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Use of exergaming and its effects on the physical health of patients diagnosed with cancer: an integrative review

Utilização de exergames e seus efeitos sobre a saúde física de pacientes com diagnóstico de câncer: uma revisão integrativa

Aplicabilidad de las ecuaciones de referencia brasileñas para la prueba de caminata de 6 minutos en pacientes con cáncer de pulmón

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ABSTRACT | This study aimed to search for records with significant differences regarding the physical health of cancer patients when practicing exergaming. The integrative literature review was used as method with the keywords "Physiotherapy," "Virtual Reality," "Wii," "Exergames" and "Cancer," in Portuguese and English, in the following databases: PubMed, Science Direct, Medline, Scopus, Lilacs, SciELO, PEDro, Cochrane and Capes Journals. The inclusion criteria were studies that used exergaming in clinical treatments and presented differences on the physical health of patients diagnosed with cancer, of both sexes, of all ages and types of cancer, published in the last 10 years, in any language. Of the 3,172 articles found, only nine were included; they evaluated physical performance, sedentary lifestyle, upper limbs functionality, lower limbs muscle strength and fatigue. The review concluded that exergaming is a promising tool for the physical health of patients diagnosed with cancer.

Keywords | Review Literature as Topic ; Lung Neoplasms; Health; Phisiotherapy.

RESUMO | Este estudo teve como objetivo a busca de registros com diferenças significativas a respeito da saúde física de pacientes com câncer ao praticarem exergames. Utilizou-se como método a Revisão Integrativa de Literatura com as palavras chaves "Fisioterapia", "Realidade Virtual", "Wii", "Exergames" e "Câncer", em português e inglês, nas bases de dados PubMed, Science Direct, Medline, Scopus, Lilacs, SciELO, PEDro, Cochrane e Periódicos Capes. Os critérios de inclusão foram: estudos que utilizassem exergames em tratamentos clínicos e que apresentassem diferenças sobre a saúde física de pacientes com diagnóstico de câncer, de ambos os sexos, de todas as idades e tipos de câncer, publicados nos últimos 10 anos, em qualquer idioma. Dos 3172 artigos encontrados, apenas nove foram incluídos, sendo que esses avaliaram: desempenho físico, sedentarismo, funcionalidade de membros superiores, força muscular de membros inferiores e fadiga. Concluiu-se que os exergames demostraram ser ferramenta promissora para a saúde física de pacientes com diagnóstico de câncer.

Descritores | Literatura de Revisão como Assunto; Realidade Virtua; Saúde; Neoplasias Pulmonares; Fisioterapia.

RESUMEN | El objetivo de este estudio fue verificar el impacto de diferentes ecuaciones de referencia brasileñas para la distancia recorrida en la prueba de caminata de 6 minutos (PC6min) en la evaluación de la capacidad de ejercicio funcional en pacientes con cáncer de pulmón (CP). Este estudio transversal incluyó a 48 pacientes con CP (promedio de edad de 60±12 años). Se evaluó las características sociodemográficas, clínicas y la capacidad funcional de los participantes para ejercitarse en la PC6min según los criterios internacionales. Se analizaron cinco ecuaciones. La distancia recorrida por los pacientes (503±102 metros) estuvo relativamente cerca de las distancias predichas por las ecuaciones de referencia (82-94% del predicho), aunque son estadísticamente menores (p<0,05 para todas).

Palabras clave | Literatura de Revisión como Asunto; Neoplasias Pulmonares; Salud; Fisioterapia.

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INTRODUCTION

Cancer treatment can generate adverse effects and each type of treatment can lead to different sequela, such as nausea, organ damage, decreased bone density, reduced muscle strength and physical fitness, impaired cardiac function and decreased lung function[1-5]. Consequently, treatment can negatively interfere with the physical and mental capacity of patients to engage in physical activities[6].

Reduced daily energy expenditure and low levels of physical activity have been described as the most important cause in reducing the ability to perform physical exercises and social insertion of leukemia and other neoplasms survivors[5]. This can be minimized or avoided by introducing an exercise program during and after cancer treatment [5], in view of the evidence showing that exercise is safe, feasible and beneficial at different stages of this rehabilitation[7]—therefore, simple, inexpensive and motivating ways to promote physical activity and exercise have become an increasingly important part in cancer treatment[8].

