kidney and dialysis

Review

Technological Resources for Hemodialysis Patients: A Scoping Review

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Abstract

Objective: This scoping review synthesized and mapped the breadth of the existing literature on technological resources used to support individuals undergoing hemodialysis treatment. Methods: Following the methodological guidelines of the Joanna Briggs Institute (JBI) for scoping reviews and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist, comprehensive searches were conducted across the following databases: MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO, Scopus, Scientific Electronic Library Online (SciELO), MedicLatina, and the Cochrane Central Register of Controlled Trials, with no time restrictions. Results: Thirty-nine studies conducted between 2003 and 2023 met the inclusion criteria. These studies covered a range of technological innovations developed specifically for hemodialysis treatment, including virtual reality, exergames, websites, and mobile applications. These technologies were designed with diverse objectives: to facilitate physical exercise, optimize dietary and medication management, improve disease adherence and management, and promote self-efficacy and self-care in patients. Conclusions: The review revealed a wide range of technological resources available to hemodialysis patients. These digital solutions show great potential to transform care by promoting more engaged and personalized health practices. Although this study did not directly assess the impact of these technologies, it provides a solid foundation for future investigations that can explore in-depth how such innovations contribute to effective disease management and improvement in clinical outcomes.

Keywords: hemodialysis; patient education; renal dialysis; digital healthcare technologies; scoping review

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1. Introduction

Chronic kidney disease (CKD) is defined as abnormalities in kidney structure or function that have been present for at least three months and have implications for a person's health [1]. This disease is classified based on its cause, the category of glomerular filtration rate (GFR), and the level of albuminuria [1,2]. The progression of CKD through its various grades culminates in kidney failure, known as grade 5 [1,3].

In 2021, a joint statement from the American Society of Nephrology, the European Renal Association, and the International Society of Nephrology pointed out that more than 850 million people suffer from some form of kidney disease, approximately double the number of people with diabetes, 20 times higher than the prevalence of cancer, and more than those living with AIDS/HIV [1].

Given the high prevalence and progressive nature of CKD, more appropriate and comprehensive patient monitoring is required to initiate renal replacement therapy, allowing for a transition to a new lifestyle [2]. There are three types of renal replacement therapies: peritoneal dialysis, hemodialysis (HD), and kidney transplantation [3]. Hemodialysis is the most common therapy, with treatment sessions lasting between 3 and 5 h [2].

Furthermore, it is important to highlight the significant impact of the symptoms associated with CKD, which directly affect patients' quality of life [4,5]. CKD causes various symptoms, such as fatigue, pain, anxiety, and depression. Renal replacement therapies like hemodialysis may improve some of these symptoms but do not completely reverse them [5].

However, the treatment of kidney failure goes beyond hemodialysis sessions. Kidney failure involves a complex therapeutic regimen requiring considerable patient adherence. In addition to hemodialysis treatment, this regimen includes medication, fluid intake control, dietary restrictions, and vascular access maintenance [4]. These therapeutic demands result in substantial changes to the patient's lifestyle and quality of life due to the challenging clinical and therapeutic management of the disease, as well as recurrent hospitalizations due to complications [6].

Considering the difficulties in adhering to hemodialysis, the need to implement new strategies that facilitate adaptation to dialysis treatment arises. The use of new technologies has been a topic of discussion within the scientific community in the healthcare field, particularly in research on the application and evaluation of health technologies for managing chronic kidney disease [7–9], with a focus on mobile applications [9].

Digital health is defined as encompassing not only eHealth but also digital consumers, smart devices, the Internet of Things, advanced computing, big data analytics, artificial intelligence including machine learning, and robotics [10]. Digital health technologies go beyond mobile apps and can be defined as a set of knowledge and practices related to developing and using digital technologies to improve health outcomes [10]. These tools can potentially provide diagnoses, treatment, prognoses, and disease management, reducing patient waiting times and travel. Additionally, they can lower costs for the healthcare system and patients, providing more comfort and enhancing self-efficacy [11]. Technological resources may exert distinct impacts across all stages of CKD, and they may support prevention and risk factor control to facilitate adherence to therapeutic regimens and self-management [8,9].

In this context, digital health interventions not only improve access to information but also promote the self-management of healthcare, thus contributing to better clinical outcomes [11–13]. Furthermore, the efficient and safe use of technological resources plays a crucial role in supporting healthcare services, disseminating health information, disease surveillance, health education, and facilitating knowledge production and scientific research [14,15], making them increasingly important tools for personalized healthcare [15].

Given the complex epidemiology of CKD and its significant impact on healthcare systems, professionals must invest not only in health promotion and preventive care but also in continuous innovation and research in their daily practices.

Hemodialysis is the most prevalent modality of kidney replacement therapy worldwide, encompassing most patients with end-stage chronic kidney disease [16]. Although other therapeutic options, such as peritoneal dialysis and kidney transplantation, also entail significant clinical and psychosocial challenges, HD is distinguished by its substantial burden in these domains, reflected in high morbidity rates and a five-year survival of less than 50% [17]. These specificities underscore the relevance of investigating and implementing technological resources tailored to this population. Patients undergoing hemodialysis face specific daily challenges, including lifestyle limitations, adherence to complex medication regimens, and nutritional adaptation [18]. Given these challenges, this investigation aims to explore how digital technologies, which are revolutionizing chronic disease care, can facilitate patient monitoring. Technological resources that may improve treatment adherence and enhance quality of life [8,19] are considered.

It is important to emphasize that the technological resources analyzed in this review are not designed to modify the fundamental nature of hemodialysis, but rather to alleviate its consequences. In this review, "technological resources" refers to digital or technology-based interventions developed to support patient care, education, monitoring, or rehabilitation, in the context of hemodialysis. These may include mobile health applications [7,9,18], websites and digital platforms [8,12], virtual reality environments and exergames [9], telehealth solutions [8], and wearable devices [10,15]. Such technologies can enable more effective health self-management by patients, potentially covering various aspects of adherence to the dialysis regimen. Self-efficacy, that is, the belief in one's ability to manage these tasks, is crucial for improving health outcomes and reducing reliance on intensive medical interventions [19]. The existing literature on digital health has mainly focused on chronic disease management in general [7,12,13], leaving a clear gap regarding technological resources specifically directed at patients undergoing hemodialysis [18]. Therefore, the primary objective of this scoping review was to map the available scientific evidence on the use of technological resources to support patients undergoing hemodialysis. This review is guided by the following research question: "What types of technological resources are available for patients undergoing hemodialysis?".

2. Methods

A scoping review was conducted following the Joanna Briggs Institute (JBI) guidelines for this type of study [20]. To structure all the information, we used the PRISMA-ScR extension (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) [21], which outlines the phases of the investigation. The research protocol was then registered on the Open Science Framework® platform (OSF: https://doi.org/10.17605/OSF.IO/VUFE3 accessed on: 9 June 2025).

2.1. Search Strategy

A search was conducted in the following databases: MEDLINE (via PubMed, National Library of Medicine, Bethesda, MD, USA), Cumulative Index to Nursing and Allied Health Literature -CINAHL (EBSCOhost, Ipswich, MA, USA), PsycINFO (American Psychological Association, Washington, DC, USA), Scopus (Elsevier, Amsterdam, The Netherlands), Scientific Electronic Library Online-SciELO (São Paulo, Brazil), MedicLatina (EBSCOhost, Ipswich, MA, USA), and the Cochrane Central Register of Controlled Trials- CENTRAL (The Cochrane Library, London, UK), using specific syntax and indexing terms for each. The search strategies were jointly formulated and conducted by two investigators (AM, CF). All searches were carried out in December 2024. The search strategies for all databases are available in Appendix A.

