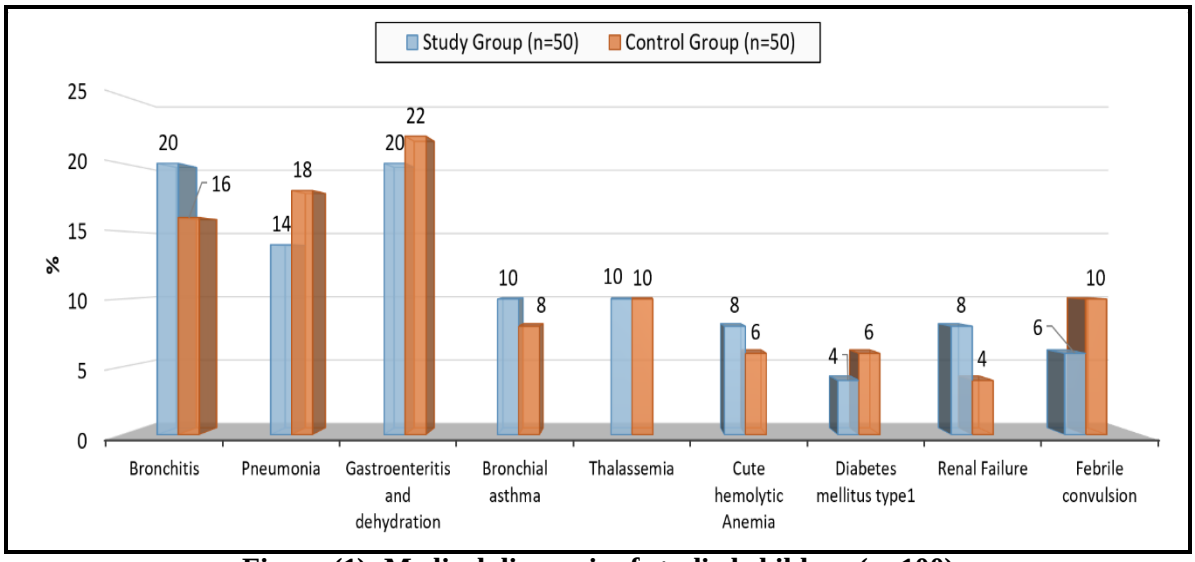


Figure (1): Medical diagnosis of studied children (n=100)

Table (3): Comparison of the Wong-Baker Faces pain rating scale between studied children post intervention (n=100)

Items	Control group (n=50)		Study group (n=50)		Fisher's exact test	
	n	%	n	%	F	P
No hurt	2	4.0	18	36.0		
Hurts little bit	3	6.0	10	20.0		
Hurts little more	7	14.0	9	18.0		
Hurts even more	9	18.0	7	14.0		
Hurts whole lot	15	30.0	3	6.0		
Hurts worst	14	28.0	3	6.0	32.186	<0.001**

Fisher's exact test. *****: Highly Significant level at P value <.001.***

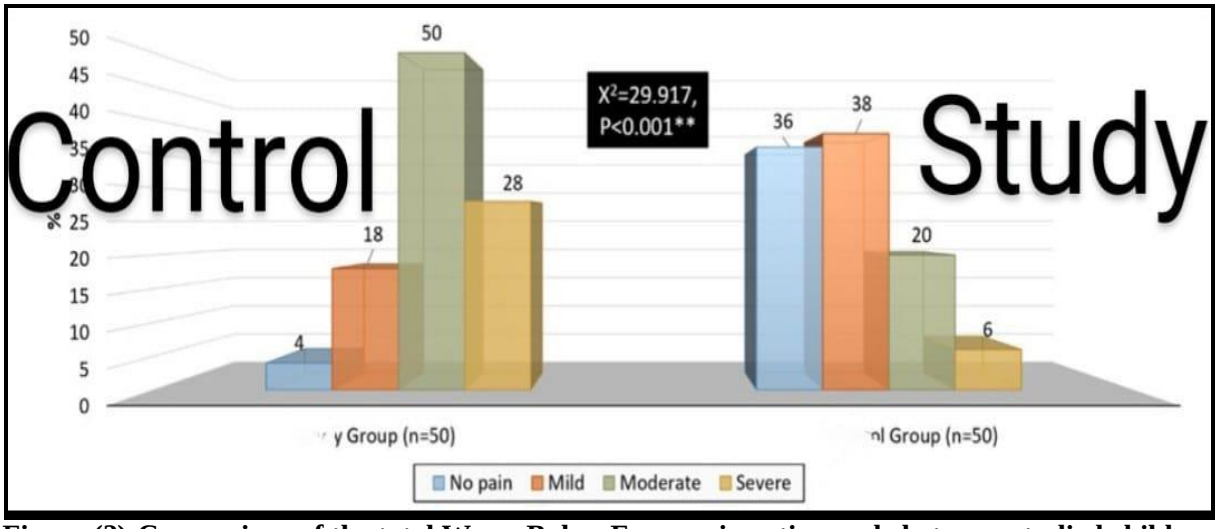


Figure (2):Comparison of the total Wong-Baker Faces pain rating scale between studied children post intervention (n=100)

