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Review Article

Therapeutic Exergaming and Its Feasibility in Developing Countries Setting

Husnul Mubarak[1], Andi Amirah Shaleha Junaedi[1]

[1] *Physical Medicine and Rehabilitation Department, Faculty of Medicine, Hasanuddin University*

Corresponding Author:
Name: Husnul Mubarak
Email: husnul.rehab@gmail.com

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ABSTRACT

Introduction: *Games have an important role from a social point of view in human and cultural development. Exergaming is a form of digital gaming that combines video games and physical activity that uses a motion tracking device to record gestures and complete gameplay on a screen. Therapeutic exergaming has the potential to facilitate improved balance, including reducing center of pressure (CoP) variability, home-based exercise for older adults, and exercise for people with balance disorders.* ***Method:*** *for this literature review we searched journals taken from search engines such as google, google scholar, Pubmed, and PubMed Central, published from the inception of the respective databases to June 2022. The keywords therapeutic exergaming, exergaming, video game, physical therapy, consoled game, virtual reality were used in writing this literature. The literature search and journal reading were limited to sources which was free and written in English. We addressed several aspects of exergaming such as the device sensor feedback, its application to augment therapy and to manage diseases, and its implementation in developing countries.* ***Conclusions:*** *The benefits of exergaming have been widely studied and are known to have many positive effects on health, such as improving cognitive function, increasing physical activity, exercising balance, and improving vascular function. Exergaming has become an alternative therapy in Huntington's disease, Parkinson's disease, and as a means of gait rehabilitation in geriatric patients. Exergaming also has the potential to reduce the risk of obesity in children.*

1. INTRODUCTION

Games have an important role from a social point of view in human and cultural development. These activities will activate motor, psychological, and/or intellectual abilities. Therapeutic exercise involves movement to improve impairment, muscle and bone function, and/or maintain a state of well-being (1).

Exergaming is a form of digital gaming that combines video games and physical activity that uses a motion tracking device to record gestures and complete gameplay on a screen (2). Exergaming has the potential to facilitate improved balance, including reducing center of pressure (CoP) variability, home-based exercise for older adults, and exercise for people with balance disorders such as spinal cord injury, brain injury, or stroke (3–5).

Therapeutic exergaming, which combines the three areas of human motion capture, computer games, and physical therapy, may be beneficial for patients with exercise programmes as prescribed by a doctor or by other rehabilitation professional(6). This program will create a conducive environment that can increase the level of motivation, compliance, and participation in training effectively. Individual rehabilitation programs are important in improving the quality of life through exercises that make patients more comfortable, satisfied, and less stressed (4).

Therapeutic exergaming has the potential to provide accurate feedback on movement and positioning during rehabilitation. The challenge in feedback is how to design therapeutic exergaming that can integrate feedback, so that intrinsic motivation arises without cognitive overloading in patients. External stimuli have a significant effect on motor function. Visual overload makes the patient focus more on the screen rather than the exercise itself, so that the goal of the exercise is not achieved. Therefore, the authors are interested in discussing therapeutic exergaming as an innovation in rehabilitation programs (7).

2. DISCUSSION

1. Therapeutic Exercise

1.1. Definition

Therapeutic Exercise is a systematic and planned exercise through body movement, posture, or physical activity with the following functions (8):

- Correction or prevent disturbance;
- Restore, enhance, or promote physical activity;
- Prevent or decrease risk factors associated with health;
- Enhancing one's general state of health, fitness, or wellbeing.

Therapeutic exercises include aerobic conditioning and reconditioning, endurance, agility, balance exercises both static and dynamic, body mechanics exercises, breathing exercises, coordination exercises, gait and movement training, motor exercises, muscle lengthening, movement pattern training, neuromotor exercises, neuromuscular or reduction exercises, perception exercises, stabilization and postural exercises, wide range of motion and stretching exercises, relaxation exercises, and strength and endurance exercises (9).

1.1.1. Types of Exercise Therapy Intervention

A variety of exercises, behaviors, and methods make up therapeutic exercise regimens. According on the therapist's evaluation of the condition or cause, activity restrictions, or patient participation barriers (disabilities or functional limits), the approach was chosen for the personalized therapeutic exercise program (9).

