

Original Research

The Effectiveness of an Educational Virtual Reality Video on Relieving Patient Anxiety Prior to Cardiac Catheterization

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Abstract

Objectives: Cardiac Catheterization which is commonly known as Coronary angiography (CAG) serves as a vital diagnostic tool for coronary artery disease (CAD) identification. Patients undergoing this procedure often encounter pre-CAG anxiety, which can adversely impact the overall treatment process. The utilization of virtual reality (VR) technology presents a novel educational approach to alleviate pre-catheterization anxiety among patients, showcasing promising potential. This study sought to evaluate the efficacy of an educational virtual reality video in reducing anxiety levels among patients undergoing coronary angiography. **Methods:** In this interventional study, 108 patients undergoing coronary angiography were divided into two groups. The experimental group viewed an educational VR video via immersive headsets, while the control group watched the same content in the most common 2-Dimensional flat format using a tablet. Anxiety levels were measured using the State Anxiety Inventory (SAI) before and after the intervention. **Results:** In the post intervention phase, the experimental group showed a significant decrease in mean anxiety levels from 49.91 ± 6.72 to 38.94 ± 8.92 , with a notable difference compared to the control group ($P < 0.001$). **Conclusion:** These findings highlight the potential of virtual reality training as a non-pharmacological intervention to effectively mitigate anxiety among CAG patients.

Keywords: Virtual Reality, Anxiety, Patients, Cardiac Catheterization, Coronary Angiography

INTRODUCTION

Cardiovascular disease (CVD) is a significant public health concern and remains the leading cause of mortality worldwide. Within the spectrum of CVDs, coronary artery disease (CAD) holds the distinction of being the most prevalent and significant contributor to CVD-related deaths. Both invasive and noninvasive methods are employed to diagnose CAD. Among these, cardiac catheterization stands out as one of the most common and precise diagnostic tests, providing insights into the extent and severity of coronary artery stenosis¹.

Although cardiac catheterization is generally considered a routine and relatively safe procedure by healthcare professionals, previous studies have revealed that a significant number of patients perceive it as a potential life-threatening event². Various studies have indicated that a considerable proportion of patients experience heightened anxiety in anticipation of cardiac catheterization³ with the highest levels reported during the immediate pre-procedural waiting period⁴. Several studies in Jordan⁴, Turkey⁵, Iran⁶ and Netherlands⁷ have highlighted the prevalence of high anxiety levels among patients scheduled for cardiac catheterization. Given the unfamiliarity with both the hospital environment and the specific procedure, it is understandable that patients undergoing cardiac catheterization commonly experience heightened anxiety.

Assessing and managing anxiety in patients undergoing cardiac catheterization is imperative for various reasons. Heightened anxiety associated with this procedure can have adverse psychological and physiological effects, potentially disrupting the process and affecting cardiac function. Studies have confirmed that unaddressed anxiety can trigger heightened activity in the sympathetic nervous system, leading to increased blood pressure, heart rate, respiratory rate, myocardial oxygen consumption, and cardiac workload. Moreover, escalated anxiety, through the activation of the sympathetic nervous system, may elevate the force of heart contractions and subsequently increase the risk of arrhythmias, a major concern during cardiac catheterization⁸.

Hence, strategies aimed at minimizing anxiety in patients undergoing cardiac catheterization are not only crucial for ensuring patient comfort but also hold potential for improving outcomes⁹. Various approaches have been employed to manage anxiety in such patients, including both pharmacological and nonpharmacological methods. Among these, nonpharmacological interventions are preferred due to their cost-effectiveness, minimal complications, and ease of implementation in clinical settings. These interventions encompass procedural and sensory education, psychological support using cognitive-behavioral techniques, and relaxation methods like music therapy, educational videos, massage therapy, relaxation techniques, and biofeedback¹⁰. In recent years, Virtual Reality (VR) has emerged as a valuable tool in healthcare, increasingly utilized by clinicians to facilitate analgesia and alleviate anxiety in inpatient settings¹¹. Its immersive nature offers patients a unique opportunity to prepare for the impending procedure and the treatment environment. Despite its rapid expansion, the specific use of

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VR to prepare patients for invasive cardiac procedures remains inadequately studied¹².

