Study Protocol

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☑ Implementation science in nursing, health, and education

The rehabilitation of children with brain tumors using exergames: a scoping review protocol

Reabilitação da criança com tumor cerebral com recurso a exergames: protocolo de uma revisão de escopo

Rehabilitación de niños con tumores cerebrales mediante exergames: protocolo de una revisión de alcance

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ABSTRACT

Objective: To map the literature on the use of exergames in the rehabilitation of school-age children with brain tumors, in any context.

Method: Scoping review protocol developed using the recommendations of the Joanna Briggs Institute. The search will include aggregators, databases, indexes, repositories, and research browsers, without limitation as to the year of publication. Primary and secondary studies that include school-age children with brain tumors and that use exergames in children's motor rehabilitation in any context will be eligible. The selection and extraction of data will be carried out by two independent researchers and, if necessary, a third researcher will resolve any discrepancies.

Results: The data analyzed will be presented in diagrammatic, tabular, and descriptive form.

Final considerations: The mapping of interventions using exergames in the rehabilitation of school-age children with brain tumors could lead to reflection on the main components to be considered in intervention programs, supporting informed nursing decision-making and identifying the main areas of interest for research. It is hoped that the results of this review can contribute to strengthening knowledge in this field, promoting a better quality of life for children with brain tumors, as well as for their families.

Descriptors: Child. Virtual reality. Augmented reality. Exergaming. Rehabilitation. Brain neoplasms.

RESUMO

Objetivo: Mapear a literatura relativa à utilização de *exergames* na reabilitação da criança em idade escolar com tumor cerebral.

Método: Trata-se do protocolo de uma revisão de escopo baseada nas recomendações do Joanna Briggs Institute. A pesquisa incluirá agregadores, bases de dados, repositórios e motores de busca, sem limitação quanto ao ano de publicação. Serão elegíveis estudos primários e secundários que incluam crianças em idade escolar com tumor cerebral, que utilizem os *exergames* na reabilitação motora das crianças, em qualquer contexto. A seleção e a extração dos dados serão realizadas por dois investigadores independentes e, se necessário, um terceiro investigador resolverá eventuais divergências.

Resultados: Os dados analisados serão apresentados de forma diagramática, tabular e descritiva.

Considerações finais: O mapeamento das intervenções que recorrem à utilização de *exergames* na reabilitação da criança em idade escolar com tumor cerebral pode conduzir à reflexão sobre os principais componentes a considerar nos programas de intervenção, para uma tomada de decisão em Enfermagem fundamentada, bem como identificar áreas prioritárias de investigação. Espera-se que os resultados provenientes desta revisão possam contribuir para o fortalecimento do conhecimento neste domínio, promovendo uma melhor qualidade de vida da criança com tumor cerebral, assim como para a sua família.

Descritores: Criança. Realidade virtual. Realidade aumentada. Jogos eletrônicos de movimento. Reabilitação. Neoplasias encefálicas.

RESUMEN

Objetivo: Mapear la literatura relacionada con el uso de *exergames* en la rehabilitación de niños en edad escolar con tumores cerebrales, en cualquier contexto.

Método: Protocolo de revisión de alcance desarrollada siguiendo las recomendaciones del Joanna Briggs Institute. La búsqueda incluirá agregadores, bases de datos, índices, repositorios y motores de búsquedas, sin limitación en cuanto al año de publicación. Serán elegibles los estudios primarios y secundarios que incluyan niños en edad escolar con tumores cerebrales y que utilicen *exergames* en la rehabilitación motora infantil en cualquier contexto. La selección y extracción de datos será realizada por dos investigadores independientes y, en caso necesario, un tercer investigador resolverá las discrepancias.

Resultados: Los datos analizados se presentarán en forma diagramática, tabular y descriptiva.

Consideraciones finales: El mapeo de las intervenciones que utilizan *exergames* en la rehabilitación de niños en edad escolar con tumores cerebrales pode conducir a la reflexión sobre los principales componentes a considerar en los programas de intervención, para la toma de decisiones de enfermería informada, así como en la identificación de áreas prioritarias para la investigación. Se espera que los resultados de esta revisión puedan contribuir a reforzar el conocimiento en este campo, promoviendo una mejor calidad de vida para los niños con tumores cerebrales y sus familias.

