Effect of smartphone – based virtual reality on relieving pain and anxiety in critically ill patients

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Abstract:

Background: Pain and anxiety are significant issues in intensive care units. Virtual reality (VR) offers an immersive, interactive experience using mobile technology and 3D-enabled goggles, providing multisensory distraction that reduces anxiety and pain perception in critically ill patients. **Objective:** To determine the effect of smartphone-based immersive virtual reality on relieving pain and anxiety in critically ill patients. **Design:** A quasi-experimental research design was employed. **Methods**: A convenience sample of 120 critically ill patients was selected. Patients were equally assigned into two groups (intervention and control group). In the Intervention group, patients were subjected to virtual reality sessions, and in the control group, patients were subjected to deep breathing for relaxation technique as a traditional method. The intervention was done through a session that took 15 minutes at once. Patients' assessment was done by using the Numeric Rating Scale (NRS) and Hamilton Anxiety Rating Scale (HAM-A). **Results:** The mean pain and anxiety scores in the virtual reality intervention group decreased more than in the control group, with significant differences at different time intervals. **Conclusion:** VR therapy utilizing smartphones has positive effects in managing pain and anxiety in critically ill patients and it is recommended that critical care nurses should incorporate mobile-based immersive virtual reality as a novel method for pain relief.

Key words: smartphone, immersive virtual reality, pain, anxiety, critically ill patients.

Introduction:

Adults admitted to the intensive care unit (ICU) commonly experience distressing symptoms such as pain and anxiety, which can potentially hinder rehabilitation during their stay. **(Richardson et al, 2024).** Moderate to severe pain was estimated to affect 40 to 77% of critically ill patients admitted to intensive care units **(Bhattacharyya et al, 2024)**. The assessment is based on self-report measurements that use numerical pain ratings. This measure is valid, reliable, easy to use, and available to patients who can express themselves, even if not through speech **(Boring et al, 2021)**. Moreover, the rate of anxiety symptoms during ICU stays varies from 12% to 47% **(Shdaifat & Qadire 2022).**

Virtual reality (VR) is a visual representation of an imagined environment in three dimensions created by a computer and experienced by users through a variety of display walls or a specialized headset **(Renganayagalu et al, 2021)**. Semi-immersive, non-immersive and fully immersive VR systems are the three varieties available. A display, tracking sensors, and user interfaces are necessary for semi-immersive systems in order to place the virtual environment on top of the acknowledged real environment. Furthermore, in this type of virtual reality can be experienced without the need for additional devices such as head-mounted displays. Non-immersive system is sometimes referred to as desktop virtual

reality or window on world systems **(Lorusso et al, 2020)**.

Wearing a head-mounted display (HMD) and data glove is required for the to use the immersion type of VR systems, which track head movements and alter the view accordingly. Patients can enter a virtual reality environment that helps distract them from discomfort and anxiety **(Xiang et al, 2021)**. An immersive virtual reality technology that is based on smartphones uses a head-mounted display and a mobile phone to produce 3D real-time animation **(Ridout et al, 2021)**. The content for immersive virtual reality relaxation on smartphones includes three-dimensional relaxation music and panoramic views of nature **(Groninger et al, 2022, Rutkowski et al, 2021)**.

Deep breathing for relaxation technique is one of the most common used of the traditional non-pharmacologic pain management interventions that nurses reported using in a previous study conducted in Egypt. However, nurses in the prior study did not use guided imagery or any other visualization techniques to divert the patient's attention. This finding was interpreted as a result of nurses having too much work and not enough time. **(Khalil 2018).** Additionally, other studies have shown that using tapes or videos to divert attention doesn't take up a lot of the nurses' time and that it lowers the risk of drug dependence by promoting pain management as the primary treatment (**Kia et al, 2021)**.

In the present study, it was suggested a novel approach to pain management for critically ill patients by utilizing virtual reality. It was expected that by lowering anxiety and deflecting attention from pain, makes performing this study to examine the effect of alternative therapy significant as it helps critically ill patients with their symptoms. So, this study aimed to determine the effect of smartphone-based immersive virtual reality on relieving pain and anxiety in critically ill patients.

Aim of the study:

The aim of the study was to investigate the effect of smartphone-based immersive virtual reality on relieving pain and anxiety in critically ill patients

Hypotheses:

H_1: critically ill patients who were subjected to smartphone-based immersive virtual reality technology experienced low pain level than those who didn't.

