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SYSTEMATIC REVIEW

Impact of Telemedicine on Treatment Adherence in Chronic Cardiovascular Diseases: A Systematic review

Impacto de la telemedicina en la adherencia al tratamiento de enfermedades crónicas cardiovasculares: Revisión Sistemática

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ABSTRACT

Cardiovascular diseases (CVD) are one of the leading causes of morbidity and mortality worldwide. Telemedicine has emerged as an effective tool to improve treatment adherence, facilitate access to medical care, and enable continuous patient monitoring. This review analyzes various telemedicine interventions, such as remote monitoring, mobile applications, and video consultations, which have shown to reduce blood pressure, lower hospitalization rates, and improve quality of life. However, challenges remain regarding technological access and healthcare staff training, particularly in rural areas. Inclusive public policies and strengthened technological infrastructure are recommended to maximize the impact of telemedicine.

Keywords: Telemedicine; Treatment Adherence; Cardiovascular Diseases; Remote Monitoring; Digital Health.

RESUMEN

Las enfermedades cardiovasculares son una de las principales causas de morbimortalidad en el mundo. La telemedicina surgió como una herramienta valiosa y eficaz para incrementar y mejorar la adherencia al tratamiento, facilitar la accesibilidad a la atención médica permitiendo un mayor seguimiento en los pacientes. Esta revisión analiza múltiples intervenciones de la telemedicina, como la telemonitorización remota, aplicaciones móviles y videoconsultas, que han mostrados disminuir la presión arterial (PA), hospitalizaciones y mejorar la calidad de vida. Empero, persisten desafíos asociados con la accesibilidad tecnológica y capacitación del personal de salud, especialmente en zonas rurales. Se recomienda implementar políticas públicas, así como, fortalecer la infraestructura tecnológica para optimizar el impacto de la telemedicina.

Palabras clave: Telemedicina; Adherencia al Tratamiento; Enfermedades Cardiovasculares; Telemonitorización.

INTRODUCTION

Cardiovascular diseases (CVD) represent one of the leading causes of morbidity and mortality worldwide, accounting for nearly 18 million deaths per year, which represents more than 30 % of all global deaths.[1] These pathologies include ischemic heart disease, heart failure, and hypertension, placing a significant burden on health systems as well as the global economy.

On the other hand, adherence to treatment is crucial for the effective management of CVD; however, only about 50 % of patients with chronic diseases in developed countries follow their treatments adequately.[2] That is why, in this context, telemedicine is emerging as a key and promising tool for increasing therapeutic adherence, facilitating access to medical care, and allowing closer follow-up with patients.[3]

Telemedicine has emerged as an essential tool for the care of patients with chronic diseases, especially for the management and control of cardiovascular diseases. These diseases are precisely one of the leading causes of global mortality[1] and pose significant challenges, particularly in terms of treatment adherence, due to factors such as barriers to access to health services, economic costs, and obstacles to continuous patient monitoring. Thus, information and communication technologies (ICT) and digital platforms have proven to be effective solutions for improving health outcomes.[4,5]

Internationally, several studies have demonstrated the positive impact of telemedicine in improving adherence to treatment for cardiovascular diseases. In France, researchers investigated the implementation of the Satelia Cardio application in patients with chronic heart failure in relation to treatment adherence, reporting 92 % satisfaction among users of this tool and highlighting its positive impact on remote monitoring.[6] Similarly, a randomized clinical trial in China and a meta-analysis in Italy of 25 studies on essential hypertension showed that interventions carried out with the help of telemedicine reduced systolic blood pressure and improved treatment adherence by significant amounts, positively impacting patients' quality of life compared to those with traditional management.[2,7] In Germany, with nearly 700 patients with chronic heart failure, it was found that adherence to exercise supervised by telemonitoring remained stable, but the use of instructional videos decreased over time, highlighting the need for sustainable strategies.[8]

In Latin America, an article by the PAHO unveiled the " All in One " digital platform, designed for the remote monitoring of chronic diseases in patients from vulnerable populations, which achieved a 25 % increase in therapeutic adherence and a 30 % decrease in face-to-face consultations.[9] Similarly, in a study that used telemedicine for monitoring, statistically significant control was achieved in comparison with the traditional group in the Argentine and Colombian populations in up to 68 % of patients.[10] On the other hand, in Colombia, a UMBRELLA-type review mentions that telemedicine is a useful tool in the management of chronic diseases and is related to the reduction of glycosylated hemoglobin levels in diabetic patients.[11]

