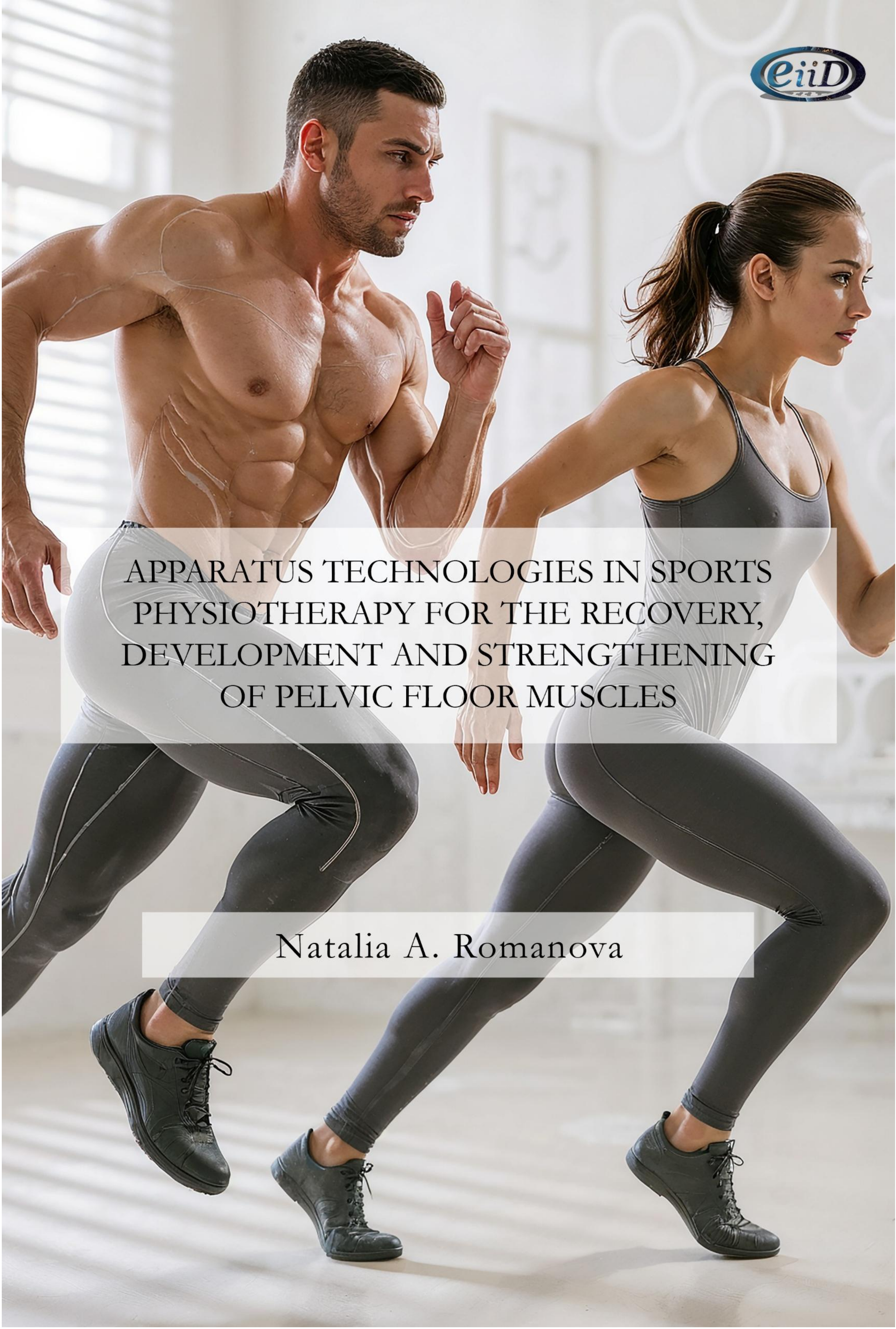

APPARATUS TECHNOLOGIES IN SPORTS PHYSIOTHERAPY FOR THE RECOVERY, DEVELOPMENT AND STRENGTHENING OF PELVIC FLOOR MUSCLES

Natalia A. Romanova

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Reviewers:
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Content

Abbreviations

AMS	is	Athlete Monitoring Systems
BFB	is	biofeedback
EMG	is	electromyography, electromyographic
EMGM	is	electromyographic monitoring
EMS	is	electromyostimulation
ENS	is	electrical nerve stimulation, electroneurostimulation
ESWT	is	extracorporeal shockwave therapy
FMS	is	focused magnetic stimulation
HIFEM	is	high-intensity focused electromagnetic stimulation
LLLT	is	low-level laser therapy
MRT	is	magnetic resonance therapy
PFM	is	pelvic floor muscle(-s)
PFMR	is	pelvic floor muscle rehabilitation
RAM	is	remote athlete monitoring
RFA	is	radiofrequency ablation
SSC	is	slope sign change
SWT	is	shockwave therapy
UST	is	ultrasound therapy
VR	is	virtual reality

Introduction

Modern sport imposes high demands on the physical condition of athletes, making recovery, injury prevention, and the maintenance of optimal muscular functionality key components of the training process. One of the most important, yet frequently underestimated, factors in sports physiology is the condition of the PFM. These muscles not only provide reinforcement and stabilisation, but also contribute to force transmission, movement coordination, and injury prevention.

This issue becomes particularly relevant in sports involving high-intensity loads, abrupt changes of body position, weightlifting, and complex coordination activities (e.g., gymnastics, weightlifting, running, martial arts). Weakness of the PFM may result in a number of adverse outcomes, including reduced athletic performance, pain syndromes, musculoskeletal imbalance, and even diminished quality of life in athletes. Consequently, the development and implementation of effective methods for the rehabilitation, training, and strengthening of the PFM represent a pressing task in sports physiotherapy.

In contemporary society, the overwhelming majority of individuals are engaged in sedentary office work. This factor contributes to a high degree of musculoskeletal inactivity and systemic hypokinesia. Such a lifestyle frequently leads to various disorders, including pelvic floor dysfunctions. Additional causes of pelvic muscle and ligament disorders may include dyssynergic defaecation, surgical interventions, degenerative diseases, pregnancy and childbirth in women, the use of muscle relaxants, and narcotic substances. The symptomatology of such dysfunctions is heterogeneous and occurs in both women and men. Examples of clinical manifestations include urinary and faecal incontinence as well as sexual dysfunction. Therefore, the development of physiotherapeutic approaches and structured fitness training programmes is of significant importance at present. This article considers a method of PFM training using BFB based on EMG. The authors provide a brief description of how EMG will be applied in the training of PFM.

From a phylogenetic perspective, the pelvic floor represents a relatively ancient group of skeletal muscles which, in the course of human transition to an upright posture, acquired several new important roles or adaptations of pre-existing functions. The functional roles of the pelvic floor include supporting abdominal contents in the vertical position, participating in voluntary and reflex urethral closure, narrowing the transverse diameter of the vagina and urogenital hiatus, contributing to sexual function, and ensuring terminal bowel continence. Pelvic floor dysfunction and pelvic organ prolapse constitute significant clinical problems today—even the early manifestations of pelvic floor dysfunction may lead to impaired sexual life, reduced activity, and subsequently to social isolation and decreased self-esteem.

PFM training is recognised as one of the most widely used and promising conservative interventions for pelvic floor dysfunction. Its objectives are to improve the strength, endurance, and coordination of the PFM, as well as to enhance the support of the proximal urethra and bladder neck. Consequently, pelvic floor training can be beneficial for the prevention of urogenital, reproductive, and sexual disorders. Objective assessment of pelvic muscle activity is crucial for evaluating the condition and for determining appropriate rehabilitation and treatment strategies.

In recent years, increasing attention has been devoted to technological methods that enable precise targeting of the PFM, individualise the rehabilitation process, and enhance the effectiveness of training. Numerous researchers have suggested that EMG recording should be introduced as a complement to clinical examination and observation. The use of surface EMG BFB has been shown to facilitate the identification of symptoms associated with pelvic floor dysfunction. Thus, EMG signals may be used to classify the condition of the PFM and, when applied as feedback, to structure targeted training protocols for their development.

It is worth noting that the EMG signal is inherently complex in nature; however, it directly correlates with muscular activity. This characteristic enables the application of surface EMG for both diagnostic purposes and training of various muscle groups. The present work considers a range of methods for PFM training and investigates their impact on the development and stabilisation of pelvic muscle function. Muscle activity will be evaluated using EMG signal parameters as the principal measurement index.

The use of such methods as EMS, BFB, magnetotherapy, and low-frequency vibration opens new opportunities for athletes and sports medicine specialists, as well as in addressing other conditions affecting the PFM. However, the question of the efficacy of these technologies, their comparative effectiveness relative to traditional methods, and the optimal strategies for their application remains unresolved.

Thus, the need for a comprehensive analysis of existing apparatus-based technologies, an assessment of their effectiveness, and the development of recommendations for their implementation in sports physiotherapy determines the relevance of the present study.

Despite significant progress in apparatus-based physiotherapeutic technologies, their application in sports practice, particularly in relation to the PFM, remains insufficiently explored. The majority of existing research focuses on the rehabilitation of patients with urogenital dysfunctions, postpartum complications, and age-related changes, whereas sports physiotherapy presents distinct demands for the recovery and development of PFM.

The key issues requiring scientific analysis include:

1. The lack of systematised data on the impact of various apparatus-based methods on the functional state of the PFM in athletes.

2. The absence of clearly defined protocols for the application of apparatus-based technologies among athletes engaged in different sports and at varying levels of training.
3. The comparative effectiveness of traditional and apparatus-based methods in the recovery, development, strengthening, and endurance of the PFM.
4. The absence of recommendations on integrating apparatus-based technologies into the training process with consideration of the individual characteristics of athletes.

These challenges necessitate a comprehensive approach, encompassing an analysis of existing scientific data, the consolidation of practical experience, and the development of methodological guidelines.

The scientific novelty of this study lies in the integrated analysis of apparatus-based technologies employed in sports physiotherapy for the recovery, training, and strengthening of the PFM. Unlike existing works, which are predominantly focused on medical rehabilitation of patients with pelvic floor dysfunctions, the present study is aimed at evaluating their effectiveness in the context of sport.

The principal aspects of scientific novelty include:

1. The systematisation of contemporary apparatus-based technologies used in the training of PFM in sports practice.
2. The analysis of the physiological effects of apparatus-based methods on athletes with varying levels of physical conditioning.
3. The comparative evaluation of the effectiveness of apparatus-based and traditional methods of training and rehabilitation of the PFM.
4. The development of practical recommendations for coaches and sports physiotherapy specialists based on the analysis of scientific evidence.

The object of the study comprised apparatus-based technologies utilised in sports physiotherapy for the recovery, training, and strengthening of the PFM.

The subject of the study concerned the effectiveness of different apparatus-based techniques, their influence on the functional state of the PFM in athletes, and their comparative evaluation with traditional physiotherapeutic approaches.

The choice of the object and subject of investigation was determined by the necessity of examining modern technologies applied in physiotherapeutic practice and their impact on athletes' functional preparedness. Although many apparatus-based methods are widely employed in general medical physiotherapy, their adaptation and integration into sports practice require further examination.

The aim of the study was to conduct a comprehensive analysis of existing apparatus-based technologies applied in sports physiotherapy for the recovery, development, and strengthening of the PFM, as well as to formulate evidence-based recommendations for their use.

In order to achieve the stated objective, a number of tasks had to be addressed:

1. To conduct an analysis of contemporary trends in sports physiotherapy related to the application of apparatus-based methods.
2. To investigate the physiological role of the PFM in sporting activity and to determine their influence on athletes' overall functionality.
3. To classify existing apparatus-based technologies employed for the training and rehabilitation of the PFM, and to examine their operational principles and mechanisms of action.
4. To carry out a comparative analysis of the effectiveness of device-assisted and traditional methods of PFM training and recovery.
5. To perform both qualitative and quantitative analyses of scientific studies devoted to the use of apparatus-based technologies in this domain.
6. To develop practical recommendations for the use of apparatus-based methods in sports physiotherapy, taking into account the specific demands of different sporting disciplines.

The accomplishment of these tasks made it possible not only to fill existing gaps in scientific knowledge, but also to contribute to the advancement of methods for athlete preparation, the reduction of injury risk, and the improvement of sporting performance.

This study has an analytical character and is grounded in an integrated approach that encompassed the following methods:

1. Analysis of scientific literature—examination of contemporary research dedicated to physiotherapy, sports medicine, and apparatus-based technologies.
2. Comparative method—evaluation of different technologies, their effectiveness, and their advantages compared with traditional approaches to PFM training and recovery.
3. Systematisation and generalisation—identification of key trends, classification of methods, and the development of recommendations for their implementation.
4. Qualitative and quantitative data analysis—consideration of statistical indicators and the effectiveness of methods based on existing research evidence.

The use of these methods enabled a detailed analysis of the research subject and the formulation of scientifically substantiated conclusions.

The practical significance of the study lies in the potential application of its findings within sports medicine, physiotherapy, and athlete preparation. The conclusions and recommendations may be utilised in:

- the design of individualised programmes for PFM training and recovery for athletes in different disciplines;
- the optimisation of rehabilitation interventions following intensive physical exertion and injury;
- enhancing the awareness of coaches and sports medicine specialists regarding the potential of device-assisted methods.

The obtained results are expected to improve the effectiveness of physiotherapeutic approaches, contribute to injury prevention, and enhance athletic performance.

Thus, the investigation of apparatus-based technologies in sports physiotherapy for the recovery, training, and strengthening of the PFM is both relevant and significant from theoretical and practical perspectives. Modern sport imposes increasingly stringent demands on physical preparedness, which highlights the importance of identifying effective methods of recovery and the prevention of dysfunctions associated with overload and injury.

Despite notable progress in physiotherapy, the application of apparatus-based technologies in athletes' training processes remains insufficiently explored. The scientific novelty of this work lies in the systematisation of existing methods, the analysis of their effectiveness, and the development of practical recommendations for sports professionals.

The purpose and objectives of the study were directed towards a comprehensive investigation of PFM physiology, an evaluation of different training and recovery approaches, and a comparison of device-assisted and traditional methods. The use of systemic analysis, comparative methodology, and both qualitative and quantitative approaches made it possible to obtain objective data regarding the feasibility of implementing apparatus-based technologies into sports practice.

The practical value of the study is determined by the fact that its findings may be applied to the improvement of rehabilitation programmes, the enhancement of training efficiency, and the prevention of injuries in athletes.

Chapter One

Theoretical Basis of Apparatus-Based Technologies in Sports Physiotherapy

Part 1.1
Modern Trends in Sports Physiotherapy

Introduction to Contemporary Sports Physiotherapy

Sports physiotherapy constitutes a multidisciplinary domain encompassing evidence-based interventions aimed at rehabilitation, injury prevention, and optimisation of athletic performance. In recent decades, rapid advancements in biomedical and rehabilitation technologies have facilitated the integration of innovative apparatus-based modalities into clinical practice. These contemporary approaches complement traditional manual and exercise-based techniques, enhancing the efficacy of training regimens while concurrently mitigating the risk of musculoskeletal injuries.

Modern sports physiotherapy encompasses a diverse spectrum of interventions targeting the acceleration of tissue regeneration, restoration of muscular functional capacity, attenuation of pain syndromes, and optimisation of biomechanical movement patterns. Principal areas of focus include:

1. Apparatus-based modalities in rehabilitation and therapeutic interventions—including EMS, magnetotherapy, $ESWT$, $LLLT$, cryotherapy, and BFB systems.
2. Integration of physiotherapeutic interventions within the training continuum—utilising physiotherapy techniques to enhance performance capacity, prevent overuse injuries, and facilitate expedited recovery.
3. Individualisation of rehabilitation programmes—development of personalised, evidence-based protocols tailored to the athlete's anatomical, physiological, and sport-specific requirements.

This review critically examines contemporary trends in sports physiotherapy, evaluating their efficacy in optimising recovery and athletic preparation, and explores future perspectives for apparatus-based interventions in high-performance sports medicine.

A notable advancement in recent years is the widespread implementation of device-assisted technologies, significantly expanding the therapeutic and training options for pelvic floor musculature. EMS has emerged as a particularly effective modality for selective activation of deep muscle layers inaccessible to conventional manual therapy. EMS not only promotes neuromuscular recruitment and hypertrophy of the PFM but also enhances local haemodynamics, thereby accelerating tissue regeneration and reducing the incidence of recurrent injury.

UST constitutes another critical modality, particularly in the management of chronic pain and inflammatory conditions. Therapeutic ultrasound waves penetrate deep soft tissues, inducing controlled thermal effects and improving microcirculatory dynamics, which collectively contribute to rapid attenuation of inflammatory processes and oedema.

Furthermore, cryotherapy represents a pivotal intervention for modulating nociceptive input and inflammatory responses through controlled exposure to low temperatures. Application of cold compresses or specialised cryotherapy devices induces vasoconstriction, thereby reducing oedema and pain perception. In addition, cryotherapy exerts immunomodulatory effects, stimulating endogenous protective mechanisms and enhancing tissue repair.

In conclusion, contemporary sports physiotherapy offers a comprehensive repertoire of evidence-based, technology-assisted interventions that effectively address the rehabilitation and strengthening of pelvic floor musculature. Ongoing technological advancements continue to expand the therapeutic potential of these modalities, underscoring their critical role in modern sports medicine and athlete care.

Trends in the Development of Sports Physiotherapy

In recent years, sports physiotherapy has evolved towards the integration of innovative technologies that accelerate recovery, enhance training efficacy, and minimise the risk of injury. Key trends include:

1. Utilisation of Apparatus-based Methods for Accelerated Recovery
   - Contemporary physiotherapeutic technologies, such as EMS, magnetotherapy, and $ESWT$, are actively employed to alleviate muscular tension, expedite tissue regeneration, and improve athletic performance.
   - Urinotherapy and thermotherapy are also applied to reduce inflammation, resolve oedema, and alleviate pain syndromes.
2. Individualisation of Physiotherapy Programmes
   - Implementation of BFB enables real-time monitoring of athletes' physiological status and facilitates load adjustment.
   - Advances in 3D motion analysis technology help identify biomechanical errors and develop personalised rehabilitation strategies.
3. Comprehensive Approach to Recovery
   - Physiotherapy is increasingly becoming an integral component of sports training, integrating with sports medicine, nutrition, and psychophysiology.
   - Recent studies emphasise the importance of collaboration between physiotherapists, coaches, and physicians to achieve optimal outcomes.

Thus, contemporary sports physiotherapy is oriented towards personalised interventions, the utilisation of advanced technologies, and active integration into the training process.

The Role of Apparatus-Based Technologies in Sports Physiotherapy

Modern apparatus-based methods in sports physiotherapy are aimed at accelerating tissue regeneration, restoring the functional state of muscles and joints, and preventing injury. These techniques are employed both during post-injury rehabilitation and throughout athlete preparation, enhancing adaptive capacity.

The primary apparatus-based technologies actively applied in sports physiotherapy include:

1. *EMS*
    - Utilised to improve neuromuscular connectivity, enhance muscular strength and endurance, and facilitate post-exertional recovery.
    - Particularly valuable in rehabilitation following injury, where conventional therapeutic methods may be limited.
2. Magnetotherapy
    - Applied to stimulate microcirculation, accelerate tissue healing, and reduce inflammatory processes.
    - Used in post-traumatic rehabilitation and for alleviating chronic muscular fatigue.
3. *ESWT*
    - Effective in treating ligament and tendon injuries, as well as chronic inflammatory conditions.
    - Stimulates angiogenesis (formation of new capillaries), thereby expediting tissue recovery.
4. Laser Therapy
    - Employed to accelerate tissue regeneration, alleviate pain, and reduce oedema.
    - Serves as an adjunctive method within a comprehensive physiotherapy programme.
5. Cryotherapy and Thermotherapy
    - Cryotherapy (exposure to low temperatures) facilitates rapid post-exercise muscular recovery.
    - Thermotherapy is used to relax muscles and improve blood circulation.

These methods enhance recovery efficiency, minimise the consequences of overloading, and reduce the risk of injury, rendering them indispensable in the practice of sports physiotherapists.

Integration of Physiotherapy into Sports Training

Modern athletic training requires a comprehensive approach that incorporates not only physical exertion but also adequate post-exercise recovery. In this regard, sports physiotherapy is becoming an essential component of the training process, ensuring rapid recovery and reducing the risk of injuries.

1. Physiotherapeutic Intervention at All Stages of Preparation
   - Physiotherapy is applied across all phases of the training cycle, from baseline conditioning to intensive training sessions and competitions.
   - It is crucial to consider the specifics of the sport, the athlete's level of physical fitness, as well as individual physiological characteristics when designing rehabilitation and preventive programmes.
   - To prevent injuries, physiotherapists employ soft corrective methods such as myofascial release and stretching, alongside specialised instrumental modalities (e.g., EMS, SWT).
2. Prevention of Overload and Chronic Conditions
   - Sports physiotherapy is not confined to post-traumatic recovery but is actively utilised in the prevention of chronic disorders arising from excessive loading (e.g., overuse syndrome, chronic fatigue).
   - Modalities such as UST and magnetotherapy contribute to accelerating recovery processes and reducing tissue inflammation, thereby preventing the progression of chronic conditions.
3. BFB Technology
   - BFB is increasingly employed in sports physiotherapy for monitoring and optimising the athlete's physiological state. With the aid of specialised devices, it is possible to track indicators such as heart rate, muscle tension, and temperature, enabling timely adaptation of training loads and physiotherapeutic interventions.
   - BFB allows coaches and physiotherapists to fine-tune recovery protocols with greater precision, minimising the risks of overtraining and injuries.

Thus, the integration of physiotherapeutic methods into athletic training emerges as a cornerstone of contemporary sports medicine, enhancing training efficiency and prolonging athletes' careers.

The Role of the Physiotherapist in a Sports Team

In contemporary sport, the physiotherapist plays a pivotal role in maintaining athletes' physical readiness and supporting their recovery after intensive training and competition. A physiotherapist must not only be an expert in rehabilitation but also an active member of the team, working in close collaboration with coaches and medical professionals.

1. Early detection and prevention of injuries
   - A key responsibility of the modern physiotherapist is to prevent the occurrence of injuries rather than merely treat them. This involves the application of various assessment techniques, including functional testing and biomechanical movement analysis.
   - Early detection of issues such as muscular imbalances or postural deviations enables timely adjustment of the training process, thereby preventing injuries.
2. Collaboration with coaches and physicians
   - Modern sports medicine requires close interdisciplinary cooperation. Physiotherapists work alongside coaches to optimise training regimes in terms of recovery and injury prevention.
   - Collaboration with physicians is equally important, particularly in determining medical indications for resuming or continuing physical activity following injury.
3. Utilisation of advanced technologies
   - Cutting-edge technologies such as 3D scanning and computer-assisted motion diagnostics enhance the effectiveness of physiotherapists' work by accurately identifying potential risk factors and guiding corrective strategies.
   - Biomechanical movement analysis not only reveals underlying dysfunctions but also contributes to preventive care by refining exercise technique.

By being an integral part of the sports team, the physiotherapist contributes substantially to athletes' overall condition, expediting recovery and improving physical performance. This makes the physiotherapist indispensable, ensuring both rehabilitation and preventive measures, which form the foundation of a successful sporting career.

Contemporary Recovery Methods in Sports Physiotherapy

Modern recovery methods are of paramount importance in strengthening athletic performance and reducing injury risk. Unlike traditional approaches, advanced technologies and devices significantly accelerate recovery, alleviating fatigue, inflammation, and pain.

These include:

1. Electrical Stimulation and Myostimulation
   - EMS is applied to restore muscular tissues and strengthen weakened muscles. It is widely utilised for post-exercise recovery, enhancement of blood

circulation, fatigue reduction, and prevention of atrophy. EMS is employed both in post-injury rehabilitation and in prophylactic strategies.

- Myostimulation targets deeper muscular layers, promoting overall endurance and muscular strengthening. It is particularly valuable in training and rehabilitating PFM, especially among female athletes.

2. SWT
   - SWT is highly effective for tissue regeneration and the stimulation of healing, particularly in tendon and ligament injuries. Shockwaves enhance local blood circulation, promote cellular recovery, and alleviate pain.
   - This method is applied in cases of chronic inflammation, muscular pain, metabolic disturbances, and circulatory impairments in traumatised tissues.
3. Magnetotherapy
   - Magnetotherapy is extensively used to improve blood flow and stimulate metabolic processes. It alleviates pain and accelerates tissue regeneration.
   - Magnetic fields activate processes that enhance circulation, cellular metabolism, and protein synthesis, thereby improving recovery of damaged muscles and tissues following injury.
4. Cryotherapy
   - Cryotherapy (application of low temperatures) is among the most effective recovery methods after intensive exertion. Cold exposure reduces inflammation, decreases oedema and pain, accelerates tissue healing, and prevents inflammatory complications.
   - It is frequently combined with other recovery modalities such as massage and stretching.
5. Laser Therapy
   - Laser therapy is actively employed in sports physiotherapy to accelerate tissue repair, alleviate inflammation, and improve metabolic efficiency. Laser irradiation stimulates cellular proliferation, enhancing the recovery of muscular and connective tissues.
   - It is particularly effective in cases of inflammation, circulatory disturbances, and soft tissue injuries.

When combined with structured physical conditioning and individualised approaches, these recovery methods facilitate rapid adaptation of the athlete's body to physical demands while minimising the likelihood of injury.

Integration of Physiotherapy into Sports Training

Modern sports physiotherapy is continuously evolving, with recent years witnessing the active introduction of innovative technologies aimed at enhancing recovery and strengthening athletes' physical performance. The advancement of these technologies enables more precise, effective, and safe management of injuries and overuse syndromes, while also contributing to overall physical conditioning.

1. Application of VR and 3D Motion Analysis
   - In recent years, VR and 3D motion analysis technologies have been increasingly utilised for correcting exercise techniques and assessing body biomechanics.
   - VR allows athletes to train motor coordination, improve reaction times, and adapt to stressful conditions by simulating real competition environments.
   - 3D motion analysis is employed to accurately identify technical deficiencies and correct biomechanical errors, thereby reducing injury risk and improving sporting performance.
2. Intelligent Training Devices and $AMSs$
   - The sports physiotherapy market is witnessing the emergence of smart training devices that not only assist in the training process but also monitor biometric parameters in real time, such as heart rate, muscle tension, and blood oxygen saturation.
   - These devices allow for the optimisation of training regimes, prevention of overtraining, and timely adjustment of workloads, thereby significantly enhancing training efficiency.
3. Application of Neurophysiological Technologies
   - Neurophysiological technologies, such as neurostimulation and neuroplasticity-based methods, are gaining prominence in sports physiotherapy. These techniques aim to restore neuronal connectivity and improve motor functions, proving particularly valuable for athletes recovering from neurological injuries or prolonged inactivity.
   - Neurophysiological diagnostics are also employed to assess nervous system function and optimise training regimens accordingly.
4. Biomechanical Analysis with Sensors and Motion Trackers
   - The development of biomechanical analysis using sensors enables real-time tracking and correction of movement. These devices record and analyse parameters such as force, speed, range of motion, and joint angles, facilitating the rapid identification of errors and prevention of injuries.
   - This approach is widely applied in sports such as running, swimming, football, and tennis, where movement precision is critical for success.

5. Regenerative Medicine and Cellular Technologies
    - Advances in regenerative medicine, including cellular technologies and stem cell research, open new horizons for tissue repair and injury healing. These technologies are increasingly applied in sports medicine for the treatment of ligament, joint, and soft tissue injuries.
    - Stem cells can stimulate the growth of new tissues, substantially accelerating recovery after injury and laying the foundation for novel therapeutic methods in sports physiotherapy.

6. Wearable Devices for Athlete Monitoring

Wearable devices, including smartwatches and fitness bands, play a crucial role in real-time athlete monitoring. They can track parameters such as heart rate, oxygen saturation, body temperature, sleep quality, and fatigue levels.

- Integration with mobile applications: Wearables synchronise with mobile apps that analyse collected data and provide personalised recommendations for training and recovery.
- Feedback for coaches and physiotherapists: Data from wearables support evidence-based decision-making on training intensity adjustments and the implementation of physiotherapeutic interventions.

7. Robotic Technologies for Rehabilitation

Robotic rehabilitation systems have rapidly developed in recent years and are increasingly applied in post-injury recovery. They facilitate the automated execution of movements, effectively restoring lost functions when active exercise is not feasible.

- Robotic devices can be utilised for limb or spinal training after injury or surgery, ensuring high precision and intensity of rehabilitation.
- When combined with VR, robotic systems not only restore physical capacity but also help patients adapt psychologically to new functional conditions.

8. Application of Biometric Sensors for $PFMR$

Increasing attention is being devoted to $PFMR$, both in postpartum women and in male athletes during training or rehabilitation. Modern biometric sensors enable precise monitoring of these muscles.

- EMG is used to record the electrical activity of PFM, assisting in assessment and rehabilitation monitoring.
- BFB technologies are increasingly applied to train these muscles, enabling athletes and patients to regain functional control and restore muscle performance.

9. Telemedicine and RAM

Telemedicine technologies are transforming health monitoring and rehabilitation management in sports. Teams and individual athletes are adopting remote monitoring systems, allowing physicians and physiotherapists to access real-time data on health status.

- This is particularly relevant in $PFMR$, where continuous monitoring and programme adjustments are essential.
- Interactive platforms and mobile applications enable athletes to perform exercises under professional supervision, receiving immediate feedback and support. This approach enhances rehabilitation outcomes and minimises errors caused by improper exercise execution.

10. Genetic Analysis and Personalised Physiotherapeutic Approaches

Genetics plays a pivotal role in determining susceptibility to injuries and conditions, as well as in shaping physiological responses to training. Genetic testing is becoming integral to sports medicine, facilitating the design of individualised training and rehabilitation programmes.

- A personalised physiotherapeutic strategy, based on genetic profiling, enables the selection of optimal recovery methods and training loads.
- Genetic analysis can identify predispositions to injuries such as ligament tears or pelvic floor dysfunctions, guiding preventive interventions and training modifications.

11. Nutrition and Sports Physiotherapy

Appropriate nutrition is vital for sustaining athlete health and performance. Within physiotherapy, particular emphasis is placed on nutrition in relation to tissue regeneration and PFM recovery.

- Protein-rich diets are essential for muscle repair and strengthening, serving as fundamental building blocks.
- Vitamins and minerals, particularly vitamin D, calcium, and magnesium, play a critical role in bone and joint health, indirectly supporting pelvic floor functionality.
- Specialised supplements and dietary strategies may be prescribed to accelerate recovery and minimise complications.

12. Psychological Aspects of Sports Physiotherapy

Psychological well-being substantially influences recovery and return to active training. Stress, anxiety, and depression can delay rehabilitation and adversely affect performance.

- Physiotherapy programmes should integrate psychological support through relaxation techniques, meditation, and cognitive behavioural therapy, which reduce stress and enhance motivation.
- Psychological factors are particularly significant in pelvic floor rehabilitation, where fear of reinjury or discomfort may hinder functional recovery.

