SECTION 22.
PHYSICAL CULTURE, SPORTS AND PHYSICAL THERAPY

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INNOVATIONS IN SPORTS AND PHYSICAL REHABILITATION

The field of sports rehabilitation has been transformed by innovative technologies, providing athletes with a faster, safer, and more effective path to recovery. Advancements such as virtual reality, wearable technology, robotics, and artificial intelligence have not only improved the rehabilitation process but have also opened up new possibilities for athletes to achieve their peak performance levels after being injured. These devices offer accurate and controlled movements, enabling athletes to partake in early-stage rehabilitation exercises, even with restricted mobility.

A lot of studies are already showing promising results through using new technologies and treatment methods. The detailed facts about innovative methods in Sports and Physical Rehabilitation were represented in the article of Jack Pottle, co-founder and chief medical officer, called "Virtual reality and the transformation of medical education" and in the article written by Jashvini Amirthalingam, Gokul Paidi, Khadija Alshowaikh "Virtual reality intervention to help improve motor function in patients undergoing rehabilitation for cerebral palsy, Parkinson's disease, or stroke: a systematic review of randomized controlled trials" [2; 5]. Victoria Reboredo, clinical specialist physiotherapist and teaching fellow, discusses the emerging use and potential role for Virtual Reality (VR) in Sports Rehabilitation [7]. Jeffrey Laut, Maurizio Porfiri, and Preeti Raghavan outline in their article «The Present and Future of Robotic Technology in Rehabilitation» the effort devoted to the development and integration of robotic technology for rehabilitation [5].

The scientific novelty lies in the understanding of innovative sports rehabilitation options and treatment methods. With the continuous evolution of technology, we can anticipate even more groundbreaking advancements in sports rehabilitation. These advancements will improve the chances of athletes recovering from injuries and coming back to the field stronger than ever.

The subject of the report is to highlight new technologies and treatment methods used in sports and physical rehabilitation, to evaluate their effectiveness and safety and to consider the ethical aspects of using innovative rehabilitation methods.

The aim of the report is to provide an overview of current innovations in sports and physical rehabilitation. It also analyzes their impact on the recovery process after injuries or illnesses and identifies the future prospects of these innovations.

Main material. Sports rehabilitation, also referred to as sports rehab, is a specialized branch of rehabilitation medicine that focuses on assessing, treating, and managing injuries and medical

conditions related to sports and physical activity. This field involves a team of healthcare professionals, including physical therapists, athletic trainers, sports medicine physicians, orthopedic surgeons, and sometimes psychologists or nutritionists, who collaborate to assist individuals engaged in sports and athletic pursuits in their recovery and restoration of optimal functionality [3].

There are several innovative technologies and treatment methods in the field of sports medicine used to improve rehabilitation outcomes. These are the following:

1. *Virtual reality.*
2. *Augmented reality.*
3. *3D printing.*
4. *AI and robotics.*

Virtual Reality, or VR, is revolutionizing the world of sports and physical rehabilitation. For athletes, VR offers a safe and controlled training ground. They can practice complex skills in virtual environments that closely resemble real-world competition. This not only reduces the risk of injuries but also allows for focused training on specific weaknesses. VR isn't just about training. It's also a powerful tool for rehabilitation. During recovery from injuries or surgeries, VR games and virtual environments can provide pain relief and distraction. This makes the rehabilitation process more enjoyable and helps patients stay motivated. Additionally, VR systems can track patients' movements and provide feedback on their progress. Beyond sports, VR is showing promise in physical rehabilitation for those with chronic conditions. And last but not least, it's emerging as a powerful educational tool in the fields of sports and physical rehabilitation. VR creates interactive game situations, letting athletes learn strategies and practice in realistic settings. It also allows their trainers to analyze movements in VR, providing real-time feedback for perfect technique. Thanks to it, novice rehabilitators will be able to learn their work more effectively and without harming others [2].

Augmented Reality Revolutionizes Physical Therapy. Physical therapy is undergoing a transformation thanks to Augmented Reality (AR**).** AR creates a unique blend of the real and virtual worlds, offering innovative ways to improve rehabilitation outcomes.

Examples of AR in Action are the following:

- *Virtual Assistants:* Imagine a virtual therapist guiding patients through exercises superimposed on their real environment.
- *Mirror Training:* AR mirrors can be used for practicing movements and visualizing proper form.
- *Engaging Games:* Gamified therapy sessions can make rehabilitation more enjoyable and motivate patients to push their limits [7].

AR creates safe and controlled spaces where patients can interact with virtual objects, making therapy more engaging and potentially leading to faster recovery, especially for stroke patients. AR systems can track patient movement and performance, allowing therapists to monitor progress and adjust rehabilitation plans as needed.

3D printing is a promising technology with the potential to transform the field of physical therapy and rehabilitation. By offering the ability to create customized, patient-specific devices and implants, 3D printing can improve treatment outcomes, reduce costs, and increase accessibility to care Key Advantages of 3D Printing in Rehabilitation are customization, cost-effectiveness and accessibility [4; 6].

3D printing is already being used in a variety of ways to improve rehabilitation outcomes. Some of the most common applications include [1]:

- *Prosthetics:* 3D printing can be used to create customized prosthetics for patients with amputations.
- *Implants:* 3D printing can be used to create customized implants for patients who have suffered bone or joint damage.

- *Orthotics:* 3D printing can be used to create customized orthotics for patients with conditions such as scoliosis, flat feet, and bunions.
- *Assistive devices:* 3D printing can be used to create assistive devices for patients with a variety of disabilities.

The role of *robotics and artificial intelligence (AI)* in rehabilitation has grown significantly in recent years. These technologies offer new and innovative approaches to improving outcomes for patients with a variety of illnesses and injuries.

Robotic rehabilitation can benefit people with a variety of mobility impairments, including: spinal cord injury, stroke, multiple sclerosis, cerebral palsy, traumatic brain injury, arthritis, orthopedic injuries. These robotic devices use AI to guide and monitor patients' movements and provide accurate diagnoses, helping therapists tailor treatment plans to each patient's unique needs, resulting in better health outcomes and faster recovery times [5].

Conclusions. It is reasonable to conclude that sports rehabilitation is a particular area of focus, exploring how new technologies and treatment methods can help to get athletes back to peak fitness following injury, helping to optimise clinical outcomes and to improve patients' quality of life. There are the following benefits of using the innovative technologies: faster and more effective treatment; enhanced patient experience; increased accessibility; personalized care; reduced healthcare costs etc. Despite all the challenges, the potential of innovation in sports and physical rehabilitation is undeniable. By promoting collaboration, research, and responsible development, we can ensure that these technologies fulfill their promise of improved recovery, enhanced quality of life, and a more equitable healthcare system for all.

It is important to note that innovative rehabilitation methods are still under development and research. Their effectiveness and safety require further study.

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