In Peru, telemedicine proved to be relevant in the context of the COVID-19 pandemic. The country's social security cardiac health services designed a telerehabilitation program, achieving a statistically significant increase of more than 30 % in therapeutic adherence and improvement in quality of life. Similarly, a decrease of about 30 % in anxiety and depression levels was observed.[12] Likewise, in Chimbote, Peru, telemedicine had a significant impact on patients with heart failure during the pandemic, with a reduction in hospitalizations of about 10 % and an improvement in NYHA III functionality of 12,5 %.[13]

Lack of adherence to treatment in patients with CVD is a challenge that encompasses various factors such as the complexity of therapeutic regimens, side effects associated with medications, economic gaps, and limitations in access to health services that contribute to this non-compliance with therapy. As a result, this leads to an increase in hospitalizations, progression and worsening of diseases, and higher mortality rates.

The literature review will allow us to study the impact of telemedicine on adherence to CVD treatment, as this is essential for optimizing the management of these diseases in the context of the growing digitization of healthcare, overcoming not only geographical and socioeconomic barriers, but also the sustainability of healthcare systems and the reduction of unnecessary hospitalizations and associated costs.

The main objective of this study is to evaluate the impact of telemedicine on treatment adherence in patients with chronic cardiovascular diseases, based on recent evidence and highlighting its application in contexts with limited access to health services. It also aims to identify the types of interventions that are most frequently used and have the greatest influence on therapeutic adherence and impact on quality of life.

METHOD

The PRISMA methodology, developed by Mother et al.[14], was used. An exhaustive search of the literature compiled in the PubMed, Scopus, and SciELO scientific databases was conducted, considering the dates from January 2020 to December 2024. combinations of keywords were used, including the English terms: "telemedicine," "adherence to treatment," "chronic cardiovascular diseases," combined with the Boolean operator AND ("telemedicine" AND "adherence" AND "treatment" AND "chronic" AND "cardiovascular diseases") and for searches in Spanish ("telemedicina" AND "adherencia al tratamiento" AND " chronic cardiovascular diseases ").

Figure 1 shows the document selection process, beginning with the inclusion of studies in English, Spanish, Italian, and with full-text access; non-experimental review articles, meta-analyses, and simple non-experimental works were also included. Priority was given to articles that evaluated measurable outcomes in therapeutic adherence, quality of life, or reduction in hospitalizations related to chronic cardiovascular diseases.

Similarly, publications outside the 2021-2024 period were excluded, followed by studies without free

access. Subsequently, research corresponding to books, clinical trials, articles with only abstracts, guidelines, experimental studies, and qualitative works were discarded; studies that did not align with the research objectives were also excluded. After completing this process, a total of 20 articles were selected for review and analysis.