Descriptores: Niño. Realidad virtual. Realidad aumentada. Videojuego de ejercicio. Rehabilitación. Neoplasias encefálicas.

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INTRODUCTION

Child cancer is an unexpected event, with significant repercussions on the lives of children and their families. In epidemiological terms, it is considered to be rare. The International Agency for Research on Cancer (IARC) estimates that, in 2022, the incidence of cancer in children under 15 years of age was of 10.3 per 100,000 children [1] worldwide, in line with the most recent data of the National Cancer Institute [2]. In Portugal, according to National Cancer Records [3], from 2010 to 2019, there were 2685 new cases in 15-year-old or younger children. Tumors in the central nervous system represented 23.8% of these cases.

If, three decades ago, the prognosis for child cancer was always death, currently the disease has a high likelihood of cure, depending on time of diagnosis, location, and histology [2,4]. Nonetheless, despite the incidence of this phenomenon, even a tumor with a low level of malignancy and a good prognosis can lead to significant morbidity, affecting the life of the child and their family. The consequences of the disease and the treatments associated with it, especially in the case of changes in the motor and/or cognitive functioning of the child, affect their normal development process. Due to its location and aggressivity, central nervous system tumors are the ones with the most physical and cognitive sequelae in children, also affecting the quality of life of the family and its members [5], reiterating why this population was chosen. Considering the above, providing adequate support and care to children with cancer is a challenge, since the current health system is focused on acute disease management and survival, neglecting issues associated with training, monitoring, and health promotion and prevention, including the improvement of functionality and quality of life, which are nuclear components of care.

Specifically, sequelae in children with brain tumors are associated with motor activity, functionality, and physical aptitude, due to changes in body balance, muscle strength, proprioception, flexibility, and coordination, all of which is caused by the area of the brain that is affected by the tumor or from adverse effects of treatment[4,6]. The child that is in a gradual process of acquiring competences is faced with a new situation, in which developing new skills becomes more difficult. Other authors [7] have suggested that, during treatment, children are more likely to show signs of physical reconditioning, associated with indicators such as decreased muscle strength, changes in body balance, flexibility, and general motor activity. These aspects are corroborated by other studies [8], which report that the impact of this disease on motor and cardiorespiratory activity is mostly related to fatigue, low muscle strength and endurance, in addition to changes in the ability to focus.

The quality standards of the National Institute for Health and Care Excellence (NICE) [5] advocate for the inclusion of multidisciplinary care, meeting the holistic needs of the child and their family. Rehabilitation is one of these types of care. Thus, a child diagnosed with cancer is likely to require rehabilitation, especially when diagnosed with brain tumors, and incorporating complex reeducation care and training over a long period. The access to this specialized care can promote independence in adulthood and reduce the need for future care. This intervention must consider the effects of the disease and its treatment on neurological, physical, psychological, and academic functions, recognizing that these may become increasingly notable over time. This is why the rehabilitation program must last for as long as it remains significant[5].

Physical exercise is a component of rehabilitation programs, as it promotes brain plasticity and has positive effects on functional recovery after non-traumatic neuronal injuries [9]. It is considered to be an effective intervention to promote the recovery of children with brain tumors, potentiating changes in brain anatomy, circuitry, and function through neuroplasticity. Thus, the existence of rehabilitation programs focused on exercise is relevant to structure intervention models that can enhance the functional capacity of the child, leading to the development of social, academic, and self-care related skills, while improving quality of life indices [10]. Indeed, exercises prescribed for healthy children and adolescents should be mostly aerobic, according to the American College of Sports and Medicine (ACSM) and the World Health Organization (WHO), which advocate physical activity for at least 60 minutes a day (moderate to vigorous intensity). In addition to these recommendations, they suggest that they should incorporate vigorous aerobic activities, in addition to muscle and bone strength workouts at least three times a week [11,12].

As a result of technical-scientific advances, technology emerges as a significant element in the progression of health care. As a result, telehealth has been increasingly used to provide care, leading to better management of symptoms, less need for emergency services, increased functioning, and increased global quality of life. Studies that use rehabilitation technology for children with cancer are scarce, but their evidence is growing and promising [13].

