ABSTRACT

Purpose: The objective of this paper is to carry out a systematic review about the information about the application of of virtual reality (VR) and videogames in cardiac rehabilitation (CR).

Methods: A systematic review was conducted. Jadad scale was applied to evaluate the methodological quality of the articles included and the degree of evidence and the level of recommendation were determined through the Oxford Center for Evidence-Based Medicine. PRISMA guidelines statement for systematic reviews were followed.

Results: The total number of articles included in the present review was 10, with heterogeneity in the study populations, CR phases, technology used and protocols. Most of the studies showed an increase in heart rate, less pain, a greater ability to walk, higher energy levels, an increase in physical activity and improvements of motivation and adherence. The methodological quality of the studies was between acceptable and poor.

Conclusions: The use of VR and videogames could be considered as complementary tools of physical training in patients with CVD in the different phases of CR. However, it is also necessary to carry out studies with adequate methodological quality to determine the ideal technological systems, target populations and clearly protocols to study their effects in the short, medium and long-term assessments.

Keywords: Adherence. Physical exercise. Cardiovascular diseases. Virtual reality. Cardiac Rehabilitation. Satisfaction. Video games.

INTRODUCTION

Cardiovascular diseases (CVD) are the leading cause of morbidity and mortality in developed countries. The consequent healthcare costs in Europe alone are estimated at 196,000 million euros annually, approximately 54% of the total investment in health, resulting in productivity losses of 24% [1-3]. In recent years, the impact of CVD in non-Western countries has been growing [4,5]; therefore, prevention is presented as a primordial tool to improve quality of life and patient survival [6,7].

Cardiac rehabilitation (CR) is defined as a multidisciplinary program of clinical application of preventive measures for risk reduction and global and long-term care of the cardiac patient. In secondary prevention, it is shown to reduce the morbimortality by almost 50% in patients with heart disease. However, the participation of patients in cardiac rehabilitation remains low, especially among the following groups: the elderly, women and patients with a low socioeconomic profile. According to the latest Euroaspire V data, participation in CR programs in Spain is around 50%. The Reureca registry reports that only 10% of patients with a CR indication attend the programs. Therefore, new technologies within the health field, specifically within cardiac rehabilitation programs through the use of virtual reality (VR) and video games, are shown as promising aids with the aim of increasing adherence, satisfaction with programs and participation rates, offering the ability to perform physical exercise [8-11].

Virtual reality is a simulation of a real or imaginary environment created by a computer system, which allows the user to feel immersed and to interact with objects in that environment [12-14]. Thus, the basic elements that constitute a VR system are simulation, interaction and immersion [15].

Moreover, the creation of more adaptable and accessible videogame platforms has meant that the phenomenon of technological expansion can be understood not only as a form of leisure but also as an important means of learning and skills training, especially in people with motor, cognitive and sensory (neurological and non-neurological) deficits [16].

In contrast to traditional RC procedures, which can be repetitive, causing a loss of interest on the part of patients, video games and VR systems offer the opportunity to participate in enjoyable tasks with a therapeutic purpose through physical interaction with the game. The design of exercise-based videogames (exergames) provides the possibility of practicing physical skills in an entertaining way and of adjusting the game according to the abilities of the subject and the level of intensity. In addition, it is known that the level of enjoyment of an activity has been identified as one of the predictive factors of the effectiveness of an exercise program, and for this reason, interactive technology based on exercise is becoming the all-time most popular strategy for the implementation of physical activity [17-23]. It is important to emphasize that VR allows the creation of environments suitable for activities related to CR. The users of these systems can develop simulated tasks and activities in a safe way, since the clinicians have the capacity to control the duration and intensity of the exercise and, in this way, to control and supervise the delivery of stimuli in the virtual environment [24]. Furthermore, knowledge of results regarding the performance of the task in real time, gained through extrinsic feedback, as well as the playful nature of the activities proposed through VR and videogame devices, generates a competitiveness and challenge component that further increases the degree of patient motivation. In this regard, Klasen et al.[25] point out that this increase in motivation is related to the influence of videogames on activation of the mesolimbic dopaminergic pathways and their repercussions on the reward system of the brain. All this promotes active participation on the part of the patient and thus increases adherence to the rehabilitation treatment.

The aim of the present work is to carry out a systematic review of published information on the application of VR and videogame systems within RC programs.

