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Potential applications of virtual reality devices in older people. Narrative review

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Abstract

Introduction

Many of the non-pharmacological therapeutic interventions such as physical and mental exercises are focused on some of the dimensions of human cognition only. Therefore, methods involving immersion in VR (VR) might presumably belong to the more effective treatment methods. VR is a rapidly evolving technology, which is successfully and increasingly present in various branches, including medicine. Despite its increasing popularity for many people it is still new and unexplored, which leads to negative opinions and unwillingness to use in geriatric population. Therefore, the main purpose of this article is to describe application of virtual reality and new technologies devices in geriatrics.

Material and methods Articles in the EBSCO database were analyzed using keywords: virtual reality, frailty, pain, phobias, stroke rehabilitation, adverse effects. Available literature has been subjectively selected.

Results Researches with applications of virtual reality techniques in sarcopenia and frailty, phobias, stroke rehabilitation, pain therapy were described. Moreover, potential adverse effects were discussed.

Conclusions An overview of the research results in this area indicates that the virtual reality, possibly could be applied in mental and physical training in the cases of both physiological aging and various disorders. At the same time, the disadvantages and potential adverse effects have been pointed out. Further studies on application of VR in older people should be conducted to determine its effectiveness in various clinical and nonclinical settings.

Keywords: virtual reality, gerontology, geriatrics

Introduction

Many of the non-pharmacological therapeutic interventions such as physical and mental exercises are focused on some of the dimensions of human cognition only. Therefore, methods involving immersion in Virtual Reality (VR) might presumably belong to the more effective treatment methods. Some authors distinguish between immersion and presence. The intensity of technical embedding is called immersion [1, 2]. The extent of a simulated environment can differ by the technic, on which level could be defined in terms of immersion-spectrum, from full-immersive [3, 4] to high-immersive [1]. As Fontanesi and Renaud [5] indicate that higher levels of immersion can increase the transfer of the user into the virtual environment. Immersion could be illustrated as the feeling of presence, which denotes the experience of ambient environment considered by some as “sense of being there”, despite the mismatch with the real-world influence on physiological state [5, 1, 6]. Presence includes 3 dimensions. First of all, spatial presence consists of the physiological sense of being in a virtual environment. Moreover, presence includes involvement presence, what consists of feeling of participation. In addition presence includes experienced realism, the participant sense of the virtual environment [7].

VR is a rapidly evolving technology, which is successfully and increasingly present in various branches, including medicine [8]. Despite its increasing popularity for many people it is still new and unexplored, which leads to negative opinions and unwillingness to use in geriatric population. [8].

The main purpose of this article is to describe application of VR and new technologies devices in geriatrics.

Material and methods

Articles in the EBSCO database have been analyzed using keywords: VR, frailty, pain, phobias, stroke rehabilitation, adverse effects. The available literature was subjectively selected.

Results

Potential applications in older people

The use of VR as a innovative tool in geriatric rehabilitation has been a frequent focus of research since the late 1990's, with a considerable increase in the number of publications in the last few years. VR makes possible to practice activities in secure and challenging environments. Presumably, these features made it more prone to use in the most vulnerable social subgroups, i.e. older people.

R in sarcopenia and frailty

Some researchers suggest that rehabilitation using VR in elderly patients brings improvements in mobility, in muscular strength of the lower limbs, in cognition, mainly of executive functions, in balance control, in reaction time and also helps to prevent falls [9,10]. The VR program promoted an increase in pelvic floor muscle contractility and a decrease in postmenopausal urinary symptoms [11,12].

Aging results in a progressive loss of muscle mass and strength called sarcopenia. It affects up to about 30% of older population. Sarcopenia could lead to functional impairment, physical disability, and even mortality. Resistance training is the most efficacious tool to reverse the consequences of sarcopenia [13]. Achieving the daily amount of exercises is not easy for many older patients and they need some help from caregivers or family members. Devices or system called assistive technology (AT) could slow down the loss of muscle and reduce disability of sarcopenic patients [14].

Also the prevention of falls is one of the most important problem in geriatrics. Balance dysfunction is one of key impairment which leads to increase number of falls. Using the virtual devices improves the balance control, gait, movement and reduces the fall risk in older population [15]. VR could also reduce the fear connected with the fall in the past (cognitive behavioral training) [16].

Further research is still required in sarcopenic populations and frailty population to find the way of effective use of VR devices.

VR in the treatment of phobias

VR is increasingly used in psychological practice, psychotherapy and medicine [8]. Therapeutic techniques in which VR is successfully used belong to behavioral-cognitive therapy, which enables the treatment of mental disorders such as specific phobias, social phobias or panic disorders [17]. In this type of therapy, the main method is the gradual taming the patient with the stimulus, which is the object of his / her anxiety. This is made by increasing the patient's contact with the object that causes him / her to anxiety, which leads to the stage where the patient is not afraid of the object of his phobia. The traditional therapy consisted of invocation in the imagination aversive situations by patient. However, this technique is often cumbersome and ineffective, as patients mostly were not able to reproduce these aversive situations from the past, and the therapist has no control over what his clients think about. The use of VR is an excellent alternative. During therapy, the patient confronts the anxious stimuli that are under strict control of the therapist and can be corrected as a result of the progress in

treatment. In addition, the exposure occurs in a patient-safe environment and is free from interfering parameters. The new form of cognitive-behavioral therapy seems to be an excellent alternative to traditional techniques [8].

