# JOGOS USADOS NA REABILITAÇÃO APÓS ACIDENTE VASCULAR CEREBRAL: SCOPING REVIEW

## JUEGOS UTILIZADOS EN REHABILITACIÓN DESPUÉS DE UN ACCIDENTE CEREBROVASCULAR: SCOPING REVIEW

## GAMES USED IN REHABILITATION AFTER STROKE: SCOPING REVIEW

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## RESUMO

**Objetivos:** explorar o estado atual do conhecimento científico relacionado com a utilização de jogos na reabilitação do indivíduo após Acidente Vascular Cerebral, para mapear os jogos e identificar as áreas de função reabilitadas.

**Método:** revisão do tipo *Scoping*, com base no modelo do *Joanna Briggs Institute*. Realizada busca nas bases de dados MEDLINE®, CINAHL® e SPORTDiscus®. Foram considerados todos os tipos de estudos científicos publicados em inglês, espanhol e português, sem limite temporal.

**Resultados:** Nos 116 artigos considerados para análise identificaram-se três grandes agrupamentos de jogos: Realidade Virtual imersiva/não imersiva, videojogos e Jogos Tradicionais, que se associaram à reabilitação das funções motora, propriocetiva, cognitiva e cardiorrespiratória.

**Conclusão:** A utilização de jogos na reabilitação cresceu ao longo dos últimos anos. Os jogos induzem maior interatividade no treino intensivo e repetitivo, acrescentando mais motivação e adesão aos processos de reabilitação, podendo ser um importante recurso terapêutico.

**Descritores:** AVC; Jogos; Reabilitação

## RESUMEN

**Objetivos:** explorar el estado actual del conocimiento científico relacionado con el uso de juegos en la rehabilitación de individuos después de un accidente cerebrovascular, para mapear los juegos e identificar áreas de función rehabilitadas.

**Método:** Revisión del alcance, basado en el modelo del Instituto Joanna Briggs. Busque en las bases de datos MEDLINE®, CINAHL® y SPORTDiscus®. Se consideraron todos los tipos de estudios científicos publicados en inglés, español y portugués, sin límite de tiempo.

**Resultados:** En los 116 artículos considerados para el análisis se identificaron tres grandes grupos de juegos: Realidad virtual inmersiva / no inmersiva, Videojuegos y Juegos tradicionales, que se asociaron con la rehabilitación de las funciones motoras, propioceptivas, cognitivas y cardiorrespiratorias.

**Conclusión:** El uso de juegos en rehabilitación ha crecido en los últimos años. Los juegos inducen una mayor interactividad en el entrenamiento intensivo y repetitivo, agregando más motivación y adherencia a los procesos de rehabilitación, que pueden ser un recurso terapéutico importante.

**Palabras clave:** Accidente cerebrovascular; Juegos; Rehabilitación.

## ABSTRACT

**Objectives:** To explore the current state of scientific knowledge related to the use of games in the rehabilitation of individuals after stroke, for mapping the games and identifying the areas of function rehabilitated.

**Method:** Scoping review, based on Joanna Briggs Institute model. Search in MEDLINE®, CINAHL® and SPORTDiscus® databases. All types of scientific studies published in English, Spanish and Portuguese, without time limit, were considered.

**Results:** In the 116 articles considered for analysis three major groupings of games were identified: Immersive / Non-Immersive Virtual Reality, Video Games and Traditional Games, which were associated with the rehabilitation of motor, proprioceptive, cognitive and cardiorespiratory functions.

**Conclusion:** The use of games in rehabilitation has grown over the last few years. Games induce greater interactivity in intensive and repetitive training, adding more motivation and adherence to rehabilitation processes, which can be an important therapeutic resource.

**Descriptors:** Stroke; Games; Rehabilitation.

## INTRODUCTION

The stroke (Cerebrovascular Accident), all over the world, is the third main cause of disability for adults. The stroke is a devastating disease for individuals and their families, being also one of the main causes of dementia and depression[1-2].

The main stroke-related sequels are the total or partial loss of upper limb (UL) and lower limb (LL) mobility, speech commitment, loss of memory capacity and reasoning that undermine the performance of daily life activities and compromise the quality of life of individuals[3]. Rehabilitation of individuals with stroke is a challenging process. To be effective, it should be precocious, intensive and repetitive for several weeks after initial lesion, which leads to the challenge of how to maintain motivation for people in therapy. Games can be an effective strategy to address the problem of involvement in therapy[4].

Games are structured activities with plays; however they are also used and exploited in different contexts, aiming to take advantage of their ability to stimulate cognitive and physical functions. Exercise done through games allows the active movement of affected areas activating sensory and cognitive systems, benefiting individuals with stroke[5]. The use of the games allows developing the potential and decreases the limitations, seeks to stimulate physical, mental and sensory skills, and improves the quality of life[6].

A preliminary survey conducted at the Joanna Briggs Institute (JBI) Database of Systematic Reviews and Implementation Reports, Cochrane Library, Medline and Cinahl, revealed that the publication of a scoping mapping or revision in this area is unknown.

This review research aims to explore the current state of scientific knowledge related to the use of games in the rehabilitation of the individual after stroke, with the main objective of mapping the games used in stroking rehabilitation. As a secondary goal, we intend to identify the rehabilitated function areas. Throughout the article, it is aimed to answer the following questions: What types of games are used to rehabilitate the individual with stroke? What functions of the individual can be rehabilitated through the games?

## METHOD

For the achievement of the objectives, a scoping review of the scientific literature was drawn up, based on the guidelines advocated by the JBI for this type of revision[7]. A scoping review assumes as main objectives: to formulate a broad and open initial issue, to map existing evidence underlying a research area, to identify gaps in existing evidence, to constitute a preliminary exercise that justifies and inform the realization of a systematic review of the literature[8].

It was chosen for this specific revision by this being suitable for determining the body of knowledge of a certain topic and highlighting the volume of literature and studies available, giving an overview of its content[9].

The Prisma - Preferred Reporting Items for Systematic Reviews and Meta-Analyts for the organization of the information and the recommendations described in Prisma-SCR (Prisma Extension for Scoping Reviews) were still followed for the presentation of this report[10].

The formulation of the investigation issue was based on the PCC acronym (population, concept and context). Thus, as population we considered all adult individuals (> 18 years-old) with a Diagnosis of stroke; we considered, for the concept, the use of games; and for the context, their rehabilitation.

On the basis of the guiding issue, the respective descriptors were identified in English, resorting to research syntaxes adjusted to each of the databases: Medline® (Medical Literature Analysis and Retrieval System Online), CINAHL® (Cumulative Index to Nursing and Allied Health Literature) and sportdiscus®. Descriptors / Medical Subject Headings (Mesh), Subject Headings and Subjects terms, for each of the databases, with use of free terms were used. In this way the following Boolean phrases: Medline® - (MH "Stroke +") and (MH "Video Games") OR (MH "Games, Recreational") OR (MH "Games, Experimental +") and ( MH "Rehabilitation +"); Cinahl® - (MH "Stroke +") and (MH "Games +") OR (MH "Video Games +") and (MH "Rehabilitation +"); SPORTDISCUS - (STROKE AND GAMES AND REHABILITATION) Not (Child or Children)).