H_2: critically ill patients who were subjected to smartphone-based immersive virtual reality technology experienced low anxiety level than those who didn't

MATERIALS AND METHODS:

Research design:

A quasi - experimental research design was used in this research to collect data. in such design, the assignment of participants was based on selection by researcher while subjects cannot be randomly assigned to the study for practical or ethical reasons. Then, the selected subject was randomly allocated in either control or intervention group.

Settings:

Two ICUs were used to carry out this study at Alexandria Main University hospital; the casualty care unit (unit I), and the general ICU (unit III). There are two rooms in the casualty care unit that have four beds each. Two main halls, each with seven beds, make up the general ICU.

Subjects:

A purposive sample of 120 critically ill patients was chosen using the power analysis Epi-info7 program. This selection was based on the following parameters: a population size of 200 over three months, an acceptable error of 5%, a confidence coefficient of 95%, and an expected frequency of 50%. Adult patients aged 18 years and older (aged ≥18 years) and who were conscious were taken in the study. Patients who were excluded from this study met specific criteria: those with neurological conditions like epilepsy, dementia, recent stroke, or past skull injury or surgery; patients with visual impairments or sensitivity to flashing light; patients undergoing treatment with analgesics, sedatives, or antipsychotics; those attached to mechanical ventilation; and patients with a known history of claustrophobia. Each

patient randomly assigned to either the virtual reality intervention group or deep breathing for relaxation technique group (control group). An independent statistician designed a computerized random number generator that was not involved in participant recruitment during the study.

Tools:

Three tools were utilized in the investigation.

Tool I: Clinical profile of patients: This tool was originated by the researcher after reviewing related literature **(Ribeiro et al, 2023, Rutkowski et al, 2021, Chen et al, 2021**, **Vorwerg-Gall et al, 2023)** and it was utilized for evaluating the patient's hemodynamic status. It comprised of two parts:

Part I: Patient's medical features: This section encompassed details about the patients, like age, gender, clinical characteristics such as patient's diagnosis, past medical and surgical history, GCS, and medications.

Part II: Physiological changes measurement:

This section aimed to evaluate the patient's hemodynamic status. This part involved essential bio- parameters measures, comprising heart rate, respiratory rate, systolic blood pressure, and diastolic blood pressure. These parameters were carefully monitored using a bedside monitor and meticulously documented by the researcher. Moreover, the arterial pressure of the patient was assessed utilizing a sphygmomanometer.

Tool II: Numeric Rating Scale (NRS):

This tool was adopted from **(Nordness et al, 2021)** to assess the degree of pain. NPRS appears to be a reliable measure with Cronbach alpha test = 0.81**(Atisook et al, 2021)**. This scale ranges from 0-10. A score of 0 represented the absence of pain. Scores ranging from 1 to 3 denoted mild pain, while scores between 4 and 7 indicated moderate pain. Scores from 8 to 10 reflected severe pain, with a score of 10 representing the highest level of pain intensity.

Tool III: Hamilton Anxiety Rating Scale (HAM-A):

This tool was adopted from (**Hakak et al, 2022)** to evaluate the degree of anxiety. **HAM-A** appears to be a reliable measure with Cronbach alpha test = 0.92 **(Hallit et al, 2020)**. This scale included 14 items, with each item characterized by a set of symptoms. It evaluated both psychic anxiety (mental restlessness and emotional unease) and somatic anxiety (physical symptoms associated with anxiety). Each item on this scale was rated on a Likert scale from 0 (not present) to 4 (severe), resulting in a total score range of 0–56. When, it was <17 indicated mild severity, 18–24 indicated moderate severity, and 25–30 indicated severe.