Considering the above, the use of virtual reality (VR) becomes interesting. VR is a computer-generated tridimensional virtual environment with which users can interact. It is usually accessed via a computer that can project tri-dimensional information in a screen, which can be isolated or placed

in a region of the body, coupled with sensors to locate the user [14]. VR can be divided into two categories: immersive and non-immersive reality [15]. Immersive VR is when the user wears a device but can move and receive information from the platform depending on their position. This allows the user to experience a 360-degree virtual environment [16]. Non-immersive VR, in turn, uses a combination of screens that surround the user in order to provide them with virtual information [17]. In addition to these, there is also augmented reality (AR), which uses computer-generated images that are superimposed on real physical elements [18].

In line with the initial goal of VR — video games —, the exergames were developed. Although their concept has not been entirely determined, its central constructs rest upon their use of variable intensity exercise, usually vigorous, in association with content from digital games [19]. The main goal of exergames is replacing sedentary activities, which are characteristic of traditional games, while not eschewing the main aspects of gamification, such as motivation and satisfaction in carrying out certain activities [18]. Thus, although exergames are available since the 80s, research on them is mostly from the last decades [19,20], showing an association between exercise and videogame and resorting to technology to promote healthy behavior and improve adherence to rehabilitation programs [21-23].

The advantages of exergames have been effectively described in literature, promoting their wide use in rehabilitation programs as a strategy to increase motivation and associate them with an exercise regime. This is related to the level of satisfaction associated with the practice of exercise using videogames, as evidence suggests that this variable is one of the basis of maintaining a higher level of physical activity [24-26]. Thus, in addition to improvements in the level of cognition and functioning, another advantage of exergames is the fact that this strategy extends into specific populations, in specific contexts, as is the case of pediatric cancer patients, enabling the individual and adapted use of the exercises and games proposed. Another particular characteristic of this strategy is its economic feasibility, since, mostly, the user only needs a console, a television, and a game, making it possible to apply it universally and, nowadays, these tools are portable [19,27].

In this regard, considering the main needs of children with brain tumors in school age, as well as the impact of the disease and its treatment, it is pertinent to investigate the use of exergames in this population, due to their potential benefits. Thus, since this is a recent topic, our goal is to carry out a scoping review (SR) to map literature regarding the use of exergames in the rehabilitation of school-aged children with brain tumors, based on the following guiding question: What is the scientific knowledge produced regarding the use of exergames in the rehabilitation of school-aged children with brain tumors?

METHOD

It can be essential to use SR methodologies before carrying out a systematic review, identifying gaps in knowledge and clarifying characteristics associated with a concept. This type of review is based on a method that synthesizes knowledge, grouping different study designs, summarizing, and synthesizing evidence, allowing professional practice, programs, and health policies to be adjusted, while also identifying which are the priorities of an investigation. In this regard, the Joanna Briggs Institute (JBI) suggests the elaboration of a protocol before conducting an SR to clarify the process for carrying out the review [28, 29]. This step is described below.

At first, a preliminary search was carried out in the databases MEDLINE Complete, CINAHL Complete, Nursing & Allied Health Collection: Comprehensive, MedicLatina, Cochrane Database of Systematic Reviews and JBI Evidence Synthesis. No ongoing systematic review or SR on the topic were found, which is one of the reasons why this methodology was chosen [28].

In this regard, this SR will follow the methodological stages proposed by the JBI [28,30], described below. The SR was registered in the Open Science Framework (OSF) (https://doi.org/10.17605/OSF.IO/ZMFKQ).

Eligibility criteria

Considering the methodology, JBI proposes eligibility criteria based on population, concept, and context (PCC) [28]. With this strategy in mind, the criteria in Chart 1 were chosen. Others were added according to the evidence sources being considered.

Search strategy and study identification

The goal of the research strategy is to find published and unpublished studies. It has three stages [28]. At first, we carried out a search limited to the databases MEDLINE (via PubMed) and CINAHL, using keywords chosen beforehand (MeSH terms). Then, the words in the title, the abstract, and the indexed terms used to describe articles were used to identify new descriptors.

In a second stage, a research strategy was structured that used a combination of words and terms adapted to the specificities of each database/repository selected.