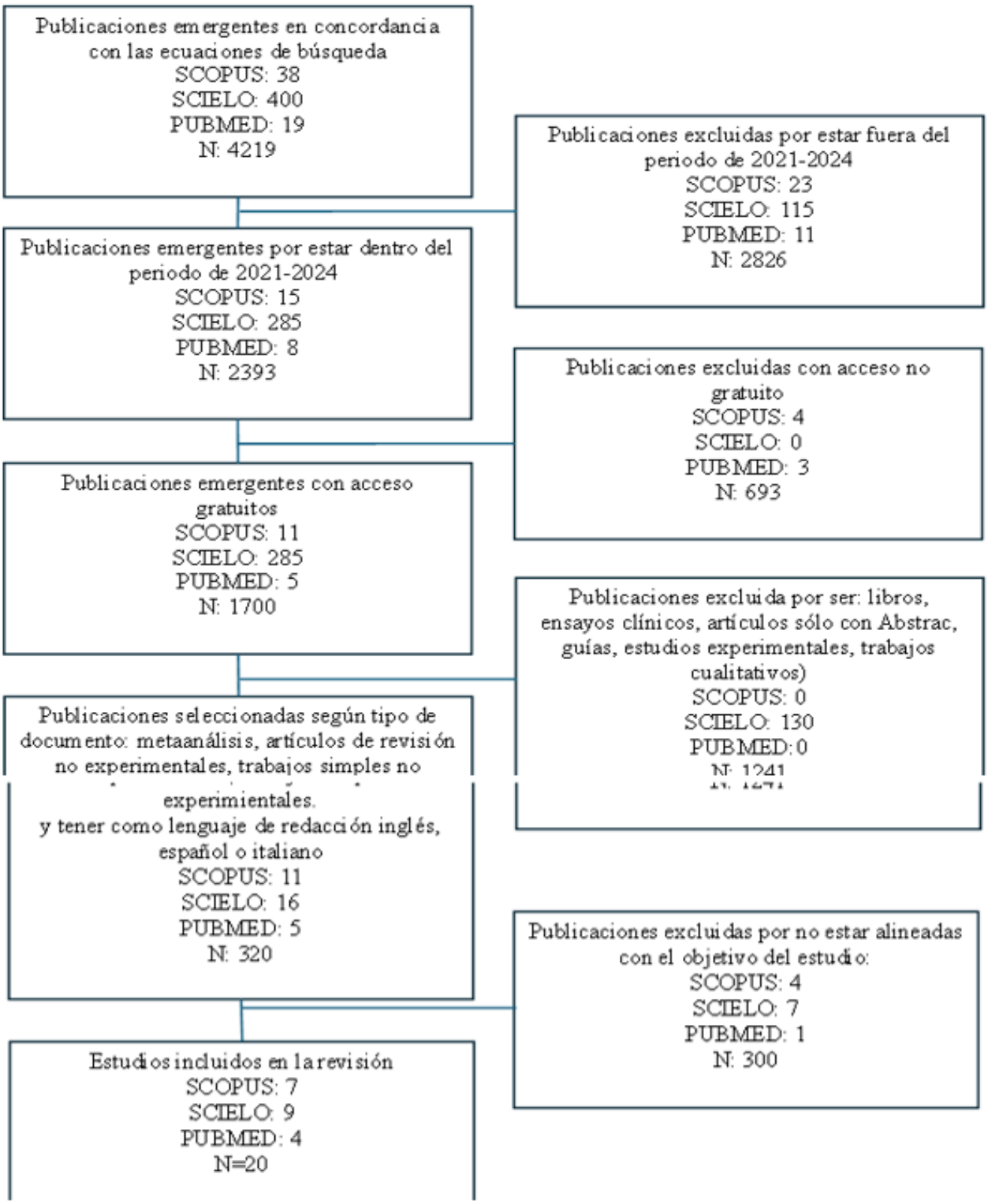

Figure 1. 1 PRISMA flow diagram of the systematization process

RESULTS

In table 1, the bibliography was systematically selected, detailing: a) author, b) year of publication, c) DOI, d) title, e) country of origin of the study, and f) abstract.

Table 1. Bibliography selected

No.	Author	Year	DOI	Title	Country	Abstract
1	Snoswell et al.[15]	2024	10.1016/j.pharm.2024.10.005	Synchronous telepharmacy models of care for adult outpatients: A systematic review	Austria	This study shows that synchronous telepharmacy improves treatment adherence (+15 %, p < 0,05) and reduces blood pressure in chronic patients (-5 mmHg, p < 0,05), with high satisfaction (4,5/5). Barriers such as technological access and pharmacist training are highlighted, suggesting that telepharmacy is a viable alternative but requires further study.
2	Kuan et al.[16]	2022	10.1016/S2589-7500(22)00124-8	Efficacy of telemedicine for the management of cardiovascular disease: a systematic review and meta-analysis	United Kingdom	72 studies with more than 127 000 participants were analyzed, evaluating the impact of telemedicine on cardiovascular disease. The meta-analysis of 34 studies showed a reduction in cardiovascular mortality (RR 0,83, 95 % CI 0,70-0,99; p=0,036) and hospitalization (RR 0,71, 95 % CI 0,58-0,87; p<0,001). The effectiveness of remote monitoring combined with virtual consultations is noteworthy.
3	Rebolledo Del Toro et al.[17]	2023	10.1007/s10741-022-10291-1	Effectiveness of mobile telemonitoring applications in heart failure patients: systematic review of literature and meta-analysis	Colombia	This study analyzed nearly 20 randomized clinical trials (RCTs) with 900 references. It found that mobile telemonitoring reduces the risk of hospitalization for heart failure (RR 0,77; 95 % CI 0,67-0,89; I^2=7 %). No statistically significant reduction in mortality was found (RR 0,90; 95 % CI 0,74-1,10; p = 0,32). Also, the impact on quality of life was variable.
4	Ziegler A et al.[18]	2023	10.1136/artjnl-2023-322518	Cost-effectiveness of a telemonitoring program in patients with cardiovascular diseases compared with standard of care	Germany	In this study, patients showed better quality of life (measured with EQ-5D) and lower annual costs, suggesting that telemedicine is not only effective but also cost-effective.
5	De Bonis et al.[19]	2022	10.3390/jcm11071920	The Telecardiology Revolution: From Emergency Management to Daily Clinical Practice	Italy	A sample of more than 1,200 patients was studied, and it was found that telecardiology reduced hospitalizations by 20 % (p < 0,01) and improved treatment adherence by 15 % compared to conventional care. There was also a decrease in response times in cardiovascular emergencies, with a reduction of approximately 10 minutes.
6	Rubanenko et al.[20]	2024	10.3390/life14040507	Comparative Effectiveness of Complex Telemedicine Support in Prevention of Hospitalizations and Mortality in Patients with Heart Failure: A Systematic Review and Meta-Analysis	Russia	This study analyzed nearly 20 randomized clinical trials in which describe that telemonitoring reduced the risk of hospitalization for heart failure by 20 % with statistical significance (RR 0,80; 95 % CI 0,68-0,94; p = 0,005). There was no statistically significant reduction in mortality (RR 0,88; 95 % CI 0,74-1,05;

