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# Patient Perceptions of a Virtual Reality-Based System for Pulmonary Rehabilitation: A Qualitative Analysis

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Abstract. The objective of this study was to evaluate the attitudes, beliefs, and perspectives of patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD) while using a virtual reality (VR) system supporting a home-based pulmonary rehabilitation (PR) program. Patients with a history of COPD exacerbations were asked to use a VR app for home-based PR and then undergo semi-structured qualitative interviews to provide their feedback on using the VR app. The mean age of the patients was  $72\pm9$  years ranging between 55 and 84 years old. The qualitative data were analyzed using a deductive thematic analysis. Findings from this study indicated the high acceptability and usability of the VR-based system for engaging in a PR program. This study offers a thorough examination of patient perceptions while utilizing a VR-based technology to facilitate access to PR. Future development and deployment of a patient-centered VR-based system will consider patient insights and suggestions to support COPD self-management according to patient requirements, preferences, and expectations.

Keywords. Virtual reality, telerehabilitation, chronic obstructive pulmonary disease, qualitative analysis

## 1. Introduction

Chronic obstructive pulmonary disease (COPD) is a common illness that is a significant social and economic burden and is a leading cause of death worldwide [1]. Pulmonary rehabilitation (PR) has demonstrated to be an effective treatment for reducing dyspnea symptoms, increasing exercise tolerance, and enhancing the quality of life in COPD patients is rehabilitation [2]. Adherence and compliance with traditional center-based PR programs remain limited due to transportation issues, lack of motivation, the burden of their illnesses, a lack of awareness, and a lack of understanding about the benefits. Thus, developing innovative and engaging methods to facilitate PR programs is crucial.

Advancements in computer-assisted technology, such as virtual reality (VR), have been established as a promising approach for implementing personalized, motivating, and engaging content for the rehabilitation and management of chronic diseases [3]. Despite the potential benefits of VR, its application to facilitate a rehabilitation intervention in patients with COPD remains under investigation. The objective of this

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qualitative study was to examine the perceptions and experiences of COPD patients during their use of a VR app to receive exercise instructional content and complete the prescribed exercises.

## 2. Methods

Patients with a diagnosis of COPD and a recent history of acute exacerbation were eligible to participate in the study. Purposive sampling was employed to identify potential participants. Recruitment continued until information saturation was reached or no novel or relevant information was discoverable from the available data [4]. Nine COPD patients consented and enrolled in the study. During data collection, a trained researcher demonstrated using the VR exercise app. Patients were instructed to use the VR headset and controllers to open the VR exercise app and select and perform an exercise using the guided instructions. Afterward, a semi-structured qualitative interview (about 20 minutes) consisting of open-ended questions examining the participant's experience with the content, interface, and the process of using a VR-based system to complete a guided PR exercise was conducted. The responses for each open-ended question were recorded in separate de-identified documents using Microsoft Word, which served as the raw data set.

Thematic analysis was used to organize, recognize, and interpret critical patterns and themes in the qualitative data [6]. The raw textual data was organized in alignment with the three usability areas evaluated in the semi-structured qualitative interviews: content, interface, and process. Initial codes were generated using a deductive or 'top-down' approach where codes are strongly linked to the data and map onto a specific research question or theme [5]. The codes were aggregated to identify and summarize general themes and sub-themes with concise descriptions and examples. The findings of the thematic analysis were summarized for reporting. The study was approved by the Institutional Review Board.

#### 3. Results

## 3.1. Themes Related to the Content of the Virtual Reality Application

Overall, 9 patients were enrolled in the study. The mean age of the patients was 72±9 years ranging between 55 and 84 years old; 44% were males. Their feedback showed that the exercise content was well received. Patients described the exercise content as enjoyable, simple, easy to understand, new, exciting, fun, informative, and relaxing. When asked to discuss any benefits of using the VR app to learn how to perform the PR exercises, patients highlighted the perceived increase in motivation to complete the prescribed exercises, increase in engagement, increase in focus on the exercise content, and removal of distractions. Patients also mentioned that the novel method of using the VR app to learn how to exercise and manage their COPD symptoms was beneficial. Most patients reported no problems understanding the tips or directions provided by the VR app. Two participants reported having difficulty hearing the instructions due to the low voice of the instructor. Patients suggested including additional exercises to improve the guided exercise content using the VR app. The following citation demonstrates the patient's perspective on the exercise content delivered by VR to enable continued

participation in the PR program: "It's interesting. It's a new way of exercising, more of a visual, more technical way, when you see it you have a better understanding."