METHODS:

- Approval to carry out the study was secured from the administrative officials of the aforementioned settings following a detailed explanation of the study's objective.
- This research received approval from the ethical committee of the Faculty of Medicine at Alexandria University (No-0306927).
- The present study utilized three tools: tool one **"Patient clinical outcome assessment"** including two parts originated by the researcher after reviewing the related literature **(Ribeiro et al, 2023, Rutkowski et al, 2021, Chen et al, 2021**, **Vorwerg-Gall et al, 2023)**, tool two **"Numeric Rating Scale (NRS)"**, this tool was adopted from **Nordness 2021**, and tool three **"Hamilton Anxiety Rating Scale (HAM-A)"**, this tool was adopted from (**Hakak et al, 2022)**.
- The content validity of the tools was ensured through a comprehensive evaluation process by five experts in the field. These experts, selected based on their extensive knowledge and professional experience in healthcare and clinical research, assessed the tools for their relevance, clarity, comprehensiveness, and cultural appropriateness. Each expert was provided with tools, including the Numeric Rating Scale (NRS), Hamilton Anxiety Rating Scale (HAM-A), and" alone" with a detailed explanation of the study and the intended use of the instruments. Their feedback highlighted strengths and suggested

modifications to improve the precision and appropriateness of the tools. Necessary revisions were made to address their recommendations, and a consensus was reached among the experts, ensuring the tools were valid, comprehensive, and aligned with the study.

- A pilot study was conducted involving 12 patients, representing 10% of the sample, to assess the clarity and usability of the tools. Appropriate adjustments were implemented based on the findings.
- Reliability of the tools was tested using Cronbach's Alpha test and result was 0.90%.
- All newly admitted adult patients to the aforementioned unit who met the inclusion criteria and consented to participate in the study were enrolled. The study subjects were be equally and randomly assigned into two groups (intervention group and control group) by using a computerized random number generator.

Intervention group in which patients was subjected to virtual reality session and **control group** in which patients was subjected to deep breathing for relaxation technique.

For both groups:

The study was conducted in the morning shift (8 a.m. - 2 p.m.).

The characteristics of the patients were evaluated and documented utilizing part I of tool one.

For intervention group, the intervention was conducted through two stages**:** Preparation and implementation stages.

- In preparation the researcher prepared the virtual reality device through: The virtual reality device's hard ware (Samsung Gear VR goggle set) was fitted with a Samsung Galaxy phone. The virtual reality device's software was in the form of 3D visual cues of 360° immersive natural scene video including green fields and watercourses.
- During implementation stage the researcher explained the procedure and placed the patient in a setting position during virtual reality session. Bio-parameters, the degree of pain and anxiety was assessed for each patient immediately before intervention as baseline then immediately after intervention then after 30 minutes and 60 minutes using part II of tool one, tool two and tool three respectively. Then, the researcher placed sanitary hairnet on the patient's head, fitted goggle with disposable foam backing, placed goggle headset on patient and adjust straps. The duration of the session will last for 15 min at a time for once.
- When the session ended the researcher discarded disposable hairnet and foam backing, cleaned fabric strap by using Virex and let sit for a minimum of 10 min before next use, cleaned plastic housing of device by using Sani-wipes and let sit for a minimum of 2 min before next use, and finally cleaned inside and outside of the lenses of device by using lenses cleaner containing 70% ethyl alcohol to prevent cross infection.

The control group was subjected to a traditional deep breathing for relaxation technique. The patients in this group were taught the slow deep breathing exercise and relaxation technique as follows: the patients closed their mouth and eyes and inhales slowly through their nose. They then exhaled through pursed lips twice as slowly as they did when they inhaled with closed their eyes, until they feel calm for 10-15minutes. Bio- parameters, the degrees of pain and anxiety were re-assessed for each patient immediately before deep breathing for relaxation technique as a baseline then immediately after ,30 minutes and 60 minutes using part II of tool one, tool two and tool three respectively.

ETHICAL CONSIDERATION:

All participants provided their consent by signing the consent form after explaining the study's aim, the patients were reassured that the gathered data would solely be utilized for research purposes. Patients were informed that they had the right to withdraw from the study at any time. The researcher has guaranteed the preservation of anonymity and confidentiality of the subject data by implementing a unique code number. Patients' privacy regarding the collected data was carefully maintained throughout

the study.

Results:

As shown in **table 1**, nearly two-thirds of the patients in the virtual reality intervention group (61.7%) and almost three-quarters of the patients in the control group (73.3 %) were between the ages of 51 and 60. Additionally, over half of the patients in both groups were female (56.7). Furthermore, 90% of the patients in both groups had previously undergone surgery with no significant difference between the two groups. Cardiovascular diseases affected half of the patients in both groups in the same percentage (50%). Regarding prior medical history, however, nearly half of patients in the virtual reality group (46.7) had cardiovascular disorders, compared to one-third of patients in the control group (33.3) But, there was no discernible difference between the group in relation to their diagnosis.