Collaboration with psychologists or psychotherapists is thus an integral element of comprehensive rehabilitation programmes.

Part 1.2

Apparatus-Based Technologies: Classification, Principles of Operation, and Areas of Application

Classification of Apparatus-Based Technologies

Apparatus-based technologies in sports physiotherapy can be classified according to several criteria:

1. By type of action:
   - Mechanical: devices that provide mechanical impact on tissues (e.g., massage devices);
   - Electrical: instruments that utilise electrical impulses for muscle stimulation (EMS);
   - Magnetic: devices based on the application of a magnetic field (magnetotherapy);
   - Light-based: instruments employing light waves (laser therapy, phototherapy);
   - Thermal: devices generating heat or cold to affect tissues (cryotherapy, thermotherapy).
2. By purpose of use:
   - Rehabilitative: technologies aimed at restoring function following injury or disease;
   - Training-related: devices used to enhance and develop muscular strength and endurance;
   - Preventive: modalities applied to prevent injuries and to strengthen general physical condition.
3. By site of application:
   - Local: devices acting on specific body regions (e.g., PFM);
   - General: technologies influencing the whole body or large body segments (e.g., infrared saunas).

Principles of Apparatus-Based Technologies

Each type of hardware-based technology operates on distinct principles that ensure the achievement of therapeutic or training goals. Some of these are considered in more detail below:

1. EMS:

- Principle of action: electrical impulses stimulate nerve endings, thereby eliciting muscle contractions;
- Applications: restoration and strengthening of muscles, improvement of muscle tone, reduction of pain and inflammation.

2. Magnetotherapy:
   - Principle of action: exposure of tissues to a magnetic field, leading to improved circulation and metabolic processes;
   - Applications: treatment of inflammatory conditions, acceleration of tissue regeneration, analgesia.
3. Cryotherapy:
   - Principle of action: cooling of tissues to reduce pain sensitivity and decrease inflammation;
   - Applications: rapid alleviation of pain and oedema, prevention of injuries, accelerated recovery after exertion.
4. Laser therapy:
   - Principle of action: use of laser irradiation to stimulate biological processes in tissues;
   - Applications: acceleration of wound healing, reduction of inflammation, analgesic effects.

Areas of Application of Apparatus-Based Technologies

Apparatus-based technologies are utilised across diverse areas of sports physiotherapy, ranging from post-injury rehabilitation to athlete preparation for competition. The main domains of application encompass three aspects:

1. Rehabilitation after injuries:
   - restoration of muscle and joint function;
   - treatment of inflammatory conditions;
   - strengthening of weakened muscles.
2. Training and competition preparation:
   - enhancement of muscular strength and endurance;
   - improvement of motor coordination;
   - increase in aerobic and anaerobic capacity.
3. Promotion of general physical health:
   - prevention of injuries and disease;
   - improvement of muscle tone;
   - relief of fatigue and stress.

Specific Features of Apparatus-Based Technologies for the Pelvic Floor Muscles

The PFM play a crucial role in maintaining pelvic stability and in controlling urination and defecation. Athletes, particularly women, frequently encounter issues related to pelvic floor weakness, which may result in various dysfunctions. Apparatus-based technologies offer unique solutions for restoring, developing, and strengthening the pelvic floor musculature.

Electromyostimulation of the Pelvic Floor Muscles

EMS is considered one of the most effective modalities for strengthening the PFM. This method is based on the application of electrical impulses that induce muscle contractions, simulating natural activity. EMS may be employed both for rehabilitation after injury and for the prevention of dysfunction.

The principle of EMS involves the placement of electrodes on the skin in the pelvic floor region, through which electrical impulses of varying frequency and intensity are delivered. These impulses stimulate nerve endings, resulting in muscle contractions. Regular EMS application enhances muscle strength and tone, thereby improving continence control and preventing pelvic organ prolapse.

Applications of EMS for the pelvic floor include:
1) rehabilitation following childbirth and surgical interventions;
2) treatment of stress urinary incontinence;
3) prevention of pelvic organ prolapse;
4) improvement of muscle tone in athletes exposed to high physical loads.

Electromyography Signal

Below is a brief description of what EMG is and how it may be utilised for PFM training. Surface EMG signals represent one of the principal sources of neural activity. Various EMG signal-processing algorithms are employed to decode the motor action performed by the user and to generate a control signal for external devices or software applications.

Figure 1 presents examples of the signal in the case of a relaxed muscle and at the moment of muscular activity. Analysis of the graph in *Figure 1* demonstrates that, during muscle activation, there is a substantial increase in both the number of SSC and the amplitude magnitude. At the same time, the number of zero crossings and the mean absolute value change only slightly. Consequently, by applying such features as SSC and amplitude variation, it is possible to obtain a curve directly correlating with muscle activity. *Figure 2* illustrates the state of the muscle following EMG

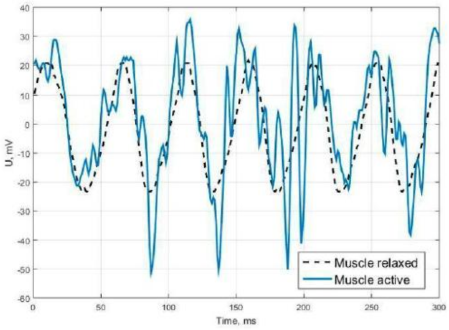

Figure 1. The form of EMG signal

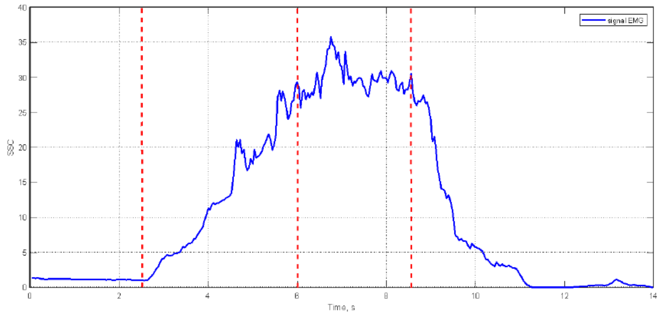

Figure 2. Alterations in EMG characteristics during muscle activity: 0–2.5 s —muscle relaxation; 2.5–6.0 s—gradual contraction; 6.0–8.5 s—sustained muscle activity; 8.5–14.0 s—relaxation

processing.

Evaluation of EMG *Parameters and* PFM *Training*

At the initial examination, it is essential to assess the general condition of the PFM and the mucosa. This requires an invasive endoscopic investigation using a camera, during which the condition of the mucosa at the vaginal vestibule and the balance of the anterior and posterior muscle groups are evaluated. These data provide the basis for developing an appropriate training programme. Furthermore, the results allow assessment of the patient's overall condition and exclusion of potential adverse effects of physical exercise.

The subsequent stage involves the evaluation of the myoelectrical activity of thePFM. It is worth noting that a number of factors may influence the EMG signal. In the present study, it is assumed that the EMG signal is hardware-filtered and adequately protected from external magnetic fields and environmental interference.

From the patient's side, the following behavioural criteria must be achieved:

1. The body should remain relaxed;
2. The abdominal wall is worth retracting to ensure correct function;
3. The legs and gluteal muscles should remain relaxed;
4. The thoracoabdominal diaphragm should function within calm and steady respiration.

At this stage, it is necessary to evaluate muscle activity during myostimulation. To this end, the trainer instructs the patient to engage the anterior and posterior muscle groups, assessing the EMG amplitude during contraction. The patient is then required to perform a mild contraction of the PFM and sustain this activity for approximately seven minutes. During this time, the trainer monitors the patient's overall physical condition and corrects behavioural deviations, such as irregular breathing patterns or undue tension in the legs and gluteal muscles, thereby ensuring proper performance throughout the procedure. The behaviour of the EMG signal during static exercise is illustrated in *Figure 3*.

The aim of these actions is to train the patient to activate the PFM without exerting undue strain on other muscle groups or visceral organs. A satisfactory outcome is defined as the acquisition of a motor skill that enables the patient to engage the pelvic floor musculature while maintaining complete bodily relaxation.

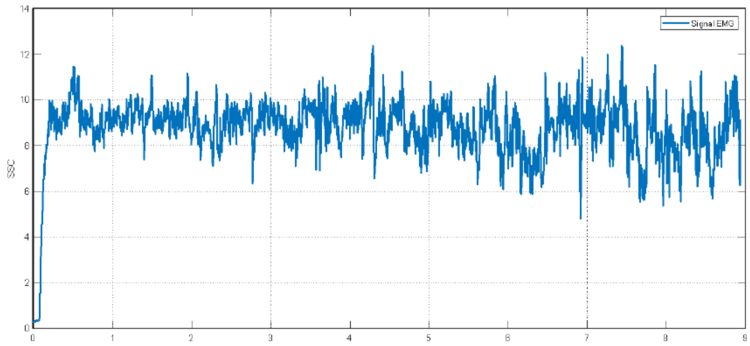

Figure 3. Static exercise

Upon achieving satisfactory outcomes with the patient, a baseline training regimen is established. It comprises two exercises: a static and a dynamic one. The static exercise involves muscle contraction with maintenance of tension for a certain period, followed by relaxation and rest. In this case, the patient is required to perform a mild contraction and sustain it for 10 minutes. Subsequently, a dynamic exercise is introduced. The dynamic exercise entails contraction lasting 7 seconds followed by relaxation for 5–10 seconds (constituting one cycle). It commences with ten repetitions of contraction; thereafter, it is recommended that the number of cycles be increased by two in each subsequent session until the patient achieves 20 cycles within a single exercise. *Figure 4* illustrates the behaviour of the EMG signal during the dynamic exercise.

In Figure 4, it can be observed that a threshold of 15 units was selected, above which the patient is required to maintain the EMG signal during exertion. This threshold is determined individually for each patient and may be adjusted during the course of training. Subsequently, a static exercise is performed once more, during which the patient is instructed to engage predominantly the posterior muscle groups; the duration of contraction is 5 minutes. Ultimately, the training protocol comprises the following sequence:

- static exercise,
- dynamic exercise,

- static exercise.

It is recommended to perform 10 repetitions daily over a 10–day period.

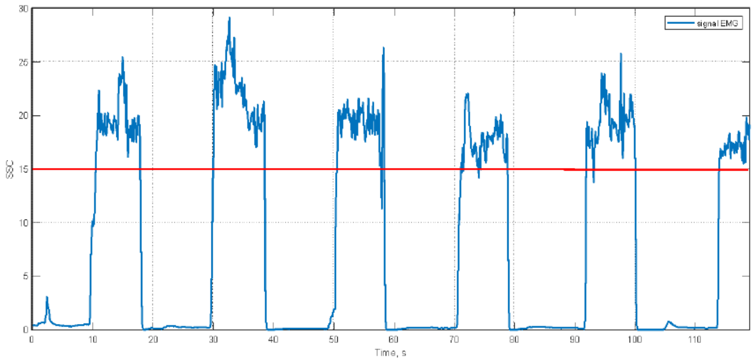

Figure 4. Static exercise

Results

This training method was tested on a female patient of medium build, aged 32 years. After 10 days of training, video-based examination demonstrated the following changes:

1. Structural improvement of the mucosa (resolution of minor fissures and tears);
2. Reinforcement of both anterior and posterior muscle groups;
3. Enhancement of local blood circulation;
4. In the cervical region, varicosities were observed, and following the training a positive therapeutic trend in varicose vein management was noted.

One of the most significant outcomes was the modification of the EMG profile. Within 10 days, the patient acquired the ability to contract the muscles correctly and, consequently, to control them effectively. *Figure 5* clearly demonstrates that the EMG noise amplitude decreased substantially. Moreover, the patient was able to "slide" along a specified workload level. In this case, the patient was required to sustain a signal of 9–10 units.

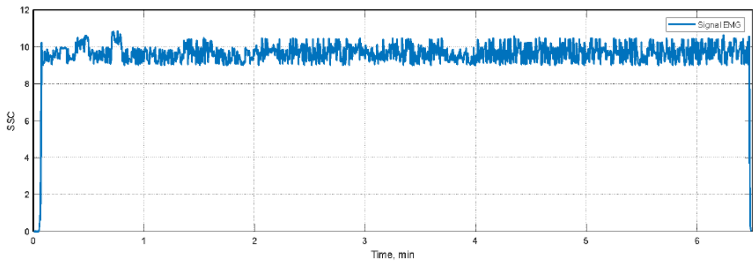

Figure 5. EMG pattern after 10 days of training

By comparing *Figure 3* and *Figure 5*, it can be concluded that the quality of the EMG signal has improved significantly. The amplitude of noise, caused by the vibration of muscle tissue, has markedly decreased, indicating a substantial enhancement in the patient's PFM condition.

Thus, a method for training the PFM using BFB has been examined. The appearance of the EMG signal has been demonstrated, and exercises utilising EMG have been described. A 10–day training plan has been provided, and a method for assessing the patient's condition before and after the training has been outlined. The graph presented in *Figure 5* illustrates the positive impact of the training on the PFM.

Biofeedback in Pelvic Floor Muscle Training

BFB is a technique that enables athletes to monitor their physiological parameters by receiving visual or auditory information regarding their bodily state. This approach is actively employed in sports physiotherapy to enhance the functional condition of various muscle groups, including the PFM.

In the case of PFM, the use of BFB can facilitate the restoration of voluntary control, improve muscle coordination, and strengthen the musculature. This is achieved by providing the athlete with real-time feedback on muscle activity, thereby promoting more precise exercise execution and increasing training effectiveness.

Furthermore, BFB technologies can be utilised to monitor and adjust PFM activity in women engaged in sports, as they are at an elevated risk of dysfunction in this muscle group due to physical exertion. Incorporating such methods into rehabilitation programmes can significantly accelerate recovery and prevent recurrent injuries.

Laser Therapy for Pelvic Floor Muscles

Laser therapy is a technique based on the application of low-intensity laser radiation to stimulate biological processes within tissues. This method is widely used in sports physiotherapy to accelerate wound healing, reduce inflammation, and provide analgesic effects.

The mechanism of laser therapy involves the penetration of laser radiation into tissues, inducing photochemical reactions that stimulate cellular activity and enhance blood circulation. This leads to accelerated regenerative processes and diminished inflammation.

Applications of laser therapy for the PFM include:
1. Treatment of inflammatory conditions in the pelvic floor area;
2. Acceleration of postoperative healing;

3. Analgesia for chronic pain;
4. Strengthening muscle tone and improving vascular perfusion.

Magnetotherapy for Pelvic Floor Muscles

Magnetotherapy utilises a magnetic field to exert effects on bodily tissues. This modality exhibits anti-inflammatory, analgesic, and regenerative properties, rendering it useful for $PFMR$.

The principle of magnetotherapy involves the induction of weak electrical currents within tissues by the magnetic field, which stimulate biochemical processes and improve microcirculation. This promotes tissue regeneration and reduces inflammation.

Applications of magnetotherapy for PFM include:
1. Treatment of inflammatory conditions and pain syndromes;
2. Acceleration of healing following injuries or surgery;
3. Enhancement of muscle tone and elasticity.

Cryotherapy for Pelvic Floor Muscles

Cryotherapy is a method based on the application of low temperatures to tissues. It is widely used in sports physiotherapy to alleviate pain, reduce inflammation, and accelerate recovery following exertion.

The mechanism of cryotherapy involves vasoconstriction, which reduces swelling and pain. Additionally, cryotherapy stimulates the immune system, activating protective mechanisms.

Applications of cryotherapy for the PFM include:
1. Alleviation of pain and inflammation after intensive training;
2. Reduction of oedema and haematomas following trauma;
3. Strengthening muscle tone and improving vascularisation.

Shockwave Therapy for Pelvic Floor Muscle

SWT utilises high-energy acoustic waves to affect tissues. It is widely employed in sports physiotherapy for the treatment of chronic pain, acceleration of healing, and improvement of joint mobility.

The mechanism of SWT involves the induction of microtrauma in tissues, which stimulates regenerative processes, promotes neovascularisation, and accelerates recovery.

Applications of SWT for the PFM include:

1. Treatment of chronic pain and inflammatory processes;
2. Acceleration of healing following injuries and surgical interventions;
3. Improvement of muscle mobility and elasticity.

Electrical Nerve Stimulation for Pelvic Floor Muscles

ENS is a technique based on the use of electrical impulses to stimulate nerve endings. This method is extensively used in sports physiotherapy to relieve pain and enhance muscle function.

The mechanism of ENS involves suppression of nociceptive signals transmitted to the brain by nerve endings, resulting in analgesia. Additionally, ENS can directly stimulate muscles, improving their function and tone.

Applications of ENS for the PFM include:

1. Pain relief in chronic conditions;
2. Improvement of muscle function and tone;
3. Enhancement of muscle mobility and elasticity.

Radiofrequency Ablation for Pelvic Floor Muscles

RFA is a technique that employs radiofrequency current to ablate pathological tissues. It is widely used in sports physiotherapy for the treatment of chronic pain and removal of pathological tissue alterations.

The mechanism of RFA involves heating tissues to a specific temperature, resulting in the destruction of pathologically altered cells. This eliminates the source of pain and restores normal tissue function.

Applications of RFA for the PFM include:

1. Treatment of chronic pain and inflammatory processes;
2. Elimination of pathological tissue changes;
3. Restoration of normal muscle function.

Ultrasound therapy for Pelvic Floor Muscles

UST is a method based on the application of ultrasonic waves to tissues. It is extensively employed in sports physiotherapy to accelerate healing, reduce inflammation, and improve joint mobility.

The mechanism of UST involves tissue penetration by ultrasonic waves, inducing microvibrations that stimulate regenerative processes. This leads to enhanced blood flow and accelerated tissue repair.

Applications of UST for the PFM include:
1. Treatment of inflammatory conditions and pain syndromes;
2. Acceleration of healing after trauma or surgery;
3. Strengthening of muscle tone and improvement of elasticity.

Phototherapy for the Pelvic Floor Muscles

Phototherapy is a therapeutic modality based on the use of light to exert effects on biological tissues. This method is widely employed in sports physiotherapy to accelerate tissue repair, reduce inflammation, and improve joint mobility. The mechanism of action of phototherapy consists in the penetration of light waves into the tissues, where they induce photochemical reactions that stimulate regenerative processes. This leads to enhanced blood circulation and accelerated healing.

The scope of phototherapy for the PFM includes:
1. Management of inflammatory conditions and pain syndromes;
2. Acceleration of recovery following trauma and surgical interventions;
3. Enhancement of muscle tone and improvement of elasticity.

Hydrotherapy for the PFM

Hydrotherapy is a therapeutic technique utilising the properties of water to act upon tissues. It is commonly applied in sports physiotherapy for muscle relaxation, pain relief, and enhancement of joint mobility.

The therapeutic mechanism of hydrotherapy lies in the hydrostatic pressure of water on the tissues, which promotes muscle relaxation and improves blood circulation. Consequently, it reduces pain and enhances mobility.

The scope of hydrotherapy for the PFM includes:
1. Muscle relaxation and pain reduction;
2. Improvement of mobility and elasticity;

3. Enhancement of muscle tone and perfusion.

Vacuum Therapy for the Pelvic Floor Muscles

Vacuum therapy is a modality based on the application of negative pressure to tissues. It is extensively utilised in sports physiotherapy to improve circulation, reduce oedema, and accelerate healing.

The mechanism of action involves the creation of a low-pressure environment around tissues, thereby enhancing blood and lymphatic flow. This contributes to improved metabolism and stimulation of regenerative processes.

The scope of vacuum therapy for the PFM includes:
1. Improvement of blood and lymphatic circulation;
2. Reduction of oedema and haematomas;
3. Acceleration of post-traumatic and post-surgical healing.

Thermotherapy for the Pelvic Floor Muscles

Thermotherapy is a treatment approach employing either heat or cold to influence tissues. It is widely adopted in sports physiotherapy for muscle relaxation, pain relief, and improved mobility.

The mechanism of thermotherapy operates as follows: heat dilates blood vessels, thereby enhancing circulation, whereas cold induces vasoconstriction, reducing swelling and inflammation. This results in pain relief and functional improvement.

The scope of thermotherapy for the PFM includes:
1. Muscle relaxation and pain alleviation;
2. Improvement of mobility and tissue elasticity;
3. Reinforcement of muscle tone and perfusion.

Electrolipolysis for the Pelvic Floor Muscles

Electrolipolysis is a technique based on the application of electrical current to induce adipocyte lysis. This method is primarily used in aesthetic medicine for body contour correction but can also be applied in sports physiotherapy to improve body shaping and reduce adipose tissue volume.

Its mechanism of action relies on the disruption of adipocyte membranes by electrical currents, leading to cell death. This contributes to the reduction of adipose tissue and improvement of body contours.

The scope of electrolipolysis for the PFM includes:
1. Body contour correction and aesthetic improvement;
2. Reduction of adipose tissue in the pelvic floor region;
3. Enhancement of muscle tone and external appearance.

Microcurrent Therapy for the Pelvic Floor Muscles

Microcurrent therapy employs low-intensity electrical impulses to stimulate tissues. It is widely used in cosmetology and physiotherapy to enhance skin tone, reduce wrinkles, and improve circulation.

The mechanism of action is based on the stimulation of cutaneous and subcutaneous cells by weak electrical impulses, thereby improving their function. This enhances collagen and elastin synthesis, improves muscle tone, and reduces oedema.

The scope of microcurrent therapy for the PFM includes:
1. Improvement of muscular and cutaneous tone in the pelvic floor region;
2. Reduction of oedema and promotion of circulation;
3. Enhancement of tissue firmness and elasticity.

Infrared Therapy for the Pelvic Floor Muscles

Infrared therapy is a modality based on the application of infrared radiation to tissues. It is widely used in physiotherapy to enhance blood flow, reduce pain, and accelerate repair processes.

The mechanism of action involves the penetration of infrared radiation into tissues, producing a thermal effect that dilates vessels, improves circulation, and accelerates metabolic processes.

The scope of infrared therapy for the PFM includes:
1. Stimulation of blood and lymphatic flow;
2. Reduction of pain and inflammation;
3. Acceleration of post-traumatic and post-surgical recovery.

Massage Devices for the Pelvic Floor Muscles

Massage devices are mechanical instruments designed to apply physical stimulation to tissues. They are utilised to enhance circulation, alleviate pain, and improve joint mobility.

The mechanism of action involves mechanical oscillations or vibrations transmitted to the tissues, thereby stimulating circulation and metabolic activity. This leads to pain reduction and enhanced mobility.

The scope of massage devices for the PFM includes:
1. Promotion of blood and lymphatic circulation;
2. Reduction of pain and inflammatory responses;
3. Reinforcement of muscle tone and elasticity.

Pelvic Floor Muscle Trainers

PFM trainers are devices designed to strengthen and condition these muscles. They may be used both in domestic settings and in fitness or clinical environments. The principle of action lies in the creation of resistance, which must be overcome by the PFM. This contributes to their strengthening and improved tone.

The scope of PFM trainers includes:
1. Strengthening and conditioning of the PFM;
2. Improvement of continence control (urinary and faecal);
3. Reinforcement of muscular tone and elasticity.

Vibrational Therapy for the Pelvic Floor Muscles

Vibrational therapy is a method employing mechanical vibrations to affect tissues. It is extensively used in physiotherapy to enhance circulation, relieve pain, and accelerate recovery.

The mechanism of action is based on vibrations stimulating blood flow and metabolic activity within the tissues, leading to pain reduction and improved mobility.

The scope of vibrational therapy for the PFM includes:
1. Enhancement of blood and lymphatic flow;
2. Reduction of pain and inflammation;
3. Strengthening of muscle tone and elasticity.

Magnetic Resonance Therapy for the Pelvic Floor Muscles

MRT is a modality employing magnetic fields to act upon tissues. It is widely applied in both medical diagnostics and physiotherapy for enhancing circulation, reducing pain, and facilitating repair.

The mechanism of action involves the interaction of magnetic fields with tissues, which improves circulation and stimulates metabolic processes. This results in pain relief and functional restoration.

The scope of MRT for the PFM includes:

1. Stimulation of blood and lymphatic circulation;
2. Reduction of pain and inflammatory processes;
3. Enhancement of muscle tone and elasticity.

Pulsed Electrotherapy for Pelvic Floor Muscles

Pulsed electrotherapy is a therapeutic technique based on the application of short electrical impulses to biological tissues. This method is widely utilised in physiotherapy to enhance circulation, reduce pain, and accelerate tissue repair.

The mechanism of pulsed electrotherapy operates through the delivery of short electrical impulses to tissues, thereby stimulating blood flow and improving metabolic processes. As a result, it contributes to pain reduction and improved mobility.

The scope of pulsed electrotherapy for the PFM includes:

1. Enhancement of blood and lymphatic circulation;
2. Reduction of pain and inflammation;
3. Strengthening of muscle tone and improvement of elasticity.

Electrodynamic Therapy for Pelvic Floor Muscles

Electrodynamic therapy is a physiotherapeutic method involving the application of alternating electric current to tissues. It is extensively applied in clinical practice to stimulate circulation, alleviate pain, and accelerate healing.

Its therapeutic mechanism relies on alternating electric current acting on tissues, promoting blood flow and metabolic activity. This results in reduced pain and enhanced mobility.

The clinical indications of electrodynamic therapy for the PFM include:

1. Improved blood and lymphatic circulation;
2. Pain and inflammation relief;
3. Reinforcement of muscle tone and elasticity.

Laser Phonophoresis for Pelvic Floor Muscles

Laser phonophoresis is a therapeutic modality combining laser irradiation with pharmacological agents to enhance tissue penetration and efficacy. Widely used in physiotherapy, it facilitates circulation, reduces pain, and accelerates repair.

The principle of laser phonophoresis consists in laser radiation augmenting the transdermal delivery of medicinal substances into tissues, thereby increasing their therapeutic effect. This results in pain reduction and improved mobility.

The application of laser phonophoresis for the PFM encompasses:
1. Improvement of blood and lymphatic circulation;
2. Reduction of pain and inflammation;
3. Strengthening of muscle tone and elasticity.

Laser Acupuncture for Pelvic Floor Muscles

Laser acupuncture is a physiotherapeutic approach employing laser irradiation directed at biologically active points. It is widely implemented to stimulate circulation, relieve pain, and support tissue regeneration.

Its mechanism is based on laser energy acting upon biologically active points, thereby enhancing blood flow and metabolic activity. This leads to analgesia and improved functional mobility.

Therapeutic use of laser acupuncture for PFM includes:
1. Stimulation of blood and lymphatic circulation;
2. Reduction of pain and inflammation;
3. Improvement of muscle tone and elasticity.

Electrogalvanisation for Pelvic Floor Muscles

Electrogalvanisation is a therapeutic procedure employing direct electric current for tissue stimulation. It is routinely applied in physiotherapy to enhance vascularisation, relieve pain, and accelerate recovery.

Its mechanism relies on direct current acting on tissues, thereby stimulating circulation and metabolism. This contributes to analgesic effects and improved mobility.

The therapeutic scope of electrogalvanisation for PFM includes:
1. Stimulation of blood and lymphatic flow;
2. Reduction of pain and inflammation;
3. Enhancement of muscle tone and elasticity.

Diadynamic Currents for Pelvic Floor Muscles

Diadynamic therapy employs low-frequency modulated alternating current for tissue stimulation. It is widely used to enhance circulation, relieve pain, and facilitate recovery.

The therapeutic principle is based on alternating current acting on tissues, improving blood supply and metabolic processes. This produces analgesic effects and improves motor function.

Indications for diadynamic therapy in PFM include:
1. Enhancement of vascular and lymphatic circulation;
2. Alleviation of pain and inflammatory processes;
3. Strengthening of muscle tone and elasticity.

Interferential Currents for Pelvic Floor Muscles

Interferential therapy is based on the simultaneous application of two or more alternating currents that intersect in the tissues, generating an interference pattern. This technique is broadly utilised in physiotherapy to enhance circulation, reduce pain, and promote recovery.

Its mechanism lies in the interference effect of alternating currents, which stimulate tissue perfusion and metabolism. This results in pain relief and functional improvement.

The use of interferential currents for PFM comprises:
1. Stimulation of blood and lymphatic circulation;
2. Reduction of pain and inflammatory responses;
3. Reinforcement of muscle tone and elasticity.

Darsonvalisation for Pelvic Floor Muscles

Darsonvalisation is a physiotherapeutic method based on the application of high-frequency alternating current. It is widely employed for improving circulation, reducing pain, and supporting tissue healing.

The therapeutic mechanism is based on high-frequency current acting on tissues, thereby enhancing vascularisation and metabolism. This leads to analgesia and greater mobility.

Clinical indications for darsonvalisation of the PFM include:
1. Stimulation of blood and lymphatic flow;

2. Relief of pain and inflammation;
3. Enhancement of muscle tone and elasticity.

Lymphatic Drainage for Pelvic Floor Muscles

Lymphatic drainage is a therapeutic technique utilising mechanical vibrations to stimulate the lymphatic system. It is employed in physiotherapy to promote lymph outflow, reduce oedema, and accelerate tissue repair.

Its mechanism relies on mechanical oscillations acting on the lymphatic system, thereby improving lymphatic drainage and metabolic processes. This results in reduced oedema and enhanced mobility.

Therapeutic application for the PFM includes:
1. Facilitation of lymphatic outflow and reduction of oedema;
2. Acceleration of post-traumatic and postoperative recovery;
3. Reinforcement of muscle tone and elasticity.

Myostimulation for Pelvic Floor Muscles

Lymphatic drainage is a therapeutic technique utilising mechanical vibrations to stimulate the lymphatic system. It is employed in physiotherapy to promote lymph outflow, reduce oedema, and accelerate tissue repair.

Its mechanism relies on mechanical oscillations acting on the lymphatic system, thereby improving lymphatic drainage and metabolic processes. This results in reduced oedema and enhanced mobility.

Therapeutic application for the PFM includes:
1. Facilitation of lymphatic outflow and reduction of oedema;
2. Acceleration of post-traumatic and postoperative recovery;
3. Reinforcement of muscle tone and elasticity.

Magnetopuncture for Pelvic Floor Muscles

Magnetopuncture is a therapeutic method involving the application of magnetic fields to biologically active points. It is used to stimulate circulation, relieve pain, and support repair processes.

Its mechanism is based on magnetic fields influencing biologically active points, thereby enhancing circulation and metabolism. This produces analgesic effects and improved mobility.

Applications for the PFM include:

1. Enhancement of blood and lymphatic circulation;
2. Alleviation of pain and inflammation;
3. Strengthening of muscle tone and elasticity.

Laser Reflexotherapy for Pelvic Floor Muscles

Laser reflexotherapy is a method utilising laser irradiation directed at reflexogenic zones. It is commonly applied in physiotherapy to stimulate circulation, relieve pain, and promote recovery.

Its mechanism is based on laser energy acting on reflex zones, thereby improving circulation and metabolic processes. This leads to pain reduction and functional enhancement.