Table 1. Types of therapeutic exercise intervention (9)

Type of Exercise Therapy	Example Programme
Capacity conditioning /aerobic endurance	• Aquatic program • Gait and locomotor training • Increased workload from time to time • Exercise efficiency of movement and conservation of energy • Programs for walking and wheelchair propulsions
Agility, balance, and coordination	• Exercise or re-education of motor function (motor control and motor learning) • Neuromuscular or re-educational exercise • Perception exercises • Posture awareness exercises • Sensory exercise or reeducation • Standardized and programmed training approach • Vestibular exercises
Flexibility training	• Stretching • Range of motion (ROM)
Gait and movement training	• Exercise development activities • Gait training • Perception exercises • Standardized and programmed training approach • Exercise using a wheelchair
Neuromotor training	• Motor exercises • Movement pattern exercises • Neuromuscular or re-educational exercise

1.1.2. Exercise Safety

Regardless of the type of therapeutic exercise intervention, safety in exercise is a fundamental consideration in every aspect of the program which can be performed independently or under direct supervision of the therapist. A patient who is not accustomed to physical activity may be at risk for the side effects of exercise related to a known or undiagnosed health condition. Medication may have an impact on a patient's cardiovascular reaction to exercise or their balance and coordination during physical activity. Therefore, before starting an exercise program, risk

considerations need to be thoroughly considered and weighed. Before beginning an exercise regimen, doctors' suggestions are carefully taken into account. Additionally, patient safety is impacted by the training environment. In practice, adequate space and a suitable support surface are essential preconditions for patient safety. Exercise equipment must be suited for the patient, maintained properly and in excellent operating order, and be applied and used carefully (8) in order to guarantee patient safety whether it is used in a clinic or at home.

1.1.3. Type of Damage/Impairment

In the International Classification of Function model, disorder are further divided into disorder of body function and body structure. Patients with compromised bodily structures and/or abilities that impact the following systems are often served by physical therapists (8):

- Neuromuscular
- Integument
- Musculoskeletal
- Cardiovascular/pulmonary

Most disorders of this system are mainly due to congenital or acquired abnormalities of physiological function or anatomical structure(8).

1.2. History and Development

Exercising the body or specific body parts to reduce symptoms, enhance function, enhance quality of life, or enhance general health is known as therapeutic exercise. The Atharva-Veda, an Indian medical text, mentions the practice of therapeutic exercises (later known as medical gymnastics) as early as 800 BC. The paper offers massage and exercise as treatments for persistent pain. But according to the majority of historical events, therapeutic activities were initially popular in ancient Greece. Herodicus, who is regarded as the Father of Therapeutic Exercise, is said to have been the first physician to write about this around 480 BC (9).

Modern physical therapy appears to have started in Sweden in the 1800s with a fencing coach by the name of Per Henri Ling. According to Ling, a skilled fencer must also learn certain movements in order to become an athlete. Dosing, counting, and thorough directions for every exercise are all part of its therapeutic exercise program. He demonstrates how the proper motions may treat illnesses and bodily dysfunctions. A contentious paper was written by Swiss physician Frenkel in 1902, at the same time as Ling was creating his technique. In order to restore injured nerve cells, Frenkel suggested an exercise regimen for ataxia sufferers that included repeated exercises. This approach has gained a lot of popularity because it doesn't include the usage of weights or strengthening exercises. Despite its decline in popularity, the Frenkel program's repeated practice has contributed most to the creation of therapeutic exercise (9).

1.3. Development of Video Game

Computer programmers created very basic gaming systems in the early 1950s using electronic devices, such as Nimrod in 1951 to play Nim or Bertie the Brain in 1950 to play tic tac toe. This system primarily used as an illustration system to

highlight the capabilities of computers at the time in major shows, using electronic light displays (10).

Although video game virtual reality (VR) systems were originally considered as a target for VR technologies created during the 1990s, their high cost and impracticality for consumer sales have hindered their development. Palmer Luckey's creation of the Oculus Rift in the early 2010s marked a significant advancement in consumer-ready VR gear. The Rift's 2013 presentation proved to be so successful that Facebook purchased the business and its technology in 2014 for $2 billion. Sony debuted the PlayStation VR in 2016, and shortly after, Valve and HTC announced the HTC Vive, which was originally made available in 2015 (13).

1.4. Video Game Rehabilitation

Researchers discovered the advantages of internal reinforcement in virtual settings, which led to the application of augmented reality technologies in the development of motor skills in the late 1990s. Meanwhile, experts from all around the world are starting to look at how virtual reality may be used to treat phobias and anxiety problems. The study's findings indicated that phobias were linked to improved motor control and decreased anxiety. As a result, in the early 2000s, academics started looking at virtual reality systems as a kind of rehabilitation. These days, researchers may employ more affordable and accessible technologies thanks to well-known console games like the Wii (Figure 1) and Kinect. This creates new chances for gaming as a rehabilitation alternative (14).

In a 2012 comprehensive literature analysis, 963 papers on virtual reality and rehabilitation from 1996 to 2010 were examined. Researchers discovered that the number of investigations undertaken annually increased from about 10 papers in 1997 to over 40 in 2010 (13).

