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Evaluation of pharmacological adherence in patients with chronic diseases treated in hospital units using virtual reality.

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ABSTRACT

The study examined the impact of virtual reality (VR)-based interventions on medication adherence for the treatment of chronic non-communicable diseases (NCDs). Patients with NCCD were examined, evaluating sociodemographic variables such as gender, age, educational level, socioeconomic level, professional activity and area of residence, to determine the effectiveness of VR as an intervention tool. The results revealed that 57.10% of patients did not reach an adequate level of compliance with pharmacological treatment. Although the sociodemographic variables studied do not present statistical significance, the area of residence seems to be a determining factor in affiliation. Women were more adherent than men, highlighting the relevance of considering gender-specific approaches in future interventions. In terms of quality of life, patients who were nonadherent to medication reported significantly worse physical health, while those with good mental health showed better medication adherence behaviors. These results highlight the importance of taking both physical and mental health into account in virtual reality-based intervention strategies. In conclusion, virtual reality-based interventions represent a promising alternative to improve treatment adherence in patients with NCD, suggesting the need to adapt these interventions based on the sociodemographic characteristics and specific needs of patients to optimize results. long-term health.

Keywords: Virtual Reality; Adherence; Chronic diseases; Interventions; Digital Health.

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1. Introduction

Chronic non-communicable diseases (NCDs) are a growing concern worldwide and represent a significant burden of morbidity and mortality. These conditions, characterized by progressive and long-term pathologies, include cardiovascular diseases, oncological pathologies, respiratory diseases, and diabetes. Medication adherence, understood as the proper following of the prescribed treatment plan for NCDs, is a key factor in managing these conditions (1).

The World Health Organization (WHO) emphasizes that NCDs are not only a category of disability but also the leading cause of death worldwide. However, alarming data reveals that only 50% of patients diagnosed with chronic diseases successfully adhere to their treatments (2). These figures are supported by statistics from the Ministry of Public Health of Ecuador, where NCDs accounted for 56% of deaths in 2018, with cardiovascular diseases, cancer, diabetes, and chronic respiratory diseases being the main contributors (3).

Non-adherence to medication not only poses risks to individual health but also has a negative impact on the efficiency of the healthcare system, increasing medical costs and leading to avoidable complications. This phenomenon results in reduced treatment effectiveness, drug resistance, recurrence of infections, and an overall decrease in well-being (4).

In this context, virtual reality (VR)-based interventions have emerged as an innovative tool in the field of health, offering new possibilities to improve therapeutic compliance in patients with NCDs. Virtual reality, by providing immersive and personalized experiences, has the potential to motivate patients and encourage positive behaviors related to their treatment. Recent studies suggest that virtual reality can be effective in increasing patient motivation and engagement, thereby facilitating better adherence to the treatment regimen (5).

The foundation of this project lies in the importance of addressing medication adherence in patients with NCDs through the use of virtual reality-based interventions. These interventions can provide an innovative and potentially more effective approach to overcoming traditional barriers to adherence.

The overall objective of this research is to assess the impact of VR interventions on medication adherence among patients with NCDs treated at Teófilo Dávila General Hospital. Through this evaluation, valuable information is intended to be provided to the community regarding the importance of self-care and the need for proper treatment follow-up, thereby contributing to improving health outcomes and quality of life for patients with chronic diseases.

Based on the information above, the following problematizing question is posed:

¿Can virtual reality-based interventions significantly improve medication adherence in the treatment of chronic diseases?

2. Materials and Methods

Type and Research Design

The study is observational, descriptive, and cross-sectional, conducted during the months of October and November 2023. It focused on evaluating the impact of virtual reality-based interventions on medication adherence in the treatment of chronic diseases.

Research Approach

The research employs a mixed-methods approach, using two validated questionnaires in non-communicable chronic diseases: the Morisky-Green adherence questionnaire and the SF-12 health survey, to measure medication adherence and quality of life among patients participating in virtual reality interventions. The data collected were analyzed and categorized.