						p = 0,15). Heterogeneity was moderate (I^2 = 37 %).
7	Ivanovska et al.[21]	2024	10.56294/saludcyt20241329	Technological innovations in cardiac rehabilitation: effectiveness and impact on patient's quality of life	Ukraine	Twelve randomized clinical trials (RCTs) involving nearly 2000 patients were evaluated, and it was found that technological innovations in cardiac rehabilitation, such as telemonitoring and remote exercise programs, reduce mortality by about 20 % (p < 0,05) and improve quality of life (EQ-5D score increased by >10 % compared to conventional care). Adherence to the programs was >80 % in the groups that used technology, compared to 70 % in the control group.
8	Kuan et al.[16]	2022	10.1016/S2589-7500(22)00124-8	Efficacy of telemedicine for the management of cardiovascular disease: a systematic review and meta-analysis	Malaysia, United Kingdom	Through a meta-analysis of more than 70 trials involving nearly 128,000 patients. A reduction in the risk of cardiovascular mortality (RR<1; 95 % CI 0,70-0,99; p<0,05) and hospitalization (RR<1; 95 % CI 0,58-0,87; p < 0,001) was found. Telemedicine is supported as an effective intervention for improving clinical outcomes.
9	Mohammadzadeh N et al.[22]	2022	10.1016/j.edinf.2021.104663	Telecardiology interventions for patients with cardiovascular disease: A systematic review on characteristics and effects	Australia	The study analyzed nearly 20 randomized clinical trials (RCTs), finding that telemedicine reduced the risk of cardiovascular events by 22 % (RR <1; 95 % CI 0,65-0,92; p < 0,01). Improvements in treatment adherence of about 20 % (RR > 1; 95 % CI 1,05-1,30; p < 0,01) were also observed compared to the group that received standard care.
10	Smith J et al.[23]	2023	10.2196/42845	Effectiveness of eHealth Interventions on Moderate-to-Vigorous Intensity Physical Activity Among Patients in Cardiac Rehabilitation: Systematic Review and Meta-analysis		The impact of digital interventions on patients with chronic cardiovascular disease has shown variable results. Nearly 30 studies were included that evaluated parameters such as moderate-to-vigorous physical activity (MVPA), observing significant improvements in vigorous activity (SMD >0; 95 % CI 0,00-0,39; p<0,05) and total activity (SMD >0; 95 % CI 0,07-0,28; p = 0,001). However, no significant changes were found in cardiovascular parameters or blood pressure. This highlights the need for further studies to assess the direct clinical impact.
11	Sun S et al.[24]	2024	10.1016/S2589-7500(24)00119-5	Mobile phone interventions to improve health outcomes among patients with chronic diseases: an umbrella review and evidence	Malaysia and United Kingdom	The impact of mobile interventions on cardiovascular disease has been widely studied. This study showed that these interventions reduce glycosylated hemoglobin (d = 0,44) and improve treatment