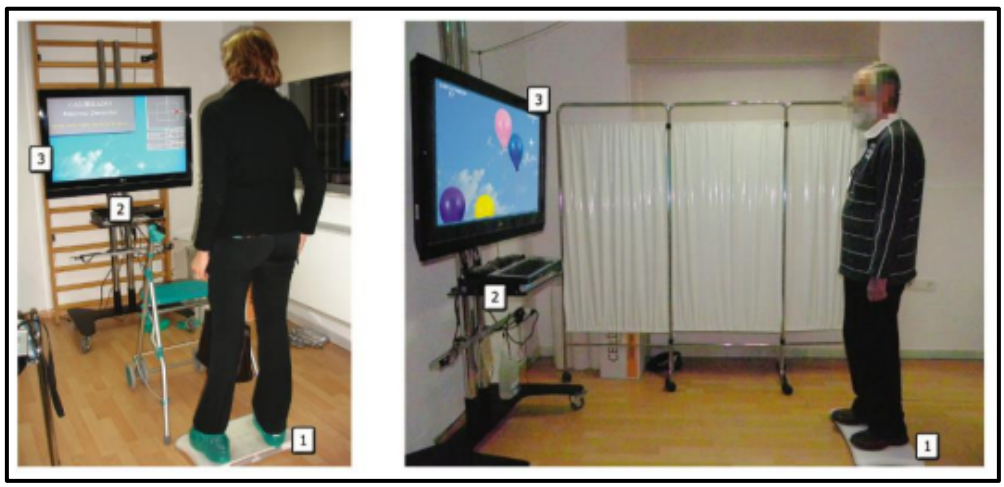

Fig. 1. The patient uses the Wii Balance Board system in a rehabilitation program consisting of 1) Wii Balance Board, 2) comuter, 3) video display (15).

2. Exergaming

2.1 Device Sensor Feedback on Exergaming

In addition to leisure simulations (like golf, tennis, etc.), exergaming offers a range of physical activities, including aerobic, balancing, and stretching exercises.

They do, however, need more gear and software. Hardware-wise, they require the appropriate sensing apparatus to monitor the user's motions. Software-wise, game situations need to support whole-body interactions. Exergaming offers a variety of commercial game kinds, such as Xbox (Microsoft), PlayStation (Sony), and Wii (Nintendo). They all have input devices, such the Kinect for Xbox, Motion for PlayStation, and Remote Plus for Wii, that let users interact with games (16).

An analysis of wearable sensors in rehabilitation applications that highlights the value of implementing technology for rehabilitation in both the home and the clinic. Additionally, technology-friendly solutions are needed to augment clinicians and therapists in order to effectively monitor and assist telemedicine while providing health rehabilitation services to the baby boomer population. Computer and video games make it easier for users to be entertained and involved while frequently practicing rhythmic exercises and boosting their therapeutic advantages (17).

2.1.1. Vibration : Output system other than audiovisual

The significance of vibration in video game controllers is explained y Newman (2002). Players may experience sensations when playing games on the Nintendo 64 thanks to a slot on the handheld device for a rumble pack attachment. As stated on the Nintendo website (Nintendo Buyer's Guide: Rumble Pak, 2022), Rumble Pak began development in 1997 as a feedback mechanism that could be integrated into the controls and gave players the ability to experience vibrations. For instance, when his avatar hits an interactive item, the user experiences a vibration (1).

Sega and Sony followed suit by introducing vibration systems for console controllers (the Dual Shock control system for the PlayStation and the Vibration Pack for the Dreamcast). On the other hand, the video game controller's motions serve to reinforce the audiovisual impression and confirm its function as a sensory device (1).

2.1.2. Input system other than push button: touch, sound and blow

In an effort to improve attractions and interaction, Nintendo created the Nintendo DS (short for dual screen) handheld system in 2004. Through the addition of a pen attachment, the system makes use of a touch-sensitive touch screen (18).

Tobin claims that playing any kind of video game involves physical activity. Using a microphone is a motion in certain games, similar to blowing out a flame. Hey You Pikachu! was released by Nintendo in 2000 for the Nintendo 64 system. Using the Nintendo 64 VRU (voice recognition unit), it was among the first video games to use speech as a source of input for data and control (18).

2.1.3. Kinesthetic and motoric input systems: body and performance

Medeiros Filho, Calado, and Neves (2013) claim that the Nintendo Wii system brought a novel control mechanism. In order to access additional inputs, it makes use of the system (which is dependent on motion and recorded by the accelerometer). Juul (2010) asserts that the Nintendo Wii's controller's ability to simulate realistic in-game motion was the key to its success (1).