Population and Sample Convenience sampling method was used. The study population included all hospitalized patients with chronic diseases in internal medicine areas 1 and 2 who visited the pharmacy area of the Medical Center between October and November 2023 and participated in virtual sessions. The sample consisted of 385 patients, calculated using the formula for an infinite population, with a confidence interval of 95% and a margin of error of 5%. The formula used was:

$$n = \frac{Z^2 * p * q}{e^2}$$

- n = Sample size sought
- Z = Statistical parameter depending on Confidence Level (95% = 1.96)
- e = Maximum acceptable estimation error, 5% (0.05)
- p = Probability that the studied event occurs (0.5)
- q = Probability that the studied event does not occur (0.5)

Inclusion and Exclusion Criteria

Inclusion criteria:

- Male and female patients.
- Patients who provide informed consent.
- Patients over 18 years old.

- Patients diagnosed with diabetes, cardiovascular disease, cancer, or respiratory disease for more than 6 months.
- Patients who participated in virtual reality sessions.

Exclusion criteria:

- Patients who refused to participate in the study.
- Patients who did not sign informed consent.
- Patients who did not participate in virtual reality sessions.

Hypothesis

- HO: Virtual reality-based interventions do not have a significant impact on therapeutic compliance in patients with chronic diseases.
- H1: Virtual reality-based interventions have a significant impact on medication adherence in patients with chronic diseases.

Variables

- Independent variable: Virtual reality-based interventions.
- Dependent variable: Medication adherence.

Materials

- Tests used (Morisky-Green Test and SF-12 Health Survey).
- Virtual reality equipment.
- HP brand computer.
- Microsoft Office software.
- Databases: Redalyc, Scielo, PubMed, Scopus, Web of Science.

Development**Data Collection**

The data collection technique involved administering validated questionnaires to measure medication adherence and quality of life among patients with non-communicable chronic diseases, before and after virtual reality interventions. The first questionnaire consisted of 4 questions with dichotomous responses related to medication adherence, where the patient's response indicated adherence (No, Yes, No, No). The second questionnaire comprised 12 multiple-choice questions related to quality of life, with patients scoring above 50 considered to have good quality of life and those scoring below 50 considered to have poor quality of life.

Statistical Analysis

After collecting data using the aforementioned questionnaires, the results were anonymized and stored in a database created with Microsoft Office Excel 365 Personal, 2020. Data from the SF-12 questionnaire were processed using a specific calculator provided by Orthotoolkit®, and the scores were saved in the Excel database. Results from the Morisky-Green questionnaire were interpreted and stored in the same database.

For processing and descriptive statistical analysis, the software Jamovi was used. Qualitative variables were represented using frequencies (percentage), while quantitative variables were expressed as mean \pm standard deviation. A comparative analysis was conducted before and after the virtual reality intervention to determine its impact on treatment adherence.

3. Results and Discussion

The final sample consisted of 410 patients, with a majority being women (50.7%). Participants aged over 60 years constituted the predominant group (66.8%). Regarding education, 39.3% of patients had a medium educational level, followed by 31.5% with a low educational level. 85.1% of patients reported a low socioeconomic status. In terms of occupation, 57.3% of patients were retired and 42.7% were employed. The majority of participants resided in urban areas (70.7%).

The most common pre-existing conditions were arterial hypertension (42.7%) and diabetes (37.1%). These data provide an overview of the studied population and their sociodemographic and health characteristics, as evidenced below:

Table 1:

Obtained Results

Sample size (n) = 410			
Sociodemographic data		Frequency	Percentage
Age	(<60)	136	33.2%
	(>60)	274	66.8
Gender	Male	202	49.3%
	Female	208	50.7%
Educational Level	Low	129	31.5%
	Intermediate	161	39.3%
	High	120	29.3%
Socioeconomic Level	High	61	14.9%
	Low	349	85.1%
Employment Status	Active Employee	175	42.7%
	Retired	235	57.3%
Residence Area	Rural	120	29.3%
	Urban	290	70.7%
Pathologies	Arthritis	9	2.2%
	Arthrosis	10	2.4%
	Asthma	20	4.9%
	Cancer	13	3.2%