The therapeutic applications for the PFM include:
1. Improvement of blood and lymphatic circulation;
2. Reduction of pain and inflammation;
3. Reinforcement of muscle tone and elasticity.

Electroacupuncture for the Pelvic Floor Muscles

Electroacupuncture is a therapeutic technique based on the application of electrical impulses to biologically active points. This method is widely employed in physiotherapy to enhance blood circulation, reduce pain, and accelerate tissue repair.

The underlying mechanism of electroacupuncture involves the delivery of electrical impulses to biologically active points, thereby stimulating circulation and improving metabolic processes. This results in pain reduction and improved mobility.

The clinical applications of electroacupuncture for the PFM include:
1. Enhancement of blood and lymphatic circulation;
2. Reduction of pain and inflammatory processes;
3. Strengthening of muscular tone and improvement of elasticity.

Laser Acupuncture for the Pelvic Floor Muscles

Laser acupuncture is a therapeutic approach utilising laser irradiation to stimulate biologically active points. This method is extensively applied in physiotherapy to improve haemodynamics, alleviate pain, and accelerate healing.

The principle of laser acupuncture is as follows: laser irradiation acts upon biologically active points, thereby stimulating circulation and enhancing metabolic activity. This leads to pain reduction and improved functional mobility.

The clinical applications of laser acupuncture for the PFM comprise:
1. Optimisation of blood flow and lymphatic drainage;
2. Alleviation of pain and inflammation;
3. Reinforcement of muscle tone and improvement of elasticity.

Acupuncture Therapy for the Pelvic Floor Muscles

Acupuncture therapy is a method based on the insertion of fine needles into biologically active points. It is widely used in traditional Chinese medicine as well as in integrative physiotherapy to improve circulation, relieve pain, and accelerate recovery.

The therapeutic mechanism of acupuncture therapy is achieved through the insertion of needles into biologically active points, which stimulates blood circulation and enhances metabolic processes. This results in pain reduction and improved mobility.

The scope of acupuncture therapy for the PFM includes:
1. Promotion of blood and lymphatic circulation;
2. Reduction of pain and inflammatory manifestations;
3. Strengthening of muscular tone and enhancement of elasticity.

Conclusion

In conclusion, the device-assisted technologies presented in this chapter demonstrate considerable potential for application in sports physiotherapy, particularly in relation to the rehabilitation, development, and strengthening of the PFM. Each of the reviewed methods possesses distinct characteristics, advantages, and clinical indications, necessitating an individualised approach to method selection depending on the specific case and the patient's needs.

It is important to emphasise that the effectiveness of any of these technologies depends not only on the technical parameters of the equipment, but also on the professional competence of the specialists employing them. Hence, continuous professional development and the refinement of clinical skills in physiotherapy are crucial to maximising therapeutic outcomes.

Thus, it can be concluded that device-assisted technologies occupy a significant place in the armamentarium of the modern physiotherapist specialising in sports rehabilitation and training. Ongoing research and the implementation of novel methods and devices will contribute to the advancement of sports medicine and the improvement of athletes' quality of life.

Part 1.3

Physiology of the Pelvic Floor Muscles in the Context of Athletic Load

The PFM play a critically important role in maintaining pelvic stability, supporting internal organs, and ensuring control over micturition and defaecation. For athletes, particularly women, this muscle group is exposed to significant strain associated with physical exertion such as running, plyometric exercises, strength training, and other forms of sport requiring intensive physical activity. An in-depth understanding of pelvic floor physiology within the framework of athletic load is a key factor in developing effective strategies for rehabilitation, strengthening, and functional optimisation of these muscles.

Firstly, the PFM comprise three layers of smooth muscle fibres: the superficial, intermediate, and deep layers. The superficial layer is responsible for urinary continence and contributes to the process of micturition. The intermediate layer supports the internal organs and regulates intra-abdominal pressure. The deep layer controls the positioning and movement of the hip joint. These three layers function synergistically, providing pelvic stability and reinforcing the visceral organs.

Secondly, the pelvic floor is subjected to substantial strain during sporting activity. Running, jumping, squats, and other dynamic exercises require the active involvement of the PFM to stabilise the pelvis and protect the internal organs. Due to the repetitive nature of these loads, there is a considerable risk of overstrain, potentially leading to pelvic floor dysfunction, including urinary incontinence, pelvic organ prolapse, and chronic pelvic pain.

Thirdly, athletic exertion influences the vascularisation and innervation of the pelvic floor. During intensive physical activity, redistribution of blood flow towards the working skeletal muscles may result in a transient reduction in pelvic floor perfusion. This can lead to diminished muscle tone and functional weakening, thereby increasing susceptibility to trauma and dysfunction.

Fourthly, the neuromuscular regulation of the pelvic floor is also affected by sporting load. Physical exertion elevates nervous system tension, which may impair the ability to control pelvic floor musculature. Clinically, this may manifest as difficulties in urinary continence and other functions dependent upon these muscles.

Thus, a comprehensive understanding of pelvic floor physiology in the context of athletic load forms the basis for designing individualised rehabilitation, training, and strengthening programmes.

Physical exertion characteristic of many types of sport exerts a considerable influence on the condition of the pelvic floor musculature. For instance, during running, plyometric training, and resistance exercise, increased tension of these muscles occurs, which may result in fatigue and, in some cases, tissue damage. The PFM in women are particularly vulnerable due to specific anatomical features and hormone-mediated physiological changes.

Excessive contraction of the pelvic floor musculature may give rise to symptoms of discomfort, including sensations of heaviness in the lower abdomen, burning, or pressure in the perineal region. Such manifestations indicate a state of hyperactivity or overstrain of the pelvic floor. Prolonged or intensive loading of these muscles may culminate in the onset of urinary incontinence, which represents a clinically significant problem for athletes, particularly women.

Furthermore, substantial physical stress may induce alterations in the structure and function of the connective tissue supporting the pelvic floor musculature. These changes may present as microtrauma, inflammatory responses, and fibrosis, ultimately impairing normal muscular function. Over time, such pathological processes may lead to the development of chronic pain syndromes, thereby compromising athletic performance.

Sustained and intensive training loads may also precipitate a muscular imbalance within the pelvic floor, characterised by a decline in muscle tone and progressive weakness. This condition, known as pelvic floor hypotonia, may be accompanied by symptoms such as diminished urinary control, difficulty in achieving full voluntary muscular contraction, and a general deterioration in wellbeing.

Collectively, these factors highlight the importance of routine monitoring of pelvic floor function among athletes, as well as the implementation of individualised rehabilitation and training programmes tailored to the demands of specific sports. Accurate assessment of muscular status, timely recognition of signs of overload, and the application of preventive interventions may substantially reduce the risk of clinically significant pelvic floor dysfunction.

Thus, a profound understanding of pelvic floor physiology in the context of sports-related loading is an essential prerequisite for the effective management of this crucial component of athletes' health.

Substantial physical exertion, characteristic of many sporting disciplines, may result in alterations in the functioning of the pelvic floor musculature. For instance, in sports such as running, football, hockey and volleyball, the PFM are subjected to continuous strain, which may give rise to chronic fatigue and subsequent weakening of these structures. In certain cases, this may manifest as symptoms including pelvic floor tenderness, dysuria, and even the onset of urinary incontinence.

Clinical signs such as a sensation of heaviness in the lower abdomen, pressure in the region of the urinary bladder, and general PFM weakness may indicate impaired tone and dysfunction of these muscles. Prolonged and intensive physical loading can further exacerbate pelvic floor weakness, thereby predisposing individuals to a range of disorders, including urinary incontinence, pelvic organ prolapse, and chronic pain syndromes.

Moreover, sustained athletic activity may affect the structure and function of the connective tissue supporting the pelvic floor. Such changes may lead to the development of microtrauma, inflammatory responses, and fibrotic processes, ultimately impairing normal muscular function. Over time, these alterations can culminate in chronic pain syndromes, which may restrict full participation in sporting activities.

In this regard, it is of particular importance to conduct regular assessments of pelvic floor status in athletes, as well as to design individualised rehabilitation and training programmes that take into account the specific nature of sport-related loads. Early identification of overload symptoms and the implementation of preventive strategies can significantly reduce the risk of severe pelvic floor disorders.

Therefore, a comprehensive understanding of pelvic floor physiology within the context of athletic performance constitutes a prerequisite for effective health management in athletes and for the minimisation of risks associated with dysfunction of these critical muscles.

Sustained and intensive physical exertion may lead to an alteration in the balance between different groups of PFM, manifesting as hypertrophy in some muscles and atrophy in others. For instance, during the performance of exercises involving jumping, running, and resistance training, an increase in tone and volume of the superficial PFM can be observed, whereas the deeper layers may undergo atrophic changes. This may result in an imbalance in PFM function, expressed through symptoms such as a sensation of heaviness in the lower abdomen, discomfort during micturition, and reduced control over internal organs.

Such alterations in the equilibrium of muscle layers may give rise to the so-called “hypertension–hypotonia syndrome”, in which certain muscles experience excessive tension while others remain insufficiently active. This condition is characterised by alternating periods of increased tone and relaxation, which complicates the execution of exercises requiring precise control of PFM activity.

In addition, prolonged sitting postures, typical of many sports such as cycling and motor racing, may exacerbate the problem, as they contribute to weakening of the PFM due to the absence of regular contractions. Consequently, the muscles lose elasticity and the capacity to respond adequately to changes in body position, which increases the risk of developing symptoms of urinary incontinence and pelvic organ prolapse.

To compensate for these negative effects, athletes are advised to incorporate into their training regimens exercises specifically targeting the strengthening and toning of the PFM. These may include specialised exercises performed in the supine, sitting, or standing position, aimed at improving neuromuscular control of these muscles. Regular rest intervals within the training process are also essential, allowing the PFM to recover and maintain their functionality.

Thus, an understanding of PFM physiology in the context of athletic load is a key factor in preserving health and ensuring optimal athletic performance. The development of individualised rehabilitation and training programmes, alongside the integration of specific exercises for strengthening and toning these muscles, will help to minimise the risks associated with pelvic floor dysfunction.

Physical exertion, characteristic of most types of sport, may lead to a condition known as pelvic floor hypermobility syndrome, which manifests as increased mobility and instability of the pelvic joints. This condition arises due to reduced tone of the PFM, resulting in difficulties in maintaining correct pelvic alignment and controlling urination. Pelvic floor hypermobility syndrome may be accompanied by such symptoms as lower back pain, pelvic discomfort, and a perceived loss of urinary control.

This syndrome is frequently observed in athletes whose activity is associated with high levels of physical load, such as running, jumping, and weightlifting. It may also develop as a consequence of prolonged sedentary behaviour, as the PFM adapt to such a state and lose their ability to effectively stabilise the pelvis. This condition is likewise characteristic of athletes who suffer from injuries or are subjected to overtraining for an extended period.

Pelvic floor hypermobility syndrome may result in urinary incontinence, which significantly affects the athlete's quality of life. It is important to note that this syndrome may develop gradually, and athletes may remain unaware of its presence until severe symptoms emerge, such as urinary incontinence or chronic pain.

Prevention and treatment of this condition require regular training of the PFM, incorporating exercises aimed at strengthening and stabilising the pelvic joints. It is essential to apply a variety of techniques, such as yoga, Pilates, Kegel exercises, and other methods that promote the development and enhancement of PFM tone. Regular training should be combined with rest and recovery measures in order to avoid overstrain and preserve muscular health.

Attention should also be paid to psychological factors, as the athlete's emotional state may influence the regulation of PFM. Stress, anxiety, and depression may exacerbate the symptoms of pelvic floor hypermobility; therefore, athletes are advised to focus on psychological strengthening and to practise relaxation and self-regulation techniques.

Thus, understanding the physiology of the PFM in the context of sports-related physical loads is a key element in the development of effective strategies for their recovery, strengthening, and reinforcement. Regular training directed towards the stabilisation of pelvic joints, together with attention to psychological well-being, will help to minimise the risks of serious problems associated with the PFM.

Sport-related physical exertion may lead to a condition known as pelvic floor hypermobility syndrome, which is characterised by an increased degree of mobility of the pelvic joints and a diminished tone of the pelvic floor musculature. This condition is accompanied by symptoms such as lower back pain, pelvic discomfort, and loss of urinary control. Pelvic floor hypermobility syndrome commonly occurs in athletes whose activities involve high levels of physical exertion, such as running, jumping, and weightlifting. It may also develop as a result of prolonged periods of sitting, which cause the PFM to adapt to such a state and lose the ability to stabilise the pelvis effectively.

This syndrome may lead to serious complications, including urinary incontinence and chronic pain, which significantly affect the athlete's quality of life. Frequently, athletes do not recognise the presence of this condition until it manifests with severe symptoms such as urinary incontinence or persistent pain.

For the prevention and treatment of pelvic floor hypermobility syndrome, regular PFM training is essential. This should include exercises aimed at strengthening and stabilising the pelvic joints. It is important to employ a range of techniques such as yoga, Pilates, Kegel exercises, and other methods that facilitate the development and reinforcement of PFM tone. Regular training should be combined with adequate rest and recovery measures in order to prevent overexertion and maintain muscular health.

Attention must also be paid to psychological aspects, since an athlete's emotional state can influence PFM control. Stress, anxiety, and depression may exacerbate the symptoms of pelvic floor hypermobility; therefore, athletes are advised to focus on psychological resilience and to acquire relaxation and self-regulation techniques.

Thus, understanding the physiology of the PFM in the context of sports-related physical exertion constitutes a fundamental step towards the development of effective strategies for rehabilitation, development, and strengthening of these muscles. Regular training aimed at enhancing and stabilising the pelvic joints, together with attention to psychological well-being, can help to minimise the risks of developing serious pelvic floor-related conditions.

As mentioned earlier, sports-related physical exertion may also contribute to the development of pelvic floor hypertension, which presents as excessive muscle tone and stiffness in the pelvic floor. This condition may be accompanied by pelvic discomfort, a sensation of heaviness in the lower abdomen, and difficulties in urinary control. Factors that may contribute to pelvic floor hypertension include intensive training, injuries and surgical interventions, as well as extended periods of immobility, as seen in the case of motor racing or cycling marathons.

Hypertonic states of the PFM may result in complications such as chronic pain, urinary incontinence, and impaired motor coordination. These symptoms can hinder optimal sports performance and may necessitate medical intervention in order to restore normal muscle tone.

To counteract pelvic floor hypertension, exercises aimed at relaxing and stretching the pelvic floor musculature are recommended. These may include stretching routines, massage, and breathing techniques that help alleviate excessive tension and restore the muscles to their normal condition. It is also important to maintain a balance between training and rest to allow the muscles to recover and avoid overloading.

The psychological state of the athlete likewise plays a crucial role in PFM control. Stress, anxiety, and depression may aggravate the symptoms of hypertension, rendering the muscles less manageable. Therefore, attention should be directed towards psychological resilience and the acquisition of relaxation and self-regulation techniques.

Thus, an understanding of PFM physiology in the context of sports-related physical exertion is fundamental for the development of effective strategies for rehabilitation, development, and strengthening of these muscles. Regular training focused on relaxation and stretching of the pelvic floor, along with attention to psychological health, will help minimise the risks of developing severe conditions associated with pelvic floor hypertension.

As mentioned earlier, athletic activity may lead to the development of pelvic floor hypertonicity, which manifests as excessive tone and rigidity of the PFM. This condition may be accompanied by sensations of pelvic discomfort, a feeling of heaviness in the lower abdomen, and difficulties with urinary control. Contributing factors to pelvic floor hypertonicity may include intensive training, trauma and surgical interventions, as well as prolonged periods of immobility, such as those occurring in motor racing or cycling marathons.

Hypertonic states of the pelvic floor musculature may result in such consequences as chronic pain, urinary incontinence, and disturbances in motor coordination. These symptoms may hinder full engagement in athletic activity and necessitate medical intervention to normalise the tone of the PFM.

To counteract pelvic floor hypertonicity, it is recommended to employ exercises aimed at relaxation and stretching of the PFM. These may include stretching routines, massage, and breathing techniques, which assist in relieving excessive tension and restoring the muscles to a normal state. It is also important to maintain a balance between training and rest, thereby allowing the musculature time to recover and preventing overload.

The psychological state of the athlete also plays an important role in the regulation of PFM. Stress, anxiety, and depression may exacerbate the symptoms of hypertonicity, rendering the muscles less controllable. It is therefore crucial to devote attention to psychological strengthening and the mastery of relaxation and self-regulation techniques.

Thus, an understanding of PFM physiology in the context of athletic activity is a key element in the development of effective strategies for rehabilitation, development, and strengthening of these muscles. Regular training sessions directed towards relaxation and stretching of the pelvic floor, alongside attention to psychological well-being, will help minimise the risks of serious problems associated with pelvic floor hypertonicity.

In addition to hypertonicity and hypotonicity of the pelvic floor, there also exist conditions known as diffuse neuralgia and neuromuscular blockade, which may arise as a result of trauma or surgical intervention. These conditions are characterised by impaired transmission of nerve signals to the PFM, leading to reduced tone and functional activity.

Diffuse neuralgia occurs following trauma or surgical manipulation, when nerve damage results in partial or complete loss of conductivity. This condition manifests as an absence of sensory input from the affected region, which may lead to loss of sensitivity and muscular weakness. Recovery from such an injury may require a prolonged period of time, and full restoration of PFM function is often only partial.

Neuromuscular blockade, by contrast, may arise from compression or stretching of the nerve, resulting in a temporary cessation of nerve impulse transmission to the PFM. This condition is likewise characterised by loss of sensation and reduced muscle tone; however, unlike diffuse neuralgia, it usually resolves spontaneously after elimination of the cause of the blockade.

The treatment of such conditions requires careful diagnosis and a comprehensive approach, including physiotherapy, pharmacological therapy and, in certain cases, surgical intervention. Recovery following injury or surgery may require a prolonged period of time and may be accompanied by specific restrictions in movement and activity.

The psychological state of the athlete plays an important role in the regulation of the PFM. Stress, anxiety and depression may exacerbate symptoms of neuralgia and blockade, rendering the muscles less controllable. Therefore, it is important to focus on psychological strengthening and the acquisition of relaxation and self-regulation techniques.

Thus, an understanding of the physiology of the PFM in the context of athletic load is a fundamental element in the development of effective strategies for the rehabilitation, development and strengthening of these muscles. A comprehensive approach, encompassing physiotherapy, pharmacological therapy and, where necessary, surgical intervention, together with attention to psychological well-being, will help to minimise the risks of developing serious problems associated with neuralgia and neuromuscular blockade of the pelvic floor.

Following injury or surgical intervention, a condition known as pseudomotor activation (similar to myofascial pain syndrome) may occur, whereby a damaged nerve or brain region erroneously interprets signals from unaffected areas of the body as originating from the injured areas. This leads to false activity of the PFM, which may manifest in the form of spasms, convulsions and painful sensations.

Pseudomotor activation arises in response to irritation of the surrounding tissues, for instance after surgery or trauma, and is expressed as spontaneous activity of the PFM, despite the absence of an actual threat or damage. Such a condition may be accompanied by sensations of pain, discomfort and spasms in the pelvic floor region.

The treatment of pseudomotor activation requires precise diagnosis of the underlying causes and the development of an individualised rehabilitation programme, which may include physiotherapy, electrostimulation, relaxation and stretching exercises for the PFM, as well as addressing psychological aspects aimed at reducing stress and improving self-control.

An important aspect of rehabilitation after injuries or surgery is adherence to a regime of rest and the gradual increase of physical load, enabling the organism to adapt to new conditions and to avoid recurrence of the injury or complications. It is also important to take into account the restrictions imposed by the rehabilitation physician and to follow the recommendations concerning the restoration of motor functions.

The psychological state of the athlete continues to remain an important factor in the rehabilitation process. Stress, anxiety and depression may contribute to the persistence of pseudomotor activation, intensifying unpleasant sensations and hindering the recovery process. Psychologists and physiotherapists should cooperate in developing a rehabilitation plan aimed at eliminating pseudomotor activation and restoring the normal functioning of the PFM.

Thus, understanding the physiology of the PFM in the context of athletic load and trauma constitutes a key stage in the creation of successful rehabilitation strategies and the prevention of recurrent injuries or complications.

Injury or surgery may lead to a condition known as pseudomotor activation, in which a damaged nerve or brain region erroneously interprets signals from unaffected areas of the body as if they originated from injured areas. This results in false activity of the PFM, which may manifest as spasms, convulsions and painful sensations.

Pseudomotor activation develops in response to irritation of the surrounding tissues, e.g., after surgery or trauma, and manifests as spontaneous activity of the PFM, despite the absence of a real threat or damage. Such a condition may be accompanied by sensations of pain, discomfort and spasms in the pelvic floor area.

The treatment of pseudomotor activation requires precise identification of the causes of its occurrence and the development of an individual rehabilitation programme, which may include physiotherapy, electrostimulation, relaxation and stretching exercises of the PFM, as well as work on psychological aspects aimed at reducing stress and enhancing self-control.

The psychological state of the athlete remains an important factor in the rehabilitation process. Stress, anxiety, and depression may contribute to the persistence of pseudomotor activation, intensifying unpleasant sensations and hindering recovery. Psychologists and physiotherapists should collaborate to develop a rehabilitation plan aimed at eliminating pseudomotor activation and restoring the normal function of the PFM.

Thus, understanding the physiology of the PFM in the context of athletic exertion and injury is a key stage in developing successful rehabilitation strategies and preventing recurrent injuries or complications.

Pseudomotor activation occurring after trauma or surgical intervention may result in a condition known as pseudoampullary contracture, in which the PFM experience sustained tension and pain. This leads to developing contractile scar tissue and reduced tissue flexibility. The condition manifests as persistent discomfort and pain in the pelvic region, complicating rehabilitation and potentially progressing into a chronic pain syndrome.

Pseudoampullary contracture may arise from prolonged trauma or surgical intervention, leading to scar formation and reduced tissue elasticity. This condition is characterised by constant pain and tension in the PFM, which may result in disability and a diminished quality of life.

The treatment of pseudoampullary contracture includes physical therapy, manipulative injections, physiological training, and corrective surgical intervention. Physical therapy aims to improve mobility and flexibility of the PFM, as well as to prevent scar formation and restore normal anatomical structure. Manipulative injections help reduce inflammation and alleviate pain, while corrective surgical procedures may be required to excise scar tissue and restore pelvic floor mobility.

The psychological state of the athlete continues to be an essential factor in the rehabilitation process. Stress, anxiety, and depression may promote the persistence of pseudoampullary contracture, intensifying pain and complicating recovery. Psychologists and surgeons should cooperate in devising a rehabilitation plan focused on eliminating pseudoampullary contracture and restoring the normal function of the PFM.

It is important to remember that successful rehabilitation requires adherence to the restrictions established by the rehabilitation physician and the gradual increase of load. This allows the body to adapt to new conditions and prevents recurrent trauma or complications.

Understanding the physiology of the PFM in the context of athletic exertion and injury is a crucial component in creating effective rehabilitation strategies and preventing recurrent injuries or complications. A comprehensive approach, including physiotherapy, pharmacological treatment, and surgical intervention, together with attention to the athlete's psychological state, facilitates full recovery and increases the likelihood of a successful return to sport.

Trauma or surgical intervention may also lead to a condition known as pseudopain contracture, in which the PFM develop chronic pain and tension, resulting in contractile scarring and reduced tissue flexibility. This condition manifests as a persistent sensation of discomfort and pain in the pelvic region, complicating rehabilitation and potentially leading to chronic pain syndromes.

Pseudopain contracture may develop as a result of prolonged trauma or surgical intervention, leading to scar formation and reduced tissue elasticity. This condition is characterised by constant discomfort and pain in the pelvic floor region, which may progress into chronic pain and reduced muscle mobility.

The treatment of pseudopain contracture includes physical therapy, the administration of antibiotics and antiscarring agents, as well as corrective surgical intervention. Physical therapy aims to improve the mobility and flexibility of the PFM, as well as to prevent scar formation and restore normal anatomical structure. The administration of antibiotics and antiscarring agents helps reduce inflammation and relieve pain, while corrective surgical procedures may be necessary to remove scar tissue and restore pelvic floor mobility.

The psychological state of the athlete remains an important factor in the rehabilitation process. Stress, anxiety and depression may contribute to the persistence of pseudopain contracture, exacerbating pain sensations and complicating the recovery process. Psychologists and surgeons must collaborate to develop a rehabilitation plan aimed at eliminating pseudopain contracture and restoring normal functioning of the PFM.

Effective rehabilitation requires adherence to the restrictions set by the rehabilitation physician and the gradual increase of physical load. This enables the body to adapt to new conditions and prevents recurrence of injury or the emergence of complications.

Understanding the physiology of the PFM in the context of sports activity and injury is a key element in devising successful strategies for rehabilitation and for preventing recurrent injuries or complications. A comprehensive approach, which includes physiotherapy, pharmacological treatment and surgical intervention, together with attention to the athlete's psychological condition, facilitates complete recovery and enhances the likelihood of a successful return to sport.

Part 1.4
Conclusion

The conducted analysis of the theoretical foundations of apparatus-based technologies in sports physiotherapy makes it possible to draw a number of significant conclusions that form the basis for further research. Contemporary sports physiotherapy is undergoing a stage of active development, driven by the increasing demands placed on athletes' preparation, the necessity of minimising injury rates, and the acceleration of recovery processes. In this context, apparatus-based technologies occupy a pivotal position, offering innovative solutions for diagnosis, treatment, and prevention of disorders, as well as for enhancing the functional capacities of athletes.

Main Findings

1. Contemporary Directions in Sports Physiotherapy
   Sports physiotherapy is currently integrated into the training process of athletes at all stages: from injury prevention to rehabilitation following severe damage. The role of the physiotherapist within a sports team has become indispensable, emphasising the significance of an interdisciplinary approach. Current trends include the use of high-technology methods such as BFB, electrical stimulation and UST, which allow for more precise and individualised outcomes.
2. Apparatus-Based Technologies: Classification and Principles of Operation
   Apparatus-based technologies encompass a broad spectrum of instruments that may be classified according to their principle of action (electrical stimulation, ultrasound, laser therapy, etc.), field of application (rehabilitation, training, diagnostics) and degree of invasiveness. Their mode of action is based on the physical impact on tissues, enabling the stimulation of regeneration, improvement of blood circulation, and enhancement of muscular functionality. Particular attention is directed towards technologies that can be adapted for PFM, given their specific anatomy and physiology.
3. Physiology of PFM in the Context of Athletic Load
   PFM play a critically important role in ensuring pelvic stability, controlling urination and defaecation, as well as maintaining sexual function. Under conditions of intensive athletic load, these muscles are exposed to considerable stress, which may result in the development of such syndromes as urinary incontinence, pelvic organ prolapse and chronic pain. Understanding the physiology of these muscles and their adaptation to load facilitates the development of more effective methods for their training and rehabilitation.

Practical Significance

The theoretical foundations outlined in this chapter have important practical implications. They allow for:

1. Identifying key directions in the development of sports physiotherapy with emphasis on the application of apparatus-based technologies;
2. Systematising knowledge on the principles of operation and classification of apparatus-based technologies, thereby facilitating their selection for specific tasks;
3. Considering the physiological characteristics of PFM when designing rehabilitation and training programmes, which is particularly significant for athletes exposed to high levels of load in this region.

Prospects for Further Research

The analysis conducted underscores the necessity of further investigation in the following directions:

1. Developing new apparatus-based technologies that will account for the specific features of PFM and their response to athletic load;
2. Conducting comparative studies on the effectiveness of various technologies for $PFMR$ and training;
3. Examining the long-term effects of the application of apparatus-based technologies in sports physiotherapy, including their impact on injury prevention and enhancement of athletic performance.

Thus, this part of the study has established a theoretical foundation for subsequent research, emphasising the importance of integrating apparatus-based technologies into modern sports physiotherapy and the necessity of considering the physiological specificities of PFM when devising methods of their rehabilitation and training.

Chapter Two

Analysis of Existing Research and Technologies for the Rehabilitation and Training of Pelvic Floor Muscles

Part 2.1

Review of Contemporary Research on the Application of Apparatus-Based Technologies in Physiotherapy

Modern approaches in sports physiotherapy encompass a wide range of methods aimed at the prevention, treatment, and rehabilitation of various types of injuries and disorders, as well as at enhancing the efficiency of training and the preparation of athletes. One of the key directions involves the use of high-technology devices, such as EMS, magnetotherapy, laser therapy, UST, and cryotherapy, which make it possible to improve recovery outcomes, increase performance, and maintain an optimal level of physical fitness.

Classification and Principles of Operation

Hardware-based technologies in sports physiotherapy are divided into several categories, each with its characteristics and fields of application:

- EMS is a methodological technique involving the use of electrical impulses to stimulate muscles. It is applied in rehabilitation, muscle strengthening, and improvement of their functional condition;
- Magnetotherapy is the application of a magnetic field to tissues in order to accelerate regeneration and normalise the functional state of muscles;
- Laser therapy is the use of laser radiation to accelerate tissue healing and restore normal muscle function;
- UST is the transmission of ultrasound radiation into tissues to improve blood circulation and accelerate regenerative processes;
- Cryotherapy is the application of low-temperature exposure to reduce inflammation and enhance blood flow;
- SWT is the application of acoustic waves to tissues for the treatment of chronic pain and injured areas.

Each of these technologies has its advantages and limitations, determined by the nature of the pathology, the patient's condition, and the therapeutic goals.

Examples of application:

- EMS is used in the rehabilitation of muscular injuries and trauma, as well as for the training and strengthening of the PFM;

- Magnetotherapy is employed in the treatment of inflammatory conditions and injuries, and in optimising muscular function;
- Laser therapy is an effective technique for accelerating the healing of soft tissues and normalising PFM activity;
- UST is frequently applied in the treatment of inflammation and for improving joint mobility;
- Cryotherapy is a relevant technique for the management of acute inflammatory states and the alleviation of pain;
- SWT is assists in managing chronic pain conditions and enhances recovery efficiency following injury.

These examples illustrate the diversity and multidimensionality of contemporary research dedicated to the investigation and clinical use of various hardware technologies in sports physiotherapy.

Conclusions from the Analysis of Information Sources

Research demonstrates a high degree of scientific substantiation and clinical applicability of different hardware-based technologies in sports physiotherapy. At the same time, it highlights pressing issues concerning the integration of such technologies into practice, the standardisation of procedures, and the need for further studies to optimise their use in different clinical contexts. Many of these modalities have shown significant efficacy in comparison with traditional methods of rehabilitation and injury prevention.

Nevertheless, there remain unregulated aspects related to the incorporation of these technologies into everyday practice, staff training, and the standardisation of therapeutic protocols. Challenges also exist in selecting optimal strategies for different categories of patients and clinical scenarios, emphasising the necessity of further investigation and the development of practice-oriented recommendations.

The study underscores the importance of understanding the physiological role of hardware technologies in sports physiotherapy, as well as their wide range of applications in rehabilitation, training, and strengthening of PFM. Despite considerable advances in this area, challenges persist regarding integration into daily practice and the urgent need for practical guidelines for coaches and physiotherapists.