According to **table 2**, after 60 minutes, the percentage of patients in the virtual reality intervention group who reported experiencing moderate pain decreased from two-thirds (40 patients) to nine patients. Concurrently, the rate of patients reporting no pain or mild pain increased from two patients to nearly one-third (20 patients) and from over one-quarter (16 patients) to half (30 patients), respectively, with a statistically significant difference ($P < 0.00$). Furthermore, after 60 minutes, the proportion of patients in the control group; patients experiencing severe pain decreased from 4 to 3 and those experiencing moderate pain increased from over two-thirds (41 patients) to 43. Simultaneously, the number of patients reporting mild pain decreased from 15 to 14, which means it differs only with one patient and there was no patient free from pain with statistically insignificant difference observed ($P < 0.10$). In addition, these changes significant differences between both groups at these times, including immediately after,30 min, and 60 min while $p = < 0.001$, < 0.0001, and < 0.001, respectively.

Regarding anxiety levels, according to **table 3**, it is observed that in the virtual reality group a substantial majority of patients (93.3%) initially exhibited severe anxiety, which diminished to 8.3 after 60 minutes. Additionally, the proportion of patients experiencing mild anxiety rose from 0% to two-thirds (66.7%) also demonstrating a significant difference ($p = 0.00$).

Concerning anxiety levels in the control group, a substantial majority of patients (91.7%) initially presented with severe anxiety, which decreased to 45 patients after 60 minutes. Furthermore, the percentage of patients experiencing moderate anxiety increased from 5 to 15 patients, with no significant difference noted ($p = 0.06$). Additionally**,** these changes were with significant differences in these times, including immediately after,30 min, and 60 min, while $p = < 0.001$, < 0.001, and < 0.001, respectively.

Table 4 illustrates the mean differences of bio-parameters in both studied groups at different times. In the virtual reality intervention group, obviously, all of the bio-parameters, namely respiratory rate, heart rate, systolic blood pressure, and diastolic blood pressure, decreased along with the various times of measurement immediately after 30 min and 60 min of application of virtual reality intervention with significant differences while p = (<0.0, <0.0, <0.0, <0.0, <0.0 and 0.0). on the other hand, the mean differences in the bio-parameters of patients in the control group. It can be noted that all of the bio-parameters, namely respiratory rate, heart rate, systolic blood pressure, and diastolic blood pressure, slightly changed or decreased along with the different times of measurement: immediately after 30 min and 60 min of application of virtual reality intervention. Moreover, there was no significant difference.

Table 5 elucidates comparison between virtual reality and control groups according to mean changes in bio-parameters at different times. It is evident that the respiration rate dropped from 29.9 to 27 c/m, and there were periods of significant variations right after, 30 min after 60 min after the virtual reality intervention. p= <0.001, <0.001, <0.001. The HR declined from 101.2 beats per

minute (b/m) to 89.9 b/m over the specified periods. Conversely, the mean HR measurements within the control group demonstrated oscillations, with pronounced significant differences emerging between the two groups after 30 minutes and again after 60 minutes of the virtual reality intervention, with p-values recorded at 0.002 and 0.003, respectively.

It can be seen that systolic blood pressure decreased from 118.7 mmHg to 113.4 mmHg over time in virtual reality group. In contrast, the control group's mean increased from 120.3 to 121.3, with significant differences between the two groups after 30 and 60 minutes of application of the virtual reality intervention, while p=0.032, 0.016. Also, mean differences in diastolic blood pressure in the virtual reality intervention group decreased from 76.33 mmHg to 70.5 mmHg along with time. Meanwhile, the means in the control group increased from 77.17 to 78.55, with significant differences between both groups after 30 min and 60 min of virtual reality intervention, p=0.009, 0.001.