Active games that demand physical effort are growing in popularity with the release of the Nintendo Wii, the Sony PlayStation and PlayStation Eye devices and the Kinect x-box console attachment (16).

Fig. 2. Medical Interactive Assistance Recovery System consists of Kinect Motion Sensor and software for correcting exercises on games, A child (left) is practicing arm exercises and an elderly person (right) is practicing hip exercises

Certain activities of daily living (ADLs) need arm mobility. Every daily action requires a minimum amount of upper arm range of motion (ROM) to be completed (19). However, neurological conditions including multiple sclerosis, stroke, spinal cord injuries, nerve damage, etc., can restrict a person's range of motion, which further impairs their quality of life by preventing them from doing some everyday tasks. Identifying movement restrictions to aid in therapy planning and monitoring recovery to adjust treatment depending on patient progress are two steps in the process of regaining lost motor abilities. A motion capture device is necessary to quantify the intricate motions of the wrist, elbow, and shoulder in the seven-degree human upper extremity (20).

2.1.4. 3-D and Augmented Reality

Nintendo debuted the Nintendo 3DS device in 2011, changing visual experiences by enabling glasses-free 3-D graphics, 3-D picture and video capturing, and augmented reality features. According to Ng et al. (2015), augmented reality (AR) enhances reality by superimposing digital information over device-captured pictures, which are frequently obtained with a camera and software. They use the Nintendo 3DS as an example, with software-recognized cards allowing the display of 3-D models on the device's screen (1).

2.1.5. Augmented Reality, Ubiquity and Walk Simulation

In 2016, Leblanc and Chaput emphasized the importance of developing novel techniques to counteract sedentary behavior and encourage physical activity, Pokémon Go (Figure 3) successfully promotes mobility by requiring users to actively search and "catch" Pokémon using their cellphones. Gamification is used in this app to motivate users to run and increase their chances of discovering Pokémon, as well as to speed up the "egg incubation" process in games. Gamification, or incorporating gaming components into daily life, is a strong technique for illness prevention and health maintenance (21).

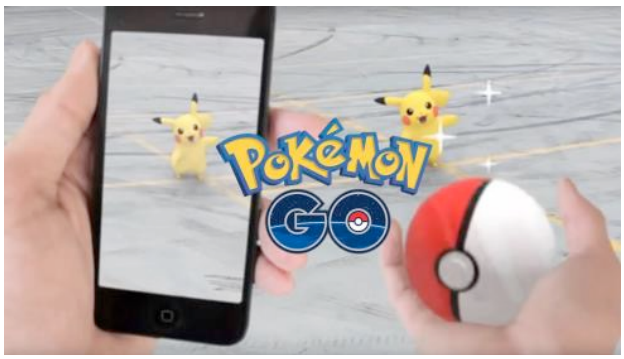

Fig. 3. Pokemon Go(21).

2.1.6. Virtual Reality: Extended Visual Security and Immersion

Virtual reality immerses players in a realistic three-dimensional computer-generated environment through a helmet-mounted display screen, allowing interaction through head motions and manual controllers or motion sensors. This technology is shown by devices like as the Oculus Rift and PlayStation VR (1).

Augmented haptic games, such as the SoEs (Sword of Elements) project, combine reality with natural physical items and haptic feedback to simulate tactile experiences like the fire of a weaponsmith's work or the wind of an expanding arrow iron through a wearable interface (1).

The FeelReal project (Figure 4) focuses on VR by creating helmets and masks that activate various senses. These gadgets include 3-D audio, high-resolution displays, micro-cooling, heating, adaptable vibrations, ultrasonic ionization for mist, seven scents, and a microphone, allowing the virtual experience to go beyond sight and sound (1).

Fig. 4. FeelReal (1).

2.2. Exergaming as Augmented Therapeutic Exercise

Exercises used in stroke rehabilitation are designed to help patients regain their fundamental motor abilities, particularly in the extremities. Motivating patients to perform exercises and using game-based Augmented Reality (AR) for rehabilitation can be tedious and repetitive. Additionally, mirror therapy gives players clear visual feedback while they watch their own motions in the game. The majority of AR systems for rehabilitation therapy need a person to wear an external device or sensor. It cannot be utilized for in-home rehabilitation because it is intrusive in that it prevents the user from moving normally, which causes discomfort (22).

The proposed non-invasive system uses a webcam to capture people who are in 2D and therefore requires another device to track and movements in 3D. With a variety of different tools not only makes the system limited to a complex laboratory

setup, but also adds to the overall cost. Virtual Avatars have been used in several systems to imitate human movements. With the advent of low-cost 3D cameras, it has become possible to capture "live" human/avatar models and immersion in AR games (23).