In the inclusion criteria we consider all eligible articles as long as it was identified in individuals with stroke, the use of games in rehabilitation. The research methodology was not restricted to any kind of primary study, and all types of scientific studies published in English, Spanish and Portuguese, with no time limit in the search. As exclusion criteria there are studies performed with children.

The selection of the articles included in this literature review undergoes a rigorous and systematized process, presented in the Prisma® diagram that exhibits the search, exclusion and selection process of the articles found. This process was performed by researchers independently and the final result was obtained after consensus meeting. The data were obtained using custom extraction forms for this purpose. For each study, information about authorship, year of publication and country were documented; Methodological drawing; Characteristics of games and intervention area in rehabilitation. Subsequently, these data were compiled in frames and figures, through a narrative summary of the data extracted in each of the articles.

## RESULTS

In the scientific research carried out in the different databases, 228 articles were obtained. After the different steps in Figure 1 were selected 128

applications for integral reading of which, 116 were included in this review.

In Table 1, the Included Studies Included Information is presented. The publications described with games occur between 2002 and 2018, evidencing an increase in scientific production in recent years. In relation to the methodology, experimental studies are mainly highlighted, and two systematic revisions have been identified. As for the games, it was possible to identify three large groups: immersive and non-immersive virtual reality games, video games and traditional games, and their associated devices and resources, which are schematized in Figure 2.

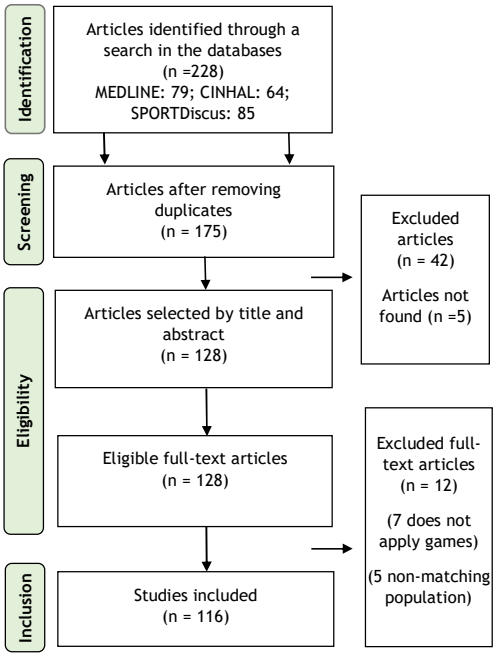


***Figure 1*** *– Prisma® Flowchart (Adapted) of the Study Selection Process*

| Study (Author, Country, Year) | Type of study | Type of game/ game description | Intervention areas/ Function |
|---|---|---|---|
| Bailey, M J. et al., United Kingdom, 2002[33] | Experimental study | Board games (Snakes and Ladders, Scrabble, Domino, word puzzle). | Motor function: UL<br>Heminegint |
| Wood, S.R., et al., Mexico, 2003[34] | Experimental study | Pong computer game with "Palanca" device - lever placed in a box named by "car". With sensors. When necessary they used a glove to hold the affected member to the lever. | Motor function: UL<br>Thin motricity<br>Ludic |
| Broeren, J., et al., USA, 2004[35] | Case study | 3D virtual reality (VR) set by computer with haptic device - portable stylus. It consists of knocking down a brick wall with a ball with various speeds. | Motor function: UL<br>fine motricity |
| Bekter, A.L., et al., USA, 2006([15] | Case study | Computer set with pressure rug - Under Pressure, Memory Match, Tic-Tac-Toe (Pickle with a basket). | Motor<br>Cognition<br>Body balance |
| Broeren, J., et al., Sweden, 2007[16] | Case study | Computer VR game with a haptic device (portable stylus) that consists of knocking down a wall of blocks with a ball. | Motor<br>Thin hand motricity |
| Flynn, S., et al., USA, 2007[36] | Case study | VR game with Sony Playstation 2 Eyetoy (23 games). | Motor<br>Balance<br>Propriception<br>Cognition |
| Santos, M.C., Mexico, 2007[37] | Experimental study | Modified pong computer game, such as additional therapy (restrictive and electrostimulation therapy). | Motor function<br>Spasticity |
| Broeren, J., et al., Sweden, 2008[38] | Comparative study | VR games (Space Tennis, Bingo, Simon, Archery, Mugmastermind and Spherethrix), by means of a hand pen (haptic device) and stereoscopic 3D glasses. | Motor<br>Thin motricity<br>Cognition |
| Broeren, J., et al., Sweden, 2008[39] | Experimental study | 3D Games: Archery; Bingo; Memory; Simon; Space Tennis and Fish as additional therapy. Use of a semi-immersive countertop, 3D glasses and a haptic - The Phantom Omni). | Motor function: UL<br>Cognition |
| Rand, D., et al., Israel, 2008[40] | Experimental study | VR Games: Space Tennis, Welyy-Washy and Kung-fu on Sony PlayStation Eyetoy. | Motor function<br>Ludic |
| Szturm, T., et al., Canada, 2008[41] | Experimental study | Video interactive game with motion sensor associated with therapeutic objects (balls, cylinders, etc.) that help in games. | Motor function: UL<br>Thin motricity |
| Yavuzer, G., et al., Turkey, 2008[42] | Experimental study | VR games in PlayStation Eyetoy "Kun-foo, Goal.Attack, Mrchef, Dig and Home-Run" combined with a conventional rehabilitation program compared to conventional rehabilitation and game viewing. | Motor function: UL<br>Body balance |
| Lange, B., et al., USA 2009[43] | Experimental study | Eyetoy: boxing and football games; Wii: Golf game and bowling with avatar on the screen or video that captures image of the patient.<br>Game developed specifically for rehabilitation with haptic device (Novint Falcon) with off-the-shelf feedback - player feels weight, shape, texture, dimension and force of an object. Can be played bimanual. | Motor function: UL |
| Qiu, Q., et al., USA, 2009[44] | Experimental study | Immersive VR games with haptic system - Cybergloves and Cybergrasp for games: Plasma Pong, Huntbird Hunt, Hammer Task, virtual piano. | Motor function: UL<br>Thin motricity |