A review of existing literature indicates that the use of Virtual Reality (VR) can contribute to improved information provision and procedure-related knowledge, leading to higher satisfaction levels and reduced concerns regarding the cardiac catheterization procedure⁷. Furthermore, VR has been found to be effective in enhancing patients' understanding of the care process associated with cardiac catheterization¹³, fostering a greater sense of comfort during hospital stays¹⁴ and impacting anxiety levels in patients undergoing this procedure¹⁵. While several studies have confirmed the positive effects of VR on anxiety⁴⁻⁶, some have reported a lack of significant impact¹⁶ emphasizing the need for further research in this area¹¹. The major goal of this study is to investigate the impact of an educational 360 virtual reality video as a modern tool in preprocedural anxiety among patients hospitalized for cardiac catheterization (CATH).

METHODS

Study design and setting

This research was conducted as an interventional-educational study. The setting for the investigation was the Cardiac Center at a private hospital located in Amman, Jordan. The study commenced in February 2023 and concluded in August 2023.

Sample size and sampling

The sample size was determined using G-power software, resulting in a total sample of 102 participants (with medium effect size of 0.5, medium power of 0.8, the total sample should be 102, with 51 individuals allocated to each group. The inclusion criteria comprised individuals who were (a) 18 years of age, (b) proficient in Arabic, (c) scheduled for their first elective diagnostic cardiac catheterization, and (d) willing to participate, evidenced by a signed consent form. Exclusion criteria included (a) patients admitted for emergency cardiac catheterization, (b) those with a history of previous cardiac catheterization, (c) individuals with cognitive impairments, (d) patients with a history of psychotropic medication use, (e) those experiencing major hearing or visual difficulties, (f) individuals with life-threatening or major associated illnesses such as renal failure or cancer, and (g) those requiring admission to the intensive care unit (ICU) due to deteriorated health conditions either before or after the cardiac catheterization. In this research, the allocation of patients to either the experimental or control group was based on their admission day. This allocation was governed by a randomized process: patients admitted on Saturdays and Mondays were placed in the control group, while those admitted on Sundays and Wednesdays were included in the experimental group. This allocation strategy was intentionally designed to reduce the risk of intergroup contamination. This concern was particularly salient given that the study was conducted within a single private hospital in Amman. By synchronizing group assignments with the hospital's natural patient admission patterns, the research methodology facilitated a clear delineation between the experimental and

control groups. Such delineation is crucial for maintaining the integrity and validity of the study's outcomes. In total, the study comprised 108 participants who were distributed between the experimental and control groups. Figure (1) shows the flow diagram of the study

Measures

Demographic information form and Spielberger's State-Anxiety Inventory (SAI) were used for data collection.

Demographic information Form: Demographic and background information included gender, age, educational level, employment status, marital status, history of hospitalizations, duration of any heart disease and the heart rate, systolic blood pressure (SBP) and diastolic blood pressure (DBP).

State-Anxiety Inventory (SAI): The assessment of anxiety levels was conducted using the Arabic version of Spielberger's State-Anxiety Inventory (SAI). This inventory, a component of the State Trait Anxiety Inventory (STAI) developed by Spielberger in 1983, comprises 20 items that require self-reporting. It serves to evaluate the individual's temporal experience of apprehension, tension, nervousness, and worry, employing a 4-point Likert scale (ranging from 1, "not at all," to 4, "very much"). Possible scores on the SAI range from 20 to 80, with higher scores indicating heightened levels of anxiety¹⁷. The Arabic version of the STAI-Y exhibited high internal consistency reliability (Cronbach's alpha: 0.989) for both state and trait subscales¹⁸.

Data collection and intervention

To collect data, the researcher initially obtained the necessary permissions from the ethical committee of the hospital. The research team approached each patient scheduled for cardiac catheterization while they were waiting in the medical department, inviting them to participate in the study. The team provided a brief explanation of the study's purpose and screened patients for eligibility. Eligible participants, meeting the inclusion criteria and expressing their willingness to participate, were asked to sign a consent form.