2.2. Eligibility Criteria

The research question was formulated using the PCC (Population, Context, Concept) acronym. The population considered were patients, the context was hemodialysis, and the concept was technological resources. The concept of this review was "technological resources". For the purposes of this study, technological resources were defined as digital or technology-based interventions designed to support, monitor, or enhance the management of patients undergoing hemodialysis, including mobile applications, websites, exergames, virtual reality, and wearable devices.

All articles published up to December 2024 were included. The search language was English, although articles published in Spanish, Portuguese, and French were also considered. Articles involving the development or use of technological resources to support patients undergoing hemodialysis treatment were deemed eligible, regardless of the period of use (inter- or intradialytic). Home hemodialysis was deliberately excluded. This decision was grounded in the observation that most technological resources reported in the literature are specifically designed for in-center hemodialysis. In addition, home hemodialysis remains a less commonly adopted modality worldwide, with technological requirements and patient experiences that differ substantially from those of in-center hemodialysis. Therefore, to maintain conceptual clarity and avoid conflating distinct patient populations, only studies involving in-center hemodialysis patients were included. All age groups were included. Articles that did not address health-related technological resources were excluded.

Eligible study designs comprised experimental studies (e.g., randomized controlled trials, pilot trials, quasi-experimental designs), observational studies (e.g., cross-sectional, cohort, descriptive prospective studies), qualitative studies (e.g., interviews, focus groups, thematic analyses), and mixed-methods studies. Reviews, protocols, and opinion papers were excluded. Additionally, any evidence that was not primary research related to the development and use of resources, such as conceptual articles, editorials, unpublished literature including theses and books, or studies in books, were also excluded.

Authors of studies with unavailable data were contacted for clarifications or additional information about their studies, as recommended by the JBI methodology [20]. Furthermore, the search for supplementary studies was expanded to include the examination of reference lists of all publications selected for inclusion in the review, a process known as "backward citation tracking".

2.3. Data Extraction

The data extraction form was initially developed by two investigators, based on the predefined objectives and inclusion criteria of the study. To ensure accuracy and consistency, the form was subsequently pre-tested by two additional investigators. The results from each database search were imported into the Rayyan® software (web-based software; 2024, Qatar Computing Research Institute, Doha, Qatar) to assist with the development of the review. Duplicate references were removed, and two investigators performed the initial selection by reading the titles and abstracts according to the pre-defined inclusion/exclusion criteria. Subsequently, the full texts of the selected references were obtained to decide their inclusion or exclusion in the final study. Any discrepancies were discussed with a third investigator. The PRISMA-ScR framework was used to organize the information resulting from the selection process [21]. All scientific articles were coded with the letter (E) in the order they were reviewed.

2.4. Data Analysis

The selection, data extraction, and synthesis process were carried out independently by two investigators (AM, CF), with the involvement of a third investigator (MF) in the case of discrepancies. To synthesize the obtained data, a customized extraction table was developed, containing the following information: authors, year of publication, country, research objectives, methodology, participants, type of technology, purpose of the technology, duration of the intervention, assessment tools, and results. The data are presented in a descriptive manner (Table 1).

Table 1. Characteristics of studies included in the scoping review.

ID.	Author(s), Year, and Country	Objective	Study Design	Participants	Resource Type	Tech Objective	Intervention Time	Assessment Tools	Results
E1	Martínez-Olmos et al. (2022) [22] Spain	Evaluate whether a virtual reality exercise program during hemodialysis improves walking speed.	RCT	56 adult patients on hemodialysis	Exergame	Physical exercise practice	12 weeks	STS; OLS; SPPB; 6MWT; TUG	Increased walking speed; improved One-Leg Stance Test results and Sit-to-Stand Test-60 results. Decreased Timed Up-and-Go results; reduced execution time in Sit-to-Stand Test 5 and 10, indicating improvement.
E2	Zhou et al. (2020) [23] Qatar	Assess the feasibility, acceptability, and effectiveness of this program in alleviating depressive symptoms.	Clinical trial	73 adult patients on hemodialysis	Exergame	Physical exercise practice	4 weeks	Demographic/ health info; FES-I; MMSE; ABI; VPT; CES-D	The number of participants at risk for clinical depression decreased in scores on the Center for Epidemiologic Studies Depression Scale.
E3	Meléndez-Oliva et al. (2023) [24] Spain	To evaluate the effectiveness of a non-immersive virtual reality intradialytic exercise program on inflammatory markers, and the impact on functional capacity and psychological well-being.	Clinical trial	80 adult patients on hemodialysis	Non-immersive virtual reality	Physical exercise practice	12 weeks	SPPB; 6MWT; STS; TUG; CAIQ-RDQ; BDI-II; STAI	Both exercise groups (non-immersive VR and static pedal) are anticipated to experience a reduction in inflammatory marker levels, along with improvements in functional capacity and psychological well-being.
E4	Smyth et al. (2022) [25] Australia	Compare participant adherence to hemodialysis regimens.	RCT	40 adult patients on hemodialysis	Immersive virtual reality	Immersive experiences	4 weeks	Attendance rates; Adherence proportions; AQoL; UES-SF	The outcomes will be assessed based on participants' attendance at scheduled dialysis sessions.
E5	Turoń-Skrzypińska et al. (2023) [26] Poland	Assess the impact of regular physical exercise using non-immersive virtual reality on the occurrence of anxiety and depression symptoms.	RCT	85 adult patients on hemodialysis	Non-immersive virtual reality	Physical exercise practice	March 2021 to February 2022	Borg; BDI; GAD-7; Demo-graphic/health/ lifestyle questionnaire	Reduction in depressive symptoms. Decrease in the frequency of anxiety and depression symptoms.

Table 1. *Cont.*

ID.	Author(s), Year, and Country	Objective	Study Design	Participants	Resource Type	Tech Objective	Intervention Time	Assessment Tools	Results
E6	Hernandez et al. (2021) [27] USA	To assess whether virtual reality aggravates symptoms commonly associated with hemodialysis.	Pilot study	20 adult patients on hemodialysis	Immersive virtual reality	Meditation/Awareness Program	25 min on two occasions	Sociodemographic/health survey; SSQ; IPQ; SUS	Patients found the program enjoyable and easy to use. During the first use, a significant reduction in symptoms such as fatigue, nausea, oculomotor issues, and disorientation, was observed.
E7	Maynard et al. (2019) [28] Brazil	Examine the effects of combining physical exercise and virtual reality on the functional abilities and quality of life in individuals receiving hemodialysis.	RCT	45 adult patients on hemodialysis	Non-immersive virtual reality	Physical exercise practice	12 weeks	TUG; Gait speed; DASI; CES-D; KDQOL-SF	Marked enhancement in functional capacity. Improvements in the Timed Up-and-Go test and the Duke Activity Status Index. Significant changes in quality-of-life metrics. Reduction in depressive symptoms.
E8	Finco et al. (2023) [29] Qatar	Assess the impact of an exergame program on gait speed and postural control in elderly patients with diabetes undergoing hemodialysis.	RCT	70 adult patients on hemodialysis	Exergame	Physical exercise practice	4 weeks	Ankle/hip oscillation; Gait speed; Single-task walking; Balance (BalanSens™ semi-tandem test)	Gait speed enhancement and postural sway stabilization in elderly individuals undergoing hemodialysis.
E9	García-Testal et al. (2022) [30] Spain	Assess variations in healthcare resource utilization and micro-costs among patients undergoing hemodialysis.	RCT	33 adult patients on hemodialysis	Non-immersive virtual reality	Physical exercise practice	12 weeks	Lab tests; Radiology exams; Outpatient consults; ED services; Hospitalizations	Healthcare resource expenses significantly declined following participation in an intradialytic virtual reality exercise program. Micro-cost reductions were observed in laboratory tests, radiological exams, and outpatient consultations.
E10	Hudson et al. (2016) [31] United Kingdom	Assess the feasibility and acceptability of implementing a universal screening process for patients undergoing hemodialysis.	Pilot study	60 adult patients on hemodialysis	Website	Improve psychological distress	6 weeks	PHQ-9; GAD-7; EQ-5D; BIPQ	The outcomes cover feasibility and acceptability, as well as descriptive data on recruitment, randomization, retention, and treatment adherence rates.