| Study (Author, Country, Year) | Type of study | Type of game/ game description | Intervention areas/ Function |
|---|---|---|---|
| Ruparel, R. et al., USA, 2009[45] | Experimental study | Video game with thermadrive system that uses games that simulate driving (Trackmania, Millipede, Need for Speed) | Motor function: UL<br>Ludic<br>Spasticity |
| Cameirão, MS., et al., Spain, 2010[26] | Experimental study | Rhab game system based on VR games and neurorabilitation. Game spheroids (uses a spring similar to spring, where you interact virtually using 2 virtual arms on the screen). | Motor function: UL<br>Proprieto<br>Reply speed |
| Golden, S., et al., USA, 2010[46] | Journal paper | Nintendo Wii Sports (football and tennis) and Nintendo Wii Fit. | Motor function<br>Balance<br>Gait |
| Lange, B., et al., USA, 2010[47] | Experimental study | VR game with Nintendo Wii Fit (Balance Board) platform set panda 3d adapted. | Balance<br>Gait<br>Ludic |
| Saposnik, G., et al., Canada, 2010[48] | Experimental study | VR Nintendo Wii (Wii Sports and Cooking Mama Game) vs. | Motor function: UL |
| Yong Joo, L., et al., Singapore Republic, 2010[49] | Experimental study | Recreational therapy (cards of deck, bingo or "Jenga") | Motor function: UL<br>Sensor<br>Ludic |
| Cameirão, M. S., et al., Spain, 2011[50] | Experimental study | VR games, Nintendo Wii Games Sports with Wiimote device (Bowling, Tennis, Golf and Baseball), used as a complement to conventional therapy. | Motor function: UL<br>Ludic |
| Hijmans, J.M., et al., New Zealand, 2011[51] | Experimental study | VR Spheroids game through gloves with motion sensors comparing with conventional rehabilitation. | Motor function: UL |
| Merians, A. S., et al., USA, 2011[52] | Experimental study | VR Games with Personal Computer (Solitaire, Mah-Jong, Freecell, and Bejeweled) Similar to Nintendo Wii - with Cywee Z, Handlebar devices. | Motor function: UL<br>Thin motricity |
| Mouawad, M.R., et al., Australia, 2011[53] | Experimental study | Immersive VR games with cyberglove that uses simulator with games (Plasma Pong, Hummingbird Hunt, Hammer Task, virtual piano). | Motor function: UL |
| Saposnik, G. and M. Levin. Canada, 2011[2] | Systematic review with meta-analysis | VR Games - Nintendo Wii Sports (Tennis, Golf, Boxing, Bowling and Baseball) with Wii Mote device) with formal workout in laboratory and informal at home. | Motor function: UL<br>Cognition<br>Cortical reorganization<br>Spasticity |
| Schuck, S.O., et al., USA, 2011[54] | Experimental study | Revision on different types of immersive and non-immersive VR systems and devices used in MS neurorabilitation. | Motor function: UL<br>Quality of life |
| Acosta, A.M., et al., USA, 2011[55] | Experimental study | VR Air Hockey 3D game video game, uses arm avatar / hPtotic interface. | Motor function: UL |
| Combs, S.A., et al., USA, 2011[56] | Experimental study | Game- Hand Dance Pro - with adapted command and motion sensors. | Motor function: UL with trunk restriction |
| Kim, E. K., et al., Republic of Korea, 2012[57] | Experimental study | Wii Sports with Wii Remote and Nunchuk Controllers device (with bandwidth to hold the commands if necessary) | Functional independence motor function<br>Balance |
| Hale, L. A., et al., New Zealand, 2012[58] | Qualitative pilot study | Easy-to-See Objects and Icons, Basic Sports Concepts, Or Simple Puzzles with Cywee Z Movement Controller Command. | Motor function: UL<br>Balance<br>Concentration |
| Kam, N., Israel, 2012[59] | Pilot study | Nintendo Games: *Wii-Sports (Bowling and Tennis); Wii-Fit (Ski-Slalom)* | Motor function: UL |
| Kim, I., South Korea, 2012[60] | Experimental study | Group games with children's toys<br>- soccer match<br>- Golf game. | Motor function<br>Cognition<br>(Fatigue, sleep disorder and depression) |
| King M., et al., New Zealand, 2012[61] | Experimental study | Cywee Z movement controller games<br>Target games and strategy: "whack a mole"; "Bejeweled"; "Balloon Popping"; "Mosquito SWAT"; "Music Catch" and "Rebounce".<br>Sport Games "Air Hockey".<br>"Mah-jong" and "Solitaire" puzzle games. | Motor function: UL |
| Reinthal, A., et al., USA, 2012[62] | Pilot study | Selected games through an algorithm that considers various particularities and characteristics of each individual: Playstation II with Eyetoy and Nintendo wii (Wii Sports, Wii Resort, and Wii Play). | Motor function: UL |
| Taheri, H., et al., USA, 2012[63] | Experimental study | GUITAR HERO game type assisted by robotic device and visual feedback. | Motor function: UL<br>Thin motricity |
| Finley, M. and S. Combs, USA, 2012[64] | Experimental study | Video game - with adapted control (reach the targets as indicated by a combination of auditory clues via music and visual clues through on-screen arrows). | Motor: UL<br>Cognition<br>Ludic / motivational |
| Fritz, S.L., et al., USA, 2013 [65] | Experimental study | RV game - interactive movement interface and avatar on the screen. | Motor function<br>Balance<br>Gait |