Upon the selection of eligible participants, they were divided into two groups of experimental and control based on their admission day as previously explained. At this point, immediately after admission both groups were asked to fill the SAI. Following this initial assessment, individuals in the experimental group engaged within an immersive experience; they wore a head-mounted display, commonly known as a virtual reality headset, to view an educational video. This video, rendered in three-dimensional virtual reality, was designed to simulate a patient's experience on the day of the procedure. In the video, the physical layout of the cardiac catheterization room was shown. At the beginning of the film, the educational objectives were stated. The video started from the entrance of the catheterization unit, with the camera moving through the hospital corridors to the section where catheterization is performed. The researcher then entered the room and explained various parts of the section. The video provided a simple explanation for the participants about the use of the



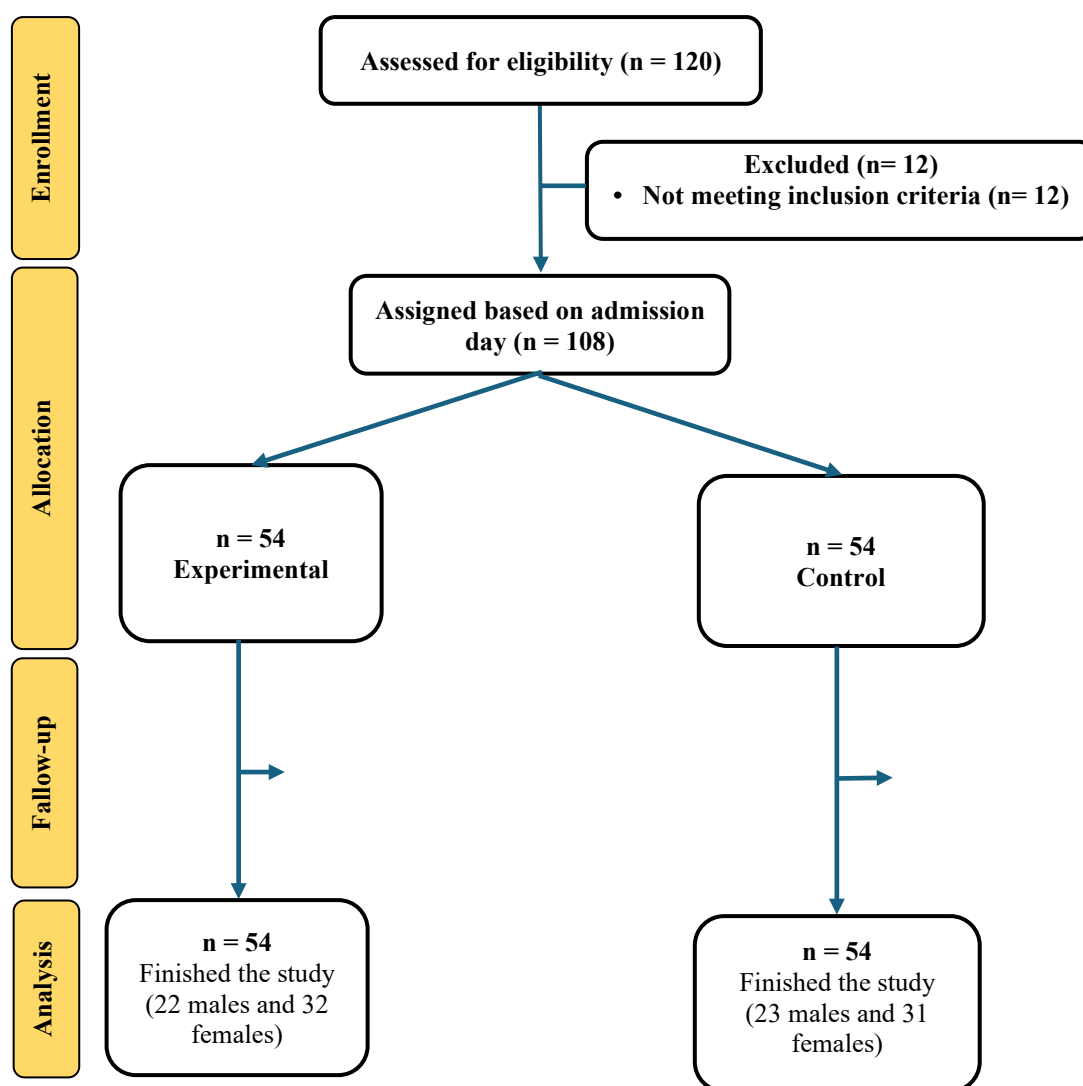


Figure 1. The flow diagram of the study.