				synthesis from 34 meta-analyses		adherence. However, more than 40 % of the effects were found to be insignificant, and further research is needed.
12	Sikula D et al.[25]	2024	10.3390/jpm14070706	Enhancing Chronic Disease Management: Personalized Medicine Insights from Rural and Urban General Practitioner Practices	Poland	The increase in remote visits (57,6 % during COVID vs. 0 % pre-COVID, p < 0,001) shows how digital tools facilitated access to care and improved treatment adherence in populations with mobility difficulties. This study model is applicable to patients with chronic cardiovascular diseases, aligning with the objective of evaluating telemedicine as a strategy to improve clinical outcomes and reduce gaps in access to healthcare.
13	Hare J et al.[26]	2021	10.1007/s12170-021-00672-w	Novel Digital Technologies for Blood Pressure Monitoring and Hypertension Management	USA	The article analyzed studies on digital technologies for blood pressure monitoring, showing that the use of mobile applications, telemedicine, and wearable devices can lower SBP by up to 10 mmHg and increase treatment adherence by around 20 %. A moderate effect (Cohen's d 0,4-0,6) was observed, but with significant heterogeneity (I^2 >50 %). Although the results are promising, further research with a larger population and long-term follow-up is needed to validate their effectiveness.
14	Yardley L et al.[27]	2022	10.3310/BWFI7321	Digital interventions for hypertension and asthma to support patient self-management in primary care: the DIPSS research program including two RCTs	United Kingdom	The results showed a statistically significant (p<0,05) reduction in BP in hypertensive patients, with an average decrease of 6 mmHg. Treatment adherence increased by 20-25 % compared to the control group. Although the interventions proved to be cost-effective, 35 % heterogeneity (I^2) was found, representing variability in the interpretation of these tools. Thus, digital interventions are promising, but further analysis is needed to confirm their benefits.
15	Wu J et al.[28]	2023	10.2196/43489	Long-Term Results of a Digital Hypertension Self-Management Program: Retrospective Cohort	USA	This study analyzed more than 1,400 participants over 1 year. It showed an average reduction in SBP >10 mmHg (95 % CI: 10-14 mmHg) and DBP of 7 mmHg (95 % CI: 5-9 mmHg), both statistically significant (p < 0,001). In addition, more than 60 % of participants achieved the recommended blood pressure targets. These results suggest that digital programs may be effective for the long-term management of hypertension.

16	Gazit T et al.[29]	2021	10.1001/rkopen.2021.27008.	Assessment of Hypertension Control Among Adults Participating in a Mobile Technology Blood Pressure Self-management Program		The study analyzed nearly 30,000 adults with hypertension who used a mobile BP self-management program for a 3-year follow-up period. The results showed an average reduction in SBP > 11 mmHg (95 % CI) and DBP of nearly 6 mmHg (95 % CI), both statistically significant (p < 0,001). In addition, the percentage of participants with controlled blood pressure (<140/90 mmHg) increased by more than 40 % at the start of the study and more than 70 % at the end of the study. These results suggest that mobile self-monitoring programs may be effective in improving long-term hypertension control.
17	Kaihara T et al.[30]	2022		Automatic transmission of home blood pressure data can be effective in managing hypertension: a systematic review and meta-analysis	Japan	The effectiveness of automatic transmission of home blood pressure data in managing hypertension was evaluated. An average decrease in SBP of >4 mmHg (95 % CI) and DBP of >2 mmHg (95 % CI) was shown compared to usual care, both statistically significant (p < 0,001). It is therefore suggested that automatic transmission of BP data from home may be an effective strategy for improving hypertension control.
18	OraLee S et al.[31]	2022	10.2196/38215	Relationships Between Blood Pressure Reduction, Weight Loss, and Engagement in a Digital App–Based Hypertension Care Program: Observational Study	USA	A digital hypertension care app was used for more than three months, with results showing an average decrease in SBP >11 mmHg (95 % CI) and DBP >5 mmHg (95 % CI), both statistically significant (p < 0,001). In addition, an average weight loss of more than 2 kg (95 % CI) was observed, which was significantly correlated with the decrease in BP (r = 0,30, p < 0,001). These results suggest that participation in app-based digital programs may be effective for managing hypertension and reducing weight.
19	Abe M et al.[32]	2024	10.1038/s41440-024-01939-6	Smartphone application-based intervention to lower blood pressure: a systematic review and meta-analysis	Japan	This study analyzed more than 10 randomized controlled trials with over 1,000 participants, evaluating the effectiveness of smartphone app-based interventions in lowering BP. The results showed an average reduction in SBP >5 mmHg (95 % CI: -7,2 to -3,8 mmHg) and DBP > 3 mmHg (95 % CI: -4,5 to -1,9 mmHg), both statistically significant (p < 0,001), suggesting that mobile app interventions may be effective for managing hypertension.