| Study (Author, Country, Year) | Type of study | Type of game/ game description | Intervention areas/ Function |
|---|---|---|---|
| Gyuchang, L., Republic of Korea, 2013[66] | Experimental study | Xbox Kinect (with conventional occupational therapy): Kinect sports (Boxing and Bowling); Kinect adventure (Rally Ball, 20,000 Leaks, and Space Pop) vs Conventional physiotherapy. | Motor Function: UL<br>Activities of daily living |
| Orihuela-Espina, F., et al., Mexico, 2013[27] | Descriptive study | VR games, based on the Gesture Therapy (GT) platform.<br>The set of games used is the Armeo system (Hocoma, Switzerland), with games representing activities of daily living. To interact with the game, the patient holds a hand module (with pressure sensor) that incorporates a ball (top) for hand exercises. | Motor Function: UL<br>Fine motor skills |
| Peters, D.M., et al., EUA, 2013[67] | Experimental study | Nintendo Wii games (Wii Fit, Wii Sports with Wii balance board) and Sony Playstation 2 (EyeToy play 2 and Kinetic games) | Motor Function<br>Balance |
| Sin, HH. and Lee, GC., Republic of Korea, 2013[31] | Experimental study | VR Games - Xbox Kinect (bowling, boxing, Rally ball, 20,000 Leaks, Space pop). | Motor Function: UL<br>Fine motor skills |
| Singh, D.K.A., et al., Malasya, 2013[32] | Experimental study | Nintendo Wii Fit Plus, (Balance Bubble with Balance Board)<br>Xbox 360 Kinect (Reflex Ridge, Rally Ball) + conventional therapy vs conventional therapy. | Motor Function: LL<br>Balance<br>Gait |
| Sucar,L.E.,et al., Mexico, 2013[17] | Experimental study | Gesture Therapy - VR based platform. Use 3 Games: Steak, Clean window, Fly Killer with tasks based on serious games.<br>The webcam tracks hand/inca movements and translates this into commands to control games. | Motor function: UL<br>Fine motor skills |
| Wüest, S., et al., Switzerland, 2013[68] | Experimental study | Rehabilitation program that uses VR games with different training scenarios.<br>Microsoft Kinect and Tymo Force Platform. | Motor function<br>Balance<br>Gait |
| Simmons,C.D., et al., USA, 2013[69] | Experimental study | Computer-based virtual anatomical interactivity, PreMotor Exercise Games (PEGs) using PreMotorSkill 3D Technology. Patients visualize movement with the help of a computer-simulated virtual limb (mirror therapy).<br>Serious games: Grab and turn the key; Two-finger action to grab the ball and drop it into the cup. Open the box correctly; set of nine boxes with voice instructions to the player; puzzle games; simple numbers game and simple letter games. | Motor function: UL<br>Fine motor skills<br>Cognition |
| Goodman, N.R., et al., USA, 2014[70] | Experimental pilot study | Sitting video game, with ankle movement, assisted by robot (anklebot) to control a cursor.<br>Auxiliary device: Ankle robot with sensors (which, if necessary, can assist movement) with electroencephalographic monitoring. | Motor function: ankle<br>Gait |
| Bower, K.J., et al., Australia, 2014[71] | Experimental study | Nintendo VR Games - 'Wii Fit Plus' and Wii Sports / Wii Sports Resort (boxing, cycling, bowling, archery). | Motor function<br>Balance |
| Donoso Brown, E.V., et al., USA 2014[72] | Experimental study | Laptop video game - Neurogame Therapy – Peggle game, assisted by an electromyography device. | Motor function: UL |
| Friedman, N., et al., USA, 2014[73] | Experimental study | Music therapy: use of "Musicglove" vs conventional hand therapy and isometric grip training with "IsoTrainer"<br>Game: “Frets on Fire”, inspired by “Guitar Hero”. | Fine motor skills |
| Hung, J.-W., et al., Taiwan, 2014[74] | Experimental study | Nintendo Wii Fit Plus (*“Table Tilt”, “Ski Slalom”, “Soccer Heading”, “Balance Bubble”, “Penguin Slide”, “Basic Step” e “Warrior”*) vs Treino convencional (exercícios de deslocamento de peso e uso de “rocker board”). | Balance |
| Jordan, K., et al., USA, 2014[24] | Experimental study | Computer games with Smart Skate device - forearm splint with built-in mouse). | Motor function: UL |
| Kafri, M., et al., USA, 2014[75] | Experimental study | NintendoWii: *Boxing, Run e Penguin*<br>Xbox + Kinect: *Boxing*. | Motor function: UL<br>Balance<br>Gait |
| Morone, G., et al., Italy, 2014[76] | Experimental study | Wii Fit games in association with conventional physiotherapy. | Balance |
| Novak, D., et al., Switzerland, 2014[77] | Experimental study | Air-hockey game displayed on computer screen using ARMin III arm rehabilitation robots. | Motor function: UL |
| Pompeu, J.E., et al., Brazil, 2014[78] | Systematic review | VR Systems:<br>IREX - virtual rehabilitation system with serious games ("Bird and Ball"; "Coconut" and "Container"; "Juggler"; "Soccer")<br>Nintendo Wii Fit; Wii Sports (tennis, golf, boxing, bowling and baseball).<br>Games with a Force platform; 3D glasses (“Pinch”, “Reaching”, “Ball Shooting”, “Rotation”); Virtual environment projection systems in front of a “treadmill” associated or not with a weight suspension system; projection of interactive virtual scenarios with camera motion sensors. | Gait<br>Balance<br>proprioception<br>Motor function: UL<br>Cognition |
| Shin, J.-H., et al., Republic of Korea, 2014[25] | Observational study<br>Experimental study | RehabMaster System (task-based interactive VR system for post-stroke rehabilitation) with games: Underwater fire, Goalkeeper, Bug hunter, and Rollercoaster. | Motor function: UL<br>Balance |

| Study (Author, Country, Year) | Type of study | Type of game/ game description | Intervention areas/ Function |
|---|---|---|---|
| Shiner, C.T., et al., Australia, 2014[79] | Experimental study | Wii-based Movement Therapy (Nintendo Wii and Wii Sports) combined with Bilateral priming (use of a device to perform symmetric mirrored movements). | Motor function: UL |
| Slijper, A., et al., Sweden, 2014[18] | Experimental study | Laptop-based game console, controlled by 1 or 2 knobs (cross-cylinder grip) for MS<br>Games: Breakout, Snake, Puzzle bubble, Boxing, Recycling, Trombone. (Home environment) | Motor function: UL |
| Subramaniam, S., et al., USA, 2014[80] | Experimental study | RV – Use of Wii Fit (with the games, Table tilt, Tightrope, Soccer and Balance bubble), associated with the performance of cognitive games together (word game, memory game, question-answer game). | Balance cognition |
| Taheri, H., et al., USA, 2014[81] | Experimental study | Video game similar to "Guitar Hero" with hand-held robotic device FINGER (Finger Individuating Grasp Exercise Robot). | Motor function: UL (hand and fingers) |
| Viana, R.T., et al., Brazil, 2014[82] | Experimental study | Transcranial Electrical Stimulation combined with TV therapy, Nintendo Wii, using three games: "Wii Sports ResortTM", "Wii Play MotionTM" and "Let's TapTM" | Motor function: UL |
| Mei-Hsiang, C., et al., Taiwan, 2014[83] | Experimental study | Conventional rehabilitation combined with VR games: Nintendo Wii (bowling and boxing) or XaviX games (bowling and climbing games). | Motor function: UL |
| Tsekleves, E., et al., UK, 2014[84] | Experimental study | Virtual reality – games (with wiimote Plus), adjustable by the therapist, associated with a 3D movement monitoring system for performance assessment and greater involvement. | Motor function: UL |
| Wingham, J., et al., UK, 2015[85] | Experimental study | Nintendo Wii Sports<br>- Bowling; Tennis; Baseball and Boxing. | Função motora: UL |
| Omiyale, O.,et al., USA, 2015[86] | Experimental study | Nintendo Wii Fit balance board (ski slalom, table tilt, penguin slide, tight rope e balance rope). | Motor function: LL<br>Balance Coordination |
| Anderson, K.R., et al., USA, 2015[87] | Clinical guidance | Wii Games, Wii Sports (package): Wii Fit (package); Just Dance (game); Zumba Fitness (game); Wii Ware Arcade Games (package); Kinect Games: Kinect Sports, Bowling, Boxing e Table Tennis; Kinect Adventures. | Motor function: UL and LL<br>Balance Resistance |
| Bower, K.J., et al., Australia, 2015[88] | Experimental study | VR: Interactive motion control games, 3D: Ball Maze, Fridge Frenzy, Tentacle Dash and Bubble Fish. They use a camera with a depth sensor (PrimeSense - similar to Microsoft Kinect), connected to a laptop. | Motor function: UL<br>Balance cognition |
| da Silva Ribeiro, N.M., et al., Brazil, 2015[89] | Experimental study | VR - Nintendo Wii: Tennis, hula hoop, football and boxing games vs conventional physiotherapy. | Motor function: UL and LL<br>Balance<br>Sensory Function. |
| Donoso Brown, E.V., et al., USA, 2015[90] | Qualitative experimental study | NeuroGame Therapy: Peggle cursor game, which combines biofeedback with surface electromyography (sEMG). | Motor function: UL (wrist flexors and extensors). |
| Hyung Young, L., et al., Republic of Korea, 2015[91] | Experimental study | VR based training schedule vs task-oriented training schedule. VR Training: Using Wii fit Plus with Nintendo Wii, Wii Remote Control, Sensor Bar for Wii and Wii Balance Board. Motion is displayed on the monitor by an Avatar. | Balance |
| Kyoung-Hee, L., et al., Republic of Korea, 2015[92] | Experimental study | VR exercise program, which uses the Interactive Virtual Reality System with the following games: Airborne Rangers, Birds and Balls, Coconuts, Conveyor, Drums, Juggler and Soccer. | Motor function: UL<br>cognition<br>Performance in activities of daily living |
| Macdonald, J. A. and L. Gauthier. USA, 2015[93] | Experimental study | 3D Virtual Game and game with behavioral techniques, which promote day-to-day problem solving and member activation. Game with eye movement tracking, involving optokinetic stimulation and promotion of functional left-side look navigation. | Hemineneglect |
| McNulty, P.A., et al., Australia, 2015[94] | Experimental study | Motion Therapy Based on Wii Vs Video Game Modified Constraint-Induced Motion Therapy.<br>Games: Wii Sports: golf, boxing, baseball, bowling and tennis.<br>(Performed at the institute and at home). | Motor function: UL |
| Mobini, A., et al., Iran, 2015[95] | Experimental study | Rehabilitation systems that analyze upper limb movement through Microsoft Kinect, using Kinect as an accessible motion capture sensor. Used at home and clinical care. | Motor function: UL and trunk. |
| Paquin, K., et al., Canada, 2015[20] | Experimental study | Nintendo WiiMote - game: Kororinpa Marble Mania<br>uDraw Game Table: Spongebob, Squigglepants Instant Artist: Studio – Alien Splat | Fine motor skills |
| Gamito, P., et al., Portugal, 2015[28] | Experimental study | VR games based on Serious games (educational games) vs group without intervention. | Cognition (memory, concentration, spatial orientation) |
| Ponte, S., et al., Italy, 2015[96] | Experimental study | Microsoft Kinect for Xbox 360 – games:<br>*Bees and Flowers; Popping Flowers; Colored Cans; Grab your can; Blackboard.*<br>Home rehabilitation program. | Motor function: UL |