Interventions through physical activity result in effects on the physical and mental health of young cancer patients and survivors. The most frequently reported benefits are more than 50% improvement in strength, fatigue and self-efficacy[9].

The positive and linear correlation, observed between the improvement variables in general physical fitness and reduction in fatigue levels of patients, suggests that the improvement in several physiological parameters—and not only of one parameter, exclusively—exerts a positive influence on the reduction of fatigue in cancer patients [10].

The combination of strength and aerobic training can benefit patients undergoing cancer treatment and post-treatment and it is well tolerated by patients. Naturally, the positive effects of exercise can vary significantly depending on the type of cancer, activity intensity , frequency and duration of the exercise program and patient's lifestyle. Careful selection of patients, supervision during training and medical follow-up are essential[3,11].

In recent years, there has been a trend towards the use of video games in health applications. Interactive video games—also known as exergames—enable the individual to interact with the game by moving their limbs or the entire body. This feature presents a variety of applications in the field of medicine and rehabilitation[12]: the often boring and repetitive nature of rehabilitation exercises can be transformed into an activity (playing video games) that patients happily accept and that promotes greater entertainment and fun when performed[12].

Depending on the design of the game, exergames can be used to improve cardiorespiratory fitness or sensory motor control[13]. Evidence of exergaming intervention effectiveness in people with some disability are still limited, but promising[13]. Studies indicate that exergaming has positive effects on both motivating active participation in rehabilitation and impaired functions[14].

Video games are capable of promoting physical activity for individuals who need to improve balance; who are in the process of rehabilitation due to acute or chronic diseases; and who have physical disabilities or delay in motor development[15]. Besides, games make it possible to perform physical activity in cancer patients who require special care regarding the risk of infections and they can be performed in the patient's own room[8,16].

Considering the relevant risk factor "sedentary lifestyle" for the manifestation of chronic diseases (and even cancer), and that cancer patients live an everyday particularity—which is to undergo regular chemotherapy and go through periods of low immunity—it is inferred that exergaming, in safe and weather-free environments of nature, can present itself as an ideal solution for the regular practice of physical exercises [17].

It is argued that intervention with digital platform exercise program may be feasible and provide preliminary evidence of mood and fatigue improvement in pediatric cancer patients. The efficacy of physical activity in pediatric oncology is promising, but it still requires continued research in patients whose sedentary behavior and associated side effects are a growing concern[18].

Educating cancer patients about the benefits of exercise in the control of fatigue should be considered from the beginning of treatment, as well as including exercise programs for individuals with cancer and associated fatigue[19].

The fact that patients can continue to exercise with the aid of video games in their own home, even after hospital discharge, is an additional potential benefit to the use of technology during rehabilitation[12,20]; video games can help physical therapists to remotely assess patients' adherence to therapy and monitor changes in functions over time[12].

The aim of this study was, therefore, to find evidence in the literature that indicated significant differences in the physical health of cancer patients when practicing exergaming.

METHODOLOGY

This study is an Integrative Literature Review (IR), which is a specific review method that synthesizes a subject to promote greater understanding of a particular phenomenon or a health-related issue, allowing a broad literature analysis[21]. IR allows research, critical evaluation and synthesis of the investigated theme and it can make research results more accessible, reducing some obstacles in the use of scientific knowledge and allowing the reader access to several studies conducted about a single theme[22,23].

The searches were performed between May and July 2017. Nine databases were defined as a source of survey of studies: PubMed, SciELO, Lilacs, MEDLINE, Science Direct, Scopus, PEDro, Cochrane and CAPES Journals. The researches were conducted using the following descriptors (Portuguese and English): "Physiotherapy"; "Virtual Reality"; "Wii"; "Exergames"; "Cancer" and the Boolean operator AND.

The inclusion criteria were studies that used exergaming in clinical treatments and presented differences on the physical health of cancer patients, of both sexes, of all ages and types of cancer, published in the last 10 years, in any language.

Articles that were not fully available, duplicate articles, articles that did not use exergaming or that did not fit the objectives of the present study were excluded from this study.

RESULTS

The research originally identified 3,172 articles that, after following the methodological steps of evaluation, were reduced to nine studies that met inclusion criteria. Figure 1 shows the methodological steps that led to this result.