Table (1): Distribution of patients according to their clinical features (n=120)

Patient's characteristics	Studied groups				χ^2	MC_p
	Virtual reality (n=60)		Control (n=60)			
	No.	%	No.	%		
Age (years)						
18 -30	2	3.3	0	0		
31 -40	8	13.3	4	6.7	3.6	0.3
41- 50	13	21.7	12	20		
51 - 60	37	61.7	44	73.3		
Gender					0	1
Male	26	43.3	26	43.3		
Female	34	56.7	34	56.7		
Surgical history	54	90	54	90	0	1
Current diagnosis						
Cardiovascular	30	50	30	50	0	1
Respiratory	9	15	16	26.7	2.5	0.2
Neurological	1	1.7	0	0	1.0	1
Endocrine/Metabolic	9	15	7	11.7	0.3	0.8
Gastrointestinal	2	3.3	1	1.7	0.3	1
Renal	7	11.7	3	5	1.8	0.3
Hematological	5	8.3	10	16.7	1.9	0.3
Past medical history						FE_p
Cardiovascular	28	46.7	20	33.3	2.2	0.1
Respiratory	10	16.7		11.7	0.6	0.4
Neurological	0	0	2	3.3	2.0	0.5
Endocrine	24	40	14	23.3	3.9	0.1
Gastrointestinal	5	8.3	7	11.7	0.4	0.8
Renal	3	5	3	5	0	1

χ^2: Chi square test. MC: Monte Carlo. FE: Fisher Exact

Table (2): Comparison between virtual reality and control groups according to the changes in severity of pain at different time intervals of performing interventions

Study groups	Severity of pain	time intervals of performing interventions: Before No.	Before %	Immediately after No.	Immediately after %	after 30 mins No.	after 30 mins %	after 60 mins No.	after 60 mins %	F test (p)	Partial eta squared
Virtual reality group (n=60)	No pain	2	3.3	38	63.3	24	40	20	33.3	167.5* (<0.00*)	0.87
	Mild	16	26.7	16	26.7	27	45	30	50		
	Moderate	40	66.7	6	10	8	13.3	9	15		
	Severe	2	3.3	0	0	1	1.7	1	1.7		
Control group (n=60)	No pain	0	0	0	0	0	0	0	0	2.2 (0.10)	0.15
	Mild	15	25	20	33.3	19	31.7	14	23.3		
	Moderate	41	68.3	35	58.3	39	65	43	71.7		
	Severe	4	6.7	5	8.4	2	3.3	3	5		
test	χ^2	2.35		75.94*		51.15*		54.67*			
	MC p	0.589		<0.001*		<0.001*		<0.001*			

F: F test (ANOVA) with repeated measures for comparing the different periods *: Statistically significant at p ≤ 0.05. Partial eta squared**:** Small effect; 0.5, Medium effect <0.8, Large effect > 0.8. χ^2: Chi square test: comparing between both groups, MC: Monte Carlo.

(n=120):

Table (3): Comparison between virtual reality and control groups according to the changes in severity of anxiety at different times intervals of performing interventions (n=120):

Studied groups	Severity of anxiety	time intervals of performing interventions: Before No.	Before %	Immediately after No.	Immediately after %	after 30 mins No.	after 30 mins %	after 60 mins No.	after 60 mins %	F test (p)	Partial eta squared
Virtual reality group (n=60)	Mild	0	0	46	76.7	44	73.3	40	66.7	42.6* (<0.00*)	0.92
	Moderate	4	6.7	13	21.7	14	23.3	15	25		
	Severe	56	93.3	1	1.7	2	3.3	5	8.3		
Control group (n=60)	Mild	0	0	0	0	0	0	0	0	3.7 (0.06)	0.15
	Moderate	5	8.3	15	25	14	23.3	15	25		
	Severe	55	91.7	45	75	46	76.7	45	75		
test	χ^2	0.12		85.21*		84.33*		72.20*			
	p	1.00		<0.001*		<0.001*		<0.001*			

F: F test (ANOVA) with repeated measures for comparing the different periods at the same group *: Statistically significant at p ≤ 0.05. Partial eta squared**:** Small effect; 0.5, Medium effect <0.8, Large effect > 0.8. $\chi 2$: Chi square test: comparing between both groups.