Table (4): Comparison of the behavioral rating scale between studied children post intervention (n=100)

Items	Control group (n=50)		Study group (n=50)		Chi – Square / Fisher's exact test	
	n	%	n	%	X^2	P
Crying						
Not crying	4	8.0	29	58.0		
Crying but the response to tender loving care	13	26.0	14	28.0		
Crying and does not respond to tender loving care	33	66.0	7	14.0	35.876	<0.001**
Moving of limbs						
No movement	2	4.0	30	60.0		
Partially bent	15	30.0	13	26.0		
Fully bent with finger flexion	33	66.0	7	14.0	41.542	<0.001**
Agitation						
Child calm	3	6.0	29	58.0		
Can be comforted to lessen the agitation (mild)	11	22.0	13	26.0		
Cannot be comforted	36	72.0	8	16.0	39.109	<0.001**
Verbal evaluation or body language						
No pain Mild pain (cannot localize)	2	4.0	26	52.0		
Moderate pain (can localize)	10	20.0	13	26.0		
Severe pain	38	76.0	11	22.0	35.840	<0.001**

Chi Square test. *****: Highly Significant level at P value <.001.***

Table (5): Comparison of the Beck Anxiety Inventory (BAI) scale between studied children post intervention (n=100)

Items	Control group (n=50)		Study group (n=50)		Fisher's exact test	
	n	%	n	%	F	P
BAI Scale						
Low anxiety	3	6.0	29	58.0		
Moderate anxiety	16	32.0	17	34.0		
Sever anxiety	31	62.0	4	8.0	41.983	<0.001**
Mean ±SD	33.9 ±2.1		22.6 ±2.8			

Fisher's exact test. *****: Highly Significant level at P value <.001.***

Table (1): Presents a distribution of studied children regarding to their personal data. In terms of age, the majority of children in both groups fall into the 6-12 years category, with 74.0% and 68.0% in the study and the control group, respectively. Regarding gender distribution, the study group consisted of 54.0% males and 46.0% females, while the control group had 50.0% males and females. Also, the majority of children in both groups had a primary education (74.0% and 68.0%) respectively. The table also provided information on the child's rank within the family less than half of studied children ranked in third within the family. Finally the majority of participants in the study and the control groups were from rural areas (76.0%, 72.0%) respectively.

Table (2): Represents the distribution of studied children regarding to their medical data. Regarding the length of hospitalization (52.0% and 46.0%) of children in both groups had a hospital stay between 6 and 10 days respectively. Regarding phlebotomy site, it noticed that 32% of children in the study group were given in dorsal metacarpal vein, while 30% of children in the control group were given in basilic vein. As regard to phlebotomy try, it was observed that the majority (96% and 98%) of children in both groups respectively were made phlebotomy in the first try.

Figure (1): Illustrates medical diagnoses of studied children; it showed the distribution of various conditions among the study group and the control group. The most common conditions in both groups were bronchitis, pneumonia, and gastroenteritis with dehydration.

Table (3): Presents a comparison of the Wong-Baker Faces pain rating scale between the studied children post intervention. Looking at the distribution of pain ratings, it was evident that the study group showed a different pattern compared to the control group. A higher percentage of children in the control group reported higher levels of pain, with 30.0% indicating "Hurts whole lot" and 28.0% indicating "Hurts worst." In contrast, the study group had a lower percentage of children reporting higher levels of pain, with only 6.0% indicating "Hurts whole lot" and

"Hurts worst." with statistically significant difference P value <0.001. This indicated that the intervention may have a positive effect in reducing the perceived pain levels in the study group.

Figure (2): Illustrates the comparability of the Wong-Baker Faces pain rating scale among the studied children following the intervention. A highly statistically significant difference (P.Value = 0.000*) was observed among the examined children. In the study group, 36% of children experienced no pain, but only 4% in the control group said the same.