| Study (Author, Country, Year) | Type of study | Type of game/ game description | Intervention areas/ Function |
|---|---|---|---|
| Prange, G.B., et al., Netherlands, 2015[97] | Experimental study | Computer game, with interactive 3D exercises, using an arm support device (ArmeoBoom) Vs Conventional therapy exercises (reaching objects positioned on top of a table/shelves or stacking cups, placing discs, transporting blocks or pegs, without assistance of mechanical supports). | Motor function: UL |
| Buick, A.R., et al., North Ireland, 2015[98] | Experimental study | ReJoyce workstation (Joystick use in VR computer games) with functional electrical stimulation via a wrist strap. Games: car racing, boxing, shooting, gardening. Games based on serious games: turning a knob, holding a can, turning a key or unscrewing a lid. | Motor function: UL<br>Fine motor skills |
| Givon, N., et al., Israel, 2015[99] | Experimental study | Use of RV Video Games Vs Conventional Therapy Exercises. Xbox Kinect; Sony Playstation 2 Eyetoy, Sony PlayStation 3; Nintendo Wii Fit, SeeMe VR System Wii Fit walking/jogging game. | Motor function: MS and MI<br>Balance<br>Gait |
| Llorens, R., et al., Spain, 2015[100] | Experimental study | Posturography system based on the Wii Balance Board. | Balance<br>proprioception |
| Bonuzzi, G.M.G., et al., Brazil, 2016[101] | Experimental study | Nintendo Wii with balance platform.<br>Game: Table Tilt - Wii Fit Plus. | Balance |
| Shin, Ho-Joon., et al., South Korea, 2016[102] | Experimental study | VR combined with occupational therapy - RAPAEL Smart Glove ™ System - glove with sensor and avatar on screen.<br>Games based on "serious games": catching butterflies or balls, squeezing oranges, fishing, cooking, mopping the floor, filling a glass of wine, turning pages of a book. | Motor Function: UL (distal extremity) |
| Kong, K.-H., et al., Singapure, 2016[103] | Experimental study | Nintendo Wii (Wii Sports and Wii Sports Resort) with Wiimote device - games: Boxing, bowling, tennis, golf, baseball, table tennis, basketball, cycling, Frisbee disc, spade and flight control on airplanes;<br>Vs Conventional Therapy. | Motor function: UL<br>Balance<br>fine motor skills |
| Lee, M., et al., Republic of Korea, 2016[104] | Experimental study | VR system: Microsoft Kinect - displays the user's reflection on the screen or a hammer that reflects the patient's hand, with visual and auditory feedback. | Motor function: UL |
| Mousavi Hondori, H., et al., USA, 2016[105] | Experimental study | Augmented reality in video game (computer projected virtual objects) - subjects see the game and their arm movements simultaneously) Vs video game on personal computer with mouse. Same movements but different cognitive request. Game Fruit Ninja. | Motor function: UL |
| Na Jin, S., et al., USA, 2016[21] | Experimental study | Virtual reality games with glove device - Kinect and P5 Glove (*kitchen, archery, puzzle*). | Motor function: UL |
| Paquin, K., et al., Canada, 2016[106] | Experimental study | VR games: *Kororinpa Marble Mania* (with WiiMote), *Spongebob Squigglepants* (with uDraw game tablet), *Instant Artist: Studio - Alie Splat* (with uDraw game tablet). | Motor Function: UL<br>Fine Motricity<br>cognition |
| Proffitt, R. and Henderson, W., USA, 2016[107] | Case study | Virtual game *Mystic Isle* on Kinect. | Motor function |
| Rinne, P., et al., USA, 2016[108] | Experimental study | Game on tablets or smartphones through: swipe, touch, joystick, tilt the screen and an adapted grip. | Motor function: UL |
| Saposnik, G., et al., Canada, 2016[109] | Experimental study | Nintendo Wii vs traditional games (playing cards, bingo, Jenga or ball game). | Motor Function: UL<br>Fine Motricity |
| Şimşek, T.T. and K. Çekok, Turkey, 2016[110] | Experimental study | Nintendo Wii (Wii Sports; Wii Fit) vs Bobath concept (conventional neurological rehabilitation treatment). | Motor: UL<br>Balance<br>Gait<br>Improvement of ADL |
| Adie, K., et al., UK, 2016[19] | Experimental study | Nintendo Wii sports (bowling, tennis, golf, baseball) with remote control vs home arm exercises. | Motor function: UL |
| Bang, Y., et al., Republic of Korea, 2016[111] | Experimental study | VR with Nintendo Wii - via wii board device. Comparison with a group that used treadmill gait training. | Balance<br>Gait |
| Zondervan, D.K., et al., USA, 2016[112] | Experimental study | Conventional exercises (table exercises) vs therapy with “music glove” on a laptop – game similar to guitar hero. | Motor function: UL (hand) |
| Khor, K. X., et al., Malasya, 2016[14] | Experimental study | Robotic device of the upper limb, associated with a VR game that assists in a passive, active-assisted and resisted way. | Motor Function: UL (wrist and forearm) |
| Nijenhuis, S.M., et al., Netherlands, 2016[113] | Experimental study | Touchscreen computer games associated with wrist and hand orthosis vs exercises in exercise/activity book. | Motor Function: UL<br>fine motor skills |
| Rand, D., et al., Israel, 2016[114] | Experimental study | Xbox Kinect: Bowling, *Table Tennis, 20,000 Leaks* - for standing exercises.<br>Sony PlayStation 2 EyeToy: *Wishi washi, Ghosts, Kong fu* - for sitting exercises. | Motor function: UL<br>Balance |
| Standen, P. J., et al., UK, 2016[115] | Experimental study | Low-cost virtual reality video games (home use) with virtual glove vs conventional therapy watch game: Spacerace Balloonpop Spongeball | Motor function: UL |