MATERIAL AND METHODS

Search methodology

We present a systematic review of studies on the use of VR and video games as measures of physical training (exergames) in CR programs of CVD in a health context. The databases used were Brain, PubMed, Scopus, Medline, PEDro, Cinahl, Science Direct, Web of Science, Trip Database, Cochrane Database of Systematic Reviews, The Cochrane Library Plus, CENTRAL, DARE, OT Seeker and Google Scholar, including scientific articles published between 2010 and June 2019. The keywords used in the search strategies and the combination of Boolean operators were «*Cardiac Rehabilitation*», «*videogames*», «*virtual reality*», «Kinect», «Wii», using the search equations: 1. “*virtual reality*” AND “*Cardiac Rehabilitation*”, 2. “*cardiac rehabilitation*” AND “*videogames*”, 3. “*cardiac rehabilitation*” AND “Wii” and 4. “*cardiac rehabilitation*” AND “Kinect”.

In those databases that allowed us to set search limits, the search was restricted to randomized controlled studies (RCTs), original clinical studies with patients and conference proceedings. The language of publication was restricted to Spanish or English.

Inclusion criteria

To be eligible for participation in the studies, patients had to meet the following inclusion criteria: either male or female; age greater than 18 years; a diagnosis of CVD confirmed by a Cardiologist; information available on risk stratification, Killip level and functional class (NYHA), level according to the Canadian Cardiovascular Society Scale or the Goldman Physical Activity Scale; information available on METS in ergometry and ejection fraction and compliance with the indications described in relation to CR. We did not include those studies in which patients presented any of the following exclusion criteria: pregnancy or planned pregnancy, high cardiovascular risk, the presence of a pacemaker, conditions that make it difficult or impossible to use VR, such as the presence of visual or auditory deficiencies, learning problems, cognitive deterioration, psychiatric pathology or the use of support products for walking or standing, the presence of other serious neurological, musculoskeletal or lung diseases, uncompensated metabolic disorders, previous cardiorespiratory arrest or a history of photosensitive epilepsy due to the use of video games.

Eligible interventions consisted of the use of videogame-based VR as a complement to conventional RC, comparing this type of therapy with conventional RC treatment or as an isolated therapeutic measure.

Article selection and evaluation of methodological quality

The process of scientific article selection was initially carried out according to article titles and summaries. Subsequently, the content of these was assessed, and the studies that met the inclusion criteria were identified. Two authors independently read the full texts of selected articles and classified them according to relevance. The information was obtained in a standardized manner in accordance with the *Consolidated Standards of Reporting Trials Statement* [26]. From each of the publications, the following information was extracted: objectives of the study, type of heart disease, variables studied, design and description of the study, randomization and masking, inclusion and exclusion criteria, description of the intervention, material used and results. Any discrepancies in the information obtained from the articles and their extraction were resolved by a third investigator.

The Jadad scale was used to evaluate the methodological quality of the different articles obtained. This scale is one of the most often used to assess the quality of clinical trials. It consists of 5 items scored on a scale of 0 to 5 points. Articles that score less than 3 points are considered of poor methodological quality, while those that score 3 or more points are considered of acceptable, good or excellent quality [27].

In addition, the degree of evidence and the level of recommendation of the articles included was determined using the Oxford Centre for Evidence-Based Medicine Scale [28] according to the type of study, by grading the level of evidence according to the best design for each clinical scenario (Table 1).

In order to ensure the quality of this systematic review, the guidelines of the PRISMA declaration were followed [29].

RESULTS

Search results

A total of 213 publications were obtained, of which 32 were discarded for repetition, leaving 181 results. From these, a second filter was used to apply the specific selection criteria, in addition to ruling out systematic reviews and meta-analyses, reducing the number of publications to 34. Finally, the total number of articles included in the present review was 10. The articles excluded was due to interventions did not use videogame-based VR as a complement to conventional RC. These results are represented in the flow diagram (Figure 1).

Summary of results

According to the characteristics of the works included in this review (Table 2), all patients had CVD [30-38] except for those of one study [39], who were prehypertensive adults. These subjects have a high risk of developing hypertension, disease or cardiovascular mortality, which is why they were considered subjects of interest. Regarding the age ranges, these were heterogeneous, ranging from 18 years without an upper limit as inclusion criteria [34,37] to detailed age ranges from 30 or 40 to 80 years [30,31,36,38,39].