devices employed during catheterization, the number of personnel present, and the procedure for positioning the patient on the table, as well as the equipment that might be attached to the patient. Additionally, the duration of the catheterization and the post-procedure steps were explained to the patients. The virtual reality video was delivered to the participants using TSCO VR glasses (model TVR 568) for 6 minutes and 22 seconds. Virtual reality glasses are fixed by interfaces around the patient's head, and the main display screen is placed on the person's eyes. For this purpose, the video was embedded in the VR glasses and displayed using a mobile phone equipped with virtual reality video playback software. Box (1) describes the production process of the used educational virtual reality video.

In contrast, the control group received the same educational content, but in a very different format. They watched a two-dimensional version of the same video on a tablet. After the

educational phase, and precisely two hours prior to undergoing cardiac catheterization, participants were instructed to complete the State-Anxiety Inventory once more. Before and after video watching, the pulse rate, systolic blood pressure (SBP) and diastolic blood pressure (DBP) of the patients were measured. To maintain blinding in the present study, participant selection was based on the patients' admission day. A nurse assessed the patients in the angiography department on designated days and participated in data collection. Additionally, physicians and nurses were not informed about the group allocations of the patients and were unaware of the group types.

Ethics Consideration

The study received ethical approval from the Ethics Committee of Al-Balqa Applied University, under the approval code 366/2/3/26. At the outset of the study, all participants

provided informed written consent. Prior to the intervention, the researcher provided a comprehensive explanation of the research's purpose and significance to the participants. The participants then completed the written consent form. The patients were assured that their involvement in the research was voluntary, and strict confidentiality would be maintained regarding their information.

Data analysis

Data analysis was conducted using SPSS 25 software. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were employed to illustrate the demographic characteristics of the participants. The similarity between the two groups was determined using an independent t-test. Paired t-test was used within the groups, taking into account the normal distribution of anxiety scores in both groups and the equality of variance. The significance level was set at 0.05 for all analyses.

RESULTS

The mean ages of the participants in the experimental and control groups were 55.37 ± 9.01 years and 56.13 ± 8.41 years, respectively. A statistical analysis revealed no significant difference in age between the two groups ($P = 0.96$, $t = 0.61$). In terms of gender distribution, 59.3% ($N = 32$) of the participants in the experimental group and 57.4% ($N = 31$) of the participants in the control group were female. Furthermore, 63.0% of participants in both the experimental and control groups were married. No significant differences were observed

between the two groups regarding marital status, education level, employment status, and income ($P > 0.05$) as shown in Table (1).

Before the intervention, the mean pulse rate was 79.35 ± 8.53 in the experimental group and 79.62 ± 7.77 in the control group. Similarly, the mean systolic blood pressure was 131.12 ± 7.58 in the experimental group and 131.98 ± 6.17 in the control group as shown in Table (2). A paired t-test revealed a significant reduction in both pulse rate and systolic blood pressure within the same group for both experimental and control groups after the intervention ($P < 0.001$). Although the independent (unpaired) t-test showed no statistically significant differences between the virtual reality and simple video groups in terms of pulse rate and systolic blood pressure ($P > 0.05$), the calculated effect sizes suggest that the intervention may have clinical relevance. Specifically, the effect size for pulse rate reduction was moderate in both the experimental ($d = 0.51$) and control ($d = 0.46$) groups, while the effect size for systolic blood pressure was small in the control group ($d = 0.11$) and small-to-medium in the experimental group ($d = 0.39$). These values indicate that, clinically, the intervention could contribute to reducing physiological stress markers, even though the between-group differences did not reach statistical significance. In the experimental group, the mean anxiety levels were 49.91 ± 6.72 and 38.94 ± 8.92 before and after the intervention, respectively. A significant reduction in anxiety was observed after the intervention ($P < 0.001$). Conversely, the mean anxiety in the control group decreased from 49.89 ± 4.51 before the intervention to 44.94 ± 4.65 after the intervention.

Table 1: Demographic information in the two groups of intervention and control.