| Study (Author, Country, Year) | Type of study | Type of game/ game description | Intervention areas/ Function |
|---|---|---|---|
| Trinh, T., et al., USA, 2016[116] | Observational study | Wii sports (golf, baseball, bowling, tennis and boxing). | Motor function: UL and LL<br>Balance<br>Gait |
| Bouchard, A.E., et al., Canada, 2016[117] | Experimental study | Pinball-like game with the hand positioned on a robotic device that induces a haptic orientation or an error magnification. | Motor Function: UL proprioception |
| Choi, H., et al., Republic of Korea, 2017[30] | Experimental study | Pinball-like game with the hand positioned on a robotic device that induces a haptic orientation or an error magnification. | Motor function: LL and Balance |
| Gauthier, Lynne V., et al., USA, 2017[29] | Experimental study | Video game with motion sensors in MS associated with restriction-induced movement therapy, therapist-assisted or video assistance, vs conventional restriction therapy vs conventional therapy. | Motor function: UL |
| Grossi, M., et al., Brazil, 2017[118] | Experimental study | Wii fit with balance board (penguin and tightrope games, ball game and river game). | Balance<br>Gait |
| Hung, J. W., et al., Thailand, 2017[23] | Experimental study | Wii Fit games (Table Tilt, Soccer Heading, Balance Bubble, Penguin Slide, and Perfect 10), Tetrax balance biofeedback system (Speedtrack, Catch, Skyball, Gotcha, Speedball, Tag, Freeze, Immobilizer) vs conventional balance training. | Balance<br>Cognition |
| James, T.T. e Brammatha, A., India, 2017[119] | Experimental study | "Thera - Trainer Balo" (robotic device similar to a standing-frame), assisted with visual feedback game (Thera Trainer Software) vs conventional therapy. | Balance (posture) |
| Park, D. -S., et al., Republic of Korea, 2017[120] | Experimental study | VR - Xbox Kinect: boxing, table tennis, soccer, golf, ski, football; vs conventional physical therapy. | Motor function: UL and LL<br>Balance<br>Gait |
| Rowe, J. B., et al., USA, 2017[121] | Experimental study | Robotic finger device that watches game similar to Guitar Hero. | Motor function: UL<br>Fine motor skills |
| Jung, S-M. et al., Republic of Korea, 2017[122] | Experimental study | VR - Nintendo Wii Sport. | Motor function: UL<br>ADL performance |
| Carregosa, A.A., et al., Brazil, 2017[123] | Experimental study | Wii sports and Wii fit (Boxing, tennis, football and hula hoop). | Motor function: UL<br>Balance |
| Huang, X., et al., Australia, 2017[3] | Experimental study | VR games assisted by handheld robotic device (Amadeo). | Motor function: UL (hand)<br>Fine motor skills |
| Rand, D., et al., Israel, 2018[22] | Experimental study | Games with the devices: Microsoft Xbox Kinect, Sony PlayStation 2 Eyetoy, Sony PlayStation 3, Nintendo Wii Fit and the SeeMe VR system (Virtual Reality Kinect Rehabilitation, 2016). | Motor function: UL<br>Balance<br>Gait |
| Choi, Y.-H. and Paik, N.-J., Republic of Korea, 2018[124] | Experimental study | VR through games viewed on a tablet, using a smartphone attached to the forearm to detect movement. | Motor function: UL |
| Silva de Sousa, J. C., et al., Brazil, 2018[125] | Experimental study | XBox360+Kinect: Tennis and boxing games. | Cardiorespiratory (Impact on heart rate (HR) and oxygen consumption) |
| Karasu, A. U., et al., Turkay, 2018[12] | Experimental study | Nintendo Wii Fit and Wii Balance Board - Games: Heading, Ski Slalom, Table Tilt, Tightrope Tension, Balance Bubble and Penguin Slide; associated with conventional rehabilitation vs only conventional rehabilitation. | Balance |

***Table 1*** *– summary of researches*

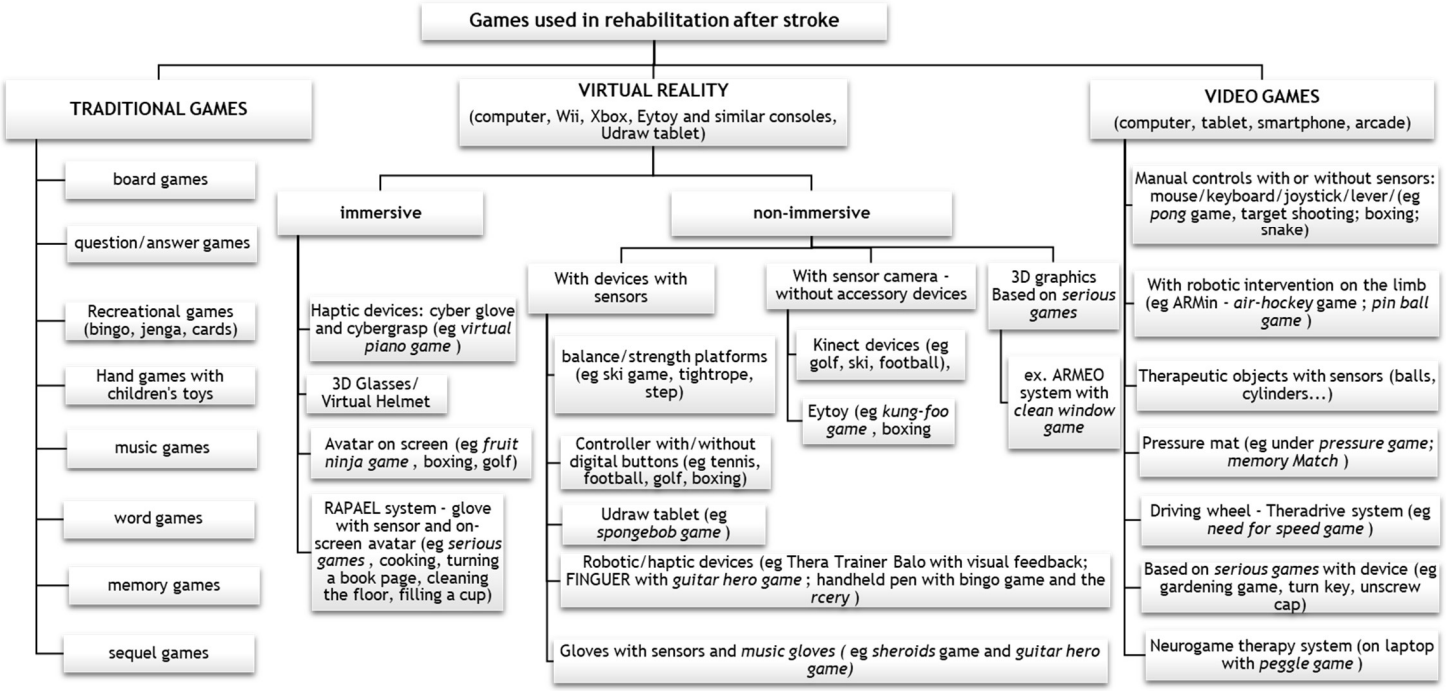


***Figure 2** – Type of games*

The first paper resulting from this research dates back to 2002 and studies the use of traditional games, through the use of board games, for rehabilitation of the motor function of the UL with hemineglect. In this decade, despite the small number of articles found (less than 17% of the total articles), it is already possible to identify the use of the three large groups of games.