Virtual reality in RC was applicable in all phases as shown in the selected articles. These included post-surgery patients in phase I [32], cardiac patients with low to moderate risk in phase II [33,38] and patients in phase III with stable coronary disease [30,31,34,36]. According to the forms of application of RV, the most used systems are low-cost consoles, XBOX with its accessory Kinect [30,31,36] or Nintendo Wii [33-35,37-39], since these systems are the most accessible. In most studies, VR is used as a complement to conventional cardiac rehabilitation. However, Blanc et al. [35] and Klompstra et al. [34] performed VR treatment in isolation. The former [35] employed a 15-minute treatment using a boxing game with the Nintendo Wii console and its Wii Sports software, with a warm-up period of 5 minutes. The second [34] used 20 minutes of treatment with the same console and software but with greater variability of games (bowling, tennis, baseball, golf and boxing). The authors conclude that VR is an alternative for patients with heart failure, increasing exercise capacity in the elderly and chronic pathologies.

There did not seem to be a consensus on the variables studied, number of sessions, protocol of each session or the technology used. In the articles found, large differences were identified and are detailed below.

Cacau et al. [32] in their post-surgery program scheduled two sessions a day until discharge from hospital. Ruivo et al. [33,38] performed two sessions per week of 1 hour duration during the 6 weeks of their program in phase II. Vieira et al. [30,31,36], conducting their investigations in phase III, carried out their protocol for 6 months with 3 sessions a week of RV and recommended that participants walk for 30 min on each of the remaining days. The duration of each session could increase according to the needs of the individual (10 minutes of warm-up followed by 20 to 25 minutes of strength work and 35 to 45 minutes of resistance, ending with 6 minutes of stretching). Klompstra et al. [34], despite performing the phase III treatment as the previous authors, applied sessions of 20 minutes a day that could be increased if the patient was not tired. Blanc et al. [35], in their preliminary study, looked for changes in HR with the use of RV in patients with heart disease who had undergone surgery. They found an increase in HR above the first ventilatory threshold, leading to an important demand. As a result, RC with VR had to be carried out with caution, being supervised and registered at all times. Jaarsma et al. [37], employed a protocol of 30-min sessions per day of exercise plus physical activity counselling for 12 months. Finally, Serber et al. [39] implemented a program of 60 minutes per session with three sessions a week for 12 weeks.

All publications pointed to improvement of the motivational factor as the main advantage derived from the use of these new technologies. The subjects reported that it was a fun and interactive form of treatment, which decreased the dropout rate, increasing adherence to the PRC [30-32,34-38]. Another of the most studied factors is the significant increase in physical activity and energy expenditure produced [32,33,38]. In addition, Cacau et al. [32], in their phase I study, recorded earlier recovery and hospital discharge due to less pain, a greater ability to walk and higher energy levels. In contrast, some subjects reported limitations derived from the use of these systems, registered through questionnaires, such as difficulty in capturing certain gestures and movements and the need for a certain diaphanous space for their installation [30].

Level of evidence and grade of recommendation

According to the JADAD scale, the methodological quality of these studies was considered between acceptable and poor, since their score was equal to or less than 3. Four of the ten papers obtained a score of 3 [31-33,38], one of them scored 2 [37], four works scored 1 [30,34,36,39] and only one of them scored 0 [35] (Table 3).

Regarding the degree of evidence and the level of recommendation, three studies presented a grade of A (extremely recommendable) and level of evidence 1b; three others, a grade of B (favourable recommendation) and level of evidence 2B; and four, a grade of C (favourable recommendation but not conclusive) and level of evidence 4 (Table 2).

DISCUSION

Multifactorial physical activity, including social, environmental, psychological, and genetic factors has demonstrated benefits on people of all age groups and ethnicities over levels of cardiorespiratory fitness, health, and wellness, and a lower risk for developing several chronic medical illnesses, including CVD, compared with those who are physically inactive [40]. Multi-disciplinary approach encompassing supervised exercise training, patient counseling, education and nutritional guidance may also enhance quality of life in CDV patients [41]. The European Society of Cardiology urges the creation of a model that optimizes the results of long-term CR programs, because loss of adherence is one of the key factors hindering this type of study [42-45]. For this reason, new technologies and within them the application of VR and videogames as tools of physical training through software that encourages the performance of physical exercise (exergames) could be promising in the coming years. Therefore, in the present systematic review, we wanted to determine the effectiveness of this type of system, applying a methodology of analysis of the scientific evidence available in patients with CVD submitted to CR programs, indicating the levels of evidence and degrees of recommendation.