Chart 1 – Eligibility criteria according to the PCC strategy and the sources of evidence. Porto, PRT, Portugal, 2023

Participants	Concept	Context	Sources of evidence
Children in school age (6 to 12) with brain tumor.	Interventions that resort to virtual reality, augmented reality, videogames, and exergames for the motor rehabilitation of children.	In any context or country.	Primary or secondary studies with any level of evidence. Including grey literature. Abstracts and posters of conferences were excluded, as were opinion articles. No time limit, until the date of the research itself. Included studies whose text was available in full, in Portuguese, English, and Spanish.

The research was carried out using descriptors or Boolean phrases in all databases included, which were searched using title, abstract, and indexed terms, in addition to gray literature, according to the research strategy defined. This is depicted in Chart 2. Each database/source will be searched individually, in order to take into account different terminologies used for these descriptors and find more reliable results.

Finally, in the full-text stage, the bibliographical references of the studies selected will be considered, in order to choose additional sources that may not have been identified in the early search, thus allowing us to reach data saturation.

The databases included in the review will be: CINAHL Complete, CINAHL Plus with Full Text, ERIC Library, Information Science & Technology Abstracts, MedicLatina, MEDLINE, MEDLINE with Full Text, Psychology and Behavioral Sciences Collection, Academic Search Complete, Business Source Complete, SPORTDiscus with Full Text (via EBSCOHost); Web of Science, TRIP Database, and Scopus. The search for unpublished studies, namely, gray literature, will be varied out in the following databases: OpenGrey, Google Scholar, the Portugal Open Access Scientific Repository of Open Access, and ProQuest.

Study selection process

The study selection and integration process is a concern in the development of the review, to minimize potential biases. As a result, we will use the procedure suggested by the JBI and exposed in a meeting with the team of investigators, in order to ensure this process is clear for all.

Thus, the studies found in each of the databases will be exported into a reference management software (EndNote 21). Duplicate references will be removed. Then, studies will be exported into the Rayyan software for analysis and selection.

At first, after eliminating duplicate articles, two investigators will select title and abstract independently, according with the research criteria previously determined. If there is any disagreement, a third researcher will decide whether to include or not the study and contention. The papers resulting from this first screening will be submitted to inclusion criteria using the Relevance/Eligibility Analysis Tool, adapted for the effect (Chart 3).

Secondly, texts will be analyzed in full, following the same principles of evaluation used in the earlier stage and being excluded when these are not respected.

Finally, we will analyze the bibliographical references of each study selected in the full-text stage, in a search for further sources.

The results of the process of selecting and obtaining articles will be presented using an adapted PRISMA-ScR flowchart [31].

Data extraction

The data from the studies will be extracted using a customized instrument, according to the goals of the SR, based on the checklist recommended by the JBI [28], as Chart 4 shows. Other pieces of information may be gathered in order to meet the goals and answer the research question. Therefore, the chart may be redefined according with each database/repository selected, so it can be used in the review stage.

Data extraction from all selected studies will be carried out by two independent investigators. During the process of data extraction, the authors of the articles selected may

Chart 2 – Example of a research strategy adjusted to the specificities of the investigation. Porto, PRT, Portugal, 2023

Aggregator	Data source	Research strategy
EBSCOHost	CINAHL Complete	TI (("Child*" OR "pediatric*" OR "paediatric*") AND ("Brain Neoplasm*" OR "Brain Cancer*" OR "Brain Tumor*" OR "Cancer of Brain" OR "Cancer of the Brain" OR "Intracranial Neoplasm*") AND ("Virtual Reality" OR "Augmented Reality" OR "Mixed Reality" OR "Video Gam*" OR "Computer Gam*" OR "Exergam*" OR "Active-Video Gam*" OR "Virtual Reality Exercis*" OR "Active Video Gam*" OR "Videogam*" OR "Play Therap*" OR "User-computer interface*" OR "Interactive videogam*" OR "Virtual reality exposure therap*" OR "Gamification" OR "Playfulness")) OR SU (("Child*" OR "pediatric*" OR "paediatric*") AND ("Brain Neoplasm*" OR "Brain Cancer*" OR "Brain Tumor*" OR "Cancer of Brain" OR "Cancer of the Brain" OR "Intracranial Neoplasm*") AND ("Virtual Reality" OR "Augmented Reality" OR "Mixed Reality" OR "Video Gam*" OR "Computer Gam*" OR "Exergam*" OR "Active-Video Gam*" OR "Virtual Reality Exercis*" OR "Active Video Gam*" OR "Videogam*" OR "Play Therap*" OR "User-computer interface*" OR "Interactive videogam*" OR "Virtual reality exposure therap*" OR "Gamification" OR "Playfulness")) OR AB (("Child*" OR "pediatric*" OR "paediatric*") AND ("Brain Neoplasm*" OR "Brain Cancer*" OR "Brain Tumor*" OR "Cancer of Brain" OR "Cancer of the Brain" OR "Intracranial Neoplasm*") AND ("Virtual Reality" OR "Augmented Reality" OR "Mixed Reality" OR "Video Gam*" OR "Computer Gam*" OR "Exergam*" OR "Active-Video Gam*" OR "Virtual Reality Exercis*" OR "Active Video Gam*" OR "Videogam*" OR "Play Therap*" OR "User-computer interface*" OR "Interactive videogam*" OR "Virtual reality exposure therap*" OR "Gamification" OR "Playfulness"))
	CINAHL Plus with Full Text	
	ERIC	
	Library, Information Science &Technology Abstracts	
	MedicLatina	
	MEDLINE	
	MEDLINE with Full Text	
	Psychology and Behavioral Sciences Collection	
	Academic Search Complete	
	Business Source Complete	
	SPORTDiscus with Full Text	

