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SEÇÃO: ARTIGO ORIGINAL

Case study – Physical and virtual exercises in aging: What are the benefits?

Estudo de caso – Exercícios físicos e virtuais no envelhecimento: quais os benefícios?

Estudio de caso – Ejercicios físicos y virtuales en el envejecimiento: ¿Cuáles son los beneficios?

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Abstract

Introduction: virtual reality is already considered an innovative method in the process of rehabilitation and motivation of elderly people in adhering to conventional interventions and in the practice of physical exercises. There are several benefits achieved in this population using Virtual Reality and physical exercise, among which we highlight: balance, muscle strength, gait and cognitive function.
Objective: to compare the evolution of cognitive (executive function), physical (gait, balance and lower limb strength) and emotional factors (satisfaction with life and quality of life) in 5 months of intervention, associating the practice of physical exercise with Virtual Reality.
Methods: two elderly people, 80 and 85 years old (male and female), were recruited for this pilot study, who performed the following procedures: eMaps virtual stationary gait software (StreetView) and stretching, relaxation and walking activities. The instruments used in both applications (initial time and after five months) were: Questionnaires for the identification and exclusion of dementias (identification form, Mini Mental State Examination, and Dementia Scale, Physical Performance Test, Stroop Test, Life Satisfaction Scale and Inventory of Attitudes Related to Technology.
Results: the association of virtual physical exercise and conventional physical exercise increased executive function by 38.5%, mobility, balance, lower limb strength by 20.55%, life satisfaction by 12.5% and the relationship with technology by 13.5%.
Conclusion: we emphasize the importance of using Virtual Reality associated with conventional physical exercise in promoting healthy aging, enhancing the physical and emotional skills of the elderly.

Keywords: aging, virtual reality, physical exercise, sport psychology.

Resumo

Introdução: a realidade virtual já é considerada um método inovador no processo de reabilitação e motivação de pessoas idosas na adesão às intervenções convencionais e na prática de exercícios físicos. Vários são os benefícios alcançados nesta população, utilizando realidade virtual e exercício físico, entre os quais destacamos: equilíbrio, força muscular, marcha e função cognitiva.
Objetivo: comparar a evolução dos fatores cognitivo (função executiva), físicos (marcha, equilíbrio e força de membros inferiores) e emocionais (satisfação com a vida e qualidade de vida) em cinco meses de intervenção, associando a prática de exercício físico com a realidade virtual.
Métodos: foram recrutados para este estudo piloto duas pessoas idosas, 80 e 85 anos (homem e mulher), que realizaram os seguintes procedimentos: *software* de marcha estacionária virtual eMaps (*StreetView*) e atividades de alongamento, relaxamento e caminhada. Os instrumentos utilizados nas duas aplicações (momento inicial e pós cinco meses) foram: Questionários para identificação e exclusão de demências (ficha de identificação, Miniexame do Estado Mental e

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Escala de Demência, Teste de Desempenho Físico, *Stroop Test*, Escala de Satisfação com a Vida e Inventário de Atitudes em Relação à Tecnologia.
Resultados: a associação do exercício físico virtual e exercício físico convencional incrementaram a função executiva em 38,5%, a mobilidade, equilíbrio, força de membros inferiores em 20,55%, a satisfação com a vida em 12,5% e a relação com a tecnologia em 13,5%.
Conclusão: enfatizamos a importância da utilização da realidade virtual associada ao exercício físico convencional na promoção do envelhecimento saudável, potencializando as habilidades físicas e emocionais das pessoas idosas.
Palavras-chave: envelhecimento, realidade virtual, exercício físico, psicologia do esporte.