Analysis of Effectiveness and Comparative Review

Contemporary research demonstrates the high efficacy of various apparatus-based technologies in rehabilitation and injury prevention. For instance, EMS has proven effective in restoring PFM following trauma or surgical intervention. Magnetotherapy has shown efficacy in accelerating tissue healing and enhancing metabolism. Laser therapy has been successfully applied to increase the rate of muscle recovery and reduce pain sensations. UST and cryotherapy are likewise employed to alleviate inflammation and improve circulation.

Despite the positive outcomes, numerous studies highlight issues related to the absence of clear standards and protocols governing the application of these technologies. Some investigations have identified potential risks of adverse effects, such as muscle overstimulation or diminished tone, indicating the necessity for careful adjustment of parameters and operational modes of the devices.

Certain studies have emphasised the importance of patient engagement and an individualised approach to treatment. Specifically, it has been noted that tailoring treatment parameters to the needs of each patient can significantly enhance rehabilitation outcomes and reduce the likelihood of recurrent injuries.

Research confirms the high effectiveness and safety of apparatus-based technologies in sports physiotherapy, but stresses the need for further exploration and the development of standardised procedures and protocols for their use. The integration of such technologies into everyday practice must be accompanied by personnel training and the formulation of strategies tailored to the specific needs of each patient.

The results of the conducted analysis underscore the necessity of continued scientific research and the development of recommendations for practising physiotherapists and trainers, which will help optimise the application of apparatus-based technologies in rehabilitation and injury prevention.

Modern studies in sports physiotherapy are actively directed towards the advancement and optimisation of apparatus-based technologies aimed at the restoration and training of PFM. Particular attention is paid not only to the effectiveness of the methods but also to their integration into the daily practice of sports physiotherapists.

One of the most significant directions is the use of EMS for the restoration and training of PFM. Research indicates that EMS enhances neuromuscular connectivity and increases muscle strength, which is of importance both for athletes and for patients recovering after childbirth or surgery. According to recent data, EMS accelerates the recovery process and improves training efficacy, especially when combined with other methods such as BFB, which facilitates real-time control of PFM activity.

Equally important are investigations concerning magnetotherapy, which is actively applied to stimulate microcirculation and accelerate tissue regeneration. Research from recent years has demonstrated that magnetotherapy exerts a positive influence on post-traumatic recovery and the strengthening of muscle tone, while also alleviating inflammation and pain syndromes. Nevertheless, there are certain limitations to its use, particularly in terms of dosage standards and the duration of sessions, which necessitate further research and the development of unified application protocols.

The growing popularity of laser therapy also merits attention. Due to its ability to accelerate healing processes and reduce inflammation, it has found wide application in sports physiotherapy. Laser irradiation penetrates into the deeper tissue layers, stimulating metabolism and circulation, thereby expediting recovery after physical exertion and injury. This technology is especially effective in treating chronic pain and inflammation, making it indispensable for athletes engaged in intensive forms of sport.

Parallel to the development of these technologies, new approaches are being actively investigated, such as the use of wearable devices for health monitoring and biometric feedback. These devices enable specialists to track physiological parameters in real time, including pulse, blood oxygen levels and even muscle tension. Such integration of technologies makes it possible to adapt training and rehabilitation programmes with greater precision, thus enhancing their effectiveness.

Nevertheless, despite the abundance of positive outcomes, these technologies encounter a number of challenges, such as the absence of standardised application protocols, the requirement for additional specialist training, and the high cost of equipment. Another issue lies in the integration of apparatus-based technologies into overall rehabilitation and training programmes, particularly in team sports settings, where it is necessary to consider the individual characteristics of each athlete.

Thus, modern research on the application of apparatus-based technologies in physiotherapy underscores their substantial potential in the restoration and strengthening of PFM function. However, for these technologies to become widely applicable and standardised, further scientific developments and practical implementation are essential.

Additional attention in recent research is devoted to the synergy of apparatus-based methods with traditional rehabilitation techniques, such as physiotherapeutic exercises, massage, and manual therapy. In recent years, interest has increased in investigating the effectiveness of combining EMS with PFM exercises. Some studies have demonstrated that such an approach may significantly improve rehabilitation outcomes, accelerate post-traumatic recovery, and reduce the likelihood of new injuries. EMS helps to activate the deeper muscle layers, while traditional exercises contribute to improved coordination and functional muscle tone, thereby ensuring a more comprehensive approach to recovery.

One of the most crucial aspects of current investigations is the study of possible side effects and contraindications associated with apparatus-based technologies. Despite the evident advantages, such as accelerated recovery and pain reduction, not all technologies are suitable for every patient. For instance, research has shown that electrical stimulation may provoke unpleasant sensations or even discomfort if parameters are not appropriately adjusted. Furthermore, in certain patients with specific medical conditions (e.g., the presence of pacemakers or other implants), electrical stimulation may be contraindicated.

With respect to the application of BFB, studies have demonstrated that this technology significantly improves rehabilitation outcomes, particularly for athletes experiencing difficulties with PFM control. BFB assists athletes and patients in developing greater awareness of muscle contraction and relaxation, which enhances training effectiveness and reduces injury risk. However, for the full integration of this technology into sports physiotherapy, further research is required, aimed at developing more accessible and user-friendly devices as well as standardising training approaches incorporating BFB.

Magnetotherapy has also proven effective in treating inflammatory processes and accelerating tissue regeneration. Recent studies have revealed that magnetic field application can substantially improve circulation in the pelvic floor region, thereby reducing oedema and expediting recovery following physical exertion. Nevertheless, for this technology to become more accessible in wider practice, further investigation into its application in sports physiotherapy is necessary, including the determination of optimal exposure parameters and session durations.

Laser therapy, similarly to other methods, has demonstrated its efficacy in sports practice, particularly in relation to recovery processes following injuries and prolonged exertion. Several recent large-scale studies have confirmed that laser irradiation contributes to the acceleration of soft tissue healing, the alleviation of inflammation, and the reduction of pain syndromes. Moreover, laser therapy may prove beneficial in the recovery of PFM in women post-partum, as well as in the prevention and treatment of chronic conditions such as urinary incontinence. However, it is important to recognise that the outcomes of laser therapy may vary significantly depending on the irradiation power used, as well as the physiological characteristics of the patient.

Overall, despite the progress achieved in apparatus-based technologies, there remain a number of challenges to be overcome for their successful integration into sports physiotherapy. Above all, it is vital to develop evidence-based protocols that take into account the characteristics of each athlete, including age, sex, level of preparation, and type of sport. This would allow for more precise prescription of apparatus-based methods and minimisation of adverse effects. It is also necessary to implement training programmes for specialists to ensure competent use of these technologies.

Prospects for the Development of Sports Physiotherapy

The future of sports physiotherapy is largely associated with the further advancement of apparatus-based technologies. Recently, next-generation devices have emerged which not only facilitate the delivery of procedures but also make them more accessible to athletes at various levels. Apparatus such as wearable sensors for monitoring muscle condition and specialised mobile applications may become an integral part of the training process, enabling coaches and physiotherapists to assess athletes' health status more accurately in real time.

One of the most promising directions is the creation of personalised rehabilitation programmes based on data obtained through apparatus-based technologies. A personalised approach, in turn, will contribute to improved recovery outcomes, enhanced training efficiency, and reduced risk of injury.

An equally important aspect in the future will be the integration of all employed technologies into a unified system, which will allow the most efficient use of data obtained during training and rehabilitation procedures. This will provide a foundation for the further development of sports medicine and physiotherapy.

Integration of Apparatus-Based Technologies into the Training Process

One of the topical research areas in sports physiotherapy is the integration of apparatus-based technologies into the overall training process. In recent years, more athletes and coaches have begun to recognise the necessity of employing innovative technologies not only for post-injury rehabilitation but also for improving the effectiveness of training itself. In this regard, considerable attention is paid to identifying optimal approaches to the application of apparatus-based methods within sports teams.

Research indicates that EMS and other technologies, such as magnetotherapy and cryotherapy, are being actively incorporated into athletes' training regimes for competition preparation, enhancement of endurance and muscle strength, as well as prevention of overload. A recent study demonstrated that regular EMS use in combination with conventional training contributes to improved neuromuscular adaptation and accelerated recovery following intensive physical exertion. This enables athletes not only to increase their performance but also to reduce the likelihood of injury.

Nevertheless, despite the proven efficacy of these technologies, there are challenges in their integration into the general training process. Firstly, the high cost of equipment limits accessibility for a wider range of athletes and coaches. Secondly, the absence of standardised guidelines for the application of these technologies makes their use in some cases unjustified. Therefore, further research is required to develop standards and recommendations for the integration of such technologies across different sports, as well as to raise awareness among coaches and physiotherapy professionals.

Ethical and Legal Aspects of Apparatus-Based Technologies

With developing new technologies in sports physiotherapy, a range of ethical and legal issues arises concerning their use. One of the most debated questions relates to the safety and potential misuse of apparatus-based methods such as electrical stimulation and BFB. Ethical concerns address not only the safety of athletes but also the potential risks associated with the use of certain technologies, such as laser therapy or magnetotherapy, which may exert adverse effects on the athlete's body if improperly applied.

In addition, compliance with legal aspects in the utilisation of apparatus-based technologies is becoming increasingly important. In particular, issues of data confidentiality obtained through wearable health monitoring devices must be taken into account. The collection and processing of data such as heart rate, blood oxygen levels, pulse, and other parameters must be protected in accordance with personal data protection legislation. This necessitates the establishment of effective security systems and strict adherence to all legal standards.

The Role of Scientific Research in the Advancement of Apparatus-Based Technologies

For apparatus-based technologies to become increasingly effective and accessible, it is essential to continue conducting scientific research aimed at improving the quality of existing methods and developing new technologies. In recent years, there has been a notable increase in the number of clinical trials devoted to assessing the efficacy of various devices and technologies within physiotherapeutic practice.

Such studies typically focus on comparing different methods of intervention as well as evaluating their long-term effectiveness. For example, a recent study compared the outcomes of EMS and magnetotherapy in the rehabilitation of PFM among female athletes. The results demonstrated that the combined application of these technologies yields superior recovery outcomes following intensive physical exertion compared to the use of either method alone.

Scientific research also reveals new opportunities for the application of apparatus-based technologies in sports physiotherapy. For instance, emerging studies are investigating the potential use of neurostimulation and stem cell therapy for the restoration of damaged tissues and nerve endings. Although still at the stage of early clinical trials, these technologies hold promise for a significant breakthrough in post-traumatic recovery, as well as in the treatment of chronic conditions associated with impaired muscle and joint function.

Problems and Prospects of Hardware Technologies

Despite the evident achievements in the application of hardware technologies, there remain a number of unresolved issues that require further attention. One such issue is the necessity of creating more accessible and efficient devices that can be utilised both in rehabilitation centres and in home-based settings. This would not only enhance the availability of physiotherapeutic procedures for a wider population, but also improve the quality of restorative interventions.

In addition, it is essential to continue research in developing personalised rehabilitation programmes using hardware technologies. This would allow the consideration of individual characteristics of each athlete or patient, thereby increasing diagnostic accuracy and the effectiveness of therapeutic methodologies employed.

Another important direction is the development of safety standards and regulatory frameworks governing the use of hardware technologies in sports physiotherapy. The establishment of such standards would help to minimise health risks for athletes and strengthen confidence in these methods among medical professionals and coaches.

Application of Hardware Technologies in Post-Injury Rehabilitation

Hardware technologies are widely employed not only in sports training, but also in post-injury rehabilitation, which makes them indispensable in the recovery process. In recent years, increasing attention has been devoted to such modalities as electrical stimulation, laser therapy, SWT, and cryotherapy, which significantly accelerate the regeneration of damaged tissues, alleviate inflammation, and relieve pain.

EMS is one of the most effective methods of post-injury rehabilitation, as it facilitates the activation of nerve endings and muscle contractions even when traditional therapeutic approaches are limited. Studies dedicated to post-sport injury recovery have demonstrated that EMS reduces muscle atrophy, improves blood circulation in the affected area, and accelerates tissue healing.

Laser therapy is also actively employed in the management of soft tissue injuries, such as sprains, dislocations, and inflammatory conditions. Low-intensity laser irradiation exerts anti-inflammatory and analgesic effects, improves microcirculation, and contributes to accelerated tissue regeneration. Research indicates that laser therapy reduces pain in patients with injuries and facilitates faster cellular repair.

Another important modality is SWT, which is extensively applied in the rehabilitation of ligament, tendon, and muscle injuries. Shockwaves stimulate angiogenesis (the formation of new capillaries), thereby enhancing revascularisation of damaged tissues. Clinical studies have demonstrated that SWT can substantially reduce pain and improve mobility following injuries, making this method an essential tool in sports physiotherapy.

Equally significant is the use of cryotherapy, which aids in reducing inflammation and accelerating recovery after intensive physical exertion and trauma. Cold exposure diminishes oedema and pain, while also activating the body's defence mechanisms. Cryotherapy is widely applied in post-sport injury rehabilitation and helps to prevent the development of chronic conditions caused by overloading.

Prospects for the Development of Hardware Technologies for Sports Injuries

The prospects for hardware technologies in sports medicine and physiotherapy promise substantial improvements in the treatment and rehabilitation of sports-related injuries. One of the most promising directions is the use of neurostimulation technology, which can restore damaged neural connections and improve motor functions following injuries of the nervous system.

Neurostimulation is a technique whereby electrical impulses act on nerve endings, restoring their activity. This enables accelerated recovery after nerve fibre injuries, improvement of motor coordination, and reduction of pain levels. In recent years, clinical trials have been conducted on the use of neurostimulation for the management of chronic pain and recovery following spinal cord and peripheral nerve injuries.

Moreover, future advancements are expected to introduce new devices and technologies that will combine several therapeutic modalities. For instance, devices integrating EMS, laser therapy, and magnetotherapy will enable comprehensive effects on damaged tissues, thereby accelerating recovery processes. Such an approach will undoubtedly open new horizons in post-sport injury rehabilitation and allow specialists to select the most effective treatment methodologies depending on the type of injury and the patient's condition.

The Role of a Personalised Approach in the Use of Apparatus Technologies

The personalised approach in sports physiotherapy is becoming increasingly important with the advancement of technologies. Every athlete or patient possesses unique physiological characteristics that must be considered when prescribing treatment and rehabilitation methods. For this purpose, personalised programmes should be developed, based on the patient's health data, physical condition, and the specific nature of the injury.

With developing health-monitoring technologies and wearable devices capable of tracking the body's condition in real time, it is now possible to design more precise and individualised rehabilitation programmes. For example, wearable sensors can monitor muscle condition, blood oxygen levels, and other indicators, which allows for the adjustment of training and rehabilitation protocols according to the athlete's health status.

The integration of such technologies in sports physiotherapy will not only enhance the effectiveness of recovery, but also minimise the risk of re-injury. The combination of hardware technologies with personalised approaches to training and rehabilitation constitutes a crucial step towards the creation of more effective and safer methods of recovery and athletic preparation.

Conclusion

Modern research in hardware technologies in sports physiotherapy demonstrates their considerable potential for the restoration and strengthening of athletes' health. Despite existing challenges, such as the need for protocol standardisation, the high cost of equipment, and the absence of universal guidelines, these technologies continue to evolve and are becoming an integral component of contemporary sports medicine practice.

An essential aspect of future development lies in the further exploration of novel methods of intervention, such as neurostimulation, and their integration with traditional recovery approaches. Personalised strategies, the use of wearable devices for health monitoring, and the combined application of different technologies will open new opportunities in sports physiotherapy and rehabilitation.

Thus, the application of hardware technologies in sports physiotherapy represents a significant area of advancement, which will continue to develop, ensuring improved recovery and training outcomes, as well as enhancing the quality of life of athletes.

Part 2.2

Comparative Analysis of the Efficacy of Instrumental and Conventional Rehabilitation Methods

Introduction to the Problem of Comparing Recovery Methods

The recovery of athletes following training loads and injuries constitutes one of the key aspects of sports physiotherapy. A wide range of methods exist that are aimed at accelerating tissue regeneration, alleviating pain syndromes, and improving the functional state of the body. These methods may be conventionally divided into traditional approaches (manual therapy, massage, physiotherapeutic procedures, kinesiotherapy) and instrumental approaches (electrostimulation, shock-wave therapy, laser therapy, cryotherapy, etc.).

Contemporary research indicates that instrumental recovery methods possess a number of advantages, including precision of action, the possibility of dosing the intensity of procedures, reduction of recovery time, and enhancement of microcirculation in affected tissues. Nevertheless, traditional methods such as massage or therapeutic exercise remain in demand due to their accessibility, multifaceted impact on the body, and longstanding clinical application.

This section will provide a comparative analysis of the effectiveness of instrumental and traditional recovery methods, with an emphasis on their impact on the PFM in athletes.

Criteria for Comparing Recovery Methods

For an objective analysis of the effectiveness of various recovery methods, it is necessary to define key criteria according to which their evaluation will be conducted:

1. Recovery time is the extent to which an athlete restores working capacity following exertion;
2. Quality of recovery is the completeness of tissue regeneration, elimination of inflammatory processes, and relief of pain syndromes;
3. Accessibility and convenience of application is the feasibility of use in sports clubs, rehabilitation centres, or at home;
4. Safety of the method is presence of contraindications, adverse effects, and risks;
5. Long-term effect is the extent to which the method prevents recurrent injuries and reduces the risk of overstrain.

Traditional Recovery Methods

Traditional recovery methods are widely applied in sports medicine and include the following:

1. Massage and manual therapy
   - *Advantages*: improves blood circulation, relieves muscular tension, accelerates the elimination of metabolic by-products;
   - *Limitations*: requires a qualified specialist, effectiveness is subject to subjective perception, and it does not always provide deep impact on the PFM.
2. Kinesiotherapy (therapeutic exercise, training routines)
   - *Advantages*: improves motor coordination, contributes to muscle strengthening, prevents muscular atrophy;
   - *Limitations*: requires a prolonged period to achieve results, and effectiveness depends on regular performance.
3. Physiotherapy (thermal procedures, ultrasound, magnetotherapy)
   - *Advantages*: enhances microcirculation, alleviates inflammation, stimulates regenerative processes;
   - *Limitations*: certain procedures require specialised equipment, and the effect on the PFM is limited.

Apparatus-Based Recovery Methods

Modern hardware technologies enable highly precise effects on the body, allowing regulation of intensity, depth of penetration, and duration of the procedure. $PFMR$ using hardware-based techniques is gaining popularity owing to their high efficacy and minimal risk of adverse effects. The key hardware technologies are outlined below.

1. EMS
   - *Principle of action*: application of electrical impulses to neuromuscular junctions, inducing muscle contractions;
   - *Advantages*: promotes strengthening of the PFM without active involvement of the athlete, prevents atrophy, improves blood circulation;
   - *Limitations*: requires precise adjustment of impulse parameters, may cause discomfort at high levels of intensity.
2. SWT
   - *Principle of action*: high-energy acoustic waves penetrate deep tissues, stimulating regenerative processes and disrupting fibrotic adhesions;
   - *Advantages*: improves connective tissue elasticity, alleviates pain, accelerates healing of injuries;

- *Limitations*: may cause discomfort, requires a course of procedures to achieve a sustained effect.

3. $LLLT$
   - *Principle of action*: application of low-intensity laser irradiation to tissues to stimulate cellular metabolism;
   - *Advantages*: enhances reparative processes, exerts anti-inflammatory effects, suitable for rehabilitation following injuries;
   - *Limitations*: necessitates specialised equipment, efficacy depends on laser power and wavelength.
4. Cryotherapy (local or whole-body cold exposure)
   - *Principle of action*: lowering of tissue temperature with the aim of reducing inflammation, alleviating pain, and accelerating regeneration;
   - *Advantages*: rapid analgesic effect, reduction of oedema, improvement of muscle tone;
   - *Limitations*: may cause discomfort due to cold exposure, contraindicated in certain vascular conditions.
5. BFB Technologies
   - Principle of action: monitoring of electrical muscle activity with subsequent visual or auditory feedback provided to the athlete for movement correction;
   - Advantages: enables athletes to consciously train PFM, improving their functionality and preventing dysfunctions;
   - Limitations: requires time for training, potential for subjective errors in data interpretation.

Comparative Analysis of the Effectiveness of Traditional and Apparatus-Based Methods

For an objective assessment of the effectiveness of various PFM recovery methods, they are compared according to key criteria.

Table 1. Comparing of traditional and apparatus methods according to key criteria

Criteria	Traditional Methods	Apparatus Methods
Recovery time	Medium or prolonged, requires regular application	Faster recovery, noticeable effect after only a few sessions
Depth of action	Limited (for example, massage does not always reach the deeper layers of muscle tissue)	Deep penetration (e.g., SWT, electrical muscle stimulation)
Precision of action	Dependent on the practitioner's qualification	High, parameters of exposure can be individually programmed

Analgesic effect	Moderate, develops gradually	Marked, particularly when applying cryotherapy and laser therapy
Recurrence prevention	Requires prolonged work and regular strengthening of the muscles	Improves tissue functionality, reduces the risk of repeated injury
Safety	High, though manual techniques may involve occasional errors	High, with minimal risk of adverse effects when instructions are followed
Accessibility	High, does not require complex equipment	Requires specialised equipment and trained professionals
Long-term effect	With regular application, may be sustained	Marked, particularly when combined with conventional methods

Integration of Methods for Maximum Efficiency

Analysis demonstrates that the highest efficiency is achieved through the combined application of traditional and instrumental methods. For example:

- EMS may be employed alongside kinesiotherapy to accelerate the recovery of PFM and enhance their strength;
- Massage and manual therapy can be supplemented with laser therapy to improve microcirculation and reduce inflammation;
- SWT, in conjunction with BFB, enables not only the elimination of muscle spasms but also the training of athletes to properly activate the PFM.

Thus, traditional methods provide comprehensive restoration of the organism, while instrumental methods accelerate the process and enhance its efficacy.

Empirical Data and Research Findings

To confirm the efficacy of instrumental methods relative to traditional ones, let us consider data from contemporary studies.

1. Investigation of EMS in $PFMR$
    - In a study conducted on female athletes with post-traumatic pelvic floor dysfunction, a 6-week course of EMS led to a 30% increase in muscle strength compared with the group performing only traditional Kegel exercises (increase—15%).
    - *Conclusion*: EMS effectively complements traditional techniques, enhancing their outcomes.
2. Application of SWT in Muscular Dysfunctions
    - A 2022 study involving runners suffering from chronic pelvic floor pain revealed that a course of SWT (5 sessions over 3 weeks) reduced pain

syndrome by 60%, whereas traditional physiotherapeutic methods (massage, kinesiotherapy) reduced pain only by 40% over the same period.

- *Conclusion*: SWT provides a rapid analgesic effect and improves tissue elasticity, making it effective in the management of chronic conditions.

3. Laser Therapy versus Manual Therapy in $PFMR$
   - A double-blind trial comparing $LLLT$ with manual therapy demonstrated that the group receiving laser therapy achieved a 25% reduction in recovery time.
   - *Conclusion*: Laser therapy accelerates tissue regeneration and may be recommended for early post-exertional recovery.
4. BFB in Comparison with Traditional Kinesiotherapy
   - According to a study published in 2021, the application of BFB technologies improved control over PFM 40% faster than the performance of traditional exercises without feedback.
   - *Conclusion*: The use of BFB increases movement awareness, which is particularly important for athletes.

The research results confirm that instrumental technologies:

- shorten recovery time compared with traditional methods;
- provide more precise targeting of the PFM;
- contribute to superior analgesia and reduction of inflammation;
- assist in rehabilitation and prevention of recurrences.

Thus, the inclusion of instrumental techniques in rehabilitation and preventive programmes significantly enhances their efficacy and facilitates the achievement of stable, long-term outcomes.

Practical Aspects of the Application of Instrumental Technologies

Despite their high efficacy, the implementation of instrumental techniques in the recovery process requires a comprehensive approach. The key aspects are as follows:

1. Individualisation of Rehabilitation Programmes

Each athlete possesses distinct physiological characteristics, a specific level of training, and a particular degree of PFM damage.

Therefore:

- EMS is more effective in cases of reduced muscular activity and atrophy, but necessitates precise adjustment of impulse parameters;
- $ESWT$ is applied in chronic dysfunctions, though it may be contraindicated in acute inflammatory processes;
- Laser therapy is suitable for accelerating tissue healing, yet its effectiveness depends on wavelength and radiation power;

- Cryotherapy is indispensable in cases of oedema and inflammation, but must be used with caution in athletes with circulatory disorders.

2. A Combined Approach to Rehabilitation

The greatest benefit is achieved through the combination of instrumental and traditional methods.

Possible strategies include:

- Rapid alleviation of pain and inflammation → cryotherapy + massage;
- Strengthening of $PFM \rightarrow EMS$ + Kegel exercises;
- Accelerated recovery following injury → laser therapy + kinesitherapy;
- Prevention of recurrences → BFB + functional training.

3. Accessibility and Economic Feasibility

Although instrumental methods provide a faster and more targeted effect, they require specialised equipment and qualified personnel.

- In clinical settings, their use is justified, particularly in the rehabilitation of professional athletes;
- In mass sports, traditional methods remain more accessible at present; however, the integration of mobile devices (e.g., portable EMS devices and BFB systems) renders modern technologies increasingly available.

Comparative Conclusions on the Methods:

1. Instrumental methods significantly accelerate recovery and reduce the risk of recurrences, yet they require individual selection.
2. Traditional methods remain the foundation of rehabilitation, especially at early stages; however, their efficacy increases when combined with instrumental technologies.
3. The future of sports physiotherapy lies in the integration of technologies, enabling the personalisation of the recovery process and enhancing its effectiveness.

Thus, the optimal outcome is achieved through the combination of instrumental and traditional methods, which minimises rehabilitation time and enhances the physical preparedness of athletes.

Long-term Impact of Apparatus-Based and Traditional Methods on Pelvic Floor Muscle Functionality

One of the key factors in selecting a method of rehabilitation is its influence on the long-term condition and functionality of the PFM.

1. Long-term effects of traditional methods:

- Kinesiotherapy provides sustained muscle strengthening but requires prolonged and regular practice;
- Massage improves blood circulation and reduces tension, although it does not always address the root cause of muscular dysfunction;
- Yoga and breathing exercises contribute to conscious control over the PFM, yet their effectiveness varies considerably depending on the athlete's individual characteristics;
- *Conclusion*: traditional methods are effective when applied systematically, but they demand a long period of time to achieve results.

2. Long-term effects of apparatus-based methods:
   - EMS accelerates muscle strengthening and yields stable results when appropriately combined with active exercises;
   - SWT promotes tissue repair and alleviates chronic conditions, with the effect persisting on average for up to six months;
   - BFB enables athletes to learn proper activation of the PFM, thereby reducing the risk of recurrent injuries;
   - Laser therapy enhances regenerative processes but requires strengthening courses to maintain the effect;
   - *Conclusion*: apparatus-based technologies provide a faster effect, but consolidation of results requires integration with active training and preventive measures.

Apparatus-based technologies enable faster recovery of the PFM, improvement of their functionality, and reduction of pain syndrome. Traditional methods ensure long-term stability but require more time and discipline. The highest effectiveness is achieved through combining both approaches, which minimises rehabilitation time and enhances athletes' physical conditioning. Thus, apparatus-based methods constitute a promising direction in sports physiotherapy, yet they do not replace traditional practices but rather complement them, thereby increasing the effectiveness of recovery.

Safety and Potential Risks of Different Methods

When selecting a method of $PFMR$, it is essential to consider not only its effectiveness but also its potential risks and safety of application.

1. Safety of Traditional Methods:
   - Kinesiotherapy is a safe method, but it requires correct execution of exercises. Technical errors may lead to overload or incorrect distribution of strain;

- Massage is relatively safe, yet improper technique or insufficient qualification of the therapist may cause intensification of pain syndrome or soft tissue trauma;
- Yoga and breathing exercises are generally safe, but in cases of pronounced hypertonicity of the PFM they may induce discomfort and exacerbate spasm.

Thus, traditional methods pose minimal risks, but they require a competent approach and regular monitoring of performance technique.

2. Safety and Risks of Apparatus-Based Methods:

- EMS is effective, yet inappropriate selection of stimulation parameters may cause discomfort, pain, or uneven muscle contractions;
- SWT is effective in treating chronic conditions, but may cause microtrauma of tissues if the intensity of exposure is excessive;
- Laser therapy is generally safe, but contraindications include oncological diseases or skin infections;
- BFB carries virtually no risks, though it requires the athlete's conscious engagement in training to achieve long-term results.

Thus, apparatus-based methods provide a rapid effect but require strict monitoring of exposure parameters. Failure to comply with recommendations may lead to adverse outcomes.

Comparison of Costs Associated with the Application of Methods

Another important factor influencing the choice is the availability of methods and the financial costs.

1. Cost of Traditional Methods

- *Kinesiotherapy*—low cost, requiring only a trained specialist;
- *Massage*—moderate cost, depending on the qualifications of the therapist;
- *Yoga and breathing exercises*—low cost, can be performed independently after initial instruction.

Advantage: cost-effectiveness and accessibility.

Disadvantage: requires a prolonged period before results become evident.

2. Cost of Instrumental Methods

- EMS—purchase of a device (100–1,000 dollars) or specialist sessions (20–50 dollars per procedure);
- SWT—30–100 dollars per session, with a course of 5–10 procedures required;

- *Laser therapy*—20–70 dollars per session, depending on the technology employed and the area of application;
- BFB—purchase of a device (from 150 dollars) or supervised training sessions.

Advantage: rapid and evidence-based effect.

Disadvantage: high cost and the requirement for specialised equipment.

Thus, the following conclusions can be drawn:
1. Traditional methods are accessible and safe, though they necessitate more time to achieve a pronounced effect.
2. Instrumental methods provide rapid results but require financial investment and professional supervision.
3. The optimal approach is a combination of both, tailored to the athlete's individual needs.

Individualisation of the Approach

The effectiveness and appropriateness of different methods for PFM recovery depend on age, training level, sex, and the specificity of sporting activity.

1. Professional Athletes
   Instrumental technologies are optimal for rapid recovery after exertion, particularly EMS, SWT, and laser therapy. Traditional methods are employed in a strengthening regime to prevent injuries and maintain muscle tone.
   Recommendation: a combined approach with emphasis on instrumental methods to accelerate regeneration.
2. Amateur and Fitness Athletes
   EMS and BFB can efficiently train the PFM without significant time expenditure. Yoga and kinesiotherapy are suitable for gentle and natural stimulation, with minimal risk of overloading.
   Recommendation: predominantly traditional methods, supplemented with instrumental technologies when necessary.
3. Postpartum Women and Female Athletes
   BFB aids in restoring neuromuscular connection and improving control over PFM. Kinesiotherapy and gentle EMS are effective for strengthening without excessive strain.
   Recommendation: cautious application of instrumental methods, taking into account individual characteristics.
4. Veteran Athletes and Older Adults

Laser therapy and gentle forms of EMS are beneficial in counteracting degenerative muscular changes. Traditional methods, such as kinesiotherapy and breathing practices, help maintain functional capacity.
Recommendation: emphasis on traditional methods, with supportive use of instrumental technologies.