Chart 3 – Relevance/ Eligibility Analysis Tool adapted to the investigation. Porto, PRT, Portugal, 2023

PCC		Question	Yes	No
Participants	1	Does the article include children from 6 to 12 years old with brain tumors?		
Concept	2	Does the article address the motor rehabilitation of the child?		
	3	Does the article analyze the impact of exergames on the rehabilitation of the children?		
	4	Does the article clearly describe how was the exergame intervention performed?		
Type of study	5	Is the article in the languages determined by the protocol?		
	6	Is the article in line with the types of evidence determined by the protocol?		

Chart 4 – Data extraction instrument, adapted to the investigation. Porto, PRT, Portugal, 2023

A_	
Title of the investigation The Rehabilitation of Children with Brain Tumors Using Exergames: a Scoping Review. **Research question** What is the scientific knowledge produced regarding the use of exergames in the rehabilitation of school-aged children with brain tumors? **Eligibility criteria** P – All studies include school-aged children (6 to 12 years old) with brain tumors. C – All studies use virtual reality, augmented reality, videogames, and exergaming in the motor rehabilitation of children. C – All studies involve inpatient, outpatient, or home care children, from any country.	
Study identification	
Database	
Title	
Author(s)	
Year and Country	
Type of study	
Study goals	
Population and sample	
Method (Study design)	
Specific questions	
Context	
Results: Intervention	
Results: Strategies	
Results: Evaluation tools	
Results: Main findings	
Conclusions	
Reviewer comment and relevance to the SR	

be contacted if necessary, to request missing or additional data. Any discrepancy will be solved in meetings to discuss the topic, or through the intervention of a third reviewer[32,33].

Presentation and discussion of results

The synthesis and analysis of data will be presented in the form of a narrative, using tables and/or graphs according with the goal of the SR in order to synthesize the components of the rehabilitation programs in the child with brain tumor using exergames.

The SR proposed here aims to provide elements for the decision making of the nurse in the scope of rehabilitating the child with a brain tumor, improving their adherence via technology, namely, the exergames.

FINAL CONSIDERATIONS

Considering the impact of cancer on the functioning and quality of life of children with brain tumors, the mapping and synthesis of rehabilitation programs, implemented in different contexts using exergames, is essential to guide the decision making of nurses in this field of care. This is a central element of the prescription of individualized interventions, aimed at preventing sequelae of a disease and treating them, while also treating health issues that emerge from it. On the other hand, integrating other strategies to facilitate the adherence to exercise regimes, in addition to conventional ones — namely, using technology —, should be in the range of options of the nurse, especially when they aim to implement interventions in particular populations such as children with cancer.

The scientific evidence found here will enable mapping and synthesizing practices in this regard, allowing an explanation of the contributions this program brings, concerning the games that require movement in the rehabilitation of children with cancer, while also identifying the several components that integrate these programs in such a way as to facilitate evidence-based decision making on the part of the nurse. On the other hand, this SR also seeks to formulate new investigation questions that would allow conducting future research in the field, especially systematic reviews that could address the effectiveness of these programs in the functioning and quality of life of children with brain tumors.

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