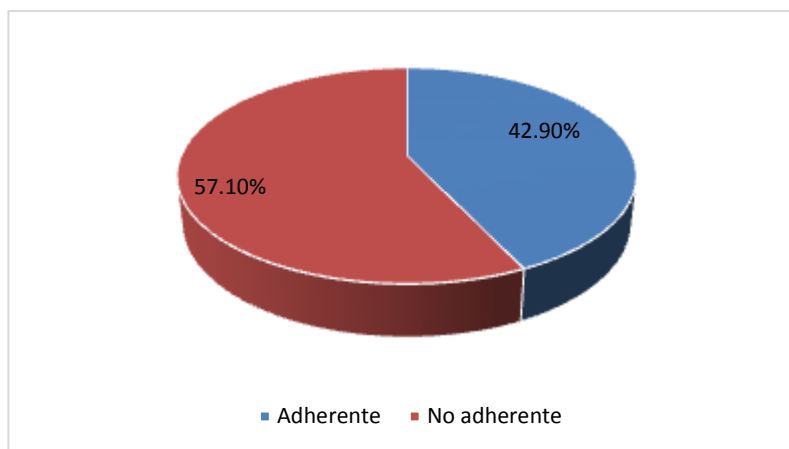
	Cirrhosis	1	0.2%
	Diabetes	152	37.1%
	Epilepsy	5	1.2%
	COPD	1	0.2%
	Pulmonary Fibrosis	1	0.2%
	Fatty Liver	1	0.2%
	Benign Prostatic Hyperplasia	4	1.0%
	Arterial Hypertension	175	42.7%
	Hyperthyroidism	2	0.5%
	Hypothyroidism	1	0.2%
	Acute Myocardial Infarction	1	0.2%
	Leukemia	1	0.2%
	Diabetic Neuropathy	1	0.2%
	Osteoporosis	8	2.0%
	Parkinson	4	1.0%

Source: Own elaboration.

The final sample consisted of 410 patients, with a balanced representation of gender (49.3% men and 50.7% women). This distribution allows for the observation of potential differences in medication adherence between both genders, which is relevant for tailoring virtual reality interventions to the specific needs of men and women. As depicted in the following graph:

Graph 1:

Treatment adherence in the studied population



Source: Own elaboration

Regarding age, the majority of participants were over 60 years old (66.8%), reflecting the prevalence of chronic diseases in this population. This information is crucial because virtual reality-based interventions need to be tailored to the needs and abilities of this age group, which typically faces greater challenges with medication adherence due to multiple comorbidities and potential physical or cognitive limitations. Thus:

Table 2:*Relationship between medication adherence and age*

Age		Medication adherence		
		Adherent	Non-adherent	Total
<60	Frequency	50	86	136
	%	36.8%	63.0%	100%
>60	Frequency	126	148	274
	%	46.0%	54.1%	100%
Total	Frequency	176	234	410
	%	42.9%	51.1%	100%

$p= 0.076$

Source: Own elaboration

The patients' educational level shows that 39.3% had a medium educational level, followed by 31.5% with a low level. These data highlight the importance of considering communication strategies and health education that are understandable and accessible for individuals with varying levels of literacy. The implementation of virtual reality tools must take these variations into account to be effective.

Table 3:*Relationship between medication adherence and educational level.*

Educational level		Adherencia farmacológica		
		Adherent	Non-adherent	Total
low level	Frequency	57	72	129
	%	44.2%	55.8%	100%
Intermediate level	Frequency	65	96	161
	%	40.4%	59.6%	100%
High level	Frequency	54	66	120
	%	45.0%	55.0%	100%
Total	Frequency	176	234	410
	%	42.9%	57.1%	100%

$p= 0697$

Source: Own elaboration

A significant number, 85.1% of patients, reported a low socioeconomic status, which could negatively influence treatment adherence, as economic limitations may impact their ability to afford medications and follow treatments. In this regard, virtual reality interventions can be a valuable tool to provide additional support and education to these patients, helping them better manage their treatments. According to the following results:

Table 4:*Relationship between medication adherence and socioeconomic level.*

Socioeconomic level		Adherencia farmacológica		
		Adherent	Non-adherent	Total
low level	Frequency	144	205	349
	%	41.3%	58.7%	100%
high level	Frequency	32	29	61
	%	52.5%	47.5%	100%
Total	Frequency	176	234	410
	%	42.9%	57.1%	100%

$p= 0.103$

Source: Own elaboration

The following table shows that 57.3% of the patients were retirees, while 42.7% were actively employed. These data are relevant for understanding the dynamics of time and availability of patients to participate in virtual reality interventions. Retirees may have more time to engage in additional health activities, whereas actively employed individuals may require more flexible schedules.