Group Variable		Experimental		Control		Chi-square test	P value
		%	N	%			
Sex	Male	22	40.7	23	42.6	0.03	0.84
	Female	32	59.3	31	57.4		
Age (year)	35 - 49	15	27.8	11	20.4	0.96	0.61
	50 - 60	21	38.9	25	46.3		
	61 -75	18	33.3	18	33.3		
Marital status	Married	34	63	34	63	0	>0.99
	Widow / Divorced / single	20	37	20	37		
level of education	High school	8	14.8	8	14.8	0.06	0.96
	Diploma	10	18.5	9	16.7		
	College education	36	66.7	37	68.5		
Work status	Working	22	40.7	22	40.7	0	>0.99
	Non-working	11	20.4	11	20.4		
	Retired	21	38.9	21	38.9		
Income	> 400	13	24.1	13	24.1	0.61	0.73
	400 - 600	33	61.1	30	55.6		
	600 <	8	14.8	11	20.4		

Data were presented numerically (%).



Table 2. Comparison of the mean of vital signs (pulse and blood pressure) at different times in the two groups of experimental and control						
Pulse Rate						
Group Variable	Experimental		Control		T - test	P value
	M	SD	M	SD		
Before the catheterization	79.35	8.53	79.62	7.77	-0.17	0.86
After the catheterization	75.38	8.66	75.66	7.74	-0.17	0.86
Paired t-test	24.65		19.86			
P value	<0.001		<0.001			
Systolic blood pressure						
Group Variable	Experimental		Control		T - test	P value
	M	SD	M	SD		
Before the catheterization	131.12	7.58	131.98	6.17	-0.64	0.52
After the catheterization	130.22	8.34	129.53	6.31	0.48	0.63
Paired t-test	3.04		9.93			
P value	0.004		<0.001			
Diastolic blood pressure						
Group Variable	Experimental		Control		T - test	P value
	M	SD	M	SD		
Before the catheterization	80.59	4.39	80.14	3.75	0.56	0.57
After the catheterization	79.59	4.28	78.96	3.51	0.83	0.40
Paired t-test	11.96		7.57			
P value	<0.001		<0.001			

M: mean; SD: standard deviation.

Independent (unpaired) t-test demonstrated a significant disparity between the two groups in terms of mean anxiety levels before the intervention ($P < 0.001$). While both the experimental and control groups exhibited reduced anxiety after the intervention, the experimental group showed a more substantial decrease in mean anxiety levels post-intervention. The results of the T-test indicated no significant difference between the two groups in terms of mean anxiety before the intervention ($P = 0.98$). However, a significant reduction in mean anxiety was observed in the experimental group after the intervention ($P < 0.001$) (Table 3). The findings highlighted a notable discrepancy between the two groups regarding the mean anxiety scores post-catheterization.

DISCUSSION

In the current literature, few studies have focused on the use of virtual reality educational videos to address pre-catheterization anxiety. Morgan and Gallagher (2019) demonstrated the positive impact of a comprehensive virtual reality experience on anxiety levels in patients undergoing cardiac catheterization¹⁵. Hermans et al. (2019) highlighted the use of VR, leading to increased patient satisfaction and effective management of apprehension and anxiety associated with the ablation

procedure⁷. Aardoom et al. found that the use of the Pre-View VR app was effective in enhancing patients' understanding of the cardiac catheterization process and in better preparing them for the procedure, thereby mitigating potential negative psychological consequences post-catheterization¹³. In Pouryousef et al.⁶ and Keshvari et al.¹⁹ studies, VR reduced the anxiety in patients undergoing angiography.

The findings of the present study are consistent with research conducted in pediatric populations. Gold et al. [2021] demonstrated the effectiveness of the "Doc McStuffins: Doctor for a Day Virtual Reality Experience" (DocVR) in reducing pediatric preoperative anxiety levels. Patients exhibited a statistically significant decrease in anxiety following engagement with the DocVR game. Additionally, 97% of the patients reported feeling more at ease in the hospital environment, while 74% reported a reduction in fear associated with the hospital setting after participating in the game¹⁴. In a systematic review and meta-analysis, the impact of VR as a novel rehabilitation method on anxiety reduction was demonstrated, although it did not have a significant effect on functional capacity (FC)²⁰. These findings support the notion that VR holds promise as an effective tool in managing anxiety across diverse patient populations.