Resumen

Introducción: la realidad virtual ya se considera un método innovador en el proceso de rehabilitación y motivación de las personas mayores en la adhesión a las intervenciones convencionales y en la práctica de ejercicios físicos. Son varios los beneficios que se consiguen en esta población mediante la realidad virtual y el ejercicio físico, entre los que destacamos: el equilibrio, la fuerza muscular, la marcha y la función cognitiva.
Objetivo: comparar la evolución de la función ejecutiva, marcha, equilibrio, fuerza de miembros inferiores y (satisfacción con la vida en cinco meses de intervención, asociando la práctica de ejercicio físico con la realidad virtual.
Métodos: para este estudio piloto se reclutaron dos ancianos, de 80 y 85 años (hombre y mujer), quienes realizaron los siguientes procedimientos: software de marcha estacionaria virtual eMaps (StreetView) y actividades de estiramiento, relajación y caminata. Se utilizó instrumentos: Cuestionarios para la identificación y exclusión de demencias (Mini Examen del Estado Mental), Test de Rendimiento Físico, Test de Stroop, Escala de Satisfacción con la Vida y Inventario de Actitudes Relacionadas con la Tecnología.
Resultados: la asociación de ejercicio físico virtual y convencional aumentó la función ejecutiva en un 38,5%, la movilidad, el equilibrio, la fuerza de los miembros inferiores en un 20,55%, la satisfacción con la vida en un 12,5% y la relación con la tecnología en un 13,5%.
Conclusión: resaltamos la importancia del uso de la realidad virtual asociada al ejercicio físico convencional en la promoción del envejecimiento saludable, potenciando las habilidades físicas y emocionales de los ancianos.
Palabras clave: envejecimiento, realidad virtual, ejercicio físico, psicología del deporte.

Introduction

A Non-immersive virtual reality (VR) associated with regular physical exercise (PE) is an innovative method in the field of Rehabilitation and in the struggle against sedentary lifestyle, and several studies proved its benefits.[1, 2, 3, 4] Thus, VR tools - used for PE - are created and improved to increase PE and balance levels, improving muscle strength, gait, cognitive function, and emotional aspects in older adults.[4]

Due to its multisensory and 3D presentations, VR brings the user closer to the reality, facilitating this interaction, considered a human-machine interaction.[5] VR benefits the rehabilitation of cognitive, physical, and psychological abilities, such as neuromuscular rehabilitation, regarding memory training, attention, balance, gait, and fight against obesity, focusing on energy expenditure, physiological improvement, increased autonomy, as well as the independence of the older individual.[5]

In this context, and without putting participants in risk, VR solutions provide complex tasks for the motor, cognitive, and psychological systems, enhancing the rehabilitation process and enabling greater independence and motivation in daily activities.[6] As also corroborates the study developed at Pontifical Catholic University of Rio Grande do Sul (PUC-RS) by Das Neves Assis et al (2015), through a systematic review presented that the use of VR to stimulate cognition increased attention, executive function and processing speed, showing that the person's brain elderly have the ability to improve cognitive abilities through new stimuli.[7]

We emphasize the importance of this present study for the area of aging, since we evaluated the evolution of physical, cognitive and psychological capacities together, different from the studies presented in the literature that evaluate, for the most part, only cognition.

Thus, this study aimed to compare the evolution of cognitive (executive function), physical (gait, balance and lower limb strength) and emotional factors (satisfaction with life and quality of life) in 5 months of intervention, associating the practice of physical exercise with Virtual Reality.

Methods

Participants

Two older adults of both sexes, aged 80 and 85 years, participated of the study, practitioners of light walking 3 times a week for approximately a year and both participants were recruited for convenience. The female participant is 150 cm height and weight 64 kg, with a Body Mass Index (BMI) of 28.44, classified as overweight and the male participant has a height of 165 cm and weight 67 kg, with a BMI of 24.61, classified as normal weight.[8] They signed the informed consent form, which disclosed that the data collected would be under scientific protection and professional secrecy, and that they were aware of the entire process. The study was approved by the Research Ethics Committee of UNICAMP (opinion Nº. 4,762,089 and CAAE Nº. 46692821.3.0000.5404).