Table (4): Reports a comparison of the behavioral rating scale between studied children post intervention. There was statistically significant improvements in behavioral responses to pain in the study group following the intervention compared to the control group (P.Value =0.000*). In terms of crying, the study group showed a lower percentage of children crying and not responding to tender loving care compared to the control group (14.0% vs. 66.0%). Concerning the moving of limbs, the study group demonstrated a lower percentage of children with fully bent limbs and finger flexion compared to the control group (14.0% vs. 66.0%). In relations of agitation, the study group exhibited a lower percentage of children who cannot be comforted compared to the control group (16.0% vs. 72.0%). Regarding verbal evaluation or body language, the study group showed a lower percentage of children experiencing severe pain compared to the control group (22.0% vs. 76.0%).

Table (5): Illustrates the comparison of the Beck Anxiety Inventory (BAI) scale between studied children post intervention. Highly statistically significant difference (P.Value <0.001**) was found between the studied children. It was found that 58% of children in the study group experienced low anxiety compared to only 3% of them in the control group.

Discussion

Phlebotomy, the process of drawing blood, can often be a distressing and anxiety-inducing experience for children. However, the use of virtual reality technology has shown promising results in alleviating pain and anxiety in various medical procedures **(Lee et al., 2024)**. Thus, this study aimed to evaluate the effectiveness of a virtual reality application on mitigating children's pain and anxiety throughout phlebotomy.

The distribution of pain ratings clearly demonstrates a noticeable difference between the study and control groups (tab 3). In the control group, a higher percentage of children reported higher levels of pain, with 30.0% indicating "Hurts whole lot" and 28.0% indicating "Hurts worst." This suggests that a significant proportion of children in the control group experienced considerable pain following the intervention. On the other hand, the study group exhibited a different pattern in pain ratings. A lower percentage of children in this group reported higher levels of pain, with only 6.0% indicating "Hurts whole lot" and "Hurts worst."

This significant difference in the distribution of pain ratings between the participants in the study and the control group indicates that the virtual reality intervention have played a role in alleviating pain or enhancing pain management in the study group. In the researcher opinion the mechanism through which virtual reality aids in reducing pain in children is multifaceted. When children are engaged in a virtual reality experience, their attention is diverted from the real-world stimuli that may be causing pain or anxiety. This distraction effectively reduces the perception of pain by altering the way the brain processes and prioritizes sensory information. Moreover, virtual reality has the potential to induce a state of relaxation and immersion, which can trigger the release of endorphins and other neurotransmitters that act as natural painkillers.

This result was consistent with **El Sharkawy et al., (2023)** who study the effect of virtual reality on pain and anxiety among school age children during vein puncture in Menoufia University Hospital and stated that the application of virtual reality distraction had appositive effect on reducing pain and anxiety during the phlebotomy among school age children. Besides, this finding was consistent with **Gerçeker et al., (2018)**. The study revealed that virtual reality reduced pain during blood draws in children aged 7 to 12 years. Furthermore, this finding was in agreement with **Yilmaz & Canbulat (2023)** study on the effects of virtual reality glasses and external cold and vibration on procedural pain and anxiety in children during venous phlebotomy, which found that children with the virtual reality and Buzzy groups had lower pain levels than those in the control group. This finding was also congruent with **Ryu et al., (2022),** who conducted research at Seoul National University Bundang Hospital on the effects of virtual reality education on procedural pain and anxiety during venipuncture in children and found that pre-procedural virtual reality education significantly reduced pain and anxiety in children while also decreasing the procedural difficulty of phlebotomists during the venipuncture procedure.

On the other hand, this study is incompatible with **Caruso et al. (2020).** Who conducted study at academic hospital in Northern California on virtual reality during pediatric vascular access: a pragmatic, prospective randomized, controlled trial and found no significant difference in post-procedure pain levels

with the usage of virtual reality. Another investigation was undertaken by **Lambert et al. (2020)** who made study about virtual reality distraction for acute pain in children. They concluded that virtual reality goggles had no therapeutic effect on pain. This disparity could be attributed to the diverse age groups and developmental stages of their study population.

The comparison of the behavioral rating scale (tab4) indicates that the virtual reality intervention had a statistically significant positive effect on the behavioral responses to pain in the studied children. These findings highlight the potential benefits of virtual reality technology as a non-pharmacological intervention to improve pain management and enhance the overall well-being of pediatric patients.

Examining specific behavioral indicators, the study group exhibited a lower percentage of children crying and not responding to tender loving care compared to the control group. This suggests that the intervention had a positive effect in reducing distress and promoting a more adaptive response to pain in the study group. Furthermore, in terms of limb movement, the study group demonstrated a lower percentage of children with fully bent limbs and finger flexion compared to the control group. This indicates that the virtual reality intervention might have influenced the children's ability to manage pain and maintain more relaxed and controlled limb movements. In relation to agitation and verbal evaluation or body language, the study group exhibited a lower percentage of children who could not be comforted compared to the control group. This indicates that the virtual reality intervention potentially contributed to a reduction in the severity of pain experienced by the study group, as reflected in their verbal and non-verbal expressions.