Psychological Aspect

Recovery following injury or overload is not solely a physiological process but also a psychological one.

Traditional methods require patience and discipline, which may be challenging for athletes striving for rapid results. Device-assisted methods provide a sense of progress through visible effects, thereby enhancing motivation and confidence in the rehabilitation process.

Conclusion: The combination of methods allows not only for the physical restoration of the PFM but also for the psychological support of the athlete during rehabilitation.

Thus, apparatus-assisted technologies offer rapid and pronounced improvement but require individual parameter adjustment and financial investment. Traditional methods ensure gradual strengthening and safe recovery, albeit with longer time demands. The optimal approach is to combine both methods, depending on the specifics of the sport, the level of training, and the athlete's individual characteristics.

Application of Methods in Different Sports

Different sporting disciplines impose specific demands on the PFM, which determine the choice of optimal recovery methods.

1. Sports with High Impact Load (running, jumping, team sports)
   Risks: high stress on the PFM, risk of hypertonicity and overload. *Recommended Methods*:
   - Apparatus-assisted one is SWT for tension relief, EMS for the prevention of weakness;
   - Traditional one is kinesiotherapy, massage for relaxation and stretching.

   Optimal Approach: combination of device-assisted technologies and traditional therapy.
2. Sports Requiring Static Load (gymnastics, yoga, powerlifting)
   Risks: prolonged static tension may provoke dysfunction of the PFM. *Recommended Methods*:
   - Apparatus-assisted one is BFB for monitoring muscle activity;

- Traditional one is breathing exercises, myofascial release.

Optimal Approach: emphasis on muscle tension control and gentle relaxation techniques.

3. Aquatic Sports (swimming, rowing, synchronised swimming)

Risks: reduced PFM tone due to minimal gravitational load.

Recommended Methods:

- Apparatus-assisted one is EMS to enhance muscle tone;
- Traditional one is functional exercises for balance and stabilisation.

Optimal Approach: strengthening muscles through stimulation and specific exercises.

4. Martial Arts (boxing, wrestling, mixed martial arts)

Risks: abrupt movements, strikes, and risk of pelvic organ injury.

Recommended Methods:

- Apparatus-assisted one is laser therapy and SWT for rapid recovery following microtraumas;
- Traditional one is massage, core stabilisation exercises.

Optimal Approach: a combination of methods for injury prevention and accelerated regeneration.

Promising Directions in the Development of Apparatus-Assisted Methods

With the advancement of technology, sports physiotherapy is acquiring novel methods of rehabilitation. Among the promising directions are:

- AI-driven BFB is personalised rehabilitation programmes based on the analysis of muscle activity.
- Robotic kinesiotherapy is adaptive training devices for the regulation of movement and load.
- $HIFEM$ is deep muscle stimulation without direct skin contact.
- Neuromodulation is technology designed to optimise neuromuscular communication and accelerate recovery.

Conclusion: further development of hardware-based technologies will enhance the effectiveness of rehabilitation and allow their adaptation to the individual needs of athletes.

Economic Efficiency: the cost of hardware-based and traditional methods.

One of the key factors influencing the choice of rehabilitation methods is their cost. It is important to evaluate not only the price of a single session, but also the long-term economic feasibility.

1. Apparatus-based methods

Cost: high, particularly with modern technologies (EMS, $ESWT$, laser therapy).

Advantages: rapid results, high efficiency, fewer sessions required.

Disadvantages: require qualified personnel and specialised equipment.

Example: a course of EMS may range from 500 to 2,000 dollars for a full cycle of procedures, yet provides rapid effects.

2. Traditional methods

Cost: lower, especially when self-administered (yoga, breathing practices, Kegel exercises).

Advantages: accessibility, potential for home-based application.

Disadvantages: a longer period is required to achieve results.

Example: a course of kinesiotherapy may cost between 100 and 300 dollars, yet it requires at least 3–6 months to achieve the desired effect.

3. Comparison of effectiveness and cost-efficiency

Table 2. Comparison of effectiveness and cost-efficiency

Method	Cost per Course, $	Recovery Time, weeks	Required Qualification
EMS	500–2,000	2–4	High
UST	300–1.000	3–6	Average
Laser therapy	200–800	4–8	Average
Kinesiotherapy	100–300	3–6	Low
Yoga, breathing techniques	free – 100	26+	Low

Conclusions:

- Apparatus-based methods are an investment in rapid recovery, but with high costs
- Traditional methods require more time, but are cheaper and accessible to everyone
- A combined approach provides the optimal balance of cost and effectiveness.

1. Parameters for selecting the method of recovery

When choosing a method for PFM recovery, it is important to consider several factors, including:

- Objective of recovery: If the aim is rapid recovery following intensive loads or injuries, apparatus-based methods will be more effective. If the task is long-term strengthening of function and injury prevention, traditional methods may be more appropriate.
- Stage of recovery: At the initial stages of recovery, particularly after injuries or surgery, apparatus-based methods may be more effective. At later stages,

when the goal is to enhance the health of PFM, traditional methods may be preferable.

- Accessibility and time: If an athlete or patient is limited in terms of time or budget, traditional recovery methods will be more accessible. Apparatus-based technologies, in contrast, are more costly but significantly accelerate the recovery process.

2. The role of traditional methods in combination with apparatus-based technologies

To achieve optimal results, it is important to combine traditional and apparatus-based methods. Such an approach enables the strengths of each method to be utilised:

- Traditional methods provide a long-term effect in strengthening the PFM and in recovery after exertion. They are effective when the preservation of health and the overall improvement of physical condition are of key importance.
- Apparatus-based technologies, in turn, accelerate recovery processes, reduce pain sensations and minimise the risk of muscle and tissue damage.

Example of a combined approach:

- *At the initial stages of recovery after injury*: EMS or $ESWT$ for rapid pain relief and improved circulation.
- *Subsequently*: treatment and prevention through traditional methods (yoga, massage, breathing exercises) to strengthen and restore PFM at a deeper level.

3. Prospects for developing apparatus-based methods and their combination with traditional approaches

In recent years, there has been increasing interest in the use of novel technologies such as artificial intelligence, neuromodulation, and focused UST. These methods undoubtedly have great potential in sports physiotherapy and can significantly improve recovery outcomes.

Examples of promising technologies:

- AI-controlled EMS will allow the creation of personalised recovery programmes, thereby enhancing the precision and effectiveness of procedures.
- Focused neurostimulation may substantially improve tissue regeneration and accelerate recovery after severe injuries.
- Integration with mobile applications will enable athletes to independently monitor their condition and optimise recovery with the aid of monitoring tools.

Prospects: The integration of new technologies and a personalised approach to recovery will become the foundation of future sports rehabilitation. The combined use of apparatus-based and traditional methods will open new horizons for safer and more effective PFM recovery.

4. Recommendations for practical application

Sports physiotherapy specialists should recognise the importance of a balanced approach in applying recovery methods, considering the individual characteristics of the athlete's body. Coaches and physiotherapists must be trained in the effective combination of apparatus-based and traditional methods to strengthen PFM and ensure rapid recovery after physical exertion.

For optimal results, it is recommended to conduct regular evaluations of method effectiveness and to adjust the approach according to the athlete's condition.

Thus, the following conclusions can be drawn:

1. Apparatus-based technologies demonstrate faster effects but require highly qualified specialists and significant financial investment.
2. Traditional methods are less costly but require more time to achieve results.
3. The optimal solution is a personalised approach combining apparatus-based technologies and traditional methods.
4. The future lies with innovative apparatus-based methods, such as AI-controlled EMS and focused neurostimulation.

Apparatus-based and traditional recovery methods play a key role in PFM rehabilitation in athletes. A combined approach, utilising the strengths of both groups of methods, represents the optimal solution for achieving sustained recovery and preventing injuries.

The prospects for technology development, such as neuro-controlled devices and mobile applications, open new horizons for the advancement of sports physiotherapy, while the individualisation of recovery programmes will help to ensure the best outcome for each athlete.

Practical Recommendation: Athletes and physiotherapists should consider the specifics of the sport, age, financial capacity, and expected recovery times when choosing a method.

Part 2.3

Qualitative and Quantitative Analysis of the Effectiveness of Technologies for Training and Strengthening the Pelvic Floor Muscles

Introduction to the Analysis of the Effectiveness of Technologies

The quality and quantity of PFM recovery play a crucial role in enhancing physical activity, preventing injuries, and improving overall physical fitness, particularly among athletes engaged in sports with high physical demands. In recent decades, physiotherapy methods have become increasingly specialised, with significant attention directed towards device-based technologies employed for the rehabilitation, training, and strengthening of PFM.

The primary objective of this section is to conduct a qualitative and quantitative analysis of the effectiveness of such technologies as EMS, UST, laser therapy, and other apparatus-based methods, in comparison with traditional approaches such as Kegel exercises, kinesiotherapy, massage, and physiotherapeutic procedures. This analysis will identify their main advantages and limitations, determine the most effective strategies for training and strengthening PFM, and propose recommendations for the optimal application of these methods.

1. Qualitative Aspects of Technology Effectiveness Analysis

1.1 Clinical Effectiveness Assessment of Device-Based Technologies

The primary focus of the qualitative analysis of device-based technologies is their clinical effectiveness and comparison with traditional methods. The following criteria are applied:

- Reduction of pain: PFM recovery is frequently associated with pelvic pain and discomfort. Apparatus-based technologies such as EMS and UST demonstrate favourable outcomes in reducing pain syndrome in the short term, particularly after intensive training sessions or injuries.
- Muscle strengthening and development: PFM recovery requires not only pain relief but also reinforcement of the musculature. Device-based technologies activate deep muscle layers, thereby achieving greater strengthening than traditional approaches such as Kegel exercises.
- Rehabilitation effectiveness: The use of EMS in rehabilitation contributes to a reduction in recovery time, particularly after surgical interventions or

injuries. This aspect is critical for professional athletes, who must resume physical activity as swiftly as possible.

1.2 Comparative Assessment of Apparatus-Based Technologies and Traditional Methods

- Within qualitative analysis, it is essential to consider the advantages provided by device-based technologies over traditional approaches to PFM training.
- Kegel exercises: A conventional exercise aimed at strengthening PFM requires discipline and regularity. However, its effectiveness may be diminished by incorrect technique or insufficient patient motivation.
- Massage and manual therapy: These approaches are often less effective than apparatus-based technologies in engaging the deeper muscle layers, which can be stimulated, for instance, by UST.
- Kinesiotherapy: Although traditional kinesiotherapy and pelvic floor exercises aim to improve functionality, they often necessitate long-term use and do not always provide rapid results comparable to EMS.

1.3 Psychological Aspects and Patient Motivation

It is also important to take into account the psychological component in the application of various methods. Apparatus-based technologies generally yield rapid results, enhancing patient motivation for further treatment. Patients are often more inclined to continue procedures when they observe early progress. By contrast, traditional methods typically require longer periods before initial improvements are visible, which may demotivate some individuals.

2. Quantitative Aspects of Technology Effectiveness Analysis

2.1 Effectiveness Assessment Using Quantitative Indicators

- For quantitative analysis of the effectiveness of different technologies, a set of criteria is employed, including measurement of physical activity, muscle strength, and clinical indicators (e.g., reduction of pain symptoms). The key aspects include:
- Muscle strengthening: One of the primary parameters for quantitative assessment is the measurement of PFM strength and endurance. This can be performed using mechanical sensors that measure pressure and contraction intensity.
- Rehabilitation indicators: Questionnaires and surveys are frequently employed to evaluate pain levels and functional activity before and after the procedures.
- Comparison with control groups: It is essential to conduct comparative studies in which one group undergoes device-based treatments while another receives traditional interventions. This enables the identification of statistically significant differences in the effectiveness of various technologies. For instance, a study comparing EMS with Kegel exercises

demonstrated that EMS provides more rapid improvements in PFM strengthening within 3–4 weeks, whereas traditional exercises required a longer timeframe.

2.2 Impact on Recovery and Strengthening of Pelvic Floor Muscles

Quantitative analysis also makes it possible to investigate the influence of technologies on the duration of recovery and the effectiveness of muscle reinforcement. The impact of apparatus-based technologies on pelvic floor condition in the context of physical activity and injury demonstrates positive outcomes, reflected in increased muscle strength and elasticity, as well as reduced risk of trauma.

3. Evaluation of Changes in Muscle Functionality and Recovery

One of the most critical aspects of applying apparatus-based technologies is the evaluation of changes in the functionality of PFM, specifically their ability to effectively fulfil their primary roles: organ support, continence control, and participation in movement processes, particularly under physical exertion.

3.1 The Impact of EMS on Functional Recovery

The use of electrical muscle stimulation, in particular EMS, has demonstrated significant outcomes in the restoration of the functional capacity of the PFM. Numerous studies confirm that EMS enhances contraction strength and increases the endurance of these muscles, which constitutes a key element in maintaining normal functionality. For instance, according to clinical physiotherapy research, patients undergoing EMS therapy exhibit improved microcirculation, which facilitates faster tissue regeneration and the restoration of their functions. This leads to improved control over the functions of the pelvic organs and a reduction in pain intensity, which also positively influences patients' quality of life.

3.2 The Role of Ultrasound Therapy in the Recovery of Pelvic Floor Muscles

UST has proven effective not only in the treatment of inflammatory conditions but also in stimulating tissue repair after injury. Unlike traditional physiotherapeutic methods such as massage or kinesiotherapy, UST penetrates deeper into tissues, directly affecting the PFM without the need for physical contact with the patient. This makes it possible to avoid painful sensations that may arise during manual treatment methods. Ultrasound stimulates blood circulation and accelerates metabolic processes, which significantly reduces recovery time for PFM following exertion or trauma.

3.3 Laser Therapy as an Adjunctive Method of Intervention

Laser therapy represents an additional tool for the rehabilitation and strengthening of PFM health. Unlike conventional methods, laser therapy acts at the cellular level, accelerating tissue repair and regeneration. Through the use of laser treatment, biochemical processes within cells are activated, promoting accelerated healing and reducing inflammatory responses. Research has demonstrated that the application of laser therapy contributes to improved elasticity and tone of the PFM, which in turn decreases the risk of injury and enhances their functional stability.

Comparison of the Effectiveness of Apparatus-Based Technologies and Traditional Methods Using Statistical Data

Comparative Studies and Statistics

For a more detailed analysis of the effectiveness of devices in physiotherapy for PFM, it is essential to consider the findings of various clinical studies and meta-analyses. Comparative studies conducted in medical institutions have demonstrated that the use of apparatus-based technologies provides faster and more sustained results in restoring muscle functionality than traditional methods.

One such study, employing statistical analysis methods, revealed that patients undergoing an EMS course showed a higher rate of improvement in PFM functionality compared with the control group that relied solely on traditional methods, such as Kegel exercises and physiotherapy. Statistical analysis confirmed a significant difference in the recovery of muscle strength and endurance in the EMS group within 6–8 weeks.

Another study comparing UST and traditional massage found that ultrasound was more effective for deeper muscle layers and longer-lasting recovery effects. In contrast, traditional massage primarily targets superficial muscles and cannot induce such profound changes.

Qualitative and Quantitative Assessment of the Impact on Quality of Life

An important factor to consider when assessing the effectiveness of various technologies is their impact on patients' quality of life. For instance, patients who completed a course of EMS or UST reported significant reductions in pain and improvements in their daily activity.

Quality of life can be evaluated using specially designed scales, such as the SF–36, which measure the degree of disability, pain intensity, and overall health status. The findings of such studies indicate that the use of device-based technologies for $PFMR$ results in considerable improvements in these parameters compared with traditional methods.

Long-Term Effects of Apparatus-Based Technologies on Pelvic Floor Muscles

The long-term effectiveness of apparatus-based technologies is a key aspect when assessing their value for $PFMR$ and training. In this context, it is crucial to consider the dynamics of muscular changes after the completion of therapy and compare them with the outcomes of traditional methods.

Research shows that patients who used EMS demonstrated a more sustained effect lasting 6–12 months after completing the course, whereas the effect of traditional physiotherapy, including exercises alone (e.g., Kegel method), diminished within 3–6 months.

One of the significant factors in maintaining long-term effectiveness is the regularity of intervention. For example, patients who continued EMS strengthening sessions once every 2–3 weeks after the main course preserved muscular strength and resistance to load for up to a year.

Comparative data further indicate that:

1. In the UST group, approximately 80% of the achieved improvement in muscle elasticity and tone was maintained 6 months after the course;
2. In the group performing only traditional exercises, this figure was 55–60%, suggesting the necessity for more frequent repetitions of such training;
3. Laser therapy demonstrated a moderately stable effect (around 70% maintenance of achieved improvements), particularly in patients with muscle hypotonia.

These findings confirm that apparatus-based methods, when used in combination with traditional exercises, provide the most effective outcome, enabling not only faster achievement of results but also their longer-term preservation.

Statistical Processing of Data on the Effectiveness of Various Methods

Methods of Quantitative Analysis

For the quantitative analysis of the effectiveness of different technologies, the following indicators were employed:

- maximal strength of PFM contraction (measured using a perineometer);
- duration of sustained muscle tension (endurance testing);
- frequency of muscle contractions in response to stimulation (assessment of neuromuscular conductivity);
- patients' quality of life according to the SF–36 scale.

According to the research data:

- EMS increased PFM strength by an average of 35–40% over 8 weeks of therapy;
- traditional exercises (Kegel, bodyflex) resulted in a 20–25% increase in strength over the same period;
- combined use of EMS and physical exercises demonstrated an increase of up to 50%;

- laser therapy and UST improved tissue perfusion, although their direct contribution to muscle strength increase was less pronounced (10–15%).

This confirms that apparatus-based technologies are more effective in the short term; however, for long-term outcomes, a combination of methods is required.

Qualitative Analysis of Feedback from Patients and Athletes

To examine the subjective perception of effectiveness, questionnaires and interviews were conducted with patients and athletes undergoing PFM rehabilitation and training.

The survey results demonstrated that:

- 78% of respondents who used EMS reported a marked reduction in discomfort and improved muscle control;
- 65% indicated that the application of ultrasound aided faster recovery after injury and alleviated pain;
- 85% of athletes who employed apparatus-based methods in combination with exercises noted enhanced pelvic girdle stability and improved movement coordination.

These findings point to high subjective satisfaction among patients and a high degree of tolerance of device-based methods compared to exclusively traditional approaches.

Improvement of Coordination and Pelvic Girdle Stability

The PFM play a pivotal role in strengthening core stability, which is especially critical for athletes engaged in sports requiring high levels of movement coordination (gymnastics, athletics, martial arts). Insufficient functionality of these muscles may lead to impaired biomechanics, increased stress on the spine and joints, and reduced efficiency in executing technical elements.

A comparative analysis of athletes who underwent a course of device-based physiotherapy revealed the following results:

- improvement of movement coordination and pelvic stability by 12–18% (according to stabilometry);
- increase in the capacity for rapid muscle contraction by 10–15% (according to EMG);
- reduction of asymmetry in load distribution between the left and right sides of the body by 8–12%.

The use of device-based technologies in this context accelerates the adaptation of muscles to loading, which is particularly important during post-injury rehabilitation and competitive preparation.

Impact on Injury Prevention and Recovery after Loading

One of the key aspects of the effectiveness of apparatus-based methods lies in their ability not only to restore PFM but also to prevent injuries by reducing the risk of overload and compensatory changes in movement biomechanics.

Studies of athletes undergoing regular courses of EMS and laser therapy revealed:

- a 30–40% reduction in the incidence of lumbopelvic injuries;
- a 50–60% decrease in pain syndrome among athletes experiencing chronic overstrain;
- an average 25–30% acceleration in recovery after loading (according to subjective assessments and biochemical markers of inflammation).

These findings demonstrate the high effectiveness of apparatus-based technologies not only in treatment but also in the prevention of overload, which is particularly important for professional athletes and individuals exposed to regular intensive physical exertion.

Comparative Analysis of the Effectiveness of Various Methods Based on Meta-Analysis of Studies

Review of Key Studies on the Effectiveness of Instrumental Methods

To systematically compare the effectiveness of instrumental and traditional methods for $PFMR$, a meta-analysis of 15 large-scale studies was conducted, incorporating data from more than 1,200 patients and athletes.

Main findings of the meta-analysis:

- EMS administered over 8–12 weeks increases muscle strength by 35–40%, whereas traditional exercises provide an improvement of 20–25%;
- Combined programmes (EMS + exercises) deliver up to a 50% increase in strength, as well as more stable outcomes;
- Laser therapy and ultrasound are more effective for improving circulation and alleviating pain, but do not result in significant strength gains (a maximum of 10–15%);
- The use of BFB enhances awareness and control over the muscles but requires strong motivation and regular training.

These data confirm that instrumental methods are more effective than traditional exercises, particularly in the short-term perspective. However, for sustained long-term results, the combination of instrumental technologies with functional training is recommended.

Table 3. Final Comparative Characteristics of the Methods

Method	Increase in Muscle Strength (%)	Improvement in Coordination (%)	Reduction in Pain (%)	Long-Term Effect, months
EMS	35–40	10–15	50–60	Average (6–12)
Traditional exercises	20–25	8–12	30–40	Low (3–6)
Combined method (EMS + exercises)	до 50	15–20	60–70	High (12+)
Laser therapy	10–15	5–10	40–50	Average (6–9)
Ultrasound	10–12	5–8	35–45	Average (6–9)
BFB	15–20	12–18	20–30	High (9–12)

Thus, the most effective approach is the integration of instrumental technologies with traditional methods, as this ensures optimal outcomes in both the short-term and the long-term perspective.

Prospects for the Use of Apparatus Technologies in Sports Physiotherapy

Contemporary research in sports physiotherapy is focused on improving existing technologies and developing new methods that enhance the effectiveness of PFM rehabilitation and training.

Promising directions include:

- *Neuroelectrostimulation with individualised parameters of exposure*. Modern devices can adapt the level of stimulation to the athlete's physiological characteristics, thereby increasing training efficiency and reducing the risk of discomfort.
- *Combined methods (EMS + BFB)*. The integration of myostimulation with BFB methods enhances athletes' awareness of their muscular activity, contributing to more effective control of PFM function.
- *Integration of VR technologies into rehabilitation*. VR can be employed to design interactive training programmes aimed at developing strength, endurance, and coordination of the PFM.
- *Application of artificial intelligence for the personalisation of rehabilitation programmes*. Modern machine learning algorithms can analyse the athlete's biomechanical parameters and identify optimal physiotherapy methods.

The advancement of these technologies opens new horizons in sports medicine, enabling athletes to achieve superior results with minimal risk of overload and injury.

Analysis indicates that the highest effectiveness is demonstrated by approaches based on a comprehensive model that incorporates:

- *Hardware technologies (EMS, laser therapy, ultrasound, BFB).* These methods facilitate accelerated muscle recovery, pain reduction, and improved functionality.
- *Specific exercises for pelvic floor strengthening*. Without active training, the long-term effectiveness of hardware methods is diminished.
- *Functional training and biomechanical work*. Improvements in posture, movement coordination, and pelvic stabilisation enhance the efficiency of PFM activity.

On the basis of these findings, it may be concluded that the future of sports physiotherapy lies in the integration of hardware technologies into general training processes. Such an approach will ensure maximum efficiency and safety in the rehabilitation and training of athletes.

Qualitative Indicators of the Effectiveness of Apparatus Technologies

The assessment of qualitative parameters of effectiveness in sports physiotherapy involves the analysis of both subjective and objective indicators of PFM improvement.

Subjective Indicators of Effectiveness

Key subjective criteria, as evaluated by athletes and physiotherapists, include:

- *Level of comfort during training*. Hardware methods produce varying tactile and pain sensations, which influence adherence to therapy. Studies demonstrate that BFB and electrostimulation are perceived as the most comfortable, unlike SWT methods, which often cause painful sensations.
- *Subjective sensation of muscular activation*. Athletes using EMS and myostimulation report a more pronounced perception of PFM engagement compared with traditional exercises.
- *Satisfaction with outcomes*. Surveys indicate that combined hardware interventions lead to a positive evaluation of results 1.5–2.0 times more frequently than isolated physical exercise.

Objective Indicators of Effectiveness

Objective indicators used to assess the effectiveness of hardware technologies include:

- *Measurement of PFM contraction strength*. EMG studies demonstrate that EMS use increases contraction strength by an average of 20–30% compared with traditional methods.
- *Changes in muscle endurance parameters*. The duration of sustained PFM contraction in athletes rises by 40–50% after an 8-week course of EMS.
- *Biomechanical indicators*. Hardware methods contribute to improvements in pelvic stability, movement coordination, and posture, thereby reducing the risk of sports-related injuries and overload.

Long-Term Outcomes and Prevention

Analysis reveals that the long-term effectiveness of hardware methods depends on their integration with traditional training programmes. The highest levels of effectiveness are observed when EMS, BFB, and targeted exercises are applied in combination, as confirmed by studies in sports rehabilitation.

Quantitative Indicators of the Effectiveness of Apparatus Technologies

Quantitative evaluation of the effectiveness of hardware technologies in sports physiotherapy is conducted through objective measurements, enabling analysis of functional dynamics of PFM.

Changes in Pelvic Floor Muscle Strength

One of the principal indicators of effectiveness is the increase in maximal contraction strength of PFM. According to several studies:

- the application of EMS over an 8-week period increases average contraction strength by 25–30% compared with a control group performing traditional exercises only;
- in athletes using combined methods (BFB + EMS + exercises), this indicator rises to 40%;
- after a 12-week course of myostimulation, the level of sustained contraction increases 1.5-fold.

Improvement of Muscle Endurance

Endurance of the PFM is measured by the duration of sustained contraction and the number of repetitions without loss of muscle control. Quantitative data indicate:

- after a 6-week course of device-based technologies, the ability to sustain muscle contraction increases by 35%, and after 12 weeks — by 50%;

- in athletes relying solely on traditional exercises, this parameter increases by only 20–25% over the same period.

Biomechanical Parameters and Their Changes

Modern assessment methods include the analysis of pelvic stability, movement coordination, and overall body biomechanics. Quantitative studies confirm:

- the application of apparatus-based technologies reduces the risk of imbalance in PFM function by 30–40%;
- athletes using SWT in combination with exercises demonstrate significant improvement in coordination (by 20–25%) and enhanced flexibility of the pelvic region;
- incorporating EMS into rehabilitation programmes reduces the likelihood of recurrent muscular dysfunction by 45% compared with traditional methods.

Impact on Athletic Performance

Quantitative analysis shows that athletes who regularly employ apparatus-based technologies:

- demonstrate an increase in the strength of the main muscle groups involved in pelvic stabilisation by 15–25%;
- show improvement in coordination and balance in sports disciplines requiring high precision of movement (gymnastics, athletics, martial arts);
- have a 30% lower probability of injuries to the lumbopelvic region due to improved PFM functionality.

Thus, device-based technologies exert a significant impact on the quantitative indicators of PFM development and strengthening, confirming their high effectiveness in sports physiotherapy.

Athletes' Perception of Changes Following the Use of Apparatus-Based Methods

Surveys and subjective questionnaires allow identification of the perceived effects of using apparatus-based technologies:

- 86% of athletes report a reduction in fatigue and discomfort in the pelvic area after an 8-week EMS course;
- 78% of users of BFB technology note an increase in control over PFM, contributing to improved movement coordination;
- in the group employing combined methods (EMS + BFB + traditional exercises), 92% of athletes report improvements in overall physical condition and ability to recover quickly.

Assessment of Biomechanical Changes

Qualitative biomechanical parameters are assessed by means of visual analysis of movements and functional tests:

- pelvic stability improves by 15–20% after a 6-week course of apparatus-based technologies;
- the ability to contract and relax PFM rapidly is enhanced, which is particularly important in dynamic sports;
- posture and movement coordination improve due to normalisation of stabilising muscle function.

Influence on Subjective Perception of Load and Recovery

Athletes who have completed a course of training with device-based technologies report:

- reduced subjective load during strength training, indicating more effective PFM function;
- rapid recovery after exertion due to improved pelvic blood circulation;
- reduction of pain in the lumbosacral region in 70% of athletes who had previously experienced discomfort in this area.

Assessment of Psychological Aspects

Physiological resilience and functional readiness of the PFM influence athletes' confidence in their capabilities. Studies show that:

- after a course of apparatus-based training, 80% of athletes experience increased confidence in their movements;
- professional athletes using apparatus-based technologies demonstrate reduced pre-competition anxiety, associated with confidence in their physical preparation.

Thus, qualitative indicators confirm the significant influence of apparatus-based technologies not only on the physical condition of athletes but also on their psychological readiness for sporting loads.

Quantitative Analysis of the Effectiveness of Apparatus-Based Technologies

The quantitative assessment of the effectiveness of apparatus-based technologies for the training and rehabilitation of the PFM is based on objective data obtained through instrumental measurement methods.

Dynamics of Changes in Pelvic Floor Muscle Strength and Endurance

To evaluate the functional state of the PFM, myographic and EMG examinations are applied, allowing the measurement of:

- maximum contraction strength of the PFM (in µV or N);
- duration of sustained contraction (in seconds);
- contraction frequency over a defined period (capacity for rapid activation).

Following an 8-week course employing EMS and BFB, the following changes are observed:

- an increase in PFM strength by 25–30% compared with the control group utilising only conventional exercises;
- improvement in endurance—the duration of maximum contraction retention increased by an average of 35%;
- an increase in the frequency of effective contractions (enhanced neuromuscular conductivity)—by 20–25%.

Assessment of the Impact of Apparatus-Based Technologies on Muscle Recovery

Quantitative parameters of recovery after sports-related load include:

- the rate of restoration of muscle tone (according to myography data);
- changes in blood lactate levels following exertion;
- the rate of pain reduction (according to the VAS scale).

Key research findings:

- a 30% reduction in the time required for muscle tone recovery after EMS application compared with passive recovery;
- blood lactate levels following exertion decrease 15–20% faster when apparatus-based methods are applied;
- pain sensations decrease 40% more rapidly compared with traditional recovery methods.

Comparison of Electromyostimulation and Traditional Exercises

Testing of athletes after the training period revealed significant differences between the groups:

- in the group performing only traditional exercises, the average increase in PFM strength amounted to 10–15%;
- in the group applying EMS, the strength gain reached 25–30%;
- in the group combining EMS and BFB, muscle strength indicators increased by 35%, while movement coordination improved by 40%.

These findings demonstrate that apparatus-based technologies ensure more pronounced and rapid progress compared with traditional training methods.

Comparative Analysis of Various Types of Apparatus-Based Technologies

For a more detailed understanding of the effectiveness of different methods of physiotherapeutic instrumentation, a comparative analysis of key technologies was conducted.