The inclusion criteria were: practitioners of physical exercises, with scores higher than the cut-off point (based on the level of education in the application of cognitive testing) of the Mini Mental State Examination.[9] Exclusion criteria were: no previous diagnoses of diseases or severe physical and mental impairments, which prevented participation in the study.

Instruments

- Anamnesis: a questionnaire, elaborated by the authors of this present study based on scientific literature and clinical and research experience, on health status with seven open-ended questions of identification and health problems, whether diagnosed or treated, as well as medications used recently.
- Mini-Mental State Examination (MMSE): screening test for dementia that evaluates cognitive function via spatial and temporal orientation, short- and long-term memory, calculus, naming language, repetition, comprehension, writing, and copying of drawing. The older adult must reach a score ≥18, with the total score being 30 points.[9]
- Clinical Dementia Rating (CDR) scale: screening test for dementias that evaluates cognition, behavior, and influence of cognitive losses on the ability to perform activities of daily living.[10]
- Stroop Test (color and words): evaluates the executive function, from a card with 112 names of colors written in colors conflicting with the printed ones.[11]
- Short Physical Performance Battery (SPPB): evaluates balance, gait speed, and lower limbs. Each stage of the SPPB is scored from 0 to 4, in which 0 indicates total inability to perform the test and 4 indicates the best performance. A score below 8 is considered low physical performance.[12, 13]
- Inventory of attitudes related to technology (IART): the bioecological model targets and evaluates the relationship of the human being with the environment.[14] Thus, a questionnaire of our own was elaborated, based on experiences in the theme and the scientific literature, aiming at evaluate the relationship of the technological environment in the daily life of older adults. The questionnaire is composed of 15 questions on a Likert scale, from 1 to 5 points, and the score can range from 18 to 90. The higher the score, the better the relationship of the older adult with technology.
- Satisfaction with Life Scale (SLS): evaluates how satisfied individuals are with their life by Likert scale (from 1 to 7),[15] and its score ranges from 5 to 25 points. The higher the final score, the better the perception of satisfaction with life.

Procedures

The instruments were applied at the beginning of the study (T0 = time 0) and after five months (T1 = time 1), individually and in person, with a total duration of 15 minutes, maintaining the same conditions for the two participants in both applications. The training was performed three times per week, in 40-minute sessions, as follows: stretching and body warm-up (5 minutes); walking exercise with light to moderate intensity (22 minutes - intensity 4 to 6 of the Borg subjective perception of effort scale)[16] and the sessions took place at Peace Square, Unicamp; stationary gait using the eMaps software program (8 minutes); and muscle relaxation (5 minutes). Each participant underwent 20 sessions.

Participants controlled stationary walking movements by an avatar. The simultaneous movements of hip and knee flexion (relative to stationary gait) allow the participant to navigate the digital map (StreetView), and the change of direction is controlled by trunk rotation (right or left). The eMaps program allows control of Google StreetView, one of the tools of the GestureCollection, which provides the user with human-computer interaction, by motor stimuli related to stationary gait.[17]

Results

Two older adults, aged 80 (woman) and 85 years (man) participated in the pilot project. The woman has complete high school and the man has complete elementary school. According to their self-reports, she has arthritis, and he has hypertension. The results show that, when comparing the two evaluations (T0 and T1), participants had differences in balance, mobility, lower limbs strength, satisfaction with life, and relationship with technology (Table 1). The association of virtual and conventional physical exercise increased executive function by 38.5%, mobility, balance, lower limbs strength by 20.55%, satisfaction with life by 12.5%, and relationship with technology by 13.5%.

Table 1 – Comparison of the variables executive function, physical capacity, satisfaction with life, and relationship with technology of the participants.