Table 1. *Cont.*

ID.	Author(s), Year, and Country	Objective	Study Design	Participants	Resource Type	Tech Objective	Intervention Time	Assessment Tools	Results
E11	Santana et al. (2020) [32] Brazil	Design a game that motivates adolescents undergoing hemodialysis to practice self-care.	Pilot study	7 adolescents on hemodialysis	App	Care of a character in the context of hemodialysis	60 days	SSIs; OBSs	The game served as a motivating factor for the participants, who gained insights into the conditions that could lead to potential hospitalizations.
E12	Hayashi et al. (2017) [33] Japan	To evaluate the feasibility and usability of the SMART-D system.	Pilot study	20 adult patients on hemodialysis	App	Disease management	2 weeks	t-test; QoL-Q; DQ	No significant differences in interdialytic weight gain, serum potassium levels, and serum phosphorus levels. The Social Functioning score showed a notable improvement, while the other scores from the Quality-of-Life Questionnaire remained stable.
E13	Hosseini et al. (2023) [34] Iran	Assessing the effect of patient education in hemodialysis via an application on patients' self-care and self-efficacy.	Quasi-experimental study	59 adult patients on hemodialysis	App	Self-efficacy and self-care	October 2020 to March 2021	SCQ; SEQ; DQ	The average scores for self-care and self-efficacy assessed after the intervention were significantly higher than those recorded before the intervention, demonstrating the application's effectiveness.
E14	Takahashi et al. (2023) [35] Japan	To summarize basic data on the safety and efficacy of the system in healthy individuals, providing a foundation for future applications in patients.	Pilot study	15 university students	Immersive virtual reality	Physical exercise practice	Not applicable	DQ; SSQ; BP/HR; Borg; BMI	This study demonstrated that virtual reality does not induce motion sickness or virtual interruptions and results in higher workload as measured by heart rate during exercise in VR conditions.

Table 1. *Cont.*

ID.	Author(s), Year, and Country	Objective	Study Design	Participants	Resource Type	Tech Objective	Intervention Time	Assessment Tools	Results
E15	Hsieh & Li (2022) [36] Taiwan	Examine alterations in physiological health outcomes and explore psychological responses in dialysis patients after experiencing 360-degree nature videos through immersive virtual reality.	Clinical trial	24 adult patients on hemodialysis	Immersive virtual reality	Immersive experience	3 weeks	SSIs; PQs; PAD; HR; ECG	The virtual reality experience had a positive impact on heart rate. This intervention reduced stress during hemodialysis, lowering sympathetic nervous system activity and diminishing negative emotions.
E16	Bers et al. (2003) [37] USA	Create technological resources to assist families dealing with pediatric illnesses.	Pilot study	7 children on hemodialysis	Computer app (video game)	Disease management	3 months	SSIs	Patients described Zora as a valuable tool for discreetly communicating with one another during the public hemodialysis setting. It allowed some individuals to share personal concerns without the pressure of face-to-face or real-time discussions.
E17	Segura-Ortí et al. (2019) [38] Spain	To evaluate the practicality of implementing a non-immersive virtual reality exercise intervention during intradialysis sessions.	Pilot study	18 adult patients on hemodialysis	Non-immersive virtual reality	Physical exercise practice	16 weeks	STS; 6MWT; GS; HRT	Sit-to-Stand test significantly improved over time; gait speed increased.
E18	Feizalahzadeh et al. (2014) [39] Iran	To outline the development and validation steps for evidence-based multimedia education apps, guided by Mayer's Cognitive Theory, for Persian patients undergoing hemodialysis.	Pilot study	14 adult patients on hemodialysis 12 healthcare professionals in hemodialysis	App	Health education	Not applicable	SSIs	The app was created through an iterative design process, including input from hemodialysis patients and experts. The study's results showed that it can enhance the educational experience for patients undergoing hemodialysis.

Table 1. *Cont.*

ID.	Author(s), Year, and Country	Objective	Study Design	Participants	Resource Type	Tech Objective	Intervention Time	Assessment Tools	Results
E19	Agapito et al. (2018) [40] Italy	Improving the quality of life of healthy individuals and people with chronic diseases related to nutrition.	Pilot study	20 healthy individuals and 20 dialysis adult patients	App	Diet and weight management	3 months	Questionnaires	DIETOS has high specificity and sensitivity, allowing the determination of a user's health profile and providing personalized nutritional recommendations that best match the individual's health status.
E20	Chettati et al. (2022) [41] Morocco	Evaluate adherence to long-term prescribed medications and determine the main factors influencing adherence.	Descriptive prospective study	90 adult patients on hemodialysis	App	Medication adherence	6 months	Questionnaires	The statistically significant factors influencing adherence were the number of pills taken per day and the presence of a vision problem.
E21	Chiang et al. (2021) [42] Taiwan	Evaluate the impact of an app-assisted care program on dietary phosphate control in patients undergoing regular hemodialysis.	Quasi-experimental study	60 adult patients on hemodialysis (30 ACP—App-assisted caring program) (30 SCP—Standard education)	App	Dietary management	3 months	SES; KTs	The study demonstrated that using the app increased patients' self-care efficacy and knowledge about dietary phosphate control, leading to a significant decrease in serum phosphate levels compared to the control group.
E22	Cho & Sohng (2014) [43] South Korea	Investigate the effects of a virtual reality exercise program on physical fitness, body composition, and fatigue in hemodialysis patients.	RCT	46 adult patients on hemodialysis (23 intervention group, 23 control group)	Non-immersive virtual reality	Physical exercise practice	8 weeks	PFA; InBody S10; VAS	The study showed that the intervention group experienced significant improvements in dorsal strength, leg strength, and flexibility. Skeletal muscle mass and balance also increased. The exercise group exhibited a drastic reduction in fatigue levels compared to the control group.

Table 1. *Cont.*

ID.	Author(s), Year, and Country	Objective	Study Design	Participants	Resource Type	Tech Objective	Intervention Time	Assessment Tools	Results
E23	Chou et al. (2020) [44] Taiwan	Evaluate the effect of a virtual reality-based exercise program on fatigue in patients with end-stage renal disease undergoing hemodialysis.	Quasi-experimental study	64 adult patients on hemodialysis (32 intervention group, 32 control group).	Non-immersive virtual reality	Physical exercise practice	4 weeks	NFSHD; Q-PCC	Patients in the experimental group showed significantly lower overall fatigue levels, reduced vigor and motivation, less distress, and better mood control. Additionally, they had higher hemoglobin levels compared to the control group.
E24	Connelly et al. (2012) [45] USA	Design and evaluation of the Dietary Intake Monitoring Application (DIMA) to assist hemodialysis patients with varying literacy levels in adhering to prescribed dietary regimes.	Pilot study	18 adult patients on hemodialysis	App	Dietary management	6 weeks	Qs; IDWLs	The participants were able to use the DIMA successfully. However, they faced difficulties in using the barcode scanner. The most commonly used feature in DIMA was the ability to view previous meals, which served as the primary reflective mechanism for users.
E25	Costa et al. (2021) [46] Brazil	Presenting the alpha test of the gamified technology prototype, Nefro Hero®, focusing on the Health-Related Quality of Life (HRQoL) of pediatric patients undergoing hemodialysis treatment.	Qualitative study	8 pediatric patients, ages 8 to 16, undergoing hemodialysis	Video game	Quality of life	3 months	DISABKIDS HRQoL; FDs; BSs	Improvements were identified in the mental domain of HRQoL for the patients. The enhancement in emotional scores demonstrated the potential of gamification in possibly re-framing aspects related to treatment, thereby strengthening resilience in the patients.