As mentioned in the results, low-cost consoles are the most used methods, but they are not the only ones that can be included in CR programs. Boulanger et al. [46] designed a novel VR based remote exercise-based CR system called MedBike which allows patients to perform a controlled exercise program in the comfort of their own home using a VR gaming experience while being monitored. They hypothesized that this home-based CR using the MedBike system will be a feasible and will effectively improve program compliance and patient risk factor reduction. The subjects will use an immersive virtual environment, using RV glasses and helmets that recreate a landscape through which the subject advanced through a path for a few predefine kilometres and could interact with the avatars of other patients. In addition, the cycle ergometer will be linked to a tablet that collected vital signs for patient monitoring.

Regarding the studied variables, most of the studies sought to obtain changes in adherence to treatment. Various professionals in the field of cardiology agree that, if there was a lower rate of abandonment of treatment and healthier lifestyles were adopted, the recurrence rate of cardiac events would decrease [30,34,38,47]. Klompstra et al. [48] in their review show how VR can be an option for those patients who are resistant to CR programs, since they are shown to be safe systems that allow physical training, as well as diminishing symptoms of the psychological sphere (depression) and achieving a better quality of life related to health. In addition, patients define VR as an enjoyable and motivating form of treatment that allows them to socialize more with other patients and family members. Volmer et al. [49] conducted a study with the main objective of improving long-term motivation in the CR process through the use of virtual reality, but not as a complement of a conventional CR programme. The system they used was a modified cycle ergometer with sensors, Oculus Rift © RV glasses, the Microsoft Kinect camera and a television. The authors concluded that the system was well accepted for being easy to use, motivating and safe and allowing professionals to monitor the sessions. Along the same lines, Siegmund et al. [50] through their study sought to evaluate the impact of a Facebook intervention to improve motivation through a private group in the social network. The patients, who were included in a phase II RC program for 12 weeks, also received a weekly publication to motivate them to carry out the program. Finally, Franklin [51] agreed on the importance of motivation and adherence in these new technologies; however, the low number of publications on the subject and the need to determine a treatment protocol were indicated.

There seems to be limited information on the consumption of oxygen or metabolic equivalents (METS) in relation to the use of VR in RC programs. Eichhorn et al. [52] carried out a pilot study in healthy students, which attempted to obtain changes in the heart rate through movement of the upper limbs. The subjects interact with the virtual world by simulating a bird that moved through a landscape with different obstacles. Ruivo et al. [38] conducted a pilot, evaluator-blinded, intention-to-treat, randomized controlled trial to check whether video games could be a complementary therapy to CR. The authors explained that the metabolic output produced by video games was comparable to that of real sports such as yoga, walking or soft endurance training, but not to that of more demanding exercises such as boxing or tennis. The authors indicated that it is not clear whether their intensity should be mild to moderate or moderate to achieve positive results and the risks appear to be minimal in adults and the elderly. Along these lines, Chaddha et al. [53] report that the metabolic rates that can be achieved by healthy adults while performing RV with the Wii and Wii Sports software vary from 1.3 to 5.6 METS. These values correspond to the energy expenditure of a slow (for the value of 1.3 METS) or very fast (for 5.6) walk. Bosch et al. [54] evaluated whether 30 minutes of boxing with the Wii produced cardiorespiratory benefits in healthy young people aged 23 to 27 years compared with treadmill. The authors concluded that VR provided adequate aerobic activity for young adults and could be used as a viable alternative to conventional RC. A growing body of evidence suggests that high intensity interval training may be superior to moderate intensity for maximizing health outcomes in CR programs in CDV patients [55]. However, there are controversies in this regard and derived derivative risks [56], so authors stated that there is still insufficient evidence to supplant a moderate intensity approach with high intensity interval training, so future studies using VR should have these approaches into account [57].