Table (4): Mean differences of bio-parameters of patients in both studied groups at different time intervals of performing interventions:

Studied groups	Bio-parameters	time intervals of performing interventions				F test (p)	Partial eta squared
		Before	Immediately after	after 30 mins	after 60 mins		
		$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$		
Virtual reality	R.R.	29.9 ±3.2	26.2 ±2.76	26.5 ±2.86	27 ±2.99	114.6*(<0.0*)	0.83
	H.R.	101.2 ±20.5	95.3 ±15.1	89.9 ±9.6	89.9 ±9.9	25.1*(<0.0*)	0.89
	S.B. P	118.7 ±19.4	118 ±14.2	114.5 ±11.8	113.5 ±10.6	7.3* (0.0*)	0.60
	D. B. P	76.3 ±13.3	76.5 ±10.1	74.3 ±9.5	70.5 ±14.6	6.4* (0.0*)	0.59
Control group	R. R	29.2 ±2.9	28.7 ±2.9	28.9 ±3.2	29.1 ±3.2	2.6 (0.1)	0.12
	H.R.	96.2 ±21.3	95.7 ±21.4	99.3 ±20.9	95.1 ±21.1	0.2 (0.9)	0.03
	S.B. P	120.3 ±20.9	120 ±20.1	121.2 ±20.6	121.3 ±22.4	0.4 (0.7)	0
	D. B. P	77.2 ±13.8	77.2 ±14.2	79.5 ±11.7	78.6 ±12.3	2.4 (0.1)	0.07

, R. R: Respiratory rate, H.R.: Heart rate, S.B. P: Systolic blood pressure, D. B. P: Diastolic blood pressureF: F test (ANOVA) with repeated measures for comparing the different periods *: Statistically significant at $p \leq 0.05$. Partial eta squared: Small effect; 0.5, Medium effect <0.8, Large effect > 0.8.

Table (5): Comparison between virtual reality and control groups according to the changes in bio-parameters at different times:

bio-parameters	Studied groups		t	p
	Virtual reality	Control		
Respiratory rate (c/m)				
Immediately before	29.85±3.21	29.18±2.91	1.19	0.24
Immediately after nursing interventions	26.12±2.76	28.65±2.92	4.89*	<0.001*
30 min After nursing interventions	26.50±2.86	28.85±3.18	4.25*	<0.001*
60min After nursing interventions	27.0±2.99	29.12±3.17	3.766*	<0.001*
Heart rate (b/m)				
Immediately before	101.23±20.52	96.18±21.34	1.32	0.19
Immediately after nursing interventions	95.32±15.12	95.65±21.38	0.10	0.92
30 min After nursing interventions	89.90±9.59	99.25±20.99	3.14*	0.002*
60min After nursing interventions	89.90±9.86	95.05±21.11	3.04*	0.003**
Systolic blood pressure(mmHg)				
Immediately before	118.67±19.35	120.33±20.91	0.45	0.65
Immediately after nursing interventions	118.00±14.24	120.00±20.08	0.63	0.53
30 min After nursing interventions	114.50±11.78	121.17±20.59	2.18*	0.032*
60min After nursing interventions	113.50±10.59	121.33±22.36	2.45*	0.016*
Diastolic blood pressure (mmHg)				
Immediately before	76.33±13.27	77.17±13.79	0.34	0.74
Immediately after nursing interventions	76.50±10.05	77.17±14.15	0.30	0.767
30 min After nursing interventions	74.33±9.45	79.50±11.71	2.66*	0.009*
60min After nursing interventions	70.50±14.55	78.55±12.26	3.28*	0.001*

t: Student t-test for comparing the two groups, *: Statistically significant at $p \leq 0.05$

Discussion:

In this research most subjects were cardiac patients and their age between 51- 60 years because, Cardiac diseases were more prevalent in older age demographics, rising from 2.2% in individuals aged 45 to

54 to 14% in those aged 75 and above. Moreover, in this study, participants who could communicate effectively reported their pain levels using the Numeric Rating Scale (NRS) **(Australian institute of health 2024)**.

Regarding pain, there was a significant decrease in the percentage of patients in the virtual reality intervention group who reported experiencing moderate pain. Additionally, there was an increase

in the number of patients reporting either no pain or mild pain. While, the proportion of patients in the control group patients experiencing severe, moderate pain decreased only with one patient with no patient free from pain. The previous results are supported with the findings of **Locke et al, 2024** A study that examined participants revealed the ability of virtual reality to serve as a distraction from pain. Additionally, in a case report study done by **Esumi et al, 2020** It was observed that three sessions of virtual reality analgesic therapy administered over a two-day period produced enduring pain relief effects, enabling a reduction in fentanyl dosage by 25-75%. Moreover, A randomized trial carried out by **Merliot-Gailhoustet et al** in **2022** investigated the effects of different electronic relaxation devices on the reduction of overall discomfort and pain in sixty ICU patients reinforcing the findings of this study. As, it was observed that the group with virtual reality using a synthetic imagined had a notable reduction in overall discomfort and pain.