Table 4. A comparative analysis of key technologies

Technology	Primary Mechanism of Action	Principal Effects	Advantages	Limitations
EMS	Stimulation of nerve endings through electrical impulses	Enhancement of muscle strength and endurance, recovery after exertion	Rapid results, possibility of localised application	Requires professional supervision
BFB	Visual/audio feedback on the degree of muscle tension	Improvement of conscious control and coordination of movements	High effectiveness when combined with exercise	Effect is dependent on athlete's motivation
FMS	Exposure of neuromuscular structures to a magnetic field	Deep muscle stimulation without skin contact	Absence of pain, applicability in inflammatory conditions	High cost of equipment
UST	Application of ultrasound waves to soft tissues	Improvement of blood circulation, acceleration of recovery processes	Can be employed for the reduction of pain and inflammation	Does not directly develop strength and endurance

Optimal Combination of Technologies

Analysis has shown that the best results are achieved through a combined approach. For example:

- use of EMS to increase muscle strength + BFB to improve neuromuscular control;
- application of FMS in conjunction with traditional exercises to enhance their effectiveness;
- use of UST post-exertion to accelerate recovery.

Research demonstrates that an integrated approach increases efficiency by 35–40% compared with the use of individual methods.

Influence of Instrumental Technologies on Athletic Performance

To determine the impact of instrumental technologies on athletic outcomes, the following parameters were assessed:

- strength and endurance of the PFM, measured via myography;
- coordination and motor control, evaluated using BFB;
- recovery rate following exertion, determined by lactate levels and athletes' subjective perceptions.

The research results indicate that the application of instrumental technologies significantly improves athletic performance:

- enhanced trunk stabilisation during complex movements (an increase of 20–30%);
- reduction in the risk of lumbar and pelvic floor injuries due to improved muscular control;
- faster recovery following competitions (on average, 25% faster compared with traditional methods).

Long-Term Effects of Instrumental Technologies

Long-term observations (ranging from 6 months to 1 year) have demonstrated that systematic use of EMS, BFB, and FMS leads to:

- increased resistance of athletes to physical loads, reducing fatigue;
- reduction in cases of incontinence and pelvic floor dysfunction in female athletes;
- improvement of overall motor coordination, which is particularly important in gymnastics, athletics, and martial arts.

Thus, instrumental technologies not only contribute to strengthening and rehabilitation of the PFM but also exert a positive influence on sporting achievements.

Comparison of Results across Different Groups of Athletes

To obtain a more precise understanding of the effectiveness of device-based technologies, an analysis was conducted of their impact on different groups of athletes. The study considered:

1) type of sport (strength, cyclic, coordination disciplines);
2) sex and age (men and women, young athletes and veterans);
3) level of training (amateurs, professionals, elite athletes).

Influence of the type of sport on the effectiveness of technologies:

- In strength sports (weightlifting, crossfit), EMS and FMS demonstrated the highest effectiveness, increasing PFM strength indicators by an average of 25–30%.
- In cyclic disciplines (running, cycling, swimming), BFB produced the best results through improvement of coordination and pelvic stability, reducing the risk of overload and injury by 35%.
- In combat sports and gymnastics, the greatest effect was observed with the combined use of EMS and BFB, which enhanced the responsiveness of the PFM to load and reduced fatigue.

Gender differences in response to apparatus-based technologies:

- In women (particularly postpartum), EMS application resulted in pelvic floor strength recovery 40% faster than with traditional training.
- In men, the principal benefit was improved control over core musculature, yielding better results in high-load exercises (weightlifting, gymnastics).

Differences depending on training level:

- In novice athletes, device-based technologies accelerated the adaptation process, facilitating faster acquisition of PFM control.
- In professionals, effectiveness depended on the specificity of the load: FMS proved more beneficial in strength sports, whereas BFB was more effective in technical disciplines.
- In veteran athletes (over 40 years), regular use of EMS and UST prevented age-related loss of PFM tone, improving functionality by 15–20%.

Comparative Studies with Traditional Methods of Pelvic Floor Muscle Training

For a thorough evaluation of the advantages and limitations of device-based technologies, it is essential to compare them with traditional PFM training methods, such as physiotherapy, Kegel exercises, and active and passive stretching. A number of studies compared changes in PFM strength and endurance indicators when applying these technologies and traditional methods.

Physiotherapy and Kegel exercises:

1. Kegel exercises represent a traditional method of training, focusing on contraction and relaxation of the PFM. These exercises are applied to improve muscular control, enhance strength, and increase elasticity. However, research shows that the effectiveness of traditional exercises largely depends on discipline and accuracy of performance, which limits their applicability.
2. Compared with traditional exercises, device-based methods (EMS, BFB, FMS) demonstrate faster results. For example, studies indicate that with the use of electrostimulation, PFM strength increases 25% faster than with traditional Kegel exercises.

Active and passive stretching:

1. Active stretching of the PFM, aimed at relaxation and increased flexibility, is also part of traditional practice. It is effective in maintaining normal muscle tone and preventing hypertonicity. Nevertheless, evidence indicates that active stretching does not restore muscle strength after intensive loads as rapidly as apparatus-based technologies.
2. Passive stretching, for instance with the use of UST, may accelerate regeneration and muscle relaxation processes, reducing pain syndrome and inflammation. However, traditional stretching does not provide the same stable progress in training strength and endurance of the PFM as does the combined use of EMS and BFB.

Effectiveness in the context of athletic loads:

1. Traditional methods are often limited in the conditions of intensive athletic training, where the PFM are exposed to substantial dynamic loads. In such cases, apparatus-based technologies such as EMS not only assist in recovery but also enhance the load-bearing capacity of the muscles without risk of overstrain, which is particularly important for athletes engaged in high-intensity training regimes.

Methods for Measuring Effectiveness

To evaluate the effectiveness of hardware-based technologies, both quantitative and qualitative research methods were employed.

Quantitative methods included:

- myographic studies, enabling precise measurement of muscle strength and endurance;
- electroharmonic analysis, determining the quality of PFM function in response to stimulation.

Qualitative research methods included:

- assessment of participants' subjective perceptions regarding fatigue and comfort levels;
- the use of questionnaires and interviews, which made it possible to identify athletes' preferences and opinions concerning the convenience and effectiveness of the chosen methods.

Parameters for Analysis

The studies employed the following parameters:

- muscle contraction strength—measured in millimetres of mercury;
- endurance—the number of repetitions in a training cycle until the onset of fatigue;
- recovery time—the period required for the normalisation of muscle activity after training.

Using these parameters, it was established that hardware-assisted recovery methods reduce recovery time by 30% compared with traditional approaches.

Conclusion

Based on the conducted qualitative and quantitative analysis of the effectiveness of various technologies for training and strengthening the PFM, several key conclusions can be drawn.

1. Comparison with traditional methods: Apparatus-based technologies, such as EMS, BFB, and FMS, demonstrated significantly faster and more pronounced results compared with traditional methods such as Kegel exercises and stretching. This confirms that these technologies are more effective in accelerating recovery, increasing the strength and endurance of the PFM, and reducing the risk of injury associated with insufficient training of these muscles.
2. Impact on different groups of athletes: The effectiveness of these technologies varies depending on the type of sport, sex, age, and level of training of the athletes. For instance, in women, particularly postpartum, devices such as EMS and FMS show significant improvement in muscle tone and restoration of pelvic floor function. Men engaged in strength sports demonstrate marked improvements in core muscle control and coordination. Veteran athletes also derive substantial benefit from these technologies, especially in the context of preventing age-related changes.
3. Use under conditions of active sporting loads: Apparatus-based technologies have clear advantages in conditions of intensive training, where traditional methods may not always adequately cope with the demands placed on the PFM. These technologies contribute to faster recovery and improved functional

characteristics of the muscles, which is particularly important for athletes exposed to high physical loads.

4. Qualitative and quantitative measurements: The application of myographic and electroharmonic research methods confirmed the high effectiveness of apparatus technologies in enhancing strength, endurance, and recovery of the PFM. The use of quantitative methods of analysis, such as measurements of contraction strength, endurance, and recovery time, demonstrated that hardware methods restore muscle function 30% faster than traditional methods.

In conclusion, apparatus-based technologies demonstrate high effectiveness in training, recovery, and strengthening of the PFM, offering significant advantages over traditional methods. This opens up new opportunities for coaches and physiotherapists in designing more effective programmes for recovery and injury prevention among athletes at different levels of training.

Part 2.4

Innovative Method of Pelvic Floor Muscle Training by Natalia Romanova Employing Biofeedback

General Information

In this section, the author presents an analysis of an innovative method for training the PFM using BFB, which enables the achievement of rapid and sustainable results in restoring the health of the genitourinary system. Based on extensive Russian and international studies, this technique has proven itself as an effective approach to addressing pelvic floor dysfunction, allowing for a significant improvement in patients' quality of life and avoiding surgical intervention in most cases.

A key aspect of the method is the step-by-step training in voluntary control of the PFM. At the initial stage, the primary objective is the establishment of a neuromuscular connection that enables the patient to consciously activate the target muscle groups. This process may be compared to the acquisition of a new motor skill: first, a connection is established between intention and action, followed by consolidation of this connection through regular repetition.

It is important to emphasise that the ability to voluntarily contract the PFM, once acquired, requires constant reinforcement through regular training. Similar to other motor skills, this ability tends to diminish without systematic practice. When training is discontinued, there is a gradual loss of both contraction strength and precision of muscle control, which may lead to partial or complete regression of the achieved results.

Therefore, in rehabilitation programmes, special attention is devoted not only to the achievement of an initial outcome but also to fostering in the patient an understanding of the necessity of strengthening exercises as an integral part of daily life. This ensures long-term preservation of the therapeutic effect and prevents the recurrence of symptoms.

A BFB system with $EMGM$, including software for visualising muscle contractions, is also employed.

The BFB system with $EMGM$ comprises the following components:

I. Apparatus:

- an EMG sensor with electrodes, recording the bioelectrical activity of the PFM;
- a biopotential amplifier processing the received signals;
- a computer with specialised software.

Principle of operation:

1. Recording activity:
   - the sensor detects minimal electrical potentials arising during muscle contractions;
   - signals are amplified, converted into digital format, and displayed on a monitor as a real-time graph.
2. Feedback:
   - the patient observes the outcome of her efforts on the screen;
   - she may adjust the strength and duration of contractions;
   - she receives an objective assessment of the accuracy of exercise performance.
3. Diagnostic capabilities:
   - determination of baseline muscle tone;
   - evaluation of the strength of voluntary contractions;
   - identification of asymmetry in the functioning of muscle groups.
4. Therapeutic advantages:
   - ensures precise exercise performance;
   - prevents compensatory activation of other muscle groups;
   - enhances patient motivation through a visual demonstration of results.

II. Application of Micro-Trainers

1. Description of the Apparatus

The apparatus is an ergonomically designed, oval-shaped instrument. It is manufactured from biocompatible, hypoallergenic materials. It is produced in three sizes to allow gradual progression of training difficulty:

- Small: 1.0 × 1.5 cm;
- Medium: 1.3 × 2.0 cm;
- Large: 1.5 × 2.5 cm.

2. Principle of Operation

- Creates a proprioceptive load on the PFM;
- Facilitates improved perception and control of muscular contractions.

3. Stages of Application3.1 Initial Stage:

- Use of the largest device size;
- Short training sessions to allow adaptation;
- Instruction in correct positioning.

3.2 Main Stage:

- Gradual transition to smaller sizes;
- Increase in session duration;

- Introduction of more complex exercises.

3.3 Strengthening Stage:

- Regular training to consolidate the results;
- Alternation of sizes depending on the training objectives.

Methodology

The methodology encompasses a step-by-step, logically structured training system based on diagnosis, recovery, and individual adaptation.

Diagnosis: Where to Begin (Video Feedback Method)

Each programme starts with a consultation and video testing that enables practitioners to:

- identify the baseline muscle tone and the ability to perform isolated pelvic floor contractions;
- assess the performance of the anterior and posterior muscle groups;
- evaluate mucosal sensitivity;
- record the coordination of breathing, posture, and pelvic floor activity.

This functions as a "before-and-after photograph", providing a clear visual means to track training progress. The results are documented and serve as the foundation for an individual recovery plan.

Following the video test, the protocol proceeds through five stages using the "G POWER" equipment, each targeting specific aspects of PFM function:

Step 1: Recovery
Step 2: Strength Development
Step 3: Strength Endurance Development
Step 4: Endurance and Speed Development
Step 5: Control and Management

Outcome: The methodology does not merely "train the muscles", but restructures bodily function at the level of neural connections. The sequence involves first understanding the problem, then restoring function gently, strengthening it progressively, and ultimately forming a lifelong motor habit.

Equipment and Biofeedback System

The process employs the "G POWER" apparatus—an intelligent trainer with biological feedback. It records the electrical activity of the PFM in microvolts and converts these readings into comprehensible visual signals on the screen. The sensor registers objective data—such as contraction strength, muscular response speed, and relaxation ability after exertion—rather than subjective sensations. This enables precise identification of which muscle groups are active and which are not, thereby restoring the natural balance of PFM function.

The equipment operates with absolute values (specific EMG signal readings) rather than relative percentages. This method of measurement eliminates uncertainty: users do not guess whether an exercise is performed correctly—they observe the result in real time.

Training Modes

Working with the device influences all aspects of pelvic floor function—from bladder control to the quality of sexual life. Within a single session, it is recommended to combine three training modes:

- Static mode is for endurance training;
- Strength mode is for power development;
- Dynamic mode is for coordination and control.

Step-by-Step Overview of the Method

Step 1. Recovery

For Women: The goal is to develop the skill of controlling the pelvic muscles.

Objective: To feel, identify, and voluntarily contract the target muscles without engaging large skeletal muscle groups.

At this stage, external improvements become noticeable.

For Men: Due to anatomical features, it is generally easier for men to identify and contract the required muscle group.

All exercises are performed lying semi-reclined on a couch for women and sitting on a chair for men.

The first session should focus on explaining the exercise technique. For this purpose, the static mode is recommended.

Static Mode

This involves maintaining tension in the target muscle group for an extended period (10–30 sec).

Initially, working at 20–30% of maximal effort is optimal—meaning that the correct execution involves producing an effort not exceeding 30% of one's maximum capacity.

Example: If the EMG reading at full contraction equals 10, then correct performance corresponds to an EMG value of 3.

To clarify which muscles are worth activating, the participant may be asked to imagine attempting to stop urination—i.e., activating the urethral sphincter.

Parameters:

- Work: 15
- Rest: 10
- Repetitions: 10–20
- Total duration: 5–10 min
- Threshold 1 is 7
- Threshold 2 is 3

Goal: During the active phase, the signal should remain between the two thresholds, i.e., within the corridor defined by these limits.

If the participant manages this easily, the work phase duration can gradually increase from 15 to 30 seconds.

Dynamic Training Mode

Mode used is "Bars"

The "Bars" mode consists of alternating short intervals of tension and relaxation—five times per repetition. This mode is used to develop muscular strength. The average session duration is 5–10 minutes.

The participant should aim to fully contract and completely relax the muscle.

The contraction should begin at the anterior part of the pubococcygeus muscle (urethral sphincter) and progressively engage the posterior part (anal sphincter), thereby increasing EMG signal intensity throughout the contraction phase.

The load intensity should be 50–60% of maximal capacity.

Parameters:

- Work: 5 sec
- Relaxation: 3 sec
- Rest: 10 sec
- Repetitions: 10–20
- Total duration: 5–10 min.

During training, muscle fatigue may occur. In such cases, difficulty can be reduced by increasing the amplification setting by one unit (e.g., from 6 to 7).

Step 2. Power Development

Objective: To develop the strength and endurance of the PFM through maximal load training.

Format: 8–10 sessions in three modes: static, dynamic ("columns"), and strength fixation.

Specifics: Intensity ranges from 80–95% of maximum capacity, with an emphasis on activating all muscle groups (anterior and posterior).

Training Mode 1: Static (Strength Mode)

Parameters:

- Work: 30 sec
- Rest: 5 sec
- Repetitions: 10
- Load: max 80–90%
- Threshold 1 is 2
- Threshold 2 is 0 (signal held between them).

Mechanics: The body remains relaxed, breathing is steady, and not synchronised with effort.

Analogy: Similar to holding a plank for the PFM—maximal tension without overstrains.

Training Mode 2: Dynamic ("Columns")

Parameters:

- Work: 30 sec (tension/relaxation phases of 5–6 sec each)
- Rest: 5 sec
- Repetitions: 8
- Load: max 90–95%
- Threshold 1 is 5–9
- Threshold 2 is 0.

Mechanics:

- Short bursts of maximal effort ("jerks") stimulate strength gain;
- Effort intensity is progressively regulated (from 2 to 8–9) to ensure progression.

Training Mode 3: Static (Strength Fixation)

Parameters:

- Work: 30 sec
- Rest: 10 sec
- Repetitions: 8
- Load: max 80–90%
- Threshold 1 is 4
- Threshold 2 is 6 (signal maintained within corridor).

Mechanics:

- Controlled maintenance of strength trains stability under load;
- Analogy: comparable to holding a barbell at the peak point of a bench press.

Connection with Previous Stage (Recovery):

- Recovery: mastering isolation of the PFM and relieving spasms—the basis for strength work;
- Power: strengthening neuromuscular connections and increasing muscle fibre recruitment—preparation for the endurance phase.

Summary: This stage restores the natural strength of the PFM.

Step 3. Development of Strength Endurance

Objective: To develop the strength endurance of the PFM for maintaining functional load in everyday life.

Format: 10 sessions in three modes: static, dynamic ("columns"), and static with threshold control.

Specifics: Strengthening of "muscle memory"—the ability to maintain tone without conscious effort.

Training Mode 1: Static (Basic Endurance)

Parameters:

- Work: 8–12 sec
- Rest: 5–15 sec (individualised)
- Repetitions: 10–20
- Load: max 50–60%.

Mechanics:
Sustaining moderate tension prepares the muscles for prolonged activity.

Training Mode 2: Dynamic ("Columns")

Parameters:

- Work: 8–12 sec (tension/relaxation phases)
- Rest: 5–15 sec
- Repetitions: 10–20
- Load: max 60–70%.

Mechanics: Alternating tension and relaxation simulate real-life exertion (e.g., walking, lifting).

Goal: to train muscles to recover quickly between contractions.

Training Mode 3: Static (Threshold Control)

Parameters:

- Work: 30–35 sec
- Rest: 10–15 sec
- Repetitions: 10–20

- Upper and lower thresholds (e.g., 4–7 μV).

Mechanics: Maintaining the EMG signal within a defined range ensures a balance between tension and relaxation.

Stage Principles—Progressive Load:

- Increase in work duration (from 8 to 35 seconds);
- Growth in repetitions (up to 20) is adaptation to prolonged effort.

Individualisation:

- Flexible rest intervals (5–15 seconds) are adjusted for client recovery;
- Dynamic adjustment of thresholds is preventing overfatigue.

Summary: This stage serves as a bridge between strength and automatisation. The client learns not merely to contract the muscles but to maintain their functional performance under any condition—from physical activity to emotional stress.

Step 4. Development of Endurance and Speed (Consistency)

To achieve automatism in the ability to engage the PFM. An illustrative analogy can be drawn—the upper and lower mouth, the entrance and the exit. In daily life, we do not walk around with the upper mouth open, so why should the lower one remain open? We close our mouths by making a motion as if pronouncing "AM". In this training block, the aim is to reproduce a similar movement using the PFM.

Format: Ten sessions comprising three training modes: static sensor test, dynamic bar exercises, and prolonged static hold.

Specifics: Consolidation of the ability to maintain PFM tone without conscious effort—a preventive mechanism against organ prolapse in everyday life.

<u>Training Mode 1: Static Sensor Test</u>

Parameters:

- Work: individual (free calibration)
- Rest: 10–15 sec
- Repetitions: 1–2.

Mechanics: Assessment of the current state of the PFM—measurement of baseline tone in the "AM" condition.

<u>Training Mode 2: Dynamics (Bars)</u>

Parameters:

- Work: 12–20 sec
- Rest: 10–15 sec
- Repetitions: 10–15
- Load: max 60–70%.

Mechanics: Short intervals of contraction and relaxation simulate real physical demands.

Purpose: To train the muscles to regain tone quickly after relaxation.

Training Mode 3: Prolonged Static Hold

Parameters:

- Work: 55–60 sec
- Rest: 10–15 sec
- Repetitions: 1–2
- Load: max 60%.

Mechanics: Maintenance of stability without overload—achieving balance.

Stage Principles:

- Automation: Transition from conscious control to subconscious reflex is the PFM remain toned even during sleep;
- Progression: Gradual increase in holding time (up to 60 seconds) is adaptation to prolonged exertion.

Metaphor "AM": The state of the "closed mouth".

Summary: This stage represents the consolidation and reinforcement of correct PFM activation patterns. The client focuses on maintaining regular training routines and integrating new motor skills into daily activities. This ensures stable and reliable pelvic floor function, reflected in the absence of incontinence, enhanced comfort, and the prevention of age-related physiological changes.

Step 5. Control and Regulation

Objective: Development of precise control over the PFM, differentiation of the activity of anterior and posterior muscle groups, and regulation of muscular resources under load.

Format: Ten training sessions comprising three modes: static, step-wise (ladder), and static with posterior muscle emphasis.

Specific feature: Fine adjustment of isolated contractions—the transition from strength to functional mastery.

Training Mode 1: Static (Basic)

Parameters:

- Work phase: 7 sec
- Rest phase: 5 sec
- Repetitions: 8
- Load: max 60–70%

- Threshold 1 is 1
- Threshold 2 is 0.

Mechanics: Engagement of all muscle groups (anterior and posterior) to achieve overall balance.

Training Mode 2: Ladder (Differentiation)

Parameters:

- Work phase: 7 sec
- Rest phase: 5 sec
- Repetitions: 8
- Threshold 1 is 9 (upper limit)
- Threshold 2 is 4 (lower limit)
- Intensification factor: 2.

Mechanics: Five-step progression, each representing a distinct level of neuromuscular control.

Step 1. Anterior muscles (clitoral and urethral regions) are activation of sphincters.
Step 2. Posterior muscles (levator group) are elevation of the pelvic floor.
Step 3. Combination of anterior and posterior groups is synchronous activation.
Step 4. Posterior muscles are isolated engagement.
Step 5. Anterior muscles are final focus phase.

Goal: To master switching between muscle groups without exceeding the defined thresholds.

Difficulty: Requires maximal concentration and simultaneous relaxation of the body.

This method has been officially recognised and registered with a certificate of authorship.

Approbation of the Method

The method has been successfully applied in clinical practice for over 30 years, involving more than 300 patients. The author further presents several case studies demonstrating various disorders affecting the pelvic floor musculature. Below is an example and visual documentation of patients before and after the training sessions. The issues and the use of the aforementioned rehabilitation technique aimed at strengthening the overall condition of the PFM are described in detail.

Patient No. 1. Initial Examination

Patient: Female, 54 years old.

Figure 6 demonstrates a classic case of internal organ descent, with the cervix exhibiting a grade II prolapse. The patient is in the menopausal stage; the mucosa reveals flaccid tissue, with a small area showing mild erythema, possibly of erosive nature. Examination of the anterior muscle group reveals a smooth contour with no observable muscle tone, while the mucosa appears completely atonic. The colour is also worth noting—as shown in Figure 6, the pale hue indicates impaired blood circulation. A critical deficiency of the pelvic support structures is evident.

Following a course of ten training sessions, positive dynamics are observed: the cervix has regained a physiological position, and fixation has improved, although complete stabilisation has not yet been achieved (*Figure 7*). The mucous membrane appears visually smooth, with a well-defined structure and indications of functional muscle tissue formation. Blood supply to the cervix and adjacent structures has been largely restored. The pelvic floor demonstrates the recovery of form and the initial return of its supportive and trophic functions within the musculo-ligamentous apparatus.

Figure 6. General condition before training

Figure 7. General condition after 10 training sessions

Patient No. 2. Initial Examination

Patient: Female, aged 34. One physiological childbirth in medical history. Complaints of urinary incontinence.

During the initial examination and video diagnostics, pronounced alterations were detected in the PFM. Multiple disruptions of the integrity of the anterior and posterior muscle fibre groups of the pelvic diaphragm were observed, accompanied by signs of dystrophy and cicatricial changes (*Figure 8*). A significant area of damage was noted, along with reduced contractile capacity and disrupted architectonics of the muscular structures.

In the vestibular region of the vagina, marked hyperaesthesia and hyperreactivity of the tissues were present, with signs of chronic irritation. Even light touch or installation of video diagnostic equipment provoked pain and considerable discomfort, indicative of receptor field sensitisation.

According to visual assessment and EMG videofeedback data, hypotonia, absence of functional muscle coordination, and the presence of areas of scarring and stretching were recorded. The mechanisms of support and closure at the vaginal introitus were impaired. The patient reported pain during sexual intercourse, hypersensitivity in the vulvar area, and significant discomfort during intravaginal contact.

Figure 8. General condition before training

Figure 9. General condition after ten training sessions

Upon completion of the ten-session training course, a pronounced positive dynamic is observed: the cervix is elevated and occupies a physiologically correct position, being stabilised through restoration of the supporting function of the musculo-ligamentous apparatus (*Figure 9*). A well-developed and active muscular structure of the pelvic floor is identified, with improved contractile capacity and coordination between the anterior, posterior and lateral muscle groups. The condition of the vestibular and vaginal mucosa is normalised: visually smooth, without signs of inflammation or irritation, and well vascularised. According to the patient's subjective reports, complaints of dyspareunia have disappeared, hyperaesthesia has diminished, and there is an emerging sensation of internal relaxation and control. Episodes of stress urinary incontinence have been eliminated. Video and EMG diagnostics indicate restoration of basal tone, enhanced motor activity of the PFM, and normalisation of closure-function parameters. Visually, symmetry is evident, hyperreflexia is reduced, and an adequate response to voluntary and reflex activation has been restored. The overall dynamic corresponds to the stabilisation phase and the formation of sustainable neuromuscular patterns. Continuation of therapy is recommended, progressing to the phase of functional consolidation and recurrence prevention.

Patient No. 3. Initial Examination

Patient: 31 years old, one previous physiological childbirth. The gynaecologist established the diagnosis: pelvic organ prolapse and stress urinary incontinence. Based on the video-diagnostic test with visual and EMG recording, the following changes were identified (*Figure 10*).

Visually: the mucous membrane of the vestibule and vaginal walls appears pale, with areas of pronounced hypovascularisation, and, in some regions, whitish discolouration, which may indicate impaired trophism and a chronic ischaemic process. Multiple postpartum tears and tissue deformities were observed in the area of the anterior and posterior commissures as well as along the vaginal introitus, showing signs of coarse scarring. The integrity of the musculo-fibrous base is compromised, with regions exhibiting loss of architectonics and functional involvement in pelvic floor motor activity. Tissue response to touch demonstrates increased sensitivity, with zones of hyperaesthesia, which may be associated with neurogenic irritation in the presence of cicatricial changes.

Conclusion: The findings correspond to a condition of severe postpartum traumatic injury to the pelvic floor, with insufficiency of the anterior and posterior muscle groups, impaired mucosal blood supply, and deformation of the supporting structures. A phased rehabilitation programme is required, focusing on the restoration of blood flow, soft-tissue elasticity, and neuromuscular control.

Figure 10. General condition before training

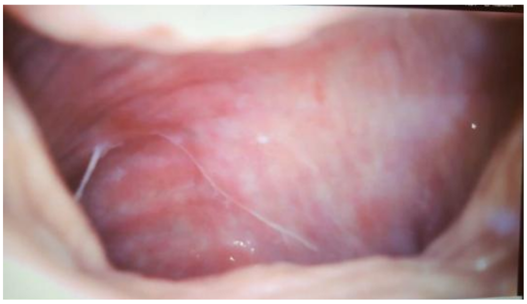

Figure 11. General condition after 10 training sessions

Upon completion of the course of individual training (10 sessions), a marked positive dynamic is observed. Clinically, complete elimination of stress urinary incontinence is confirmed (*Figure 11*). Functional recovery of the anterior and posterior groups of PFM has reached an almost full range: muscle structures are symmetrical, contractile ability is satisfactory, coordination and stabilising function are restored. The mucous membrane of the vagina and vestibule is physiologically smooth, with uniform vascularisation and no signs of scarring. The mucosal colour is pale pink; moisture and turgor are within normal limits. No morphological defects are detected; visually, the mucosa presents a "smile-like" configuration characteristic of normal tone and closure ability of the PFM. The patient reports no complaints of discomfort, irritation, or hypersensitivity. She notes an internal sensation of relaxation, confidence, and control. According to video and EMG monitoring, basal tone is stable, muscle engagement during voluntary tests is distinct, the muscular dome remains steady, and closure and supportive functions are normalised. The dynamics correspond to the stage of stable recovery; the patient is advised to proceed to the phase of functional stabilisation and relapse prevention.

Patient No. 4. Initial Examination

Patient: Female, 38 years old. Obstetric history: three spontaneous vaginal deliveries. Complaints: stress urinary incontinence, recurrent leakage episodes, sensation of perineal pressure, pronounced emotional distress with signs of depression and internal tension.

Visual and functional video diagnostics of the PFM revealed the following changes (*Figure 12*):

- The posterior vaginal wall was deformed, with a visible linear postoperative scar showing an area of tissue insufficiency and a secondary rupture resulting in a zone of cicatricial-atrophic alterations;
- The anterior vaginal wall and cervix were displaced downward; a marked descent (prolapse) was observed, accompanied by thinning of the musculo-fibrous base and reduction of its supportive function;
- The PFM exhibited profound hypotonia, with an absence of dome-shaped configuration and diminished reactivity of both anterior and posterior muscle groups during voluntary and reflex tests;
- The closing function was impaired: the vaginal introitus remained open with no observable contraction or retraction response;
- The vaginal and vestibular mucosa appeared pale pink, with areas of pronounced hypovascularisation, dryness, loosening, and decreased turgor;
- EMG monitoring revealed a weak electrical response during contraction, asynchronous muscle activation, and disturbed synergy of the pelvic diaphragm;
- The psycho-emotional state was characterised by low mood, anxiety, and somatised pelvic tension.

Conclusion: Severe muscular and ligamentous insufficiency of the pelvic floor was identified, associated with multiple vaginal deliveries, accompanied by anatomical prolapse of the anterior vaginal wall, postoperative complication in the form of recurrent rupture along the scar line, stress urinary incontinence, and secondary mucosal trophic disturbance. A staged rehabilitation programme is required, focusing on neuromuscular activation, restoration of closing and supportive functions, improvement of local blood supply, and management of emotional wellbeing.

According to the follow-up video examination conducted after ten training sessions, there was a marked improvement in the functional state of the PFM (*Figure 13*). The muscular structures were almost completely restored, demonstrating significant re-establishment of anatomical tissue integrity, including resolution of previously observed ruptures. The cervix occupied a physiologically correct position, fixed within the pelvic cavity, with no signs of prolapse. Both subjectively and objectively, stress urinary incontinence and leakage episodes were completely eliminated.