In relation to the applicability of these systems in RC programs, Fung et al. [58] conducted a study aimed at physiotherapists and occupational therapists to assess their subjective perception of the degree of viability and applicability of the Nintendo Wii video game console in the CR process. These health professionals, through a self-administered opinion questionnaire, reported that this system was easy to use and safe and could improve treatment compliance, both in outpatients and inpatients. However, they considered this form of treatment not applicable for certain cardiac patients, for example, transplant patients, since their aerobic resistance is seriously compromised. Therefore, monitoring, supervision and adequate design of a protocol, as well as the inclusion and exclusion criteria, are key to guaranteeing its success. In parallel, other technological devices, such as telerehabilitation [59] and mobile applications [60] through using smartphones, could help the implementation of VR systems in CR programs in those patients with accessibility problems or who live in remote areas. Therefore, future studies should assess their applicability through studies with an adequate methodological design under the correctly supervision and monitoring of clinicians.

This review presents some limitations. First, there is a low number of publications about this topic. This indicates the need to carry out studies with adequate methodological quality. In addition, according to the number of articles found, the results could not be unified according to the phases of rehabilitation, conditioning the results since the physiological responses and objectives are not the same in patients in the acute and chronic phases. At the same time, the diseases, technologies used, protocols and number of sessions were heterogeneous among the different works included. Finally, the present systematic review only selected studies published in Spanish and English.

CONCLUSIONS

New technologies using VR and video games, mainly those employing low-cost movement capture systems, could be considered as complementary tools for physical training in patients with CVD in the different phases of CR, allowing them to improve adherence to CR programs. However, studies with adequate methodological quality are necessary in order to determine the technological systems, cardiac diseases, protocols and training intensity levels, as well as short-, medium- and long-term outcome measures, through the use of these promising technologies in secondary prevention and CR programs.

Conflict of interest

The authors declare no conflict of interest

Competing interests

The authors declare that they have no competing interests.

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Table 1. Oxford Center Scale for Evidence-Based Medicine

Grade of recomendation	Significance	Level of evidence (*)	Type of study
A	Extremely recommendable	**1a**	Systematic review of randomized clinical trials, with homogeneity.
		1b	Randomized clinical trial with narrow confidence intervals.
		1c	Clinical practice.
B	Favorable recommendation	**2a**	Systematic review of cohort studies, with homogeneity.
		2b	Cohort studies or randomized clinical trials of low quality.
		2c	Outcomes research (**), ecological studies.
		3a	Systematic review of case and control studies, with homogeneity.
		3b	Cases and controls study.
		Extrapolation level 1 studies	
C	Favorable but not conclusive recommendation	**4**	Case series or cohort studies and cases of low quality.
		Extrapolation of level 2-3 studies	
D	Neither recommended nor disapproved.	Level 5 studies or inconclusive studies of any level	Opinion of experts without explicit critical assessment, or based on physiology, bench research or first principles (***).

(*) Level of evidence:

B: level 2-3 studies, or extrapolation of level 1 studies.
C: level 4 studies, or extrapolation of level 2-3 studies.
D: Level 5 studies, or inconclusive studies of any level.

Extrapolation is applied when the clinical scenario has important differences with respect to the original situation of the study.
(**) The term outcomes research refers to studies of cohorts of patients with the same diagnosis in which the events that occur are related to the therapeutic measures they receive.
(***) The term first principles refers to the adoption of a certain clinical practice based on physiopathological principles.

Table 2. Characteristics of the articles included

Author	Disease	CR phase	Age	Patients	Interventions´ groups	Type of VR	Protocol	Results	Grade of recommendation	Level of evidence
Vieira et al. (30)	Stable coronary pathology	III	40-75	11	Intervention group	Kinect (Project Kinect RehabPlay)	3 sessions of VR per week and 30 minutes of walking on the remaining days, for 6 months. The intensity of the exercises and repetitions were increased according to the Borg scale.	The participants reported that the VR was motivating and that it could be an instrument of interest in cardiovascular rehabilitation. They found limitations in the capture of certain gestures and movements, in addition to needing a large space at home.	B	2b
Vieira et al. (31)	Stable coronary pathology	III	40-75	33 (11 each group)	- VR domiciliary group - Domiciliary group with informative guide -Control group (usual care)	Kinect (Project Kinect RehabPlay)	3 sessions of VR per week and 30 minutes of walking on the remaining days, for 6 months. The intensity of the exercises and repetitions were increased according to the Borg scale.	Significant improvements in executive function, attention and conflict resolution for the RV group, compared with the other two groups. No significant differences were found in quality of life, depression, anxiety and stress.	A	1b
Cacau et al. (32)	Post-cardiac surgery (bypass or valve replacement)	I	<75	60 (30 each group)	-VR group plus conventional CR (motor exercises were performed with VR) --Control group (conventional RC)	--	twice per day (morning and afternoon).	VR as a complementary treatment to CR achieves benefits in functional performance, higher energy levels, less pain and greater ability to walk. Patients report a faster recovery and earlier hospital discharge.	A	1b
Ruivo et al. (33)	Cardiac patients susceptible to	II	60±10	32 (16 each group)	-VR group (video games) plus conventional CR	--	twice weekly for 6 weeks	VR as a complement to CR is a feasible and safe method, as well as a promising strategy to increase adherence. The VR	C	4