	Participant 1 (man)		**Participant 2 (woman)**	
	Scores	**% of difference**	**Scores**	**% of difference**
STROOP TEST	T0 = 37 T1 = 47	27%	T0 = 44 T1 = 47	50%
SPPB	T0 = 8 T1 = 9	12.5%	T0 = 7 T1 = 9	28.6%
SLS	T0 = 30 T1 = 30	0%	T0 = 28 T1 = 35	25%
IART	T0 = 45 T1 = 49	8.8%	T0 = 63 T1 = 74	17.5%

Caption: SPPB = Short Physical Performance Battery; SLS = Satisfaction with Life Scale; IART= Inventory of attitudes related to technology.

Discussion

This Thus, the interventions improved physical, cognitive, and emotional abilities of the participants. Moreover, the eMaps software program was well accepted by the participants, showing its safety and feasibility in the application. Regarding physical aspects, the results showed an improvement of 20.55% in mobility, balance, and strength of the lower limbs. These findings corroborate the study by Panassol et al. (2017), which used the Balance Board® software program and observed improvement of mobility, balance, postural control, aerobic capacity, and gait in 16 older adults after two months of intervention.[18] The association of virtual reality with physical exercise also benefits cognitive abilities. We evidenced that executive function improved by 38.5%. Oliveira et al. (2019) also observed such improvement in three older adults with Parkinson's disease, after training with conventional PE (functional training and stationary bike) and exercises with the game Kinect Adventures® of the XBOX 360® console with KinectTM sensor.[19]

We observed that participants' satisfaction with life in-creased by 12.5% by conventional and virtual PE, further strengthening data from the study by Nonimo, Bortolozzi, and Branco (2018). These authors recruited 12 older adults and performed an intervention with the game Bowling® for two months, improving SWLS.[20] The relationship of our participants with technology increased by 13.5%. Corroborating these data, Farias et al. (2015) emphasize the importance of activities that involve technology for older adults to feel part of society in general, assisting in the demands of daily life, and sharing new knowledge with other people in their personal networks.[21] what can be considered as limitation is the method itself, as it is a case study that makes it impossible to generalization due to a reduced number of participants (two). To compensate for this, we sought to use wide range of information from secondary sources, published throughout a period of 13 years, which allowed for the necessary bibliographic review to support the present study.

A strong point of this study was the opportunity to test the eMaps software, to evaluate the safety in the execution of the stationary gait, if the elderly would accept the virtual reality exercise well and to be able to apply the interventions by virtual reality exercise and conventional physical exercise in the future jointly. The practical application of the assessments (pre and post) and interventions took place safely, within the time each participant understood, solving the doubts and curiosities that arose throughout the entire process. Due to the interaction with VR technology, the male participant began to use the smartphone to search the internet and watch videos about dance, which is a modality that he likes a lot.

Conclusion

Executive function and physical aspects obtained higher results, followed by the relationship with technology, and satisfaction with life. Therefore, we emphasize that the new stimulus offered, VR associated with PE, provided new challenges, tracing new strategies and putting the person in greater contact with technology, in a different perspective from the usual, and with good acceptance of the programs by the participants. The intervention proposed in this study should be reproduced with more volunteers during the next stages of the research.

Individual contributions by authors

Thaís Sporkens-Magna – conception, study design, acquisition, analysis, interpretation of data, preparation of preliminary versions of the manuscript.

Luiz Rogério – conception, study design critical review of important intellectual content, final approval of the version to be published and responsible for all aspects of the work.

Luis Guilherme Silva – conception, study design critical review of important intellectual content, final approval of the version to be published and responsible for all aspects of the work.

Alexandre Fonseca Brandão – conception, study design critical review of important intellectual content, final approval of the version to be published and responsible for all aspects of the work.

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Clinical trial registration

Virtual physical exercise intervention on physical, cognitive and psychological capabilities in the elderly. Brazilian Clinical Trials Registry (ReBEC): RBR-3vymq2j/ https://ensaiosclinicos.gov.br/rg/RBR-3vymq2j

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