The proposed Augmented Reality Technology (ART) system is capable of manipulating the experience of reality around aspects of trust, interactivity, certainty, decoupling and demonstration of the potential for AR to improve health and well-being. Although physical therapy is a big part of the rehabilitation process, the individual efforts of the patient also have a big responsibility in his recovery. The patient must be prepared to learn about his condition and how to do the recommended therapy without the need for professional supervision. It is hard for the patient, alone and without significant body awareness, to perform the exercise properly. Without real-time feedback, patients can end up getting injury (23).

Research has shown that augmented reality feedback enhances motor learning in an individual (Figure 5). SleeveAR, is a platform that combines multiple sources of mindfulness feedback to assist and guide during rehabilitation exercises. Ultimately, we want to be able to determine the most appropriate combination of feedback to successfully guide someone through a particular movement (Figure 6) (22).

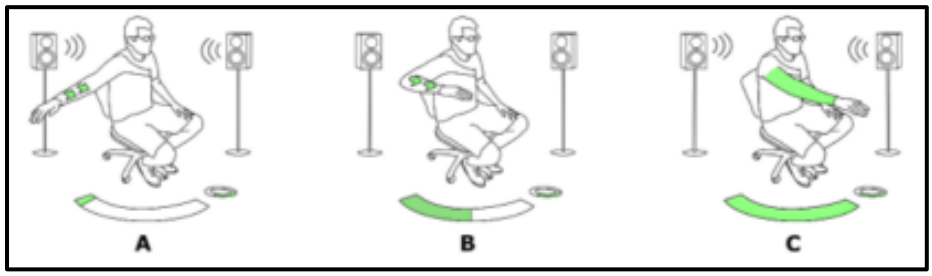

Fig. 5. Patient follows feedback for simple movement commands; (a) Initial phase, a combination of audio and visual cues; (b) Floor projected visuals follow the patient's movements in real time; (c) complex exercises that trigger audio feedback(22).

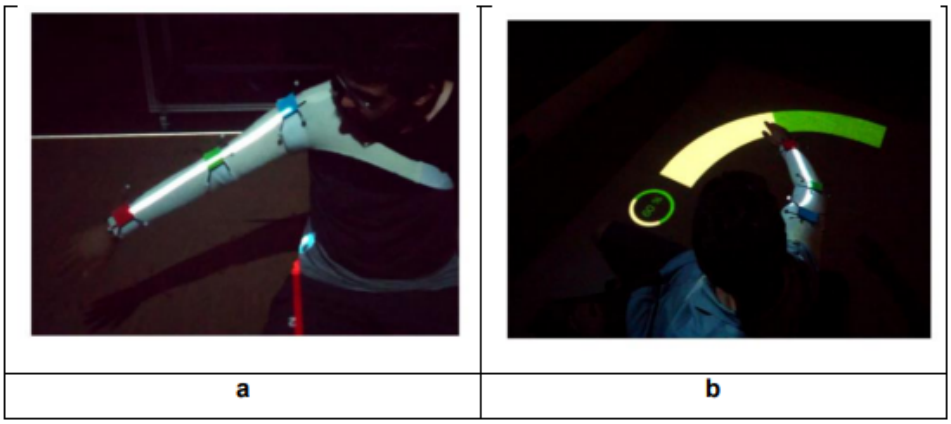

Fig. 6. (a) Sleeve is responsible for staying in the tracking equipment; (b) Real time visual feedback (22).

2.3. Definition and Scope of Exergaming

Exergaming refers to a form of digital gaming that aims to combine video games and physical exercises that require physical effort on the part of the player to play the game, with the outcome of the game being determined primarily by these

physical efforts (2). Aspects of the game, sports and technology domains are relevant for exergame development. Various aspects of different domains influence each other and influence each other and the attractiveness, effectiveness, flow, user experience, and experience of Gameflow (24).

Exergaming can overcome one of the problems such as aging and also has the advantage of motivating people to exercise and dual task cognitive and motor skills. Exergaming focuses attention on the result of the movement, not on the movement itself (25). In exergaming the algorithm is different, required for game control and feedback depending on the input. Exergaming devices are controlled using various sensor systems. Sensors commonly used in input devices are gyroscopes, accelerometers, infrared, RGB optical cameras/sensors, and pressure sensors (15).

2.4. Advantages Over Conventional Therapy

The exact effects of exergaming are still being discussed, but there is no doubt that playing exergames has a positive effect on the health of the players. But apart from the health benefits, exergaming also has several other benefits. Exergame is a form of entertainment and offers users a motivating way. In conventional exercise, people will usually think about how tired they are; through exergaming, their minds will be immersion in the game and they will feel happy. As a result, the level of motivation to stay on the training program will be much higher than with conventional training (26).