This finding was congruent with the findings of **Orhan & Gozen (2023)** and **Amin & Abdalkhair (2023),** at Cairo University Specialized Pediatric Hospital who investigated the effect of virtual reality on alleviating children's fear and pain during painful procedures and reported that virtual reality resulted in significant improvements in pain during venipuncture in children.

This study's statistical analysis shows a significant difference in anxiety levels (tab5) among the investigated children (P.Value < 0.001**). This implies a significant difference in anxiety levels between the study and control groups. Specifically, the findings demonstrate that 58% of the children in the study group reported low anxiety after the intervention. In comparison, only 3% of children in the control group reported feeling low anxiety. The striking difference in anxiety prevalence between the two groups implies that the virtual reality intervention had a significant influence on anxiety reduction in the study group.

Reducing anxiety in children is critical for their general well-being and has a favorable impact on many parts of their lives, including cognitive functioning, emotional control, and social interactions. The fact that the vast majority of children in the study group reported no anxiety shows that the virtual reality intervention may have been beneficial in reducing anxiety symptoms and increasing emotional well-being. In the researcher opinion the mechanism through which virtual reality aids in reducing anxiety is that virtual reality experiences can offer children a sense of control and empowerment, allowing them to interact with the virtual environment and participate in activities that provide a sense of agency. This feeling of autonomy can help mitigate feelings of helplessness and anxiety often associated with medical procedures, contributing to a more positive emotional state.

This finding was in harmony with **Wong & Choi (2023),** who conducted the research at public hospital in Hong Kong about effects of an immersive virtual reality intervention on pain and anxiety among pediatric patients undergoing venipuncture: a randomized clinical trial and found that including procedural information and distraction in a virtual reality intervention for pediatric patients undergoing venipuncture significantly reduced pain and anxiety in the virtual reality group compared to the control group. Furthermore, the result was in line with **Gao et al., (2023),** who stated that pediatric patients having needle-related procedures might benefit from virtual reality interventions for pain, anxiety, and fear management.

Furthermore, this result was consistent with **Goldman & Behboudi (2021)** who made the research in Vancouver, Canada, about virtual reality for intravenous placement in the emergency department—a randomized controlled trial**.** It was reported by children in the study group (virtual reality) that level of anxiety from IV management was lower after utilization than before. In contrast, a study conducted by **Yıldırım & Gerçeker, (2023)** in Turkey, about the effect of virtual reality and buzzy on first insertion success, procedure-related fear, anxiety, and pain in children during intravenous insertion in the pediatric emergency unit. The study showed that there was no difference in post procedural anxiety scores (P > 0.05).

Conclusion

According to the findings of the current study, virtual reality applications had a significant effect on lowering pain and anxiety during phlebotomy in children. Children who participated in virtual reality

sessions (study group) reported less pain and anxiety scores after the intervention than children who did not (control group).

Recommendations

This research recommended that incorporating virtual reality applications as standard nursing strategies for alleviating pain and anxiety in pediatric patients. It is advisable to conduct cost-effectiveness analyses comparing virtual reality tools with alternative distraction methods to ascertain the comparative advantages of virtual reality in terms of efficacy versus cost. Subsequent investigations should examine into the enduring impacts of virtual reality interventions on pain and anxiety management, while also exploring potential psychological and physiological advantages. Furthermore, future studies should encompass a broad demographic of children with chronic illnesses undergoing diverse procedures in varied healthcare settings, focusing on outcomes across different age group.

Implications of the study

The study's findings suggest that virtual reality applications can effectively reduce pain and anxiety in children during phlebotomy procedures. By creating an immersive environment, virtual reality distracts children from the procedure, improving their experience and potentially leading to better outcomes. Integrating virtual reality into pediatric healthcare can enhance patient satisfaction, decrease the need for medication, and improve overall healthcare results. This highlights the importance of incorporating innovative non-pharmacological approaches in pediatric care. Healthcare providers should consider implementing virtual reality applications to offer a more comprehensive and patient-centered approach.

Limitations of the study

Certain limits must be recognized. The sample size of the study may restrict the generalizability of the results. An expanded and more varied sample would yield a more thorough comprehension of the efficacy of virtual reality in alleviating pain and anxiety during phlebotomy procedures. The study concentrated exclusively on phlebotomy operations, and the results may not be relevant to other medical procedures or diseases. Additional study is required to investigate the effectiveness of virtual reality across diverse healthcare settings and among distinct patient demographics.

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