	CR (low-moderate risk)				-conventional CR			group reported a significant increase in physical activity and energy expenditure.		
Klompstra et al. (34)	Patients with stable heart failure	III	>18	32	Treatment group	Nintendo Wii and Wii Sports (bowling, tennis, baseball, golf and boxing)	Minimum 20 minutes of daily play for 12 weeks.	VR is presented as an alternative for patients with HF. In addition, it has the potential to increase physical capacity in the elderly and chronic pathologies but does not improve activities of daily living.	C	4
Blanc et al. (35)	Cardiac patients (coronary revascularization, valvular replacement, angioplasty, dilated cardiomyopathy and other cardiac pathologies)	--	50.6 ± 13.3	27	Treatment group	Nintendo Wii and Wii Sports (boxing)	15 minutes of training with RV (with a 5-minute warm-up)	VR generates an increase in HR above the ventilatory threshold, implying a significant demand for the anaerobic threshold. For this reason, caution should be recommended when exercising with RV without supervision or constant control.	C	4
Vieira et al. (36)	Stable coronary pathology	III	40-75	33 (11 each group)	-Virtual reality group (RV): Computer and Kinect -Conventional RC Group: Brochure -Control group: Education about risk factors	Microsoft Kinect-Project Kinect-RehabPlay	3 sessions of VR a week and 30 minutes of walking on the remaining days, for 6 months. The intensity of the exercises and repetitions were increased according to the Borg scale.	The VR program had a positive influence on body composition compared with the control group, both in the first three months and after 6 months. In addition, high-density lipoprotein cholesterol in this group was increased after the end of the program.	B	2b

Jaarsma et al. (37)	Heart failure	--	>18	600	-Control group (counselling on physical activity and motivational support) -VR group (physical activity and VR counselling)	Nintendo Wii	30 minutes per day of exercises with Wii for the RV group and 30 minutes of activity per day for the control group, for 12 months (with assessment at 3, 6 and12 months after starting and with a follow-up of 3 months).	VR using low-cost commercial consoles that imply greater accessibility can be effective at increasing exercise capacity in patients with HF. This type of exercises motivates the patient so there is a greater degree of adherence, translated into greater physical activity and quality of life, reducing symptomatology.	B	2b
Ruivo et al. (38)	Cardiac patients susceptible to CR (low-moderate risk)	II	40-80	32 (16 each group)	-VR group plus conventional CR -Conventional CR	Nintendo Wii and Wii Sports (boxing and canoeing)	2 sessions per week of 1-hour duration, for 6 weeks.	The VR group reported greater interactivity in the treatment and did not perceive a greater risk of injury. There was a lesser tendency to abandon treatment, as well as greater improvements in physical capacity and energy expenditure.	A	1b
Serber et al. (39)	Pre-hypertensive patients	--	30-65	14	-Treatment group	Nintendo Wii	60-minute sessions, 3 sessions a week, for 12 weeks.	VR was shown to be effective and enjoyable as long as it was addressed through moderate physical activity and was carried out regularly. Changes were obtained at the cardiovascular level and in psychosocial health.	C	4

HR: heart rate; HF: heart failure; CR: cardiac rehabilitation; VR: virtual reality.