Exergame can be done alone at home, and can also offer a social way to get in shape. Friends and family can join the game at home. Some games can be guided by the trainer online, such as: Fitness Evolved and Nike+ Kinect Training. This virtual trainer provides the user with a personal training plan and monitors all the activities carried out by the user. The trainer provides feedback on how well the exercise is done by the user, and tries to motivate the user through communication (26).

In revalidation and correct physical exercise movements are more important than in normal exercise. Exercises for people recovering from injuries usually get special exercises that strengthen the injured muscles. It is important that the exercises are done regularly and the motivation is high. Exercise after injury is often seen as strenuous and/or tedious, which is a major reason why people quit an exercise program. Exergame can help by providing a distraction. Feedback is pleasant and positive, so people are more motivated and increase the chances of successful recovery. Exergame can also gradually increase the difficulty and motivate to exceed the user's best abilities (26). For example in Parkinson's patients, some exergames can be a solution in the treatment of Parkinson's, especially effectiveness in the treatment of rehabilitation of motor function disorders (27).

3. Exergaming In Disease Management

3.1. Diseases that have the potential to give exergaming

Most exergames are designed for children and young adults but current research also suggests their use for the elderly. As we age, it causes changes in different systems and the most common ones include decreased fine motor skills and changes in posture and balance, decreased learning of new motor skills, decreased

sensory processing, cognitive impairment, reduced attention span, loss of self-confidence, anxiety and increased depression (28). Several exergaming therapies have been documented in the field of rehabilitation. Several publications are merely scientific papers, case reports, or qualitative research based on tiny patient data, in contrast to the preventative field. Asthma, diabetes, cancer, respiratory conditions, heart rehabilitation, neurological therapy following stroke and other brain injuries, leukemia, cystic fibrosis, burns, patients in wheelchairs, therapy robots, developmental and intellectual impairments, and subsyndromal depression are among the conditions covered by exergaming and rehabilitation (29).

3.2. Side effects

Possible injuries from exaggerating are frequently documented, including tendinitis, patellar dislocation, and hand laceration, even though play-based therapy may be advantageous since it can boost enthusiasm for recovery and decrease distractions from the tiresome routine of medical treatment. According to a new study, playing video games during treatment might make patients more susceptible to musculoskeletal problems. Large-scale research is required to examine the harm that millions of gamers experience globally, even if these injuries may be rare or sporadic (11–12).

Additionally, it is proposed that the usage of game systems for at-home rehabilitation might result in a communication breakdown between patients and therapists. It is challenging to accurately monitor the patient's development in these situations, and it is uncertain how the therapy is working. Because the therapist is not accurately assessing the patient's performance level, it is also likely that in this case, the lack of tracking results in an increase in the amount of time spent on the activity. Additional difficulties in video game therapy may include the therapist's lack of computer ability, a lack of framework to support it, costly technology, ineffective interaction, and patient safety concerns (11–12).

Additionally, it was discovered that this technique also caused rehabilitation instances for frequent virtual reality environment side effects as nausea, dizziness, and disorientation. Because these scenarios are used in conjunction with other virtual reality situations, patients have demonstrated that they are not immune to the detrimental effects that may be observed in any of these systems. It has also been challenging to maintain and sterilize virtual reality systems after usage, which has caused some people to stick to standard procedures instead of using them (30).

3.3. The Future of Exergaming

According to researchers, technology will play a central role in occupational therapy in the future century as it is an essential aspect of human labor and the human experience. As time goes on, technology will become more advanced and permeate many aspects of professional life. Some occupations may be replaced by video game rehabilitation (11).

3.3.1 **Indonesia**

Based on researchers Ardianto et al. about design of virtual reality-based hippotherapy simulator exergaming software and its controller for rehabilitation of

children with cerebral palsy in Indonesia, due to design limitations during experiments and commercialization, some limitations in design found that the riding simulator purchased did not have an adjustable saddle and footrest to support the child between the ages of 3 and 18 (41). In Indonesia, the development of exergaming is limited to the equipment available and the cost to manufacture.

3.3.2 **Pakistan**

Based on researchers Afridi et al. about the emerging role of virtual reality training in rehabilitation in Pakistan, VR rehabilitation is a relatively new rehabilitation tool in Pakistan. Few centers have VR settings, and all of them are located in major cities in Pakistan. The most commonly used VR device is the X-Box Kinect 360. Most show that VR is an effective tool in terms of purpose, motivation, and engagement compared to traditional exercise programs. All studies have shown positive effects of VR. However, most research has been limited to older adults and neurological disorders, focusing only on balance, mobility, and function. Furthermore, many studies lacked statistical power and used weak experimental study designs. Future studies with larger sample sizes, using more study designs and targeting other conditions and outcomes are needed to draw better conclusions about the scale of VR rehabilitation in Pakistan (44).