Of the total results obtained in the survey, traditional games were mentioned in 7% of the articles, video games in 21% and virtual reality games in 72%. The latter appear in large numbers mainly due to the use of commercial consoles (52%), which begin to be studied in rehabilitation in 2007 (the same year they are commercially launched). It was in this year that we identified the first article that studies the use of a commercial console (Sony Playstation2 Eyetoy®) that, through a camera with a motion sensor, captures the player's image, projecting it on the screen and uses body movements to interact with the virtual objects inside the screen. Later, another commercial console, Nintendo Wii®, which is characterized by the use of a wireless control device, the Wii Remote, equipped with an accelerometer capable of detecting movements in three dimensions, was identified in a 2009 article. articles that refer to this type of console multiply. The use of equipment associated with these consoles are also mentioned, such as the TYMO® force platform (portable posturography system and balance platform), the Wii Balance Board (a scale with pressure sensors that allows the player to perform various activities physical games such as sports games or yoga) and the uDraw GameTablet (graphic game tablet that has a pressure-sensitive stylus that allows users to draw and visualize on the screen). In addition to commercial consoles, other types of equipment associated with video games or virtual reality games were identified, such as computers (fixed or portable), arcade, tablet and smartphone. The equipments associated with traditional games were board games, children's toys, musical instruments, activity books and activity tables.

Described in Table 2 are mentioned the different devices associated with video games and VR games that allow greater playability and interaction with the game, which can also promote sensory and/or motor feedback.

Gaming systems based on VR, developed and designed specifically for rehabilitation, were identified with greater representativeness at the end of this decade, in order to provide a more individualized treatment and keep the patient more motivated. These systems add different games in different virtual environments that can be customized according to patients' needs. These systems include serious games class games. Although there is no clear definition of the term serious games, this class of games is mainly aimed at simulating practical everyday situations. The term serious games came to be used to identify games whose purpose is to favor the absorption of psychomotor concepts and skills, benefiting from playful and recreational characteristics[11].

Through the analysis of the description of the games, it was also possible to identify the different classes of games used in rehabilitation: word games, recreational games, memory games, question/answer, strategy, puzzles, music and rhythm games, sports games, of physical activity and adventure, skill games and serious games.

| DEVICES | DESCRIPTION |
|---|---|
| **With sensors** | Commands (ex: cewezz, wiimote); handle; therapeutic objects balls and cylinders; pressure mat; Thera Drive® (steering wheel for driving game). |
| **Platforms** | TYMO® force platform (portable posturography system and balance platform); Wii Balance Board (balance with pressure sensors that allows the player to do various physical activities, such as sports games or yoga); walking mat; pressure mat. |
| **With support** | *ArmeoBoom* (adjustable arm and hand support, which counteracts the effects of gravity and facilitates self-initiated movements with greater feedback in a three-dimensional work environment); Smart Skate (forearm splint with built-in mouse). |
| **Gloves type** | Often used for games similar to Guitar Hero®, namely in the rehabilitation of the distal end of the UL and fine motor training: Music Glove/P5 Glove/Cybergloves® (gloves with sensors); Cybergrasp (hand haptic exoskeleton); FINGER (robot with finger bending mechanisms); RAPAEL Smart Glove TM System (biofeedback system designed for the rehabilitation of the distal extremity of the UL of the stroke patient, through a sensor glove device that tracks the movement and posture of the limb using a software application that allows to play different games , manipulating hands or virtual objects). |
| **Haptics/ robotics** | Portable stylus; hand pen; The Phantom Omni® (pen-like device that interacts with virtual scenery, through a semi-immersive bench and stereoscopic 3D glasses); Novint Falcon (provides bimanual training, allowing the player to feel the weight, shape, texture, dimension and strength of an object); Pinball-like handheld robotic game that induces haptic orientation or error magnification; Amadeo hand robotic (passively or actively-assisted flexion and extension of each finger; ARMin III arm robotic (provides up to seven degrees of freedom for shoulder and elbow joint and includes a manual module); Anklebot ankle robot (allows dorsiflexion or plantar flexion of the paretic ankle to move the cursor on the screen) Thera trainer balo (a device similar to standing frame, for dynamic balance exercises and postural control assisted by visual feedback through computer game). |

***Table 2*** *– Devices associated with games*

| SYSTEMS | DESCRIPTION |
|---|---|
| **Rehabilitation Gaming System** | It provides neurorehabilitation training for the affected upper limb extremity. |
| **SeeMe** | It combines therapeutic tasks with interactive games (Kinect technology) to make the rehabilitation process easier, funnier and more effective. Can practice and assess strength, endurance, range of motion, postural control, reaction time, proprioception, quality of movement, perception, attention, and memory. |
| **Reab Master** | It provides a rich environment for interactive rehabilitation and uses the concept of games, without the need to use any device, reproducing movement through an avatar. It involves four games (sports, skill and adventure) that require movement of the upper limb and/or torso to train control, endurance, speed, precision, range of motion and hand-vision coordination. |
| **Gesture Therapy** | Platform/therapy based on virtual reality for upper limb motor rehabilitation that favors the principles of rehabilitation (repetition, feedback, motivation and training for a specific task), challenging the patient to perform daily tasks, in the form of serious games, in a safe virtual environment. |
| **IREX®** | GestureTek Interactive Exercise and Rehabilitation System that uses immersive video control technology to place patients in virtual gaming environments where they are guided by therapeutic exercise regimens. |

***Table 3*** *- Game systems designed for rehabilitation.*

Therapies associated with playing games were mentioned in some articles, such as restriction-induced movement therapy, electrostimulation, transcranial electrical stimulation or mirror therapy, in order to enhance the individual's functional recovery. A video game (Peggle) was also found that combines a surface biofeedback - NeuroGame Therapy, with the objective of promoting the motor recovery of the UL (wrist flexors and extensors).

Most of the identified games were used with the objective of recovering UL motor function (55%). Other areas of intervention mentioned were: balance, posture, gait and proprioception reported in 23%; fine motor skills reported at 12%; cognition in 9% and only one experimental study from the year 2018 was found that investigated the impact of games (tennis and boxing) on cardiorespiratory function (impact on heart rate and oxygen consumption) through the use of a commercial console.