Table 1. *Cont.*

ID.	Author(s), Year, and Country	Objective	Study Design	Participants	Resource Type	Tech Objective	Intervention Time	Assessment Tools	Results
E26	Dingwall et al. (2021) [47] Australia	Examine the effectiveness of the Stay Strong app in improving psychological distress, depressive symptoms, quality of life, and adherence to dialysis.	Pilot study	156 adult patients on hemodialysis	App	Improvement in psychological distress	3 months	K10; PHQ-9; EQ-5D	The results suggest that using apps for treatment may improve the well-being of individuals undergoing dialysis.
E27	Khoury et al. (2020) [48] United Arab Emirates	Estimate the potential effectiveness of a dietary intervention using a person-centered, theory-based smartphone app.	Pilot study	23 adult patients on hemodialysis	App	Dietary management	2 weeks	Biochemical parameters	The average protein intake increased. The intake of dietary minerals remained unchanged, except for sodium, which decreased. There were no significant changes in the average serum levels of phosphorus, potassium, or albumin.
E28	Hernandez et al. (2023) [49] USA	Test the feasibility and preliminary efficacy of a positive psychological intervention.	RCT	84 adult patients on hemodialysis with depression	Virtual reality	Reduction in depressive symptoms	5 weeks	BDI-II; PROMIS; PSS; KDQOL-SF; EMRs	This trial will be the first to test a customized virtual reality software to provide a positive psychological intervention aimed at reducing depressive symptoms.
E29	Min & Park (2020) [50] South Korea	Identify the effects of a self-management program based on a mobile application.	RCT	56 adult patients on hemodialysis (28 intervention group, 28 control group).	APP	Self-efficacy	10 weeks	Q-AB/PN/SE/DCs; CRs	Patient adherence behavior increased. Self-efficacy improved after 10 weeks of intervention. No significant differences in serum phosphate and potassium levels were observed.
E30	Minatodani & Berman (2013) [51] USA	Evaluate a telehealth pilot project in terms of improved health outcomes and significant cost savings.	Pilot study	99 adult patients on hemodialysis (43 intervention group, 56 control group).	Remote technology	Telemonitoring	3 years	HOSP-N; ERV-N; HOSP-D; PMs (BP, HR, W, SpO_2, BG)	Costs associated with hospital admissions and emergency visits were significantly lower. The number of medical and technical incidents decreased drastically, leading to fewer nurse contacts.

Table 1. *Cont.*

ID.	Author(s), Year, and Country	Objective	Study Design	Participants	Resource Type	Tech Objective	Intervention Time	Assessment Tools	Results
E31	Ong et al. (2016) [52] Canada	Evaluate the acceptability of this enhanced smartphone system in the management of patients with advanced CKD and examine changes in various clinical parameters.	Pilot study	47 adult patients on hemodialysis	App	Self-management	6 months	Eval-N; Eval-C/R; SSIs; CD	The app simplified important tasks and supported patients' real-time decision-making through embedded algorithms for each behavioral component.
E32	Pack & Lee (2021) [53] South Korea	Develop a dietary self-management program for hemodialysis patients based on a smartphone app and examine its effects on biochemical markers.	Prospective study	75 adult patients on hemodialysis (37 intervention group, 38 control group).	App	Dietary management	12 weeks	CD; Qs; KDQOL-SF	In the experimental group, phosphate levels decreased to within the normal range, in contrast with the control group. Self-efficacy and quality of life improved significantly over time among hemodialysis patients.
E33	Park & Kim (2019) [54] South Korea	Evaluate the effects of an integrated self-management program using a mobile app.	Quasi-experimental study	84 adult patients on hemodialysis (42 intervention group, 42 control group).	App	Self-management	8 weeks	CPRB; IDWG/DW; Serum K + /P; DCs	Scores related to self-efficacy and treatment adherence were significantly higher. Interdialytic weight gain and dry weight significantly decreased.
E34	Ren et al. (2019) [55] China	Develop and evaluate the effects of a health education program using WeChat.	Clinical trial	85 adult patients on hemodialysis (49 intervention group, 36 control group).	Digital platform (WeChat)	Self-management	3 months	SMS-HD; CPKQ; CDSES; DCs	Patients in the intervention group showed a significant increase in self-management scores, knowledge about hemodialysis, and self-efficacy immediately following the health education program via WeChat.

Table 1. *Cont.*

ID.	Author(s), Year, and Country	Objective	Study Design	Participants	Resource Type	Tech Objective	Intervention Time	Assessment Tools	Results
E35	Rocco et al. (2023) [56] USA	Evaluate the utility and safety of a mobile application (app) that allows self-monitoring of daily fluid intake.	Pilot study	25 adult patients on hemodialysis	App	Self-management	3 months	SIs; CD; AppUse%	61% of participants experienced a decrease in interdialytic weight gain while using the app.
E36	Saadatifar et al. (2022) [57] Iran	Examine the effect of mHealth training on treatment adherence in hemodialysis patients in Zahedan.	Quasi-experimental study	80 adult patients on hemodialysis	App	Adherence	3 months	DIF; MLQ; ESRD-AQ	Contrary to expectations, the adherence scores of the control group, which received routine training from healthcare staff, were higher than those of the group that received mHealth training.
E37	Teong et al. (2022) [58] Malaysia	Determine the effectiveness of a phosphate mobile application (PMA) in hemodialysis (HD) patients with hyperphosphatemia.	RCT	74 adult patients on hemodialysis (38 intervention group, 36 control group).	App	Dietary management	12 weeks	BP; Q; IDIs; MMAS-4; SD	Hemodialysis patients with hyperphosphatemia using the app experienced reductions in serum phosphate levels and dietary phosphate intake, along with improved knowledge of phosphate and increased adherence to phosphate binder medication.
E38	Khah et al. (2023) [59] Iran	Compare the effects of a mobile health (mHealth) application based on microlearning with in-person training on treatment adherence and perception.	RCT	70 adult patients on hemodialysis (35 intervention group, 35 control group)	App	Treatment adherence	12 weeks	ESRD-AQ	The results showed that the overall effect of the mHealth method was superior to that of in-person education in treatment adherence. The lower average scores obtained by hemodialysis patients before the intervention were associated with water and dietary restrictions, respectively.

Table 1. *Cont.*

ID.	Author(s), Year, and Country	Objective	Study Design	Participants	Resource Type	Tech Objective	Intervention Time	Assessment Tools	Results
E39	Willis et al. (2021) [60] USA	Test the usability of a tablet-based intervention that includes theory-informed educational modules and mentoring.	Pilot study	14 adult patients on hemodialysis	App	Health education	Not applicable	SSIs	Four general restrictions were identified when designing for dialysis patients: touch dexterity and interface navigation, movement limitations and device positioning during dialysis, readability, and vision challenges for older patients due to small text size.