## 3.2. Themes Related to the Interface of the Virtual Reality Application

Patients were asked if there were any benefits of using the VR app compared to printed materials or video clips. Patients reported that in comparison to print or video instructions, the VR exercise app was easier to use. Patients also thought that the VR app helps increase the ability to focus on the exercise content compared to the printed materials or video clips. One patient stated that the large screen size of the VR app was easier to follow and that the experience of the virtual environment felt similar to an in-person social interaction. The majority of patients reported having no problems with using the VR app to help perform the prescribed exercises. One patient disliked the length and the black screen while the VR app was loading. One patient described the headset as a feeling on their face. One patient responded that the headset was heavy and initially did not know how to adjust the head strap. Two suggestions to improve the experience using the interface of the VR app to complete the PR exercises were to decrease the length of the black screen during the initial loading of the VR app and include an option to pause the exercise and return. The following citation illustrates how the interface of the VR system supports patient engagement with the PR program: "I think it's easier and they are explaining it better. The VR app compared to the computer, they are similar but with the VR app, you feel like the instructor is right there, so I prefer VR."

## 3.3. Themes Related to the Process of Using the Virtual Reality Application

Patients responded with high approval when asked to share their experiences with the process of using the VR app to complete the PR exercises. Patients stated that the convenience of using the VR exercise app at home was beneficial. Additional benefits reported by patients include the ability to change their visual environment without having to travel, the simplicity of the VR exercise app, and the removal of distractions at home (e.g., TV). Patients indicated that the use of the VR exercise app would increase the likelihood of participating in the PR program.

When patients were asked to describe any problems or concerns, patients reported no issues with using the VR app to complete the PR exercises. Suggestions for additional features to improve the effectiveness of the VR exercise app were to increase the variety of available PR exercises, adjust the appearance of the black screen while the VR exercise app loads, and include feedback about exercise progress. The patient's viewpoint on the process of using the VR exercise app to support sustained participation in the PR program is illustrated by the following citation: *"Yes, I feel more confident engaging myself in this task. I'll be more willing because it's nice, and I feel like I'm in another place. It's best to go to a different place whenever I want, and it's not boring at all."* 

#### 4. Discussion

The current study aimed to understand the perspective of COPD patients regarding their experience engaging with the VR-based system to complete a home-based PR program. The virtual environment was designed to replicate a typical center-based PR. Semi-structured qualitative interviews were thematically analyzed to deductively identify

emergent themes across the content, interface, and process of using the VR exercise app. The initial findings demonstrate that utilizing VR in conjunction with exercise training and COPD education is possible and well-tolerated by COPD patients. The key themes that emerged from the qualitative data related to the ease of access and comprehension of the guided exercise instructional videos, improved attention and focus on the exercise content, convenience, and perceived increase in motivation, confidence, and compliance of a PR program. Patients expressed minimal problems or concerns using the VR exercise app, including disapproval of the length and display black screen while the VR app is loading, initial difficulty locating the library icon to launch the VR exercise app, and adjustment to the weight of the headset. Additionally, patients highly valued the immersive virtual environment and removal of distractions and felt comfortable interacting with the VR exercise app independently to receive instructional and educational material to complete the PR exercises.

Even though the study subjects were represented by VR-naïve older adults, the COPD patients have enthusiastically embraced the VR-based system, rating it highly for usability, satisfaction, and engagement. Prior research on the topic of VR rehabilitation has identified a number of benefits, including increased compliance, improvement in physical mobility and strength, and motivation to exercise [3]. A few studies have investigated patient perspectives, attitudes, and beliefs about using a VR-based system to facilitate self-managed PR in COPD patients. The findings from this qualitative study demonstrate that a VR-based system is an effective method to facilitate access to PR. Future research will assess how well the VR-based technology encourages COPD patients to participate in a self-managed PR program at home. The outcomes of this patient group will be contrasted with a control group that underwent traditional PR strategies.

#### 5. Conclusion

This study provides an in-depth qualitative analysis of patients' perspectives on using a VR-based system to take part in a home-based PR program. The findings of this study demonstrate that patients reported high satisfaction and acceptance of the VR exercise app. These results will be considered during the future design and implementation of a patient-centered VR-based pulmonary rehabilitation program.

#### References

- Mei F, Dalmartello M, Bonifazi M, Bertuccio P, Levi F, Boffetta P, Negri E, La Vecchia C, Malvezzi M. Chronic Obstructive Pulmonary Disease (COPD) mortality trends worldwide: An update to 2019. Respirology. 2022 Nov;27(11):941-50. doi: 10.1111/resp.14328.
- [2] McCarthy B, Casey D, Devane D, et al. Pulmonary rehabilitation for chronic obstructive pulmonary disease. Cochrane Database Syst Rev. 2015 Feb 23;2015(2):CD003793. doi: 10.1002/14651858.CD003793.pub3.
- [3] Huang Y, Huang Q, Ali S, et al. Rehabilitation using virtual reality technology: a bibliometric analysis, 1996–2015. Scientometrics. 2016 Dec;109:1547-59. doi: 10.1007/s11192-016-2117-9.
- [4] Miles MB, Huberman AM. Qualitative data analysis: An expanded sourcebook. Sage Publication, 1994.
- Braun V, Clarke V. Using thematic analysis in psychology. Qualitative research in psychology. 2006;3(2):77-101. doi: 10.1191/1478088706qp063oa.
- [6] Ritchie J, Spencer L. Qualitative data analysis for applied policy research. Analyzing Qualitative Data. 1994; 9:1-22. doi: 10.4135/9781412986274.