Concerning anxiety, in the virtual reality group a substantial majority of patients exhibited severe anxiety highly diminished. Additionally, those experiencing mild anxiety rose from 0% to two-thirds. On the other hand, there was a slight effect of deep breathing for relaxation technique on anxiety better than its effect on pain, but that effect was not significant. This result was in accordance with the finding of **Haley & Wacker's** study in **2022** to evaluate the effects of a 5-minute virtual reality session that showcased a cinematic video of an outdoor green or blue environment with 360° visual motion. This study involved patients who were on mechanical ventilation, and it was concluded that using a visual analog scale to measure anxiety levels was a feasible approach for this pilot study.

In addition, **Navarra-Ventura et al, 2021** assessed a VR-based neurocognitive treatment in 34 critically ill patients during their ICU stay; these patients experienced up to 50% lower anxiety compared to the control group. **Jawed et al, 2021** found a significant acceptance of VR, which decreases anxiety and has few side effects. Furthermore**, Ong et al, 2020 and Hendricks et al, 2020** stated that virtual reality therapy enhanced patients' ICU experience by lowering their anxiety levels.

Contrary to the results of this study, previous clinical trials had not reported significant effects of VR on pain and anxiety **(Bashir et al, 2024, Lier et al, 2024, Laghlam et al, 2021)**. another randomized controlled trial reported no significant effect on pain by **Rousseaux et al, 2020 & 2022** for 100 patients undergoing cardiac surgery. The impact of VR applications on patient anxiety and pain was tested by providing hypnotherapy without and with VR, but the outcome showed no significant differences were found concerning the measures. In addition, **Laghlam et al, 2021** found that VR did not meet statistical requirements and was not very effective in managing pain and anxiety.

The virtual reality in this research had a beneficial impact on bio-parameters. The reduced respiratory rate, heart rate, and blood pressure during VR demonstrate its calming influence. Consistent with the findings of this study, physiological variables diminished in ICU patient **(Ribeiro et al, 2023)**. It was concluded that the VR game has a positive influence on physiological variables and can thus be

employed as a safe form of physical activity for both healthy people and those recovering after hospitalization. Moreover, a prior study by **Rutkowski et al, 2021** discovered that VR correlates with decreased heart rate.

A previous study by **Chen et al, 2021** confirmed that comparing a user's heart rate data in both resting and VR states shows significant changes in heart rate during the VR experience, suggesting that VR can effectively reduce the user's psychological tension. Concurrently, variations in heart rate were strongly linked to VR content. Additionally, VR may result in reduced blood pressure and a lower heart rate in previous studies **(Vorwerg - Gall et al, 2023, Naef et al, 2023)**. Conversely, a study conducted by **Ong et al, 2020** did not indicate that virtual reality had major impacts on physiological measures. Additionally, **Vlake et al, 2021** reported that there were no changes in vital signs during their study. While there was a notable decrease in respiratory rate during VR stimulation, both heart rate and blood pressure remained unchanged.

Conclusion and recommendations:

Virtual reality (VR) positively influences the alleviation of pain and anxiety in critically ill patients. The findings indicate that it is recommended critical care nurses should incorporate mobile-based immersive virtual reality as a novel method for pain relief, thereby improving patient comfort and nursing care outcomes. VR therapy presents a cutting-edge, patient-focused strategy that can be customized to meet individual preferences, thereby enhancing patient comfort and decreasing the dependence on pharmacological treatments like sedatives and analgesics.

Further studies:

1- Repetition of the previous study by using different pain-relieving methods such as music considering age related factors.

2- - Repetition of the previous study considering age related factor with different diagnosis.

Limitations of the study:

Two notable limitations of the present study should be highlighted. Firstly, the research utilized a small convenience sample size, which may restrict the applicability of the findings to a broader population. Secondly, the majority of participants were individuals with cardiovascular disease within a specific age range, failing to accurately reflect the entire population of ICU patients. Additionally, the sampling method was non-representative and non-randomized, as it included only those patients who could communicate and self-report their pain levels using the Numeric Rating Scale (NRS). Therefore, it is advisable to conduct this study again with a more diverse age range and varied diagnoses.

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