Legend: ABI—Ankle-Brachial Index; ACP—App-Assisted Caring Program; AppUse%—Percentage of Days App Used vs. Available; AQoL—Australian Assessment of Quality of Life; BDI—Beck Depression Inventory; BDI-II—Beck Depression Inventory-II; BIPQ—Brief Illness Perception Questionnaire; BMI—Body Mass Index; BP—Biochemical Parameters; BP/HR—Blood Pressure/Heart Rate; BSs—Brainstorming Sessions; CAIQ-RDQ—Comprehensive Adaptation to Illness Questionnaire for Renal Dialysis Patients; CD—Clinical Data; CDSES—Chronic Disease Self-Efficacy Scale; CES-D—Center for Epidemiological Studies Depression Scale; CPRB—Compliance of Patient Role Behavior; CRs—Clinical Records; CPKQ—Chinese Patient Knowledge Questionnaire; DASI—Duke Activity Status Index; DCs—Demographic Characteristics; DIF—Demographic Information Form; DISABKIDS HRQoL—Health-Related Quality of Life Questionnaire for Children and Adolescents with Chronic Conditions; DQ—Demographic Questionnaire; ED services—Emergency Department Services; EMRs—Electronic Medical Records; EQ-5D—EuroQol-5 Dimensions; ERV-N—Emergency Room Visits Number; ESRD-AQ—End-Stage Renal Disease Adherence Questionnaire; Eval-C/R—Evaluations Completed vs. Recommended; Eval-N—Total Number of Evaluations; FES-I—Falls Efficacy Scale International; FDs—Field Diaries; GAD-7—Generalized Anxiety Disorder-7; GS—Gait Speed; HOSP-D—Hospitalization Days; HOSP-N—Number of Hospitalizations; HR—Heart Rate; HRT—Heel-Rise Test; IDWLs—Interdialytic Weight Logs; IDWG/DW—Interdialytic Weight Gain/Dry Weight Ratio; IDIs—Interviews on Dietary Intake; InBody S10—Body Composition Analyzer; IPQ—Igroup Presence Questionnaire; K10—Kessler Distress Scale; KDQOL-SF—Kidney Disease Quality of Life Instrument—Short Form; KTs—Knowledge Tests; Lab tests—Laboratory Tests; MLQ—Media Literacy Questionnaire; MMAS-4—Morisky Medication Adherence Scale—4 items; MMSE—Mini-Mental State Examination; NFSHD—New Fatigue Scale for hemodialysis; OBSs—Observation Sessions; OLS—One-Leg Stance Test; PAD—Pleasure–Arousal–Dominance Emotional State Model; PFA—Physical Fitness Assessment; PHQ-9—Patient Health Questionnaire-9; PMs—Physiological Measurements (Blood Pressure, Heart Rate, Weight, SpO_2, Blood Glucose); PQs—Psychological Questionnaires; PROMIS—Patient-Reported Outcomes Measurement Information System; PSS—Perceived Stress Scale; Qs—Questionnaires; Q-AB/PN/SE/DC—Questionnaires on Adherence Behavior, Psychological Needs, Self-Efficacy, and Demographic Characteristics; Q-PCC—Questionnaires on Personal and Clinical Characteristics; QoL-Q—Quality-of-Life Questionnaire; SCQ—Self-Care Questionnaire; SCP—Standard Caring Program; SD—Sociodemographic Data; SES—Self-Efficacy Scale; SEQ—Self-Efficacy Questionnaire; SIs—Structured Interviews; SMS-HD—Self-Management Scale for hemodialysis; SPPB—Short Physical Performance Battery; SSIs—Semi-Structured Interviews; SSQ—Simulator Sickness Questionnaire; STAI—State–Trait Anxiety Inventory; STS—Sit-to-Stand Test; TUG—Timed Up-and-Go; UES-SF—User Engagement Scale—Short Form; VAS—Visual Analog Scale; VPT—Vibration Perception Threshold; VR—Virtual Reality (Immersive/Non-immersive).

3. Results

The search strategy identified 932 records. In line with the PRISMA 2020 statement, it is important to distinguish between records, reports, and studies when describing the evidence selection process. Records correspond to the bibliographic citations retrieved from databases prior to deduplication. Reports denote the full-text publications assessed for eligibility, which may consist of one or more records referring to the same investigation. Finally, studies constitute the primary unit of inclusion in this review and may be reported in single or multiple publications. This distinction enhances transparency and consistency in the reporting of systematic and scoping reviews [61]. After the different stages outlined in Figure 1, 39 studies were deemed eligible and included in the analysis.

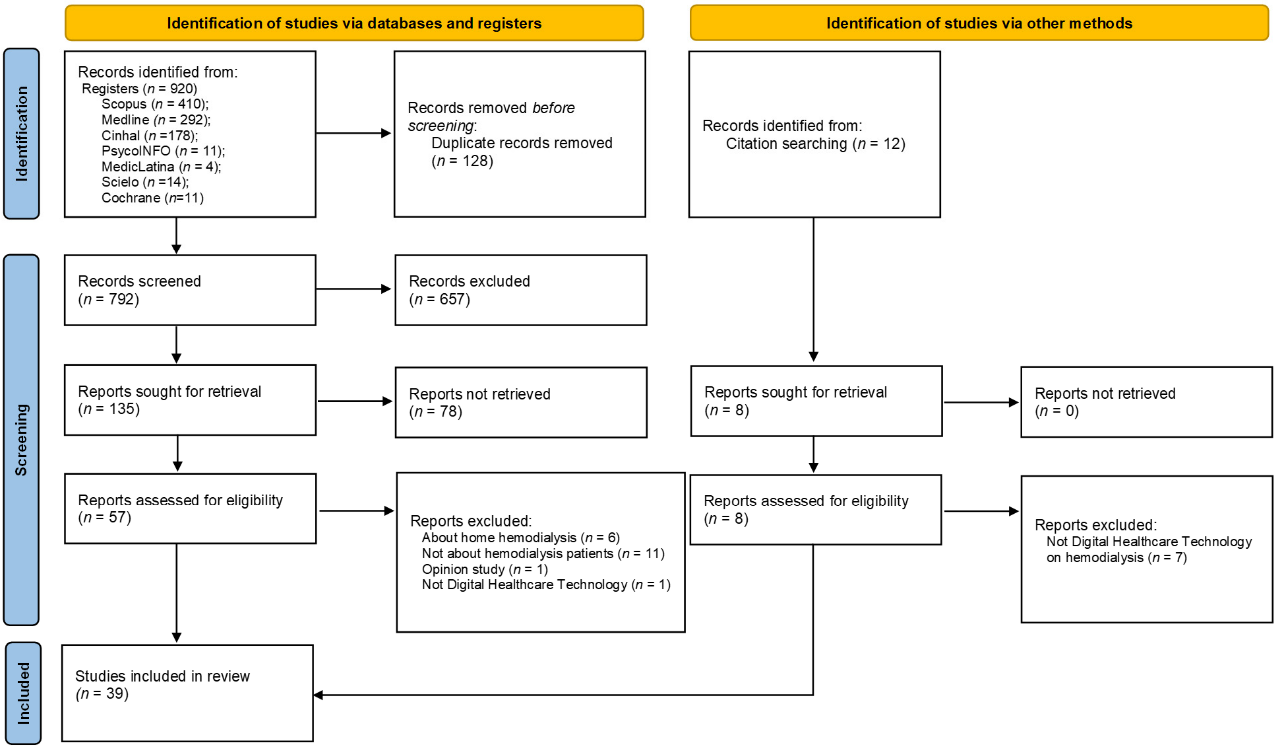

Figure 1. Article identification and inclusion process.

3.1. *Characteristics of the Included Studies*

Table 1 summarizes the characteristics of the 39 studies included in this review, including authors, year, country, objectives, methodology, participants, type of technological resource, purpose of the technological resource, duration of the intervention, assessment tools, and results. A total of 39 articles published between 2003 and 2023 were selected for inclusion in the review [22–60]. The studies were conducted in various countries. The most frequent study design identified was the pilot study, representing 16 of the 39 included studies, followed by randomized controlled trials (n = 11), clinical trials (n = 4), and quasi-experimental studies (n = 5).