Table 5:*Relationship between medication adherence and employment status.*

Employment status		Adherencia farmacológica		
		Adherent	Non-adherent	Total
Active employee	Frequency	68	107	175
	%	38.9%	61.1%	100%
Retired	Frequency	108	127	235
	%	46.0%	54.0%	100%
Total	Frequency	176	234	410
	%	42.9%	57.1%	100%

$p= 0.151$

Source: Own elaboration

Regarding residence, the majority of participants lived in an urban area (70.7%). This may influence access to the necessary technologies for virtual reality interventions, as urban areas tend to have better technological infrastructure and better access to advanced health services compared to rural areas, as shown below:

Table 6:*Relationship between medication adherence and residence area.*

Residence area		Adherencia farmacológica		
		Adherent	Non-adherent	Total
Rural	Frequency	40	80	120
	%	33.3%	66.7%	100%
Urban	Frequency	136	154	290
	%	46.9%	53.1%	100%
Total	Frequency	176	234	410
	%	42.9%	57.1%	100%

$p= 0.012$

Source: Own elaboration

On the other hand, the most common pre-existing conditions in the sample were arterial hypertension (42.7%) and diabetes (37.1%). These results align with the most prevalent chronic diseases in the general population and underscore the need for effective interventions to improve medication adherence in these patients. Virtual reality could offer specific benefits in educating and monitoring these patients, thereby enhancing their compliance and health outcomes.

This highlights that the socio-demographic and health data of the sample provide a detailed insight into the study population, essential for the design and implementation of virtual reality-based interventions. Sample characteristics, such as the high prevalence of low socioeconomic levels, the predominance of individuals over 60 years old, and the prevalence of diseases such as hypertension and diabetes, must be considered when developing and adapting virtual reality tools to improve medication adherence. Strategies should be accessible, understandable, and tailored to the specific needs of this diverse population.

4. Discussion.

Various studies have identified multiple factors contributing to non-adherence to pharmacological treatment among patients with chronic diseases. Moura et al. (2016) (6), in their study of 138 Brazilian patients, highlighted factors such as low socioeconomic levels, stress, anxiety, lack of family support, difficulties in accepting and adapting to lifestyle changes, polypharmacy, and inadequate disease information as influencing non-adherence. This analysis underscores the importance of considering these factors when designing interventions, such as those based on virtual reality, to improve adherence.

A study conducted at three primary care centers in Quito by Hernández et al. (2018) (7) revealed that approximately one in four patients does not adhere to prescribed medication regimens, regardless of the disease or treatment duration. This finding is consistent with information from Martin et al. (2005) (8), who noted that approximately 40% of patients do not follow pharmacological treatment recommendations, with non-adherence rates reaching up to 70% for more complex treatment regimens. Chaudri (2004) (9) also considers socioeconomic status as a

key factor in adherence, observing that in developing countries, medication adherence among patients with chronic diseases is only around 50%.

Effective communication between doctor and patient is another essential aspect. Non-adherence can lead to inappropriate dose adjustments by the physician, which may result in complications and suboptimal outcomes, impacting not only the individual patient but also public health overall (Hernández et al., 2018) (7).

Further research, such as that by Ortiz et al. (2022) (10), Bello Escamilla and Montoya Cáceres (2017) (11), and Guamán-Montero et al. (2021) (12), indicated that women tend to adhere better to treatment than men, possibly due to a greater willingness to use healthcare services. According to Romero et al. (2017) (13), adherence to pharmacological treatment gradually increases with age, especially after 60 years old, although Brugere et al. (2020) (14) and Rodero et al. (2020) (15) caution that individuals over 60 face factors such as concurrent use of multiple medications and cognitive impairments that may negatively affect adherence.

The level of education also plays a crucial role in medication adherence. Montenegro Esmeral (2022) (16) and other studies have indicated that higher education is associated with better adherence due to a better understanding of medical instructions. However, Muñoz Acuña et al. (2021) (17) found that patients with lower educational levels have an average risk of non-adherence to treatment, which aligns with the observations of Bello Escamilla and Montoya Cáceres (2017) (11), Cieza-Arámbulo and Zapata-Bayona (2022) (18), and Cordero-Sánchez et al. (2022) (19).

The lack of economic resources and limited accessibility to healthcare services are also important factors. According to Brugère et al. (2020) (14) and Parra et al. (2019) (20), many patients experience difficulties accessing medical appointments due to economic and transportation issues. Lee et al. (2018) (21) pointed out that the limited availability of medical services constitutes a widespread socioeconomic barrier in low-income countries, particularly affecting individuals from lower social positions. On the other hand, Ferreyra Dávila (2021) (22) highlighted that patients with higher economic status adhere better to treatment due to their ability to access private healthcare services and medications from private pharmacies.