VR in stroke rehabilitation

Hemiparesis resulting in functional limitation of an upper extremity is common among stroke survivors. Although existing evidence suggests that increasing intensity of stroke rehabilitation therapy results in better motor recovery, limited evidence is available on the efficacy of VR for stroke rehabilitation [18]. Recent evidence suggests that repetitive, task-oriented training of the paretic extremity is beneficial [19, 20]. Recovery of function, both spontaneous and secondary to intense rehabilitative treatments, is sustained by plasticity and rewiring in the injured brain in adults [21, 22, 23]. Neurons in the adult human brain increase their firing rates when a subject observes movements performed by other persons. Activation of this mirror–neuron system, can induce cortical reorganization and possibly contribute to functional recovery [24]. VR technologies allow for interactive observation of avatar movements captured on the screen and combine features of increasing rehabilitation intensity required for induction of neuroplasticity [24, 25, 26]. Virtual gaming technology represents a safe, feasible, and potentially effective alternative to facilitate rehabilitation therapy and promote motor recovery after stroke [18].

VR in pain therapy

VR is becoming more widely used as support in pain therapy, also in geriatric patients. Previous researches showed that VR may reduced pain resulting from ankylosing spondylitis and post-mastectomy, neuropathic and phantom limb pain. In the other hand this method has not effect in chronic back pain or neck pain [27]. Research using VR in analgesic therapy among geriatric patients showed that it is helpful in reducing pain, but no changes was observed in the depression occurrence nor in the quality of life. However, these were studies on a small group of people [28]. There are also reports showed that VR can be successfully used as adjuvant therapy, because the level of pain and anxiety is lower than with pharmacotherapy alone, even when considering application of strong opioids [29]. Interestingly, no specialized devices are needed to use VR. Research shows that even smartphones with applications that use VR can be an effective non-pharmacological method in reducing pain [30].

Adverse effects in VR

Research assessing reported symptoms and side effects of using VR systems indicates that these factors combine to influence user experiences of VR induced symptoms and effects (VRISE) [31]. Sharples and co-authors [31] conducted a series of experiments and prove that 60–70% patients experience an increase in symptoms pre–post exposure for VR. These adverse effects are: nausea, oculomotor and disorientation symptoms, dizziness, headache. Also some of participants dropped out of the immersion due to adverse symptoms before their allotted time was over. No effect of lighting condition was found. Higher levels of symptoms were reported in passive viewing compared to active control over movement in the VR. However, they stated that most participants enjoyed the experience but reported some discomfort. As this supports other findings of individual susceptibility to VRISE, recommendations are offered concerning design and use of VR systems in order to minimise VRISE [31].

Discussion

When describing the use of VR in order to improve the physical and mental fitness of older people, it is first of all necessary to pay attention to its importance in achieving better results in motor functioning. This is especially important because such functioning involves more independence in the performance of activities at home and outside that require physical strength. Research conducted on older people indicates a positive effect of VR primarily on the postural system, reducing the risk of falls during activities requiring physical effort [32]. Realizing these reports, Rendon et al. conducted a 6-week intervention in which 20 people in advanced age performed tasks in the VR conditions received by the Nintendo Wii FIT, and then compared the results of the 8-foot Up & Go test of the said group with the results of 20 other older people who were not subject to intervention. According to the obtained results, exercises in VR improve the dynamic balance, confirmed using the mentioned test [33]. This fact should be taken into account when planning further research on VR, on which knowledge needs to be developed all the time.

The topic in a special way raised in our article, which should not be overlooked, is the impact of VR on cognitive functioning in the elderly. An overview of the research results in this area indicates that the VR, despite the more frequent use by younger people, can be a great source of rehabilitation activities in patients of advanced age suffering from cognitive functioning disorders. At the same time, the disadvantages of using such methods have been pointed out. For the elderly, especially in less affluent countries, this type of technology may be too expensive and too complicated to use. It was also found that nausea and orientation disorders

can occur in older people after exercises with VR [34]. The disadvantages of this type are also described in the above article.

The use of VR is not without significance in the therapy of psychiatric diseases. In studies conducted on Chinese citizens in advanced age, an attempt was made to determine whether VR training can be effective in people suffering from chronic schizophrenia. The project involved 27 elderly people suffering from the disease, 12 of whom underwent intervention in the form of 10 sessions in VR. 15 people were a control group. Then the memorizing and repeating abilities were compared in both groups. According to the results of the research, people after trainings with virtual space showed better abilities [35]. This type of research should continue to determine the importance of VR in the treatment of both schizophrenia and other psychiatric illnesses.

One of the most important situations in which the use of virtual space can be significant is the broadly understood brain damage. In our article special attention was paid to the rehabilitation after a stroke, but it should be remembered that there was evidence of the possibility of using VR in rehabilitation also in other cases with brain damage. Review of research results about the importance of exercises using virtual space indicates their high effectiveness, but also highlights the very large, almost uncontrolled expansion [36]. This conclusion and the fact that brain damage is a relatively common situation suggests that VR will soon be an integral part of rehabilitation treatments.

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