3.2. *Characteristics of Participants*

Regarding the participants, 2036 individuals were included in the analyzed studies, with adults predominating. However, study E16 involved children, study E11 was conducted with adolescents, and study E25 included both adolescents and children. In studies E18 and E19, both healthy individuals and patients undergoing hemodialysis were included. In study E14, healthy university students were used to assess the safety and efficacy of a virtual reality intervention in a context that could potentially be adapted for patients in the future.

3.3. Characteristics Technologies Resources

Regarding the types of technological resources developed in the included studies (Table 1), 12 studies used virtual reality technology. Of these, seven studies addressed non-immersive virtual reality (E3, E5, E7, E9, E17, E22, E23), while five studies used immersive virtual reality (E4, E6, E14, E15, E28). Three studies involved exergames (E1, E2, E8), and nineteen studies utilized mobile apps (E11, E12, E13, E18, E19, E20, E21, E24, E26, E27, E29, E31, E32, E33, E35, E36, E37, E38, E39). Additionally, five studies used other types of technologies, including a website (E10), two video games (E16, E25), a remote technology (E30), and a digital platform (E34) (Figure 2).

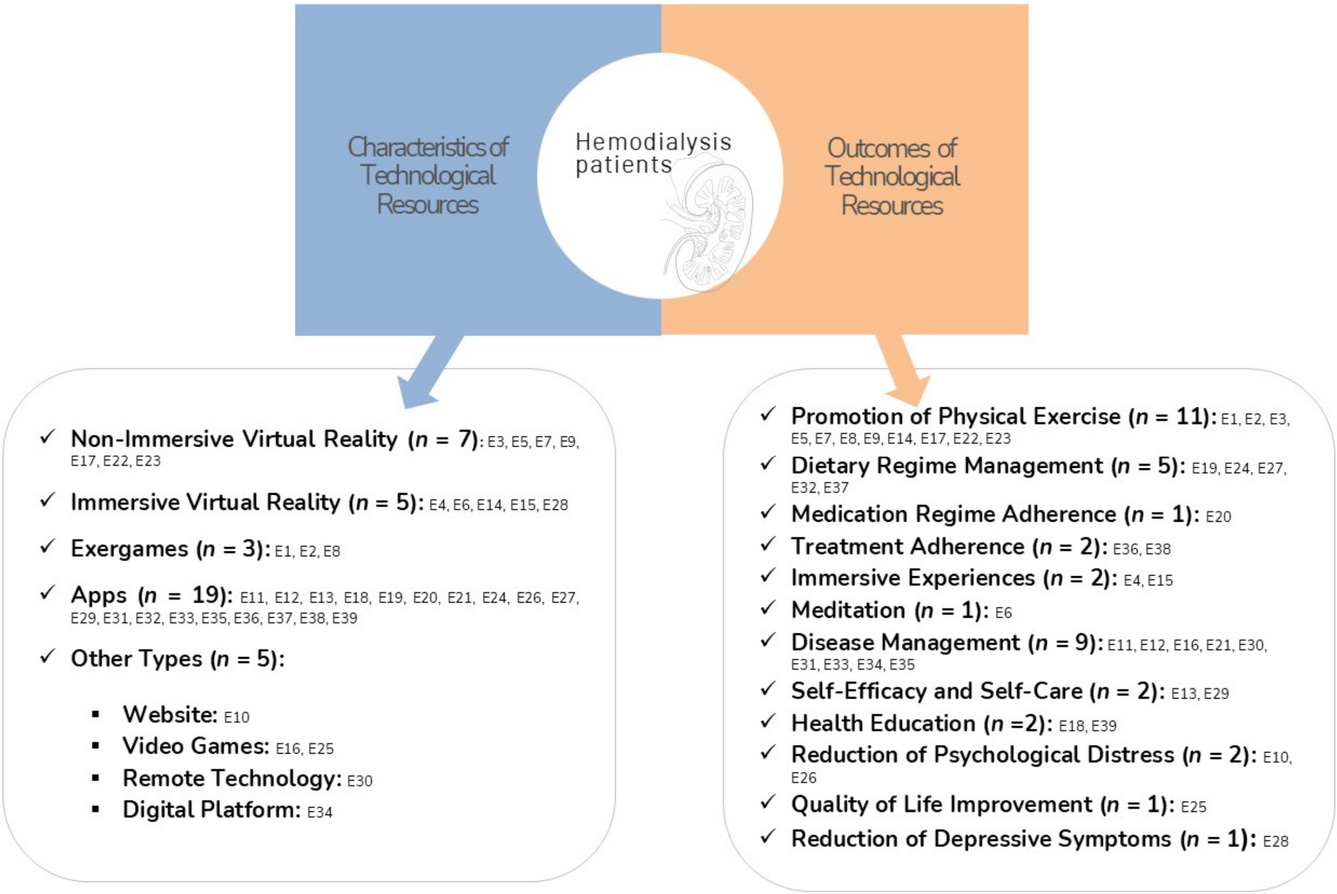

Figure 2. Distribution of technologies resources.

3.4. Outcomes of the Technologies Resources

The outcomes of the technologies were as follows: eleven promoted physical exercise (E1, E2, E3, E5, E7, E8, E9, E14, E17, E22, E23), five focused on dietary regimen management (E19, E24, E27, E32, E37), one aimed at medication adherence (E20), two focused on treatment adherence (E36, E38), two provided immersive experiences (E4, E15), one offered meditation (E6), nine focused on disease management (E11, E12, E16, E21, E30, E31, E33, E34, E35), two aimed at increasing self-efficacy and self-care (E13, E29), two focused on health education (E18, E39), two aimed to reduce psychological distress (E10, E26), one aimed to improve quality of life (E25), and one aimed to reduce depressive symptoms (E28).

4. Discussion

In this scoping review, 39 studies conducted between 2003 and 2023 were analyzed, investigating the use of 39 different technological resources in treating hemodialysis patients. This review spans an extended period to provide a comprehensive view of technological advancements in this field. The types of technological resources discussed in this context include virtual reality systems, mobile applications, interactive websites, and digital platforms, each tailored to enhance the management and treatment of hemodialysis patients.

4.1. Mobile Applications (Apps)

According to the analysis of the studies, the use of mobile applications was explored in 19 studies [32,41,42]. Mobile applications were developed to assist in dietary regimen management [40,42,53], medication adherence [41], disease management [33,52,54,56], promotion of self-efficacy and self-care [32,34,50], health education [39,60], treatment adherence [57,59], and reduction in psychological distress [47]. Mobile applications are essential in supporting both patients and healthcare professionals, allowing for the storage and sharing of information that fosters a collaborative approach to patient care. However, the development of these tools must include all end-users to ensure efficient design [62].

According to the included studies, the apps provided practical support for monitoring health indicators, such as weight, potassium, phosphorus, iron, and albumin levels in the blood [48,53,58]. They also offered spaces for food diaries and tracking fluid and mineral levels [40,45]. Dietary and fluid intake restrictions require constant management by patients, making it one of the most challenging aspects of dialysis treatment. In this regard, mobile health applications can be valuable tools to facilitate self-management of these patients' nutritional and dietary plans [63].

In one study, a mobile application was developed for phosphate control, incorporating educational videos and interactive features that allowed for dietary self-management. The use of this app resulted in reductions in serum phosphate levels and phosphate intake, improving patients' knowledge and adherence to phosphate binders [58].

Another study developed a dietary self-management app that allowed patients to monitor nutrients such as protein, calories, and minerals in their food. After 12 weeks of use, the app resulted in reductions in phosphorus and potassium levels [53]. Hemodialysis patients often need to make significant dietary adjustments. Mobile applications focused on nutrition tend to improve adherence to dietary changes compared to traditional methods [64]. Additionally, these interventions facilitate the daily recording of food and fluid intake, making them accessible tools for dietary self-management in hemodialysis patients [65].