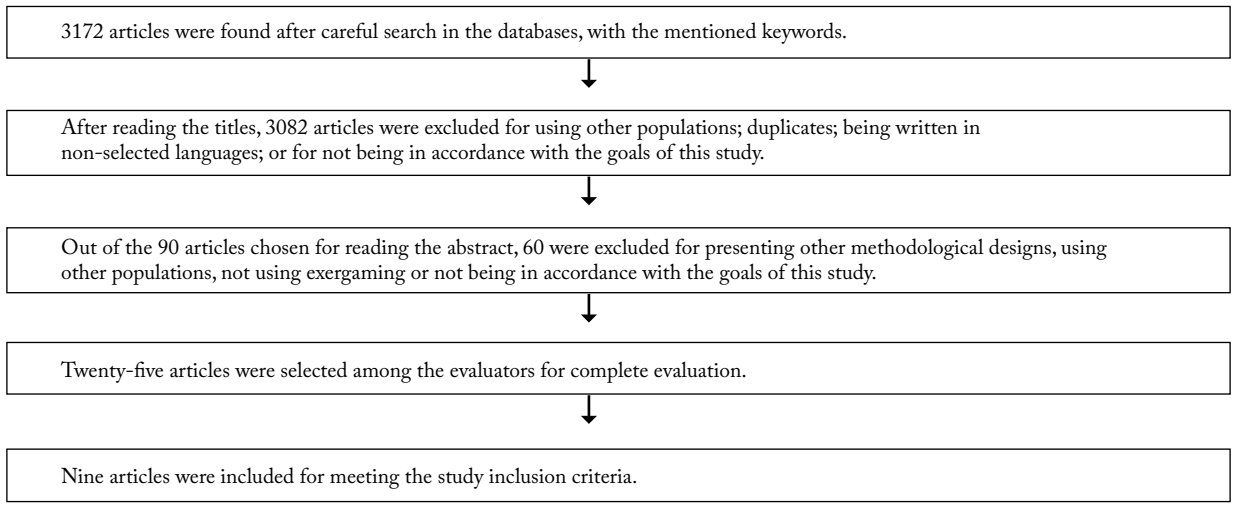

Figure 1. Scheme with the distribution of articles according to descriptors and the criteria of inclusion and exclusion

The studies that presented repercussions on the physical health of patients evaluated physical performance (n=3); upper limbs functionality (n=2); lower limbs muscle strength (n=1); fatigue (n=3); and sedentary lifestyle (n=3).

All included studies were clinical trials. Six studies were conducted with patients over 18 years of age, two were conducted with young people under 18 years of age and one used adolescents and young adults (13 to 25 years old). In terms of gaming platforms, most studies (n=7) used the Nintendo Wii™ (Kyoto, Japan). Only one study used the Xbox360 Kinect™ (Microsoft, Redmond, WA) and another used the IREX System.

The minimum frequency of exergaming, in most studies, was 30 minutes per day, three times a week. The types of cancer included in the studies were brain tumor (n=2), hematological neoplasms (n=1), hematopoietic stem cell transplant recipients (n=1), non-small cell lung cancer (n=1), breast cancer (n=1), and articles that included patients with any type of cancer (n=3). The other results can be found in Chart 1.

Chart 1. Characteristics and results of the included studies that used exergaming in cancer patients