A type of game often referred to in the rehabilitation of the motor function of the hands and fingers is the Guitar Hero game, associated with haptic and robotic devices. For balance training, the games that use balance platforms stand out, which allow you to play physical activity, skill, sports and adventure games, such as ski slalom, table tilt, penguin slide, balance rope, soccer heading , balance bubble, basic step. For cognitive training, serious games stand out. In the rehabilitation of UL and LL, games classified as sports stand out, present in the three large groups of games

(traditional games, video games and virtual reality), such as football, boxing, bowling, tennis, golf, baseball.

## DISCUSSION

Virtual reality games are the ones that have aroused the most interest in research into their use in rehabilitation after stroke, and they were unequivocally the most found in this review. In recent years, there has been a growing interest in the use of new technologies such as VR in the rehabilitation of individuals after stroke. Clinical results indicate that the use of virtual reality technologies improves motor functioning and can be used to improve upper limb function, gait and balance, global motor function and cognitive function in stroke patients[12]. On the other hand, traditional games were the least identified, and most were studied in association or comparison with video games and VR games.

Video games and VR games are often referred to using devices with haptic or robotic sensors. Rehabilitation robots have become important tools in the rehabilitation of individuals with stroke. Compared to manual arm training, robot-supported training can be more intensive, longer and more repetitive, giving robots the potential to improve the rehabilitation process in stroke patients[13]. However, the cost of rehabilitation robots is still a problem, limiting their cost-benefit profile and making large-scale evaluation and implementation difficult[14]. Haptic devices, identified in a large number of articles with the aim of enhancing the function of the affected limb, can exercise movement passively, actively assisted or resisted, with the possibility of transmitting feedback at various levels, from vibrotactile, visual, auditory or even proprioceptive. The use of these devices has been suggested to improve the rehabilitation of individuals with stroke, using virtual reality in order to increase users' motivation[15-16]. Feedback improves learning, being extremely important for motor learning. It evokes neurophysiological processes that induce profound cortical and subcortical changes. In general, computer games are excellent at providing feedback, contributing even more to keeping the player involved[17].

VR can be classified from non-immersive to fully immersive, depending on the degree to which the user is isolated from the surrounding physical environment when interacting with the virtual environment. Immersive virtual reality is not so used in experimental studies, as it is more expensive and implies its use in a controlled manner in the laboratory[2]. The most common games in our sample were non-immersive virtual reality games associated with commercial devices such as the Nintendo Wii and similar ones. The entertainment industry developed these games for home use, making this technology less expensive and easier to access for use in rehabilitation[12]. Several of these games have been adopted by health professionals as rehabilitation interventions, although they were not initially designed for this purpose. The interactivity that characterizes these games, as well as the different associated devices, make the game environment more real, more dynamic, challenging, competitive, stimulating and motivating for the user. The patient's motivation is essential to exercise adherence to exercise[17]. The challenge and competition inherent in games are elements that can improve it. Considering that repetition, feedback, task-oriented training and motivation are important factors for the rehabilitation of the individual after a stroke, these games are an important tool to increase adherence[17-18] and can motivate patients in the interconnection with friends and family, giving them a social feeling of connection[17].

Based on the chronology of published studies, it was possible to observe an evolution in the use of games that accompanies technological development. Different types of devices have emerged in order to make the user's involvement greater and greater, using devices that are easy to manipulate, with the possibility of transmitting feedback at various levels simultaneously. They were found mainly for the UL (e.g. Wii Remote device)[19] and its distal extremity (e.g. tablet udraw)[20]; P5 Glove[21]. Devices such as the Thera Trainer Balo were also investigated for the trunk and LL, a device that resembles a standing frame [22-23] to allow the user to interactively play virtual reality games (with visual feedback), while simultaneously performing posture and balance training, being suitable for patients unable to stand or at high risk of falling, providing an effective and safe form of exercise.

The use of arm and hand orthoses or limb supports (example: arm skate)[24] were also referred to in several articles as a fundamental strategy for the user to be able to use the necessary commands to carry out the game with their affected limb .

In this review, mainly in recent years, game systems based on VR, developed specifically for rehabilitation, were found. These VR platforms, capable of assisting the patient in training, are based on the principles of rehabilitation, promoting repetition, task-oriented training, appropriate feedback and a motivating environment. These systems use concepts identical to commercial games, from which several advantages stand out: low cost, an attractive environment, gradual and individual training protocols, wide adaptability to the patient's needs and progress, performance recording capabilities, producing real-time feedback for patient and therapist, and the possibility of using it with minimal supervision from the health professional, facilitating home prescription. The RehabMaster system has proven to be feasible and safe to improve upper extremity function in stroke patients[25]. The games used in these systems are mostly from the serious games class, simulating activities of daily living[26-27]. These contain educational content that contrasts with traditional computer games, whose main purpose is to entertain. Serious games include games for learning, games for health and games for politics and social change, hence the health sector shows a greater interest in these games[28].

Associated with games, articles were identified that tried to enhance the effect of the game, relating its execution with conventional therapy techniques, such as mirror movement or restriction-induced movement therapy. It is known that mechanical and functional restriction increases the use of the most affected limb and promotes brain plasticity[29], as well as recovers the symmetry of the lower limbs, improving balance[30].

The use of games - either associated with conventional therapy or as a comparison group - allowed some authors to conclude that their use in exercise-oriented training with the paretic extremity (repetition, intensity) allows obtaining the same results as conventional rehabilitation, in a shorter period of time[31]. It also makes it possible to reduce the time spent by the therapist with individuals[32] and increases motivation and adherence to treatment.

## CONCLUSION

The objective of this scoping review was to map and analyze the games used in the rehabilitation of individuals after stroke. 116 studies were obtained where it was possible to identify three large groups of games: immersive and non-immersive VR Games, videogames and Traditional Games. These games were used for the rehabilitation of global motor function and cognitive function in stroke patients, and most of the identified games were used for the recovery of the UL motor function.

The use of games in individuals' rehabilitation processes has been growing over the last few years, following technological development and making this process more interactive, motivating and stimulating for the user. Intensive and repetitive training, combined with the interactivity and motivation that are inherent to them, facilitates adherence to rehabilitation, which can improve its effectiveness. Virtual reality games are the ones that have aroused the most interest.

Knowledge about the use of games and their development can make a valuable contribution to the recovery processes of individuals after a stroke and for the respective health professionals, and should increasingly be a tool to be considered. Thus, we believe that in the future the theme of this study can be completed with a more in-depth investigation into the functions that can be rehabilitated with each type of game and into the environmental contexts where games are used for the rehabilitation of the individual after a stroke. We thus conclude that the results of this review may be useful both for clinical practice in the context of Rehabilitation Nursing as well as for future investigations in the area.

Some limitations found in this study were related to: the poorly detailed description of the games that some authors refer to; with the concepts associated with VR and its immersiveness that are not always well understood and present different interpretations; and the lack of clarity sometimes found in describing the use of traditional games in conventional rehabilitation.

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