In addition to nutritional aspects, an app focused on medication adherence incorporated features such as medication reminders for hemodialysis patients [41]. Seven other applications concentrated on self-management, self-efficacy, and self-care, offering information on hemodialysis, nutrition, infection prevention, and preventive measures, positively impacting patients' self-care and self-efficacy [32–34,50]. The need to integrate features such as education, goal setting, self-monitoring, and interactive feedback into health apps was emphasized [66]. Moreover, one application allowed for the monitoring of interdialytic weight and diet adherence, providing real-time feedback, and showed significant improvements in patients' self-efficacy and behavior [50].

4.2. Virtual Reality

After analysis, 12 studies addressed virtual reality (VR), with a predominant use of non-immersive virtual reality [39,43,44] compared to immersive VR [27,36,49], which offers more immersive experiences [67]. These technologies showed significant improvements in patients' functional capacity, mobility, balance, and flexibility [28,38,43], positively impacting hemodynamic parameters and stress levels during treatment [36,44].

In addition to its physical benefits, virtual reality (VR) has been shown to reduce negative emotions and enhance psychological well-being by serving as a distractive intervention that alleviates physical and psychological symptoms such as pain, nausea, and anxiety [28,36,49,68]. Both immersive and non-immersive VR are regarded as safe and effective during hemodialysis sessions, without inducing adverse effects such as nausea or virtual disruptions [27,35,38]. These findings are complemented by studies that assessed the cost-effectiveness of these technologies, demonstrating that virtual reality-based interventions can significantly reduce healthcare costs, including expenses for laboratory tests, radiology exams, and outpatient consultations [30]. These discoveries highlight VR's potential not only to improve the quality of life of hemodialysis patients but also to optimize healthcare resources.

4.3. Exergames

Exergames, games that track user movements and integrate them into an engaging environment, are noted for their ability to encourage active participation during hemodialysis [69]. Three studies in the exergame category [22,23,29] have adopted this technology to promote physical activity by merging exercise with digital game components. These studies have demonstrated significant improvements in areas such as gait speed and motor control, in addition to helping reduce depressive symptoms [23,70]. It is important to highlight that engaging in physical exercise through exergames during hemodialysis can offer multiple benefits: optimizing time spent at the dialysis center, enhancing the treatment experience, alleviating the monotony of the treatment, and significantly contributing to the mental health promotion of patients [26].

4.4. Other Health Information Technologies

In the context of hemodialysis treatment, besides technologies like VR, mobile apps, and exergames, other modalities were explored, including two video games [37,46], one website [31], one digital platform [55], and one remote technology [51]. These innovations not only diversified therapeutic options but also enriched the patient experience. The video games, specifically designed for children and adolescents undergoing hemodialysis, provided a three-dimensional virtual environment that allowed users to interact in a virtual city, promoting socialization and creativity [37]. One such game, a Role-Playing Game (RPG) called Nefro Hero®, was created to enhance the quality of life through interactive narratives that encouraged problem-solving and reflection, addressing the experiences of young patients [46].

Additionally, a website was developed to offer online cognitive behavioral therapy, focusing on challenges and the associated psychosocial changes [31]. A digital platform also stood out by providing educational programs about the disease, showing improvements in patient self-management and knowledge [55]. These digital platforms proved to be valuable resources in health management and psychological support for patients, facilitating ongoing education and active involvement in their treatment.

4.5. Impact of Technological Resources on Health Outcomes

The objectives of technologies reflected in the study outcomes span a wide range of applications, underscoring the diversity and potential of technology in chronic disease management. A significant focus is placed on promoting physical activity, with 11 technologies specifically aimed at this purpose [22–25]. Intradialytic exercise could enhance the quality of life across various domains for patients undergoing hemodialysis [71]. Dietary management [40,45] and disease management [32,33] are other prevalent areas highlighted by the study findings, illustrating the importance and complexity of these interventions in the patient care continuum. While information or knowledge about the different aspects of therapy is critical for building awareness, it alone is insufficient to effect or sustain behavioral change [72,73].

An important consideration concerns whether the integration of technological resources in HD represents a technology-driven (push) or a patient-driven (pull) process. Evidence from patient-reported outcomes remains limited, and few surveys have systematically explored the priorities and expectations of individuals undergoing HD regarding such technologies. Nevertheless, available data indicate that patients highly value interventions that address depression [23,26], enhance dietary and medication adherence [22,38], and improve psychological well-being [31,47]. Thus, while auxiliary technological resources offer promising support, their benefits must be interpreted within the broader and often conflicting clinical and psychosocial trade-offs that characterize the HD experience.

Hemodialysis prolongs survival but imposes a profound burden on patients' daily lives [74]. The impact extends across physical, psychological, social, and financial domains [75,76]. Patients frequently report debilitating symptoms, including persistent fatigue, muscle cramps, pruritus, sleep disturbances, gastrointestinal complaints, and anorexia, in addition to a high burden of cardiovascular complications [77]. Moreover, strict dietary and fluid restrictions represent ongoing challenges, often exacerbating frustration and emotional distress [76]. Within this context, technological resources emerge as promising adjuncts, with potential to mitigate symptom burden, enhance treatment adherence, and ultimately improve patients' quality of life.

In summary, the resources analyzed in our review study emerge as crucial for enhancing the patient experience during hemodialysis, encouraging them to take an active role in managing their health. These resources have the potential to significantly increase patient engagement in their own care [62], with an observed increase in recent years [78,79]. However, while these solutions serve many well, younger patients, especially those in the early stages of the disease, may require more advanced technological approaches focused on primary prevention and improving treatment adherence [78]. For future developments, it is crucial to recognize that the chronic kidney disease population is diverse in terms of digital health literacy, suggesting that standardized approaches may not be effective for everyone [78,79].

4.6. Limitations

As a scoping review, this study offers a comprehensive overview of the available literature, but it has several important limitations. One such limitation is language restriction, as only studies in four languages were included. Relevant studies published in other languages were not considered, potentially limiting the generalizability of the results. Another significant limitation of this type of review is that, unlike systematic reviews, a scoping review does not assess the methodological quality of the included studies. This means the results might encompass studies with lower scientific rigor, preventing a deeper critical analysis of the strength of the evidence. These characteristics limit the ability to distinguish between technologies' proven effects and those that may have been positively reported due to potential biases in the original studies.

Furthermore, implementing technology in hemodialysis treatment faces challenges, such as adapting technological resources to the diverse needs of patients, who vary in terms of age, medical conditions, and cognitive ability. Adopting a user-centered design methodology is crucial to overcome these barriers and ensure that devices are useful and accessible [70,79–81]. Finally, the effective implementation of technologies in dialysis centers requires that they be integrated in a way that does not disrupt existing workflows and that patient data is handled with the utmost security to ensure privacy and compliance with legal standards. Acceptance by healthcare professionals and adequate training is essential for the successful and sustainable adoption of technological solutions.

5. Conclusions

This study provided a comprehensive overview of the technologies applied in supporting patients undergoing hemodialysis, mapping a variety of tools, ranging from VR to mobile applications, developed and evaluated over the past two decades. Among the technologies cataloged, mobile apps and VR technologies stood out due to their prevalence, highlighting their potential to assist in disease management, self-management, and improving patients' quality of life. These technologies primarily focused on promoting physical exercise, managing diet and medication regimens, and other essential aspects of patient self-care and self-efficacy. The development of these technologies reflects a growing trend toward integrative approaches in hemodialysis, with a strong emphasis on personalizing treatment to meet patients' specific needs.