Study design					Sample				
Reference	Objective	Exergaming time	Type of intervention	Dependent variable	Sample size	Average age	Characteristics	Platform/Game	Main findings
Aguirre-Carvajal & Marchant-Pérez[24]	Describe the effect of early physiotherapy on upper limb pain and function in mastectomy patients using virtual reality exercises	32 minutes per day, three days a week, totaling 10 sessions	Intervention group: exergaming. Control group: no intervention.	Functionality of the ipsilateral upper extremity of the mastectomy by means of the QuickDASH scale and pain through the Visual Analog Scale (VAS)	77	26-83	Women with unilateral mastectomy without shoulder injuries	Nintendo Wii	Improvement in functionality of ipsilateral upper extremity of mastectomy and pain reduction
Silva Alves et al.[25]	Evaluate the influence of an exercise protocol on cancer-related fatigue, muscle fatigue and muscle strength in cancer patients	20 sessions of exergaming, with variable number of sessions per week according to exercise tolerance	Only exergaming	Fatigue assessed by the Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-F) questionnaire and lower limb muscle strength with an isometric dynamometer	45	18-80	Any type of cancer that was not stage IV	Xbox360 Kinect ™: "Wall Breaker," "Stomp It," "Run the World," "Your Shape Fitness Evolved 2012"	Fatigue reduction and increased muscle strength of lower limbs
Sabel et al.[26]	Investigate whether active video game (AVG) can provide pleasant physical exercises; what level of physical activity can be achieved; and whether physical functioning can improve in children with brain tumor	30 minutes a day, five days a week, for 10 to 12 weeks	Only exergaming	Physical performance through the Bruininks-Osteretsky Test of Motor Performance (BOT-2)	13	7-17	Brain tumor	Nintendo Wii: "Wii Sports," "Wii Sports Resort," "Wii Fit," "Wii Fit Plus," "Just Dance" 1–3, "Michael Jackson – the Experience"	Improvement in BOT-2 body coordination item
Rosipal et al.[27]	Examine exercise behavior and preferences among hematopoietic stem cell transplant recipients of adolescents and young adults	Minimum of 60 minutes per week throughout the hospitalization period	Patients could choose between performing exergaming with Nintendo Wii, stationary bike with video game or dance game 'Dance dance revolution.' Besides, they could also go hiking, do strengthening exercises and/or play basketball	Physical performance was evaluated using the six-minute walk test (6-MWT) and the Timed-Up-and-Go test (TUG); the Behavioral, Affective, and Somatic Experiences Scale–Child Version (BASES-C) was used to measure health-related quality of life (HRQL)	18	13-25	Hematopoietic stem cell transplant recipients	Nintendo Wii, Stationary Bike with video games / "Wii Fit," "Dance Dance Revolution"	No improvement in quality of life and physical performance

(continues)

Chart 1. Continuation

Study design					Sample				
Reference	Objective	Exergaming time	Type of intervention	Dependent variable	Sample size	Average age	Characteristics	Platform/Game	Main findings
Jahn et al.[28]	Explore the application of the Nintendo Wii game console to motivate adult cancer patients to be physically active during treatment periods	30 minutes per day for 5 days	Only exergaming	Levels of physical activity and sedentary behavior through General Activity Questionnaire; health-related quality of life through the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire–Core 30 (EORTC QLQ-C30); mood status and perception of time assessed through interviews	7	47 - 70	Hospitalized cancer patients receiving radiotherapy or combined radio therapy and chemotherapy	Nintendo Wii / "Wii Sports," "Family Trainer," "Sports Island," "Family Ski and Snowboard"	Patients lost track of time and felt distracted from the daily routine of the hospital. Improved mood and motivation in performing physical activity
Kauhanen et al.[8]	Evaluate the effect of active video games on the promotion of physical activity in children with cancer	30 minutes per day, for 8 weeks, with 2-year and 6-month follow-up	Intervention group: exergaming and conventional therapy, as needed; Control group: general information on physical activity and conventional therapy, as needed	Levels of physical activity and sedentary behavior through The Fitbit Tracker accelerometer; Engine performance through the Movement test Assessment Battery for Children (M-ABC); and fatigue through the PedsQL Multidimensional Fatigue Scale questionnaire	-	3-16	Any type of cancer outside the CNS	Nintendo Wii / "Wii Fit"	Study not completed
Tsuda et al.[29]	Investigate the feasibility and safety of virtual reality exercise intervention using Nintendo Wii Fit in patients with hematological neoplasms receiving chemotherapy	20 minutes a day, 5 days a week, from the start of chemotherapy to hospital discharge	Intervention group: exergaming and conventional therapy, as needed;	Physical performance evaluated with barthel index, Timed-Up-and-Go test (TUG) and instrumental activities of daily living (IADL). Psychosocial functioning assessed using the Hospital Anxiety and Depression Scale (HADS)	16	66	Hematological Neoplasms	Nintendo Wii / "Wii Fit"	Maintenance of physical performance and psychosocial functioning

(continues)