These results highlight the need to develop interventions that address these multiple and complex factors. Virtual reality technologies could offer new avenues to improve medication adherence by providing personalized education, interactive reminders, and psychological support tailored to the specific needs of different patient groups.

Studies indicate that retired patients adhere better to pharmacological treatment than actively

employed individuals. Coque Tutasing (2011) (23) corroborates this finding by emphasizing that retirees, having more time and fewer responsibilities, are more likely to follow their treatment correctly. On the other hand, actively employed individuals, due to their multiple roles and daily responsibilities, face greater difficulties in adhering to prescribed treatment regimens.

Non-compliance with pharmacological treatment is particularly common among patients residing in rural areas. According to García Valle (2020) (24), this non-compliance is a significant cause of illness, especially in cases of hypertension, and is linked to economic limitations and mobility difficulties that hinder adequate intervention against non-communicable chronic diseases. Ortega Cerdá et al. (2018) (25) emphasize the importance of education, communication, and information to improve medication adherence among rural residents, which can have a positive impact on public health.

In addition, Gigoux López et al. (2010) (26) mention that non-communicable chronic diseases are common in rural communities due to the lack of cultural recognition of these conditions, which increases the risk of complications. In contrast, urban communities tend to show higher adherence to treatment due to better education and access to treatments and epidemiological studies. Vilugrón Aravena et al. (2018) (27) indicate that factors such as family conflict, abuse, mental disorders, and low income negatively affect medication adherence in both rural and urban areas.

As patients age, there is an increased risk of experiencing poor quality of life due to declining functionality associated with aging, particularly among women, who experience higher rates of disability and depression (Lera et al., 2021) (28). These factors negatively influence therapeutic compliance. Lara et al. (2020) (29) highlight the importance of the SF-12 in assessing quality of life, allowing for comparisons of health status between different populations and evaluating therapeutic interventions.

The SF-12 results indicate that 59.8% of the study population enjoys good quality of life in terms of physical health and 65.6% in terms of mental health, reflecting the positive impact of health interventions and policies, as well as the success of prevention and education programs. Vera-Villaruel et al. (2014) (30) mention that the SF-12 adopts a modern approach to health, inspired by the physical and mental well-being proposed by the World Health Organization, emphasizing the importance of objective and subjective assessments to promote health and well-being.

4. Conclusion

In the study on the impact of virtual reality (VR)-based interventions on medication adherence in managing non-communicable chronic diseases (NCDs), it was found that 57.10% of patients did not achieve an ideal level of pharmacological treatment compliance. This finding underscores the need to explore new strategies, such as virtual reality, to enhance treatment adherence in this

population.

Regarding sociodemographic factors, it was observed that variables such as gender, age, level of education, socioeconomic status, and occupation did not show statistical significance in relation to treatment adherence. However, it was found that the area of residence is a significantly related factor to treatment adherence in patients with non-communicable chronic diseases (NCDs). This result suggests that virtual reality-based interventions could be tailored specifically to the needs and conditions of different geographical areas to enhance their effectiveness.

Additionally, it was identified that the female gender shows higher adherence to pharmacological treatment in the studied population. Women demonstrated a greater tendency to comply with prescribed treatment, which could be due to a greater willingness to follow medical recommendations. Therefore, virtual reality interventions could be designed to leverage this trend and further strengthen adherence in both sexes.

Finally, regarding the relationship between adherence and quality of life, it was observed that, concerning physical health, most patients do not adhere to pharmacological treatment, resulting in poor quality of life. This finding suggests that virtual reality interventions should focus not only on improving adherence but also on promoting healthy lifestyle habits that benefit patients' physical health. In terms of mental health, patients reporting good quality of life showed better therapeutic compliance behaviors. This suggests that virtual reality interventions addressing mental health as well may be particularly effective in improving adherence to pharmacological treatment, providing a holistic approach that encompasses both physical and mental health aspects for patients.

5. Conflicts of Interest

No conflict of interest.

6. Author Contributions

N.I conducted the investigation, collected data, and wrote the manuscript following statistical analysis. KSG helped develop the topic, design, supervise, correct, and approve the text.

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