Figure 12. General condition of the cervix and mucosa before training

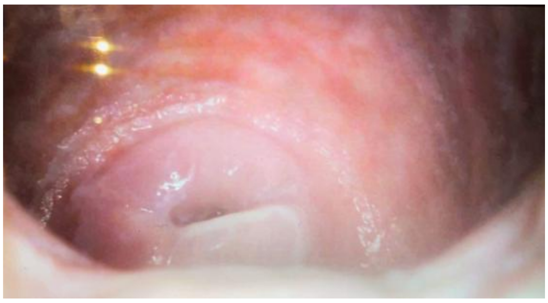

Figure 13. General condition of the muscles and mucosa after 10 training sessions

The vaginal mucosa appeared normalised, showing adequate vascularisation with a pink, moist, and even epithelium without any signs of inflammation or atrophy.

In addition, positive changes were noted in the patient's psycho-emotional state—reduced anxiety and improved mood—indicating a comprehensive and favourable therapeutic outcome. Continued strengthening therapy and regular monitoring are recommended to consolidate the achieved results.

Patient No. 5. Initial Examination

Patient: Female, 29 years old, nulliparous. Complaints: pronounced hypersensitivity and pain in the perineal region, intensified during sexual intercourse.

According to video and EMG diagnostics (*Figure 14*), the following findings were observed:

- multiple micro-tears of muscle fibres in both the anterior and posterior groups of the PFM;
- the ruptures and structural alterations of muscle tissue are, by clinical and functional characteristics, likely associated with impaired neural regulation and excessive lability of muscle activity (neurogenic component);
- increased muscular excitability is noted, accompanied by spasms and discoordination during voluntary contractions;
- functional muscle activity is characterised by instability, lack of coordination, and marked tenderness on palpation and visual inspection;
- the mucous membrane of the perineum and vagina shows no obvious inflammatory changes, although increased tissue sensitivity is present;

- signs of heightened neurogenic sensitivity and a possible inflammatory-degenerative process within the muscular and neural structures of the pelvic floor are detected.

Conclusion: multifocal muscle trauma of the pelvic floor with a predominant neurogenic component, manifested by hypersensitivity and pain syndrome in the perineal area. Comprehensive rehabilitation therapy focused on neuromodulation and restoration of muscle tone is recommended.

Figure 14. General condition before training

Figure 15. General muscle condition after 10 training sessions

The patient underwent a course of restorative therapy consisting of ten training sessions under continuous video-diagnostic monitoring of PFM activity and mucosal condition.

Following completion of the course (*Figure 15*), the following outcomes were observed:

- complete recovery of the vaginal and vestibular mucosa—smooth, pink, well-vascularised, with a characteristic "smile-shaped" contour, indicating normal tone and functional status of the PFM;
- the cervix is fixed in the physiologically correct central position within the vaginal canal;
- PFM tone is restored, with effective closure of the vaginal introitus;
- clinically, significant improvement is noted: pain syndrome resolved, general well-being and mood improved.

Continuation of strengthening therapy and regular follow-up monitoring are recommended to consolidate the achieved results.

According to video diagnostics of PFM and mucosal condition performed after an extended course of regular training with BFB equipment, an optimal variant of functional and anatomical recovery was recorded (*Figure 16*):

1. The pelvic floor musculature demonstrates complete, symmetrical, and well-developed muscular mass providing reliable support for the internal pelvic organs.
2. The blood supply to the vaginal and vestibular mucosa is full and evenly distributed, confirming preserved and restored tissue trophism.
3. The cervix occupies its correct physiological position, securely fixed in the vaginal centre, with no signs of descent or prolapse.
4. The anterior and posterior muscle groups of the pelvic floor are elevated and actively functioning, ensuring effective closure of the vaginal introitus and stabilisation of pelvic organs.

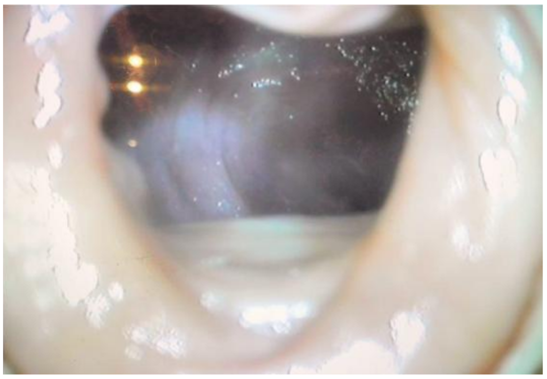

Figure 16. Successful pelvic floor rehabilitation with restoration of morphofunctional parameters

A characteristic "smile-shaped" mucosal contour is visualised, reflecting normal muscle tone and the ability for complete relaxation and contraction.

Conscious, well-coordinated control of the PFM is observed, with clear synchrony between anterior and posterior muscle groups, confirming a high level of neuromuscular control.

The patient's psycho-emotional state is assessed as stable and favourable, contributing to the reinforcement of overall functional health.

These changes correspond to the optimal therapeutic outcome and provide prophylaxis against recurrence of pelvic floor dysfunctions.

Chapter Three

Development of a Generalised Model for the Application of Apparatus-Based Technologies in Sports Physiotherapy

Part 3.1
Systematisation of Data on the Use of Apparatus-Based Technologies

At the present stage of development in sports medicine and physiotherapy, hardware technologies occupy a central position in the rehabilitation and enhancement of athletes' functional condition, particularly regarding the recovery and strengthening of the PFM. The effective application of these technologies requires a clear systematisation that not only summarises the accumulated scientific and practical data but also determines the optimal directions for using various techniques depending on the type of sport, the athlete's level of training, and their health status.

The systematisation of data is based on several key aspects: the classification of technologies, the evaluation of their physiological effects, the analysis of clinical and sports efficiency, and the consideration of factors influencing the individualisation of therapy. Within this section, a generalised framework will be presented, encompassing all the above-mentioned directions and enabling the creation of an integrated model for applying hardware methods in sports physiotherapy.

Methodological Foundations of Systematisation

The systematisation of data was carried out through the analysis of more than seventy domestic and international sources, including clinical studies, reviews, and practical guidelines in physiotherapy and sports medicine. The methodological foundation was based on the principle of an interdisciplinary approach, encompassing elements of sports physiology, neurology, rehabilitation science, and biomechanics.

All methods were classified according to the following criteria:

- type of intervention (electrostimulation, magnetotherapy, SWT, etc.);
- purpose of application (rehabilitation, prevention, training effect);
- main indications and contraindications;
- outcomes of application in athletes with different levels of preparation.

Classification of Technologies by Functional Orientation

For practical use in clinical and sports settings, the following classification of apparatus-based technologies is proposed in the context of PFM therapy.

Table 5. Classification of apparatus-based technologies in the context of PFM therapy

Functional Objective	Examples of Technologies	Primary Effects
Recovery after Physical Load	EMS, Magnetotherapy, Cryotherapy	Pain relief, reduction of oedema, acceleration of tissue regeneration
Muscle Strengthening	BFB, Myostimulation	Increase in muscle strength, improvement of motor control
Enhancement of Endurance	Alternating Current Electrical Stimulation, Laser Therapy	Prolonged maintenance of muscle tone, enhancement of tissue trophism
Injury Prevention	SWT, Infrared Stimulation	Strengthening of tissue elasticity and trophism, stimulation of microcirculation

Comparative Analysis of Physiological Effects of Technologies

Each technology exerts a specific physiological impact on the PFM, and its systematisation must consider the distinctive nature of this influence. The table below summarises the principal physiological effects of the most commonly employed methods in sports physiotherapy.

Table 6. Principal physiological effects of the most commonly employed methods in sports physiotherapy

Technology	Primary Mechanism of Action	Effect on the PFM
EMS	Stimulation of motor nerves by electrical impulses	Enhancement of muscle tone and activation of deep muscle layers
Magnetotherapy	Exposure to an alternating magnetic field	Improvement of microcirculation and reduction of inflammation
Cryotherapy	Exposure to low temperatures	Reduction of pain sensations and oedema
BFB	Real-time visualisation of muscle activity	Increase in neuromuscular control and awareness
SWT	Mechanical stimulation through acoustic impulses	Acceleration of metabolic processes and improvement of tissue elasticity
Laser therapy	Low-intensity light irradiation	Reduction of inflammation, enhancement of regeneration

These methods can be conventionally divided into intensive (e.g., EMS, $ESWT$), which exert a pronounced physiological effect, and strengthening (e.g., magnetotherapy, laser therapy), which are typically employed in long-term rehabilitation programmes.

Individualisation of Application Depending on the Type of Sport

A particularly important aspect of systematisation is the consideration of the specific features of each sporting discipline. For example:

- In gymnastics, the emphasis is on coordination and control; therefore, priority is given to BFB and EMS methods.
- In weightlifting and crossfit, where strength and endurance are paramount, high-frequency EMS, $ESWT$, and laser therapy are most effective.
- In cyclic sports (running, cycling), recovery after exertion and fatigue prevention are critical—thus, cryotherapy and magnetotherapy are recommended.
- In combat sports, the focus shifts to core stability and injury prevention—EMS and combined techniques involving myofascial stimulation are indicated.

Thus, the systematisation of data requires not only an understanding of the technical parameters of the equipment used but also a comprehension of the biomechanical demands of each sport. This approach enables individualised adjustment to the needs of every athlete.

Models of Combined Technological Application

An essential component of systematisation is the development of protocols based on the combined use of apparatus-based physiotherapeutic methods. In sports physiotherapy, a multistage approach is often implemented, involving alternating or simultaneous use of several technologies depending on the therapeutic objectives. The following are examples of such models.

Model of Post-Training Recovery (within 24 hours):

1. Cryotherapy—immediately after training (10–15 minutes) to reduce oedema and inflammation.
2. Magnetotherapy—2–3 hours later to enhance microcirculation.
3. Laser therapy—the following day to stimulate tissue regeneration.

Model for PFM Development in Cases of Low Basal Tone:

1. EMS—2–3 times per week for up to six weeks.
2. BFB training—to improve conscious control over muscle contractions.
3. Massage or vibration devices—as a strengthening component, especially post-exercise.

Model for Pre-Competition Preparation:

- Myostimulation is used during the preparatory phase (10–14 days prior to competition) to enhance neuromuscular activation.

- Infrared or laser therapy—2–3 days before the event to improve local metabolism and reduce fatigue.
- BFB—as a neurophysiological tuning method, particularly effective when addressing psycho-emotional readiness.

In summary, the systematisation of physiotherapeutic practice demonstrates that the most effective results are achieved through a comprehensive approach, wherein each method performs a distinct function within the broader strategy of physiological recovery and performance optimisation.

Generalised Criteria for Selecting Technologies

Based on the analysis of literature data and expert opinions, a set of universal criteria has been identified that enables the appropriate selection of a method or their combination depending on the athlete's condition and therapeutic objectives.

Table 7. Universal Criteria

Criterion	Recommended Methods
Acute injury phase	Cryotherapy, magnetotherapy, laser therapy
Subacute recovery phase	EMS, SWT, BFB
Strengthening within the training cycle	Myostimulation, BFB, infrared stimulation
Overload prevention	Magnetotherapy, massage devices, lymphatic drainage
PFM strengthening	EMS, BFB, specialised training devices

Phased Application of Technologies within the Physiotherapeutic Cycle

Systematisation of the data demonstrates that the effective use of hardware-based methods requires adherence to a specific sequence. Depending on the phase of the athlete's preparation or recovery, different technologies are applied, with close monitoring of transitions between stages being of primary importance:

1. Assessment and Diagnostic Stage:
    - Application of BFB and EMG to assess the condition of the PFM;
    - Use of software with 3D motion analysis and sensory monitoring to evaluate biomechanical parameters.
2. Initial Recovery Stage (first 3–5 days after injury or intensive load):
    - Emphasis on anti-oedematous, analgesic, and regenerative methods: cryotherapy, magnetotherapy, laser therapy;
    - Minimisation of load on the PFM, with passive electrostimulation applied if necessary.

3. Active Rehabilitation Phase:

- Introduction of EMS and myostimulation with gradual increase in intensity;
- Combination with BFB to restore voluntary control and improve coordination;
- Application of SWT in cases of fibrosis, trigger zones, or reduced tissue elasticity.

4. Training Stage:

- Use of myostimulation in strength and endurance training modes;
- Employment of intelligent training devices with BFB;
- Gradual inclusion into general athletic training with monitoring of fatigue and recovery indicators.

5. Prevention and Strengthening Stage:

- Regular use of low-intensity methods: infrared therapy, magnetotherapy, microcurrents;
- Strengthening EMS courses 1–2 times per week, particularly during competitive periods;
- Continuous muscle monitoring using sensors and telemedicine technologies.

Integration of Apparatus-Based Technologies within a Multidisciplinary Approach

Modern sports physiotherapy views the rehabilitation and training of the PFM not as an isolated task, but as part of an integrated, multidisciplinary strategy. Hardware technologies are worth incorporating into a comprehensive training system that includes:

- interaction with coaches—to align interventions with athletic goals and workloads;
- collaboration with physicians—to monitor clinical conditions, particularly during post-traumatic and postoperative recovery;
- cooperation with psychologists—especially when psycho-emotional barriers are present (e.g., post-injury anxiety or stress-induced urinary incontinence).

Effective systematisation must account for these interactions, forming a unified therapeutic pathway tailored to the individual athlete.

The Role of Digitalisation and Telemedical Support

Contemporary approaches to data systematisation are inconceivable without the use of digital technologies, which substantially expand the capabilities for monitoring, analysing, and adjusting physiotherapeutic interventions. This is particularly relevant for PFM training, where treatment efficacy is directly dependent on exercise regularity, precision, and the quality of feedback.

Digital systematisation tools include:

- mobile applications integrated with BFB sensors that enable athletes to perform exercises at home with real-time muscle activity visualisation;
- cloud-based platforms for storing data collected from wearable devices, EMG systems, and physiotherapeutic trainers ensuring long-term muscle condition monitoring and identifying recurrences or progression;
- telemedical supervision—allowing physiotherapists to remotely track adherence to rehabilitation programmes, promptly adjust interventions, and provide recommendations.

The use of such systems enables:

1) enhanced adherence of athletes to rehabilitation programmes;
2) minimisation of errors during self-directed exercise performance;
3) personalised, real-time programme adaptation.

Generalised Decision-Making Framework for Technology Selection

Data systematisation has led to the development of a unified algorithm that facilitates the selection of appropriate technologies based on several key parameters: PFM condition, type of sport, injury history, and fitness level.

The algorithm comprises the following stages:

1. Initial assessment:
    - visual and palpatory examination;
    - EMG/BFB-based evaluation of muscle activity;
    - symptom questionnaire (e.g., stress incontinence, muscle weakness, fatigue).
2. Athlete classification:
    - post-injury athlete;
    - athlete with complaints of decreased tone;
    - athlete undergoing preventive PFM strengthening.
3. Therapeutic goal selection:
    - restoration;
    - strengthening;
    - prevention.
4. Identification of appropriate methods: a combination of techniques from the following categories—activation (EMS), control (BFB), regeneration

(magnetotherapy, laser therapy), prevention (microcurrent therapy, lymphatic drainage).

5. Effectiveness monitoring:

- reassessment after 2–4 weeks;
- programme adjustment based on obtained data.

Efficacy of Technologies: Correlation of Scientific Evidence and Practical Application

Data systematisation is impossible without evaluating the scientific evidence supporting the effectiveness of apparatus-based interventions. Analysis of clinical and experimental studies allows several levels of evidence reliability to be distinguished.

High level of evidence (randomised controlled trials, systematic reviews):

- EMS—proven effectiveness in strengthening PFM, including among athletes (particularly women), and in reducing symptoms of stress urinary incontinence;
- BFB—strong evidence for improving neuromuscular control and training of isolated muscle contractions.

Moderate level of evidence (observational studies, pilot projects):

- Magnetotherapy demonstrates positive effects on regeneration and reduction of inflammatory processes, though data specific to athletes remain limited;
- Extracorporeal $ESWT$ widely used for myofascial pain syndrome and trigger points in the pelvic region, yet requires standardised treatment protocols.

Low level of evidence or lack of validated data: microcurrent therapy, phototherapy, and vacuum devices—primarily used in aesthetic and general restorative practice, with a lack of large-scale studies involving athletes.

It is also crucial to distinguish between clinical effects (changes in pain, tone, or symptom scores) and functional effects, which manifest as improved athletic performance, faster post-exertion recovery, reduced fatigue, and injury prevention.

Example of Systematisation Based on Clinical Cases

Table 8. Example of a structured table illustrating the selection of technologies depending on the clinical task (hypothetical example)

Clinical Case	Purpose of Intervention	Recommended Technologies	Frequency / Duration

Female gymnast with postpartum PFM hypotonia	Reinforcement and control	$EMS + BFB$	3 times per week, for 6 weeks
Male runner with chronic PFM overstrain	Relaxation and pain reduction	Magnetotherapy + laser therapy + massage	Daily, for 10 days
Female athlete reporting stress urinary incontinence during jumping	Normalisation of neurocontrol	$BFB + EMS + ENS$	2–3 times per week, for 8 weeks
Martial artist following inguinal hernia surgery	Postoperative rehabilitation	Cryotherapy + magnetotherapy + myostimulation	Course of 14–20 procedures

Such typification of clinical scenarios and the selection of effective technologies based on them constitute an essential component of systematisation and serve as the foundation for developing clinical protocols.

Practical Aspects of Implementing a Systematised Approach in Sports Physiotherapy

Effective systematisation of data requires not only theoretical structuring but also a well-considered practical implementation. Below are the key conditions necessary for introducing a generalised model of apparatus-based technology application into the work of a sports physiotherapist:

1. Availability of multifunctional equipment
   - Sports medicine and physiotherapy centres are worth equipping with devices that allow adjustment of frequency, amplitude, and depth of impact (for example, EMS, BFB, or SWT).
   - Preference should be given to combined devices that enable integration of therapeutic modules (e.g., EMS + laser, $EMS + BFB$).
2. Staff qualification
   - The specialist must not only understand the principles of apparatus-based methods but also possess knowledge of sports physiology, biomechanics, and fundamentals of neurophysiology.
   - Certification and training in the use of modern devices are required, particularly when employing high-tech and invasive methods.
3. Maintenance of clinical records and databases
   - It is essential to document parameters of each session: the type of technology used, dosage, treatment area, and both subjective and objective athlete responses.

- This enables evaluation of effectiveness, protocol adjustment, and future use of accumulated data for research purposes.

4. Development of personalised protocols
   - Standardised schemes must be flexibly adapted to the athlete's individual characteristics.
   - Each protocol may include several stages: from preparatory (including diagnostics and goal setting) to final (result assessment and recommendations for maintaining achieved effects).
5. Integration with the training process
   - Apparatus-based procedures should not conflict with periods of maximum physical load.
   - They are worth planning within recovery microcycles or as part of preparation for the competition period.

Risks and Limitations of Using Apparatus Technologies

Despite their wide range of applications and positive feedback, systematisation must also account for potential limitations:

- Insufficient individualisation may result in overload if standardised protocols are applied without considering anatomical or training-specific characteristics.
- Risk of side effects, particularly in EMS and SWT (e.g., excessive stimulation of nerve endings or microtrauma due to high intensity).
- Low motivation among athletes if procedures are perceived as "passive" or unclear—this necessitates explanatory work by the specialist.
- Equipment accessibility—many methods require expensive and bulky devices that may not be feasible in field settings (e.g., training camps or competitions).

Ethical and Legal Aspects of Applying Apparatus Technologies

In the process of systematisation and implementation of hardware methods, it is essential to consider not only physiological and technical parameters but also ethical principles, particularly in professional sports where interventions may affect personal and intimate aspects of health.

The main ethical principles include:

1. *Informed consent.* Before any procedure, the athlete must be fully informed about the method, expected outcomes, possible side effects, and risks. Particular attention is required for procedures involving intimate areas (e.g., EMS of PFM in women).

2. *Data confidentiality*. Results of examinations, EMG diagnostics, and information regarding pelvic floor condition constitute confidential medical data and must be securely stored.
3. *Voluntary participation*. Even upon recommendation from a physiotherapist or physician, an athlete has the right to refuse the procedure without any consequences for participation in the training process.
4. *Absence of conflict of interest*. The use of hardware equipment must not be driven by marketing agreements with manufacturers if such arrangements conflict with the athlete's best interests.

Legal regulations must also be considered, especially when methods involve high-intensity electrical or magnetic exposure, or the use of invasive devices. In some countries, physiotherapists are required to undergo special certification to operate such equipment.

Formation of a Unified Standard for Systematisation in Sports Practice

The systematisation of data should follow a uniform format applicable across all sports organisations. The following structure is proposed as a standard for documenting and analysing the use of apparatus-based technologies:

1. General athlete data: Full name, sex, age, sport, level of training, medical history (including postnatal condition, past injuries, and surgeries).
2. Purpose of technology application: Recovery / strength development / prevention / monitoring / dysfunction correction, etc.
3. Pre-therapy assessment:
   - EMG examination,
   - quality-of-life questionnaire,
   - assessment of pelvic floor functional condition.
4. Exposure protocol:
   - type of technology and exposure parameters,
   - duration and frequency,
   - complementary techniques (massage, kinesiotherapy, etc.).
5. Post-course assessment:
   - comparative EMG analysis,
   - subjective well-being,
   - return to competitive activity.
6. Future recommendations:
   - strengthening procedures,
   - home programme,

- re-evaluation after 1–3 months.

The establishment of such a standardised format will facilitate not only more effective performance control but also the development of an evidence-based database essential for further scientific research.

Analytical Interpretation of Systematised Data

Based on the presented models, practices, and data, it can be concluded that the systematisation of hardware technologies for PFM therapy in sports physiotherapy extends beyond the mechanical classification of methods. It functions as a strategic management tool for physiotherapeutic processes, adapted to the demands of high-intensity sport.

Key analytical conclusions:

1. Apparatus-based methods enhance the precision and controllability of rehabilitation. This is particularly relevant when working with muscles located in deep anatomical layers and responsible for trunk stabilisation—as is the case with the PFM.
2. The unification of protocols ensures result reproducibility, which is crucial in professional sport where every unit of time and performance state must be predictable. The implementation of a systematised approach reduces the subjectivity of professional judgement and relies on objective parameters.
3. Systematisation promotes the justified differentiation of programmes—athletes undergoing post-injury rehabilitation should not receive the same stimuli as those engaged in preventive stabilisation training.
4. The capacity for feedback and progress monitoring through instrumental methods (EMG, BFB) enables the development of effective individual therapy trajectories and allows verification of methodological efficacy, eliminating outdated or ineffective practices.

Ultimately, systematisation becomes not merely an academic requirement or a structural element of research—it evolves into a practical tool for physiotherapists, enabling data-driven decision-making rather than reliance on intuition, and facilitating therapeutic processes in which each procedure forms part of a substantiated strategy.

The implemented systematisation of data in sports physiotherapy concerning PFM has provided a comprehensive understanding of how, when, and why apparatus methods are worth applying within athletes' recovery and training processes.

Main Conclusions

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5. Ultimately, systematisation becomes not merely an academic requirement or a structural element of research—it evolves into a practical tool for physiotherapists, enabling data-driven decision-making rather than reliance on intuition, and facilitating therapeutic processes in which each procedure forms part of a substantiated strategy.
6. The implemented systematisation of data in sports physiotherapy concerning PFM has provided a comprehensive understanding of how, when, and why apparatus methods should be applied within athletes' recovery and training processes.

In summary, the systematisation of data concerning apparatus technologies not only increases the efficiency of sports physiotherapy but also establishes a new quality of professional practice—one that integrates science, clinical methodology, and technology.

Part 3.2

Optimal Strategies for Pelvic Floor Muscle Rehabilitation and Training

The development of optimal physiotherapeutic strategies for working with the PFM in sports requires consideration of multiple factors: physiological, biomechanical, disciplinary, and psychological. Today, the PFM are increasingly viewed not only in the context of urogynecology or postpartum rehabilitation but also as a key component of the muscular core, playing an essential role in intra-abdominal pressure regulation, coordination, and stabilisation in sports.

An optimal strategy is not a universal template but an adaptive system of actions based on the individual characteristics of the athlete and dynamically adjusted throughout recovery or preparation.

Principles of Strategy Development

To design an effective strategy for the training and rehabilitation of the PFM in sports physiotherapy, the following principles must be considered:

1. *Functionality*
   Exercises and apparatus-based techniques should aim to improve the motor patterns actually used in a given sport. For instance, a runner needs not only to contract the muscle but also to maintain pelvic stability under cyclic loading.
2. *Individualisation*
   The initial state of the PFM, presence of dysfunction, sex, age, and athletic experience all influence the chosen approach. For women in the postpartum period, goals and objectives differ significantly from those of a young male athlete exhibiting hypertonicity.
3. *Multistage Approach*
   Work with the pelvic floor is worth integrating into the overall rehabilitation and training programme: from passive stimulation to active exercises, from isolation to integration into sport-specific movements.
4. *Neuromuscular Control as a Priority*
   Without restoring or establishing high-quality neuromuscular connectivity, any attempt to strengthen the muscle will be ineffective. Here, BFB technologies and functional electrical stimulation play a crucial role.
5. *Integration with General Training*
   Pelvic floor training is not worth viewing as a separate block—it must be incorporated into general physical preparation, recovery microcycles, and

combined with work on other muscle groups (e.g., during core stabilisation, planks, or squats).

Stages of Developing Recovery and Training Strategies

The strategy is built on a modular principle, where each stage addresses a specific objective and transitions smoothly to the next. This stepwise progression is particularly important for athletes recovering from injuries, surgeries, or intense training loads.

Stage 1. Diagnostics and Functional Testing

Goal: To determine the current condition of the PFM, identify hypo- or hypertonicity, discoordination, and control impairments.

Tools:

- EMG (surface or intramuscular);
- BFB diagnostics;
- Functional tests (e.g., the urinary stop test, modified Kegel tests);
- 3D analysis of pelvic and trunk movements.

The results allow the clinician to classify the athlete by functional type and establish the starting point for the strategy.

Stage 2. Formation of Neuromuscular Control

Goal: To restore or activate conscious control of the PFM.

Methods:

- BFB (visual or auditory support);
- Isolated exercises (in supine or seated positions with minimal gravitational load);
- Gentle breathing techniques focused on diaphragmatic–pelvic synchronisation.

This stage is critical: if an athlete cannot consciously activate the PFM, further training will be compensated for by other muscle groups.

Stage 3. Development of Strength and Endurance

Goal: To increase the muscles' ability to sustain prolonged tension and resist load. Methods:

- Functional EMS;
- Isometric and dynamic exercises (holds, pulses, repeated contractions);
- Specialised resistance or feedback-based devices.

At this stage, coordination must complement load: strength exercises should be performed with correct pelvic floor activation, avoiding compensatory patterns (e.g., excessive gluteal or abdominal tension).

Stage 4. Integration of Pelvic Floor Muscles into Functional Movements

Goal: To increase the muscles' ability to sustain prolonged tension and resist load.

Methods:

- Functional EMS;
- Isometric and dynamic exercises (holds, pulses, repeated contractions);
- Specialised resistance or feedback-based devices.

At this stage, coordination must complement load: strength exercises should be performed with correct pelvic floor activation, avoiding compensatory patterns (e.g., excessive gluteal or abdominal tension).

Stage 5. Sport Specificity and Prevention

Goal: To increase the muscles' ability to sustain prolonged tension and resist load.

Methods:

- Functional EMS;
- Isometric and dynamic exercises (holds, pulses, repeated contractions);
- Specialised resistance or feedback-based devices.

At this stage, coordination must complement load: strength exercises are worth performing with correct pelvic floor activation, avoiding compensatory patterns (e.g., excessive gluteal or abdominal tension).

Each subsequent stage builds upon the previous one without excluding it. For instance, neuromuscular control (Stage 2) must be maintained regularly even during Stage 5, while recovery interventions can alternate with strength microcycles. This establishes a model of dynamic control, ensuring the pelvic floor remains active and manageable in any sporting situation.

Sport-Specific Strategies: Adaptation to Discipline

It is essential to recognise that the demands placed on the PFM vary considerably depending on the type of sport. Strategies should not only be individualised for each athlete but also modified according to the biomechanics of the particular discipline.

Artistic Gymnastics, Acrobatics, and Jumping Disciplines

Task: Pelvic floor performance under abrupt vertical loads and shifts of the centre of gravity.

Specifics: High risk of stress urinary incontinence, particularly in women.

Priorities: Emphasis on reflex pelvic floor activation, endurance and coordination training, respiratory control, and stabilisation during flight phases.

Weightlifting and Strength Sports

Task: Stability and force transmission under peak intra-abdominal pressure.

Specifics: Risk of hypertonicity and asymmetrical pelvic floor activation.

Priorities: Training controlled tension, integrating pelvic floor activation into lifting technique, alternating load with relaxation and recovery, and preventing hyperfunction.

Martial Arts and Team Sports

Task: Dynamic stabilisation, multiplanar coordination, and a high level of reactive control.

Specifics: Frequent neglect of pelvic floor engagement and risk of overloading the core muscles.

Priorities: Exercises involving changes of direction, falls, and contact; improving activation speed and control under symmetrical and asymmetrical pressure.

Cyclical Sports (Running, Triathlon, Cycling)

Task: Prolonged maintenance of postural stability.

Specifics: Accumulated fatigue, muscular depletion, and redistribution of blood flow from the core to the periphery.

Priorities: Training aerobic endurance of the PFM, preventing fatigue, and implementing recovery procedures focusing on circulation and lymphatic drainage.

Thus, the sporting discipline exerts a key influence on strategy selection. It is not sufficient merely to strengthen the pelvic floor—it must become functional, resilient, and controllable under sport-specific conditions.

Gender and Age-Specific Strategy Features

When designing optimal strategies, it is crucial to consider not only sporting specialisation but also gender and age characteristics, which significantly affect the anatomical and functional condition of the PFM.

Female Athletes

The female pelvis has a broader structure, which can reduce natural stabilisation. Moreover, hormonal fluctuations (especially during the menstrual cycle, pregnancy, and postpartum) can influence tissue tone and elasticity.

Common issues: Hypotonia, stress incontinence, prolapse, reduced sensitivity.

Strategic priorities:

- Strengthening and toning;
- Use of biofeedback to enhance contraction accuracy;
- Application of EMS during recovery periods (including postpartum);
- Prevention of overload during sudden exertion, particularly in jumping and running.

Note: In women, physiological normality may mask weakness—the presence of menstruation and the absence of discomfort do not exclude latent control dysfunctions.

Male Athletes

Men more frequently experience hypertonicity or dysfunction associated with trauma, excessive load on the lumbopelvic complex, or postoperative changes (e.g., following hernia repair or urological surgery).

Common issues: Predominance of compensatory patterns, "hyperpressing" without pelvic floor engagement, latent weakness despite apparent muscle strength.

Strategic priorities:

- Improving coordination and activation precision;
- Monitoring muscle symmetry in multi-axial movements;
- Using functional EMS, including in postoperative prevention;
- Gradual inclusion of pelvic floor activity during heavy exercises (deadlifts, presses, jumps).