Chart 1. Continuation

Study design					Sample				
Reference	Objective	Exergaming time	Type of intervention	Dependent variable	Sample size	Average age	Characteristics	Platform/Game	Main findings
Yoon et al.[30]	Assess the benefit of virtual reality-based rehabilitation in upper extremity function in patients with brain tumor	30 minutes a day, five days a week, for 3 weeks	Intervention group: exergaming and conventional therapy, as needed; Control group: only conventional occupational therapy	Upper extremity function evaluated using the Brunnstrom approach, manual function test (MFT), Box and Block test (BBT) of manual dexterity and Fugl-Meyer scale (FMS); and the Ashworth scale modified to classify spasticity	40	49	Brain tumor	IREX System / "Birds and Balls," "Coconuts," "Conveyor," "Drums," "Juggler" and "Soccer"	Improved proximal function of upper extremities
Hoffman et al.[31]	Evaluate the viability, acceptability, safety and changes in the endpoints of the study of a home exercise intervention to improve perceived self-efficacy for self-management of cancer-related fatigue (CRF) for people after thoracotomy for NSCLC	5 days a week for 6 weeks	Only exergaming	Fatigue assessed by the Brief Fatigue Inventory (BFI); self-efficacy perceived by Perceived Selfefficacy for Fatigue Self-management (PSEFSM); the instrument of self-efficacy for walking; and the activity-specific balance Confidence Scale	7	53-73	Non-small cell lung cancer	Nintendo Wii / "Wii Fit Plus"	Improvement in perceived self-efficacy for self-management of cancer-related fatigue

DISCUSSION

In general, the vast majority of studies have shown promising results regarding the effects of exergaming on physical health. Games that focused on specific skills or deficits proved themselves particularly useful in helping patients achieve rehabilitation goals[24-27].

The games used in the studies were judged acceptable and enjoyable by almost all populations included in this review, including older people with little or no prior exposure to video games. No serious adverse events were reported in the analyzed studies. The fun and distracting nature of exergaming can be helpful in complementing therapy and restoring mood, in addition to the achieved physical improvements.

Physical performance

As for the effects on physical health, each of the studies addressed a different variable. The study by Sabel et al.[26] (members of the Department of Pediatrics at the Institute of Clinical Sciences) evaluated physical performance through the Bruininks-Osteretsky Test of Motor Performance, second edition (BOT-2), and found significant difference in body coordination values before and after exercise intervention in children with brain tumors.

On the other hand, Tsuda et al.[28]—from the Division of Hematology and Rheumatology of Teikyo Chiba Medical Center in Japan—verified that physical performance was mantained in patients with hematological neoplasms, in which the obtained values of Barthel index, wrist strength, knee extension strength, length of single leg stance, TUG score and the questionnaire of instrumental activities of daily life remained similar before and after the intervention. Rosipal et al.[29], from Texas Children's Hospital, in the United States, evaluated the physical performance of hematopoietic stem cell transplant recipients through the 6-minute Walk Test (6-MWT) and the Timed-Up-and-Go (TUG) test and did not obtain positive results at the end of the study.

In a different population, the study conducted by Taylor et al.[30]—from the University of Essex in Colchester, United Kingdom—evaluated physical performance using the TUG test and the 10-Minute Walk Test and after an exergaming intervention, significant improvement was observed in older people with history of falls.

Functionality

Aguirre-Carvajal and Marchant-Pérez[24] and Yoon et al.[27] observed significant post-treatment improvements in the degree of functionality of the upper extremities. While Yoon et al.[27] (of the Department of Rehabilitation Medicine of the Faculty of Medicine of the University of Ulsan, in Seoul) used the Box and Block test (manual function test, Fugl-Meyer scale and korean version of the Modified Barthel Index) to evaluate functionality in patients with brain tumor, Aguirre-Carvajal and Marchant-Pérez[24,] (from the *Pontificia Universidad Católica de Valparaiso*, Chile) evaluated the degree of functionality of the ipsilateral upper extremity of mastectomized women through the QuickDASH test.

Joo et al.[31], members of the Tan Tock Seng Rehabilitation Center in Singapore, used an exercise program in patients with stroke sequelae. The upper limb function was evaluated through the Fugl-Meyer Assessment of Upper Limb Motor Function (FMA) and showed significant improvement after the intervention.