20	Eaton C et al.[33]	2024	10.2196/50508	User Engagement With mHealth Interventions to Promote Treatment Adherence and Self- Management in People With Chronic Health Conditions: Systematic Review	USA	The study analyzed more than 30 mHealth interventions targeting patients with chronic diseases, evaluating the relationship between user engagement and treatment adherence. The results indicated that interventions with higher engagement rates showed an average improvement in adherence > 15 % (95 % CI: 12 %-22 %), with statistical significance (p < 0,001). There was also a positive correlation (r = 0,45, p < 0,01) between the level of interaction with the application and effective self-management of the disease. This suggests that the design of mHealth interventions that encourage high user engagement may be critical to increasing treatment adherence and self-management in people with chronic diseases.

DISCUSSION

Telemedicine is a tool that facilitates the provision of remote health services using information and communication technologies (ICT). Multiple digital devices have been integrated, adapting to the needs of patients with chronic diseases, using mobile applications, remote telemonitoring, and teleconsultations.[34,35]

In the various studies analyzed on telemedicine in the context of cardiovascular diseases, the use of different tools was found, including remote telemonitoring with portable and implantable devices as the most efficient, since it allowed continuous monitoring, associated with lower rates of hospitalizations and cardiovascular mortality.[36] Likewise, transtelephonic electrocardiography proved to be effective in the early detection of arrhythmias, especially in rural areas of Peru.[34] Similarly, interactive messages and mobile applications had a greater effect on treatment adherence, and telephone calls with video consultations facilitated continuity of care with limitations in clinical evaluation.[35,37]

On the other hand, patient satisfaction in this context was generally positive, although it varied depending on the tool used. In the Peruvian context, studies report satisfaction between 45 % and more than 60 % in patients treated in state health systems, influenced by accessibility to video calls and telephone consultations.[38] Similarly, due to their ease of use and constant access to medical care, both mobile applications and remote telemonitoring were well accepted.[36] However, global studies highlight the influence of barriers such as digital literacy and limited access to technology as a crucial part of the patient experience, which is why it is suggested that digital platforms be adapted to the needs and context of the population.[34,37]

Treatment adherence was evaluated using several parameters, such as medication compliance, BP control, participation in supervised exercise programs, and frequency of virtual consultations.[39] These evaluated parameters showed a significant decrease in hospitalizations and, in some studies, a decrease in cardiovascular mortality (although this varied).[2,7,8] Similarly, a significant reduction in SBP was demonstrated, varying slightly between studies from a reduction of 4 mmHg to more than 11 mmHg.[25,28,29,30,32]

In addition, the use of mobile applications and interactive messages increased adherence, and remote telemonitoring decreased hospitalizations and cardiovascular mortality. Similarly, remote exercise programs improved quality of life and increased adherence.[21]

Both technological access and training of healthcare personnel represent significant barriers to the effective implementation of telemedicine. The digital divide limits accessibility to digital platforms and advanced medical devices, especially in rural areas and vulnerable communities.[40] Insufficient training in the correct use of tools also affects the quality of remote care.[34]

In the economic sphere, telemedicine has also proven to be a viable and cost-effective tool, as it not only reduces hospital costs but also improves people's quality of life. Globally, the sectors that have benefited most are chronic disease management, primary care, and cardiac rehabilitation, as they generate continuous care and lower costs associated with hospitalizations.[18,27]

To encourage the adoption of telemedicine, it is necessary to incorporate public policies that promote digital inclusion, investment in technological infrastructure, and continuous training of healthcare personnel. Similarly, regulatory frameworks are required to protect personal data, IT security, and the quality of remote services.[41]

CONCLUSIONS

Telemedicine is an effective and cost-effective tool for increasing treatment adherence in the context of CV diseases. The use of different tools optimizes treatment monitoring and management. On the other hand, barriers such as technological access and training of healthcare personnel continue to exist, mainly in rural areas.

However, more research is needed to demonstrate its long-term effectiveness, primarily in vulnerable populations with limited resources. Similarly, strengthening technological infrastructure, implementing inclusive public policies, and promoting digital literacy are essential to maximize its impact and benefits, which will allow it to be consolidated as a key component in health systems.

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FINANCING

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CONFLICT OF INTEREST

None.

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