Table 3. Jadad scale

JADAD SCALE						
Studies	**Randomized**	**Double-blind**	**Drops and abandoned**	**Appropriate randomization**	**Double blind**	**Total score**
Vieira Á et al. (30)	NO	NO	YES	NO	NO	1
Vieira Á et al. (31)	YES	NO	YES	YES	NO	3
Cacau Lde A et al. (32)	YES	NO	YES	YES	NO	3
Ruivo JMADS et al. (33)	YES	NO	YES	YES	NO	3
Klompstra L et al. (34)	NO	NO	YES	NO	NO	1
Blanc P et al. (35)	NO	NO	NO	NO	NO	0
Vieira Á et al. (36)	NO	NO	YES	NO	NO	1
Jaarsma T et al. (37)	YES	NO	NO	YES	NO	2
Ruivo JMADS et al. (38)	YES	NO	YES	YES	NO	3
Serber ER et al. (39)	NO	NO	YES	NO	NO	1

Figure 1. Flow chart

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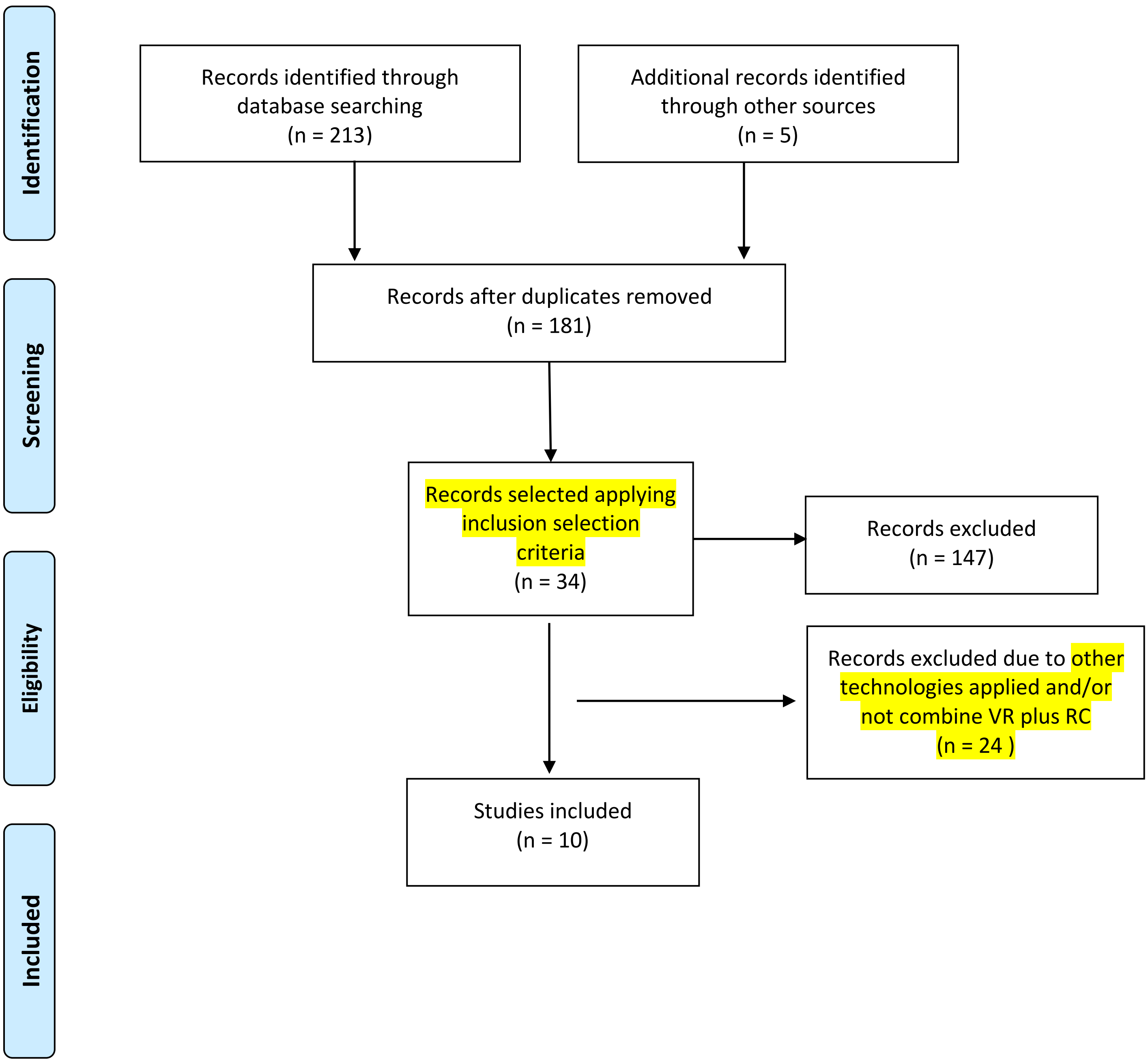

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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