Despite challenges related to safety, adaptation, and implementation, these technologies emerge as valuable tools for healthcare professionals to develop more effective support strategies. To maximize the potential of these innovations, it is recommended that healthcare professionals maintain a continuous and evolving dialog with patients, ensuring that interventions are tailored to individual needs and effectively promote treatment adherence.

For future research, it is essential to adopt a multidisciplinary approach, integrating knowledge from fields such as medicine, engineering, design, and information technology. This collaborative effort could result in developing even more effective and personalized solutions. Moreover, it is crucial to explore the integration of patient feedback to continuously assess the applicability and safety of implemented technologies, adjusting them as necessary to ensure that interventions are both safe and beneficial.

In summary, although the study did not directly assess the impact of these technologies, its compilation offers a solid foundation for future investigations, which may explore in depth how these innovations can continue to transform hemodialysis, significantly improving treatment outcomes and patients' lives.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Search Strategies According to the Database

Database	Research Strategy
MEDLINE	(((MH "Patients") OR (MH "Patient Education as Topic") OR ("Patient*") OR ("Adult*") OR ("Person") OR ("Aged")) AND ((MH "Educational Technology") OR (MH "Digital Technology") OR (MH "Games, Recreational") OR (MH "Video Games") OR (MH "Gamification") OR (MH "Play and Playthings") OR (MH "Mobile Applications") OR (MH "Digital Technology") OR (MH "Technology") OR (MH "virtual reality") OR ("Game*") OR ("Gamification") OR ("APPs") OR ("Video Game*") OR ("virtual reality") OR ("Boardgame") OR ("Digital Technology") OR ("Mobile Application") OR ("Web System")) AND ((MH "Renal Dialysis") OR (MH "Kidneys, Artificial") OR (MH "Intermittent Renal Replacement Therapy") OR (MM "Renal Insufficiency, Chronic") OR (MH "hemodialysis Units, Hospital") OR (MH "Renal Replacement Therapy") OR (MH "Dialysis") OR ("hemodialysis") OR ("hemodialysis") OR ("Renal Dialysis") OR ("Renal Insufficiency") OR ("Kidney Failure")))
CINAHL	(((MH "Patients") OR (MH "Patient Education") OR (MH "Dialysis Patients") OR ("Patient*") OR ("Adult*") OR ("Person") OR ("Aged")) AND ((MH "Educational Technology") OR (MH "Digital Technology") OR (MH "Games, Recreational") OR (MH "Video Games") OR (MH "Gamification") OR (MH "Play and Playthings") OR (MH "Mobile Applications") OR (MH "Technology") OR (MH "virtual reality") OR ("Game*") OR ("Gamification") OR ("APPs") OR ("Video Game*") OR ("virtual reality") OR ("Boardgame") OR ("Digital Technology") OR ("Mobile Application") OR ("Web System")) AND (((MH "hemodialysis") OR (MH "hemodialysis Therapy (Iowa NIC)") OR (MH "Dialysis Centers") OR (MH "Renal Replacement Therapy") OR (MH "Kidney Failure, Chronic") OR ("hemodialysis") OR ("hemodialysis") OR ("Renal Dialysis") OR ("Renal Insufficiency") OR ("Kidney Failure")))
PsycINFO	((DE "PATIENTS") OR (DE "PATIENT care") OR (DE "PATIENT education") OR (DE "hemodialysis patients") OR ("Patient Education") OR ("Dialysis Patients") OR ("Patient*") OR ("Adult*") OR ("Person") OR ("Aged") AND (DE "GAMIFICATION") OR (DE "GAMES") OR (DE "GAMES & technology") OR (DE "GAMES -- Therapeutic use") OR (DE "EDUCATIONAL games") OR (DE "VIDEO game software") OR (DE "VIDEO games") OR (DE "TECHNOLOGY") OR (DE "EDUCATIONAL technology") OR ("Educational Technology") OR ("Digital Technology") OR ("Games Recreational") OR ("Video Games") OR ("Gamification") OR ("APPS") OR ("Play and Playthings") OR ("Mobile Applications") OR ("Technology") OR ("virtual reality") OR ("Game*") OR ("Gamification") OR ("Video Game*") OR ("virtual reality") OR ("Boardgame") OR ("Digital Technology") OR ("Mobile Application") OR ("Web System")) AND ((DE "KIDNEY disease treatments") OR (DE "RENAL replacement therapy") OR (DE "HEMODIALYSIS") OR (DE "KIDNEY disease treatments")
Scopus	(TITLE-ABS-KEY (("Patient Education") OR ("Dialysis Patients")) AND TITLE-ABS-KEY (("Educational Technology") OR ("Digital Technology") OR ("Games Recreational") OR ("Video Games") OR ("Gamification") OR ("APPS") OR ("Play and Playthings") OR ("Mobile Applications") OR ("Technology") OR ("virtual reality") OR ("Game*") OR ("Gamification") OR ("Video Game*") OR ("virtual reality") OR ("Boardgame") OR ("Digital Technology") OR ("Mobile Application") OR ("Web System")) AND TITLE-ABS-KEY (("Renal Dialysis") OR ("Kidneys Artificial") OR ("Renal Therapy") OR ("hemodialysis Units") OR ("Dialysis") OR ("hemodialysis") OR ("hemodialysis") OR ("Renal Insufficiency")))

Database	Research Strategy
SciELO	(((“Patient Education”) OR (“Dialysis Patients”)) AND ((“Educational Technology”) OR (“Digital Technology”) OR (“Games Recreational”) OR (“Video Games”) OR (“Gamification”) OR (“APPS”) OR (“Play and Playthings”) OR (“Mobile Applications”) OR (“Technology”) OR (“virtual reality”) OR (“Game*”) OR (“Gamification”) OR (“Video Game*”) OR (“virtual reality”) OR (“Boardgame”) OR (“Digital Technology”) OR (“Mobile Application”) OR (“Web System”)) AND ((“Renal Dialysis”) OR (“Kidneys Artificial”) OR (“Renal Therapy”) OR (“hemodialysis Units”) OR (“Dialysis”) OR (“hemodialysis”) OR (“hemodialysis”) OR (“Renal Insufficiency”)))
MedicLatina	(((“Patient Education”) OR (“Dialysis Patients”)) AND ((“Educational Technology”) OR (“Digital Technology”) OR (“Games Recreational”) OR (“Video Games”) OR (“Gamification”) OR (“APPS”) OR (“Play and Playthings”) OR (“Mobile Applications”) OR (“Technology”) OR (“virtual reality”) OR (“Game*”) OR (“Gamification”) OR (“Video Game*”) OR (“virtual reality”) OR (“Boardgame”) OR (“Digital Technology”) OR (“Mobile Application”) OR (“Web System”)) AND ((“Renal Dialysis”) OR (“Kidneys Artificial”) OR (“Renal Therapy”) OR (“hemodialysis Units”) OR (“Dialysis”) OR (“hemodialysis”) OR (“hemodialysis”) OR (“Renal Insufficiency”)))
Cochrane Library	(((“Patient Education”) OR (“Dialysis Patients”)) AND ((“Educational Technology”) OR (“Digital Technology”) OR (“Games Recreational”) OR (“Video Games”) OR (“Gamification”) OR (“APPS”) OR (“Play and Playthings”) OR (“Mobile Applications”) OR (“Technology”) OR (“virtual reality”) OR (“Game*”) OR (“Gamification”) OR (“Video Game*”) OR (“virtual reality”) OR (“Boardgame”) OR (“Digital Technology”) OR (“Mobile Application”) OR (“Web System”)) AND ((“Renal Dialysis”) OR (“Kidneys Artificial”) OR (“Renal Therapy”) OR (“hemodialysis Units”) OR (“Dialysis”) OR (“hemodialysis”) OR (“hemodialysis”) OR (“Renal Insufficiency”)))

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