The study by Lattuca et al. (2018) indicated that watching a



Table 3. Comparison of the mean of anxiety at different times in the two groups of experimental and control						
Group Variable	Experimental		Control		T - test	P value
	M	SD	M	SD		
Before the catheterization	49.91	6.72	49.89	4.51	0.01	0.98
After the catheterization	38.94	8.92	44.94	4.65	-6.00	<0.001
Paired t-test	7.96		9.75			
P value	<0.001		<0.001			

M: mean; SD: standard deviation.

specialized educational video improved patients’ understanding and satisfaction before coronary angiography, although it did not affect their anxiety levels¹⁶. Discrepancies in the results might stem from variations in the tools used to measure anxiety, as well as differences in the demographic variables of the study samples.

However, the impact of information on anxiety remains a topic of debate. The utilization of social media, patients’ previous medical history, their prior knowledge about coronary angiography, and their interactions with cardiologists can all contribute to the information pool that potentially influences patients’ anxiety levels¹⁶.

Research indicates that enhancing patients’ motivation to comprehend their medical condition and encouraging active participation in education can potentially contribute to reducing patient anxiety. For instance, in patients scheduled for atrial fibrillation (AF) ablation, the utilization of a VR preprocedural educational video resulted in improved information provision and enhanced knowledge about the procedure, leading to increased satisfaction and reduced concerns regarding the intervention⁷. Additionally, findings suggest that the implementation of a fully immersive VR cognitive training program could be viable and effective for patients with mild cognitive impairment and mild dementia. Psychiatrists, occupational therapists (OTs), and patients reported positive satisfaction with the program, demonstrating a willingness to utilize it²¹.

Virtual reality has garnered attention as an educational tool capable of enhancing patient comprehension of their medical conditions and improving treatment satisfaction in practical healthcare settings²². By enabling the creation of lifelike experiences, VR technology facilitates a sense of immersion and situational realism for patients, thus promoting relaxation and alleviating anxiety. Previous studies have also demonstrated the positive effects of VR, particularly among elderly patients. Furthermore, VR has the potential to effectively convey medical information and knowledge to patients. Nevertheless, further research is necessary to identify the specific patient populations and contexts in which VR proves to be the most beneficial. Healthcare professionals should consider integrating virtual reality into their patient education strategies, and concerted efforts are required to address existing knowledge gaps in this domain²².

Research has demonstrated that the implementation of

VR-based patient education can significantly enhance patient comprehension of treatment regimens, improve adherence, and facilitate shared decision-making in disease management, consequently fostering an improved patient-provider relationship within authentic healthcare settings²³. Notably, patients’ understanding of clinical concepts was notably enriched through the utilization of educational videos, particularly in comprehending examination procedures and the implications of pathological findings¹⁶. This comprehensive educational approach can effectively alleviate patient apprehension and anxiety, empowering them in recognizing and managing their health concerns.

Limitations

Several limitations are apparent in the current study. Firstly, the absence of randomization in participant selection may lead to selection bias, potentially impacting the generalizability of the findings. Secondly, the study participants primarily represented individuals from Jordan. Thus, the applicability of the study findings to more diverse populations warrant further investigation. Consequently, it is advisable to conduct similar interventions within societies with diverse cultural backgrounds to ascertain the cross-cultural efficacy of the intervention.

Lastly, the use of self-reported anxiety assessment tools represents another limitation of the study. The reliance on these tools may not fully capture the subtle behavioral manifestations of anxiety among patients, potentially limiting the comprehensive understanding of the patients’ actual emotional states. Despite these limitations, the study offers valuable insights into the potential benefits of virtual reality in medical settings, though further research with more rigorous controls is recommended to substantiate these findings.

CONCLUSION

This study provides compelling evidence that the integration of virtual reality videos can effectively mitigate anxiety levels among coronary angiography (CAG) patients. Therefore, it is strongly advised to consider the incorporation of virtual reality videos as a practical and accessible method within medical centers to alleviate patient anxiety. Additionally, it is recommended to prioritize the training of healthcare professionals, particularly nurses, to enhance their proficiency and understanding of virtual reality implementation and utilization in patient care.



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