3.4. The effect of exergaming on changes in molecular levels in the body

A good example of exergaming is the Xbox 360 Kinect game, in which participants move their bodies (dancing, kicking, jumping) while interacting with the avatar on the screen, increasing physical activity and health (31). In exergaming, human motions are recorded by a variety of devices (accelometer, force plate, camera) and transmitted to the console (Nintendo Wii, X-Box, PlayStation). A good example of exergaming is the Xbox 360 Kinect game, in which participants move their bodies (dancing, kicking, jumping) while interacting with the avatar on the screen, increasing physical activity and health (31). In exergaming, human motions are recorded by a variety of devices (accelometer, force plate, camera) and delivered to the console (Nintendo Wii, X-Box, PlayStation).

Exergaming evaluation of cardiovascular risk factors for triglyceride, cholesterol, LDL, and HDL levels in the blood samples o the players before and after the training period. The results showed that total serum cholesterol, triglycerides, and LDL had decreased by 64 ($p < 0.05$), 29 ($p < 0.05$), and 12% ($p < 0.05$), respectively. There was no change in HDL in this study. Dyslipidemia and related conditions such as obesity and insulin resistance are often accompanied by low-grade chronic inflammation. In addition, there was a decrease in the concentration of TNF- (57%, $p < 0.05$) which was assessed after exergaming exercise. Although there was no difference in IL-1β levels, there was a significant decrease in CRP concentration (84.7%, $p = 0.01$) (35).

Xbox 360 Kinect interactive games may be a helpful tool in rehabilitation treatments, according to Camara Machado's research on the impact of engaging game-based therapies utilizing motion sensor Kinect on children with cerebral palsy (36).

In the elderly, increasing age is accompanied by a decrease in subsystem functions (nerve, perceptive, cognitive, sensorimotor cardiovascular, neuromuscular) which have an impact on mobility, balance control, motor coordination, and quality of life (37). Exergame can also provide benefits to cognitive abilities by combining aerobic exercise, strength training and cognitive training into various multicomponent training modes(38). According to Torre and Temprado, there are three types of multicomponent training associations, namely physical-cognitive training (PCT), motor-cognitive training (MCT), and multi-domain training (MDT). In PCT exercises where cognitive stimulation via virtual reality does not involve the whole body or complex coordinated movements of the upper extremities, for example cyber-cycle expresso – an exercise that controls, records the duration, and intensity of aerobic exercise while interacting with a gamified 3D environment on a screen. The interaction is in the form of small amplitude movements consisting of lifting/pushing the handles located on both sides of the saddle. The training program lasts for 3 months with sessions lasting from 20 to 45 minutes, a frequency of two to five times per week (39). During exercise, the heart rate reserve (HRR) is calculated to control the intensity of the exercise by maintaining 60% of the HRR. In the cyber-cycle expresso exercise, there was an increase in the blood concentration of brain-derived neurotrophic factor (BDNF) compared to the conventional physical exercise group. In addition, there was a 23% reduction in the risk of clinical development in mild cognitive impairment (MCI) (40).

Another explanation, refers to the neurobiological underpinnings of the combination of physical and cognitive exercise in cyber-cycle expresso that stimulates brain plasticity mechanisms (angiogenesis, neurogenesis) and other changes that promote neurovascular integrity. According to this hypothesis, cognitive stimulation will increase the blood release of BDNF, when compared to conventional physical exercise interventions (40).

4. Exergaming In Developing Countries

4.1. Indonesia

In recent years, the trend in children's sports has been called by the development of active video game technology and exercise games. Exergaming represents a modality of physical activity that integrates video games with engaging activities designed for children. Various video game developers, including Konami, Nintendo, Sony, and Microsoft, have created a range of game models to facilitate this interactive approach to exercise (41).

In Indonesia, Surabaya, an exergaming study examined the potential impact of video game-based exercise for combating childhood obesity. Determining the way moderate-intensity exercise affected the development of fundamental motor abilities and the reduction of body mass index (BMI) in children who were overweight or obese was the goal of this study. The 17 primary school participants ranged in age from 6 to 12. Overweight and obese individuals with a BMI over the 85th percentile conducted 12 sessions of moderate-intensity exercise, three times a week, lasting 30 to 40 minutes each, for four weeks. Weight, BMI, body fat percentage, basic athletic performance, and anticipated energy expenditure are the factors that are considered (41).