Fatigue

The studies of Kauhannen et al.[8], Hoffman et al.[32] and da Silva Alves et al.[25] observed the effects of exergaming on fatigue. Kauhannen et al.[8], associated with the Department of Nursing Sciences of the University of Turku, Finland, used standardized questionnaires of the PedsQL Multidimensional Fatigue Scale to assess the fatigue of children with cancer (although they did not published their results). Hoffman et al.[32], from the Michigan State University School of Nursing in the United States, evaluated the fatigue of patients with non-small cell lung cancer through the Brief Fatigue Inventory (BFI) and Perceived Self-efficacy for Fatigue Self-management (PSEFSM) questionnaires. They obtained positive results at the end of the intervention.

Da Silva Alves et al.[25], phD students from the *Universidade Federal de Alfagas*, Brazil, evaluated cancer-related fatigue using the Functional Assessment of Chronic Illness Therapy (FACIT-F) questionnaire and observed a significant difference after the intervention. In African-American patients with lupus, the study by Yuen et al.[33]—from the Department of Occupational Therapy at the University of Alabama at Birmingham—assessed the perception of fatigue through the Fatigue Severity Scale (FSS) and, after exergaming intervention, they observed a significant reduction in fatigue in this population.

Sedentary lifestyle

Sedentary lifestyle is one of the risk factors derived from cancer and, because it has several consequences on physical health, it was included in this study. Thus, three articles evaluated the sedentary behavior and levels of physical activity of their patients.

Kauhannen et al.[8] used The Fitbit Tracker accelerometer in children with cancer to assess levels of physical activity and sedentary behavior, although they did not published their results. Jahn et al.[34]—from Halle University Hospital, Martin Luther Halle-Wittenberg University in Germany—used the General Activity Questionnaire to assess the same parameters in hospitalized cancer patients and observed increased motivation to perform physical activity. Sabel et al.[26], used the SenseWear Pro 2 armband multisensory activity monitor to record physical activity levels of children with cancer. They did not observe changes in sedentary behavior levels compared with the beginning of the study.

Absolute rest to cancer patients was recommended in the past, due to the conviction that any type of physical activity could aggravate the clinical scenario—already deteriorated by treatment or the disease itself; however, this thought has been questioned in recent years, since scientific evidence, although scarce, shows that excessive rest, with lack of physical activity, results in severe physical deconditioning, fatigue, reduced functional status and well-being of individuals[35].

Practicing physical activities can improve physical and emotional performance, consequently, it improves the quality of life of cancer patients, both during and after conventional treatment (chemotherapy and radiotherapy) and bone marrow transplantation. Therefore, physical activity can be added as a complementary therapy for the treatment of patients with malignant neoplasms to reduce sedentary lifestyle levels and, thus, to avoid the consequences of this behavior[36]. In view of the benefits of physical activity, exergaming arises as a motivational alternative in promoting exercises and combating sedentary behavior. It can also be supervised at home and, for those with low self-confidence, it provides a means to practice physical activity in a family environment [15,37].

Muscle strength

The only study that evaluated the muscle strength parameter was that of Silva Alves et al.[27], who used an isometric dynamometer in the ankles of cancer patients, presenting positive results in lower limbs muscle strength at the end of the exergaming intervention.

In the study by Gschwind et al.[38] (of the Assistive Healthcare Information Technology group, at the Austrian Institute of Technology in Vienna, Austria), muscle strength was assessed through one of the topics of the Physiological Profile Assessment (PPA); through the same test, the increase in muscle strength of the lower limbs in older people after exergaming intervention was also observed. Theodore[39] used an exergaming protocol in a patient with chronic non-progressive encephalopathy in childhood (NPEC) and observed improvement in static balance in standing posture, lower limbs muscle strength and coordination of left superior limb.

CONCLUSION

Exergaming proved itself as a promising tool for improving physical health among cancer patients. Although the results of the studies are mostly positive regarding physical effects, it is necessary to conduct a greater number of clinical trials, with greater methodological rigor, to evaluate whether exergames are effective for therapeutic purposes in cancer patients. It is of paramount importance that further studies determine the best way to incorporate exergaming into conventional rehabilitation programs and the ideal protocol for duration and frequency of execution for the user population. The potential of exergaming to motivate rehabilitation in a fun way among cancer patients should be used by researchers, physiotherapists and other health professionals.

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