Participants engaged in exergaming using a Microsoft X Box 360 Kinect system. Kinect dancing and his moderately intense Kinect workout (equal to 3-6 METs; 1 MET is equivalent to 3.5 ml/kg min, regulated by an Actiheart® device) are the play modes. Numerous sports games, including track and field, soccer, table tennis, boxing, volleyball, and bowling, are available on Kinect Sports. Kinect dancing is a term used to describe many dancing games for children. While keeping a balance between upper and lower body activities, participants are free to select the games they want to play. Three times a week, twelve sets spread over four weeks, lasting thirty to forty minutes each, this exergaming is conducted in the Exergaming Laboratory of the Department of Physiology at the Faculty of Medicine Airlangga University (41).

As a result, the jump skill component of the basic movement increased, but the other components did not. Additionally, there was a considerable decrease in body weight, BMI, and body fat percentage., but energy expenditure was not. The conclusion of this study was that four weeks of regular vigorous exercise improved children's basic skills, which means it helps lower your BMI (41).

4.2. Turkey

The effects of video-based exergaming on arm and cognitive function in individuals with multiple sclerosis were examined in a randomized controlled experiment conducted in Turkey. As is well known, multiple sclerosis is a chronic, progressive, and demyelinating disease of the central nervous system that can cause acute or subacute motor dysfunction, sphincter issues, arm dysfunction, balance and gait disturbance, partial or total blindness, double vision, sensory loss in the extremities, and cognitive impairment. Furthermore, we are aware that playing video games might enhance both cognitive and physical abilities (42).

Out of the 203 individuals that were tested for multiple sclerosis, 60 took part in this study. Using a game console (Microsoft Xbox One with Kinect motion sensor), the exercise is video-based. A 50-inch LG 50UH635V 4K Ultra HD LED TV served as the screen. The Kinect Sports Rivals game from Microsoft Studios was chosen because, out of all the games that were examined and sold commercially, it covered the most sports that were appropriate for the therapy objectives. Bowling, Jet Ski racing, rock climbing, football, tennis, and target shooting were all covered in the Kinect Sports Rivals game by Microsoft Studios. Arm and leg function, balance, and core stabilization were all required for all gameplay. Exercises for arms, core stability, and balance are part of the exergaming program. In the five to ten minutes following the session, patients cooled down after warming up. The rehabilitation treatment ran for eight weeks, with 45-minute sessions once a week (42).

The effectiveness of video-based exergaming in improving arm and cognitive abilities in people with mildly disabled multiple sclerosis is demonstrated by this study. Furthermore, it offers additional proof of its impact on psychological status as well as leg function and balance-related performance (42).

4.3. China

A pediatric- exergaming program and a conventional directed by teachers physical activity (PA) program were the ubjects of a pilot randomized experiment

conducted in China to assess the impact on preschoolers' executive functions and perceived competence. At a daycare facility in a Southern Chinese city, 60 preschoolers between the ages of four and five took part in the study (43).

The exergaming intervention session was offered daily for eight weeks or five days a week during the 20-minute recess period in this research. In a vacant room, four exergaming stations were set up. Each station included a 32-inch TV, one Wii gaming system and associated gear (such as controllers), and several games (such as Nickelodeon Fit, Just Dance for Kids, and Wii Sports). To be specific, Nickelodeon Fit has 30 For eight weeks, the program applied twenty minutes per session, five days a week. Targeting the development of motor skills, balance, coordination, cardiovascular fitness, upper and lower body strength, and core muscular strength, PAs are included into interactive games. Among the workouts were jumping rope with The Backyardigans, jumping over hurdles with Kai-lan, pogo sticking with Dora, and river rafting with Diego. For the conventional PA program, which includes soccer, tag games, and mobility exercises. The Dimensional Change Card Sort (DCCS) Test, which is valid in the United States, was used to evaluate the participants' executive function (43).

According to the study's final findings, children in the exergaming group had noticeably higher gains in perceived social support and executive function over time than did children in the standard PA group (43).

3. CONCLUSION

Playing video games has become one of the most popular recreational facilities. One of the exercises in rehabiltation that combines physical activity with playing video games is exergaming. Exergaming is defined by the American College of Sports Medicine as a video game that requires players to be physically active to play. This physical activity is not only limited to finger or hand movements but also moves all parts of the body to interact in the game. The benefits of exergaming have been widely studied and are known to have many positive effects on health, such as improving cognitive function, increasing physical activity, exercising balance, and improving vascular function. The sedentary lifestyle that is usually the result of playing too many video games has also decreased in frequency in exergaming players. In medical science, exergaming has become an alternative therapy in Huntington's disease, Parkinson's disease, and as a means of gait rehabilitation in geriatric patients. Exergaming also has the potential to reduce the risk of obesity in children.

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Conflict of Interest Statement:

The author declares that the study was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.