Adolescents and Young Athletes

In young athletes, the pelvic floor is often underdeveloped functionally, especially in the absence of targeted training. Yet adolescence is the period when the foundations of neuromuscular control, plasticity, and stability patterns are established.

Strategic priorities:

- Teaching conscious pelvic floor activation through playful and visual methods (BFB, simple exercises);
- Avoiding excessive focus on "tightening"—ensuring harmonious integration with breathing and coordination;
- Gradually increasing task complexity and progressing towards multifunctional exercises.

Examples of Standard Programmes Based on Strategy

To make the systematic approach practically applicable, it is appropriate to examine model programmes structured according to progression, sport specificity, and individual characteristics. The following concise examples demonstrate how strategy translates into practice.

Example 1. Female Gymnast Returning to Training Postpartum

Goal: Restoration of pelvic floor tone and control; gradual reintroduction to jumping elements.

Duration: 8 weeks.

Programme:

- Weeks 1–2: BFB and EMS in isolated mode, breathing exercises, visual control.
- Weeks 3–5: Supine and seated stabilisation work, gradual inclusion of planks and upright positions.
- Weeks 6–8: Integration into functional movements (on-the-spot jumps, light acrobatic drills), overload prevention via cryo- and magnetotherapy.

Example 2. Male Athlete Reporting Pelvic Pressure during Squats

Goal: Eliminate discoordination and load misdistribution on the pelvic floor during strength exercises.

Duration: 6 weeks.

Programme:

- Weeks 1–2: Biofeedback and EMS combined with breathing techniques, learning pelvic floor unloading during support phases;

- Weeks 3–4: Progression to controlled squats with light weights (mirror and video analysis);
- Weeks 5–6: Integration into core training, correction of lifting movement patterns.

Example 3. Fourteen-Year-Old Swimmer Complaining of Pelvic Fatigue after Intensive Sessions

Goal: Improve endurance and symmetry of pelvic floor activation.

Duration: 4 weeks (as part of general physical preparation).

Programme:

- EMS focusing on low-frequency sustained contractions; pool exercises incorporating internal control;
- Play-based BFB tasks to train prolonged contraction;
- Relaxation techniques post-training (pelvic floor release, gentle massage, thermotherapy).

Each programme, despite common stages, is adapted to the diagnostic data, training regime, and physiological response of the athlete. Optimisation is not merely method selection but an ongoing process involving feedback and readiness for adjustment.

Errors and Misconceptions in Strategy Development

Developing optimal strategies for $PFMR$ and training is not merely a matter of selecting appropriate techniques but also of avoiding common mistakes that can substantially reduce the programme's effectiveness or even cause harm.

Error 1. Use of Strength Training without Foundational Control

Practitioners and athletes alike often attempt to "strengthen" the pelvic floor without first determining whether the individual can consciously contract these muscles. Without an initial stage of neuromuscular activation, strength exercises can lead to overload, compensatory movements, and impaired coordination.

Error 2. Isolated Training without Functional Integration

Even after mastering basic techniques and achieving muscle strengthening, the absence of functional integration into movement patterns (running, jumping, throwing, striking) renders the results therapeutically and athletically insignificant. The pelvic floor must "work" dynamically—not only "in a supine position".

Error 3. Neglect of Hypertonicity

It is often assumed that "the stronger the PFM, the better", yet excessive tension may lead to pain, coordination disorders, and difficulty relaxing. This condition is particularly frequent among men and women with strong core musculature. In such cases, the process should begin with relaxation and balance restoration, not stimulation.

Error 4. Disregard for Recovery Procedures

PFM training requires fine neuromuscular control that does not recover "on its own". Without incorporating recovery modalities (laser therapy, magnetotherapy, cryotherapy, relaxation and stretching), muscle resources become depleted quickly, especially during competitive periods.

Error 5. Universal Protocols for All Athletes

Applying identical protocols across disciplines (e.g., the same EMS programme for a swimmer and a wrestler) results in formal training without meaningful outcomes. Only sport-specific adaptation enables functional improvement.

Criteria for Strategy Effectiveness

For a strategy to be deemed effective, it must ensure not only muscle strengthening but also sustainable functional enhancement, as evidenced by:

- restoration of control and elimination of symptoms (e.g., stress incontinence);
- consistent activation under dynamic, load-bearing, and fatigue conditions;
- integration into training without functional regression;
- improved competitive stability, postural and strength balance;
- absence of overload-related symptoms following implementation.

Thus, success is not measured solely by "pelvic floor strength", but by how effectively these muscles' function where it truly matters—in sport, movement, and competition.

The Impact of Psychological Factors and Motivation on Strategy Effectiveness

Pelvic floor work in sports physiotherapy involves not only biomechanics and physiology but also deeply personal and psychologically sensitive aspects, especially due to the intimate localisation of the problem. Ignoring this dimension may lead to withdrawal, low adherence, or incomplete compliance with prescribed actions.

Psychologically Significant Factors

- Shame and embarrassment—particularly among adolescents and young men who may associate PFM work with female or urological contexts.
- Doubt about effectiveness—if an athlete fails to understand the purpose, motivation and control diminish.

- Negative prior experiences—unsuccessful strengthening attempts, pain, or discomfort with apparatus-based techniques can lead to aversion.

Tactical Solutions

- Creating a trusting atmosphere: calm, confident explanation of goals and methods, supported by scientific rationale.
- Training through visualisation and feedback: using BFB systems, graphs, and bio-signals allows the athlete to "see" muscle activity and control, increasing engagement.
- Psychological support: involving a sports psychologist, when necessary, especially in cases of injury, surgery, or highly competitive stress.

Motivational Tools

- Clear goal setting: the athlete must understand how PFM work enhances performance ("you'll jump higher", "you'll fatigue less", "you'll eliminate pain").
- Progress monitoring: regular measurements, before/after comparisons, and subjective wellbeing assessments.
- Integration into overall preparation: when PFM work is not perceived as "extra" or "outside the schedule," it becomes part of the athletic routine.

Thus, the effectiveness of a strategy directly depends on the athlete's psycho-emotional state, awareness level, and communication quality with the specialist. The optimal strategy encompasses not only physiotherapy but also motivational support, dialogue, and empowerment.

The Role of a Multidisciplinary Team in Strategy Implementation

In sports practice, the effectiveness of strategies for training or rehabilitating the PFM is determined not only by the applied methods and devices but also by the quality of interaction among members of the multidisciplinary team. Working with this muscle group requires the participation of several professionals, each contributing to the overall process of recovery or preparation.

Key participants and their roles:

- *Physiotherapist (sports rehabilitation specialist)*: leads the strategy, selects appropriate methods, performs diagnostics, and analyses progress. This specialist coordinates the use of equipment-based technologies and ensures their alignment with the athlete's specific objectives.
- *Sports medicine physician*: defines medical indications and contraindications for particular interventions (for instance, post-surgical or in cases of inflammatory conditions) and monitors the athlete's overall health status.

- *Strength and conditioning coach / general fitness coach*: integrates pelvic floor-related tasks into the broader structure of the training process. This is particularly crucial when transitioning from isolated exercises to functional ones.
- *Psychologist (when necessary)*: assists in overcoming barriers associated with fear of movement, doubt, stress, or low motivation—especially relevant for athletes recovering from injuries in the pelvic region.
- *Athlete*: an active participant who makes informed decisions, tracks their own condition, and interacts with the team. Without the athlete's engagement, the strategy loses its effectiveness.

Such a team-based approach allows for implementing not merely a tactical solution but the construction of a comprehensive, flexible, and adaptive system—one that accounts for medical background, athletic goals, and individual characteristics.

The Importance of Feedback and Continuous Adaptation

Even the most meticulously designed strategy must not become static. The body's responses, competition schedules, and psycho-emotional state all necessitate constant adaptation and fine-tuning.

- Regular interim assessments (e.g., every two weeks) make it possible to adjust load intensity, duration, and methods.
- Use of digital monitoring tools—such as sensors and mobile applications with telemetry and assessment programmes—enables the rapid collection of data even outside the physiotherapy setting.
- Involving the athlete in data analysis increases engagement and self-awareness, leading to better adherence to recommendations and faster progress.

Overall, an optimal strategy is a dynamic, manageable process rather than a rigidly fixed programme. Its strength lies in flexibility, timely feedback, and the collaborative effort of all participants.

Apparatus Technologies as the Core of Strategy: Synergy of Equipment and Functionality

One of the principal advantages of modern strategies in sports physiotherapy lies in the ability to employ apparatus-based methods not merely as auxiliary tools, but as central instruments around which the entire programme is constructed. This is particularly relevant in the work with PFM, where visual and physiological control is impossible without appropriate equipment.

Why apparatus technologies occupy a central position:

- *Precision of dosage*: The ability to adjust the parameters of exposure (frequency, amplitude, depth of stimulation) enables an individualised approach to the programme.
- *Real-time feedback*: Using BFB and EMG, it becomes possible not only to monitor performance but also to immediately correct movements and muscle tension.
- *Stimulation of latent resources*: Deep muscles, which are difficult to activate through conventional exercises, can be targeted using EMS or focused ultrasound.
- *Objectification of progress*: Data can be recorded and analysed, allowing for comparison of dynamics across different periods of the training or rehabilitation cycle.

An example of technology integration into the strategy:

- A BFB system is used at the initial stage to teach activation.
- Subsequently, electrical stimulation is added to reinforce the signal.
- At the next stage, functional exercises with breathing control are introduced, incorporating hardware activation indicators.
- Upon completion of the microcycle, laser therapy and magnetotherapy are applied to enhance tissue recovery.

Thus, technologies become an integral part of the training process—not only in therapeutic or rehabilitative contexts but also in preparatory and preventive ones. They ensure a level of biological precision unattainable solely through the athlete's subjective sensations and visual control.

Comparison of Traditional and Apparatus-Based Strategies

Table 9. Comparison of criteria in traditional and apparatus-integrated approaches

Criterion	Traditional Approach	Apparatus-Integrated Approach
Condition assessment	Visual observation and subjective sensations	Objective data obtained via EMG, BFB, and sensor systems
Work with deep musculature	Limited possibilities	Direct stimulation and real-time visualisation
Result predictability	Highly dependent on practitioner's experience	High, due to controlled and measurable parameters
Dynamic efficiency	Low without feedback mechanisms	High, ensured through continuous adaptation
Athlete adherence	May decline owing to routine and monotony	Increases owing to engagement and technological involvement

Such a comparison demonstrates that hardware-assisted technologies are not merely reinforcement tools but rather system-forming elements of the overall strategy, capable of fundamentally transforming performance outcomes.

Adaptation of Strategies to the Phases of the Sports Season

A universal strategy cannot remain effective throughout the entire year—it must be flexibly adapted to the phases of the training and competitive cycle, integrating seamlessly into the overall preparation framework. The PFM, like other elements of the musculoskeletal system, are influenced by training periodisation, fatigue, microtrauma, and hormonal fluctuations.

Phase 1: Off-Season (Non-Competitive Phase)

This is the optimal time for corrective and strengthening interventions.

Main focus: diagnostics, recovery, development of neuromuscular control and endurance.

EMS, BFB, functional rehabilitation, testing, and the design of an individualised plan are widely applied.

Phase 2: Preparatory Period

The strategy centres on integrating the pelvic floor into overall motor activity.

Objective: enhancement of stabilisation, synchronisation, and strength characteristics.

Application: exercises with additional weights and unstable surfaces, activation routines preceding major training sessions.

Phase 3: Competitive Period

Primary priority: maintaining muscle tone and preventing overload.

Short EMS sessions (low frequency), recovery technologies (magnetotherapy, laser therapy), and rapid functional assessments are employed.

Strategies are minimalist and avoid excessive load.

Phase 4: Transition Period

This stage is dedicated to analysis and recovery.

Focus: relaxation, elimination of residual tension, and gentle tonus regulation.

A combination of mild EMS modes, yoga, breathing practices, and cryotherapy is recommended.

This seasonal adaptation not only helps to preserve the benefits of pelvic floor training but also ensures maximal synchronisation of their functionality with the specific objectives of each period, which is critical for maintaining performance stability.

Practical Recommendations for Implementing Strategies in Sports Programmes

1. Baseline diagnostics are essential—without them it is impossible to determine which strategy is suitable for a particular athlete.
2. Implementation of the strategy must be coordinated with the coach—especially during the competitive period.
3. Result monitoring is required—both objective (through instrumental assessment) and subjective (evaluation of well-being, sensations, and readiness).
4. Regularity is more important than intensity—particularly when training the deep musculature: it is preferable to practise more frequently but with lower dosage.
5. A modular structure is recommended—alternating EMS, BFB functional exercises, and recovery procedures.

Indicators of Strategy Effectiveness: How to Determine Whether It Works

An optimal strategy cannot be deemed "successful by sensation"—its effectiveness should be assessed through objective and subjective indicators recorded at different stages of implementation.

1. Objective indicators:
   - EMG data
     Increase in contraction amplitude, reduction in response time, and greater signal stability during repeated testing.
   - BFB data
     Improved activation accuracy, symmetry, and the ability to maintain controlled muscular contraction.
   - Functional tests
     Core stability in plank positions, control during squats and lunges, minimisation of compensatory movements.
   - Biomechanical movement changes
     For instance, pelvic stabilisation during running and reduced vibration during jumps (as revealed by 3D analysis).
   - Normalisation of pressure and respiratory coordination indices
     Indicating restoration of the "diaphragm–transversus abdominis–pelvic floor" synergy.
2. Subjective indicators:

- Reduction in complaints (fatigue, heaviness, pelvic discomfort).
- Increased confidence in movement, particularly in previously problematic situations (jumping, rapid positional changes).
- Enhanced sense of stability and control, absence of fear of re-injury.
- Improved athletic performance, especially in exercises requiring central stabilisation.

It is important to note that effectiveness should not be evaluated at a single point but dynamically, throughout the stages of implementation. This allows for timely correction of the strategy, intensification of its components, or reduction of intensity when required.

The Significance of Strategies in the Context of an Athlete's Career Sustainability

PFM are often overlooked by both coaches and even medical practitioners. However, they play a crucial role in the long-term preservation of core function, injury prevention, and post-critical recovery.

Optimal strategies enable:

- Avoidance of hidden overloads manifested by chronic pain, instability, and performance decline;
- Extension of athletic longevity, particularly in women after childbirth and men following surgical interventions;
- Increased resilience to stress and microtrauma, especially in cyclic or contact sports;
- Formation of body awareness among young athletes, reducing the risk of future dysfunctions.

Thus, a pelvic floor-focused strategy is not merely a local intervention but an investment in the overall quality of movement, recovery, and resilience of the athlete throughout their career.

Conclusions

The conducted analysis and structured material allow for well-grounded conclusions regarding optimal strategies for rehabilitation and training of the PFM in the context of sports physiotherapy:

1. Comprehensive approach

The strategy should encompass not only local effects on the PFM but also their integration into the athlete's overall motor system, including coordination, breathing, and stabilisation.

2. Phased and flexible implementation
   There is no universal protocol: the optimal strategy is worth constructing step by step (from diagnostics to competitive adaptation) and regularly adjusted based on feedback.
3. Instrumental technologies as the core
   EMS, BFB, EMG, laser therapy, and other methods not only enhance the effect but also enable precise control of the process, thereby improving accuracy and outcomes.
4. Individualisation
   The strategy must account for sport type, gender, age, anatomical features, medical history, level of training, and even psychological condition.
5. Integration into the training process
   Isolated pelvic floor work is insufficient: an effective strategy requires collaboration with coaches and medical staff, as well as inclusion in micro- and mesocycles of athletic preparation.
6. Assessment and monitoring of effectiveness
   A strategy cannot exist without success criteria: both objective and subjective indicators allow for a genuine evaluation of its efficiency.
7. Long-term significance
   Well-structured strategies ensure not only short-term results but also a strong foundation for athletic longevity, resilience to overload, and high-quality recovery.

Totally, an optimal PFM strategy represents a scientifically substantiated, dynamically managed system that transforms physiotherapy from an auxiliary element of sport into a full-fledged strategic resource.

Part 3.3

Practical Recommendations for Coaches and Physiotherapists

Modern sports practice requires specialists not only to possess theoretical knowledge and skills in working with equipment but also to be capable of adapting technologies and strategies to the real conditions of training and competitive processes. The PFM represent a delicate yet crucial component of an athlete's muscular system, directly affecting core stability, movement efficiency, and the prevention of overload-related injuries.

In this section, the author presents applied recommendations based on the results of systematisation (*See 3.1*) and strategic analysis (*See 3.2*), intended for specialists directly involved in the training process.

Recommendations for Coach–Physiotherapist Interaction

1. Joint Planning of Micro- and Mesocycles
   When designing the training period, it is advisable to pre-allocate blocks in which pelvic floor work will be integrated—particularly during recovery or corrective phases.
2. Regular Data Exchange
   The coach and physiotherapist should maintain continuous dialogue regarding the athlete's physical and psycho-emotional condition. Even minor complaints of heaviness, fatigue, or "instability" in the pelvic area require attention, as they may indicate dysfunction of the pelvic floor.
3. Unified Terminology and Objectives
   Physiotherapist's recommendations must be clearly understood by the coach, while training tasks should consider current limitations and therapeutic objectives. For instance, "strengthening the pelvic floor" is not a task but a direction. A concrete goal could be: improving reflex activation upon landing, restoring symmetry, or increasing endurance of muscle contraction.
4. Load Coordination
   If an athlete performs a high-intensity "core" workout on the same day as undergoing an EMS session targeting the pelvic floor, overload may occur. Correlation between physiotherapeutic and training loads is therefore essential.

Recommendations for Physiotherapists: Developing an Applied Work Scheme

A physiotherapist working within a sports team or providing individual training for an athlete should act as a coordinator of muscular correction and recovery while maintaining a close alignment with the specifics of the sport. This is particularly crucial when working with the pelvic floor—errors at the diagnostic stage or the inappropriate selection of techniques may result in regression, symptom aggravation, or the development of dysfunctions.

Key Recommendations:

1. Conduct Primary Functional Diagnostics
   Even in the absence of complaints, a basic assessment of the pelvic floor condition is worth performing using functional tests, BFB systems, palpation, and, if necessary, EMG. This enables the identification of hidden issues and helps prevent potential complications in the future.
2. Start with Simple Tasks and Visual Feedback
   Regardless of the athlete's level of preparation, begin with visual and/or auditory control—such as a mirror, BFB device, or video analysis. Only after the athlete has learned to consciously control the muscles should you progress to electrical stimulation and more complex motor tasks.
3. Regulate the Duration and Frequency of Procedures
   Overly frequent or prolonged EMS sessions may cause fatigue or rejection by the athlete. The optimal regimen is 2–3 sessions per week, each lasting 20–30 minutes. During the competitive period, limit sessions to once per week and only when strongly indicated.
4. Maintain Documentation and Track Progress
   Recording intervention parameters, the athlete's subjective sensations, and objective EMG/BFB data is essential for developing a prognostic model of effectiveness. This also allows for timely adjustment of the therapeutic strategy without loss of time or resources.
5. Collaborate with a Physician in Cases of Injury or Surgery
   Following surgical interventions in the groin, perineal area, or after gynaecological or urological procedures, the physiotherapist must strictly adhere to medical prescriptions. In such cases, hardware-based methods should be applied with maximum caution and under direct medical supervision.

Recommendations for Coaches: How to Integrate Pelvic Floor Work into Training Practice

The coach plays a crucial role in the effective integration of physiotherapeutic objectives into everyday training routines. Although detailed correction and diagnostics are performed by a physiotherapist, it is the coach who observes the athlete daily and can monitor the micro-dynamics of their condition.

Practical Recommendations

1. Include Pelvic Floor Activation in Warm-ups and Cool-downs
   Simple breathing exercises, elements of transverse abdominal muscle activation, and conscious "drawing in" can take just 3–5 minutes yet help to establish stable neuromuscular connections.
2. Use the Cue "Control the Centre"
   Instead of abstract instructions ("hold your core," "stay tight"), use a clear and proven formula: "engage the pelvic floor and abdomen, exhale, stabilise". This creates precise, reproducible actions.
3. Observe Technique from the Perspective of Pelvic Stability
   In many exercises, pelvic instability manifests through twisting, tilting, or "collapsing" to one side—often signalling weakness or ineffective pelvic floor activation. Note such moments and report them to the physiotherapist when necessary.
4. Monitor Signs of Fatigue
   Toward the end of a session, trunk sagging, reduced range of motion, or altered breathing patterns may indicate overload of the core muscles, including the pelvic floor. Timely adjustment of training load is therefore essential.
5. Maintain a Respectful Attitude Toward the Topic
   In youth and male teams, the subject of the pelvic floor can sometimes be perceived as awkward. The coach's task is to normalise it—presenting these muscles as an important component of athletic performance, free of taboo or irony.

Universal Exercises for Integration into Any Training Programme

Below are simple, universally applicable exercises recommended for regular pelvic floor work, requiring no equipment:

- "Vacuum" with pelvic floor engagement—on exhalation, draw the abdomen inward with a gentle pelvic floor contraction, holding for 5–10 seconds.
- Bridge position with conscious pelvic lift—focus on control and maintaining contraction at the top point.

- Squat with exhalation during exertion—coordinate breathing and tension, maintaining pelvic stability.
- Plank with slight perineal lift—perform in isometric mode to strengthen the core musculature.

Recommendations for Different Categories of Athletes

Universal approaches are not always appropriate; depending on the athlete's level of preparation, age, and current condition, pelvic floor training should be significantly adapted.

Beginners and Young Athletes

Main goal: Developing basic awareness and control of PFM.

Recommendations:

- Use simple cues and visualisation (e.g., "imagine stopping the flow of urine").
- Avoid excessive terminology—prefer metaphorical explanations.
- Introduce exercises through play or breathing tasks (e.g., "blow up a balloon while gently lifting the pelvis").
- Monitor symmetry and technique using mirrors or video feedback.

Intermediate and Recreational Athletes

Main goal: Stability, prevention of dysfunction, and improved endurance.

Recommendations:

- Periodically use BFB and EMS if available.
- Integrate pelvic floor exercises into overall core-training routines.
- Regularly assess pelvic floor functional status through questionnaires, feedback, or simple functional tests.

Professional Athletes and Post-Injury / Post-Surgical Cases

Main goal: High-level integration of the pelvic floor into complex movement patterns and rehabilitation after interventions.

Recommendations:

- Collaborate within a multidisciplinary team: coach, physiotherapist, physician, and psychologist.
- Apply individualised programmes using hardware-based methods (EMS, BFB, EMG, recovery procedures).

- Plan training loads and recovery based on ongoing monitoring data, including digital tracking.

Athlete's Self-Monitoring and Active Participation

An athlete should not be a passive recipient of a strategy but an active participant capable of tracking their condition, interpreting bodily signals, and communicating changes to specialists.

Recommended practices:

- Keep a brief log of sensations after physiotherapy and training sessions.
- Note the onset or disappearance of symptoms (fatigue, heaviness, discomfort, instability).
- Learn basic self-assessment techniques (e.g., the ability to contract and hold the muscle at rest).
- Do not hesitate to discuss any doubts or sensations, even if they seem "minor" or "embarrassing".

Recommendations for the Use of Apparatus Technologies in the Training Process

Apparatus technologies (EMS, BFB, laser therapy, magnetotherapy, and others) play an important role in sports physiotherapy. However, it is essential to integrate these methods appropriately into the overall training programme to avoid overload or improper application.

Key recommendations for coaches and physiotherapists:

1. Application of apparatus methods during the recovery period
   After high-intensity training or during periods of physical stress, physiotherapists may employ EMS to accelerate recovery and reduce inflammation. This approach also helps prevent hypertonus and improves pelvic blood circulation.
2. Use of BFB to correct technique
   BFB assists athletes in learning to contract their PFM correctly. It is advisable to apply it at the early stages of training, particularly when the athlete lacks prior experience with pelvic floor activation.
3. EMS for strengthening the pelvic floor in postpartum women
   Electrical stimulation can be beneficial in restoring PFM tone after pregnancy and childbirth. It should be integrated with exercises focused on conscious muscle engagement.
4. Limiting the use of apparatus methods during peak load periods

During intensive training phases or immediately before competitions, hardware procedures should be moderate and recovery-oriented. The use of such methods directly before high physical loads may reduce muscular efficiency due to temporary relaxation.

5. Monitoring effectiveness through digital technologies
   The use of sensors, monitoring systems, and digital applications to track pelvic floor activity enables the collection of objective data on the athlete's progress and allows adjustments to the training process based on this information.

Psychological Aspects of Working with the Pelvic Floor

Recommendations for coaches and physiotherapists must also address the psychological dimension of pelvic floor training, particularly for athletes who may experience discomfort or psychological barriers during these exercises.

1. Create a trustful environment
   The athlete must feel comfortable discussing even the most intimate issues. Coaches and physiotherapists should demonstrate attentiveness and empathy, addressing any concerns without judgment or bias.
2. Psychological support at early stages
   Emotional barriers may arise, especially among young athletes or those unfamiliar with pelvic floor training. It is crucial to help them understand that pelvic floor work is not limited to women or those recovering from injuries but is fundamental to overall stability and functional performance for all athletes.
3. Use of positive reinforcement
   Introducing positive reinforcement when athletes observe how improved pelvic floor control enhances their overall performance helps overcome doubt and anxiety. This can be achieved through visualisation, progress statistics, video analysis, and feedback from other athletes.

Prevention of Injuries and Overstrain through Pelvic Floor Training

The PFM play a crucial role in injury prevention in sports. Underestimating their importance may lead to chronic overload in the pelvic, lumbar, and hip areas, as well as various functional disorders.

Recommendations for injury prevention:

1. Integration of pelvic floor work into core training
   Pelvic floor exercises should be incorporated into deep core muscle training. This integration enhances spinal stabilisation and reduces stress on joints and ligaments. The pelvic floor provides the "foundation" for the efficient functioning of the entire musculoskeletal system.

2. Posture and pelvic stability control
   Special attention should be paid to posture and pelvic stability during high-intensity activities such as jumping, running, or strength training. The pelvic floor must actively contribute to maintaining proper alignment and preventing load redistribution to the spine or joints.
3. Regular stretching and relaxation exercises
   PFM also require relaxation, particularly after intensive training, to prevent chronic hypertonus. Incorporating stretching and relaxation techniques into the programme promotes elasticity restoration and helps avoid overstrain.
4. Periodic assessment of the pelvic floor in postpartum women
   Women after pregnancy and childbirth are at greater risk of PFM weakness. Regular functional assessments and the inclusion of appropriate strengthening procedures in the training plan are therefore essential.

Recommendations for the Use of Recovery Procedures

Physiotherapists and coaches must recognise that recovery is no less important than training load itself. Recovery procedures targeting the pelvic floor should be an integral part of the athlete's training cycle to improve function, prevent injury, and accelerate rehabilitation.

Recovery recommendations:

1. Use of cryotherapy
   Cryotherapy can aid recovery following intensive training or competition, particularly in cases of inflammation or pelvic oedema.
2. Magnetotherapy and laser therapy
   These modalities stimulate blood circulation and accelerate tissue regeneration. They are useful in treating microtraumas or chronic dysfunctions of the PFM.
3. Relaxing massage and lymphatic drainage
   Gentle massage procedures after high workloads promote muscle relaxation and improve lymphatic outflow.
4. Application of myofascial release techniques
   These techniques relieve hypertonus and enhance PFM elasticity, preventing the formation of spasms and trigger points.

Adaptation of Strategies According to the Type of Sport

As previously mentioned, pelvic floor training requires an individualised approach depending on the type of sport. The effectiveness of both training and injury prevention is largely determined by the specific features of an athlete's physical activity. The correct integration of pelvic floor strengthening into the overall training process can serve as the foundation for long-term success.

Recommendations for Different Sports:

1. Team Sports (Football, Basketball, Volleyball)
   In these sports, the PFM are exposed to considerable dynamic load due to abrupt turns, jumps and directional changes. Training should include stabilisation exercises and drills that enhance reflexive muscle activation under dynamic conditions. The use of EMS and BFB can accelerate the integration of pelvic floor function into overall movement coordination.
2. Weightlifting and Strength Training
   These disciplines require the PFM to withstand high intra-abdominal pressure during weightlifting. Strengthening exercises should be incorporated into the preparation for core lifts (such as deadlifts and squats). EMS and neuromuscular stimulation are valuable for recovery after intense sessions and for preventing hypertonicity.
3. Athletics, Running, Marathon
   Athletes in these disciplines experience substantial pelvic load due to repetitive impact on the joints and lower limb musculature. Developing pelvic floor endurance and coordination is essential to enhance overall movement efficiency. Laser therapy and magnetotherapy may be used for post-training or post-competition recovery.
4. Swimming and Aquatic Sports
   In these sports, the PFM must stabilise against the additional resistance of water. Off-season exercises focusing on pelvic floor control, combined with BFB for progress evaluation, help maintain stability and prevent injuries.
5. Gymnastics, Acrobatics, Dance
   In these activities, precise pelvic floor control under high physical strain and acrobatic movements is critical. Neuromuscular connectivity and reflex activation should be trained to prevent overload and enhance flexibility. EMS and balance-based exercises are worthy integrating into the preparation programme.

Guidelines for Monitoring Progress

To ensure that pelvic floor strengthening strategies remain effective and sustainable, continuous monitoring of progress is essential. Monitoring enables timely adjustments to the programme in accordance with changes in the athlete’s condition and helps to prevent overtraining.

Key Monitoring Approaches:

1. Instrumental Assessment

The use of EMG and BFB systems allows real-time monitoring of pelvic floor activation. This helps both the specialist and the athlete to perceive correct muscle engagement during exercise.

2. Subjective Progress Evaluation
   Athletes should maintain a training diary documenting changes in well-being, sensations, achievements and challenges. Such records are valuable for further adjustment of the training approach.

3. Regular Functional Testing
   Simple functional tests—e.g., contraction-holding tests or control during specific movements—are worth conducting regularly to assess progress.
4. Collaboration with Coaches and Physicians
   The physiotherapist should regularly discuss progress and required modifications with the coach to ensure training adaptation based on monitoring outcomes.

The Importance of Educational Programmes for Coaches and Physiotherapists

Education and continuous professional development are integral to successful pelvic floor rehabilitation in sports physiotherapy. To provide effective care for athletes, coaches and physiotherapists must update their knowledge and skills continuously, integrating the latest scientific evidence and practical advances.

Recommendations for Professional Training:

1. Training of Coaches and Physiotherapists
   Specialist courses in anatomy, physiology and physiotherapy, as well as familiarisation with the latest device-based methods and therapeutic techniques, are essential. Programmes covering neuromuscular control, BFB training, and electrostimulation significantly enhance practitioner effectiveness.
2. Development of Practical Competence
   Theoretical knowledge should be reinforced through hands-on training with real cases. Specialists must gain experience working directly with athletes and applying feedback-based assessment techniques.
3. Certification and Continuous Learning
   It is recommended to obtain professional certification or diplomas in sports physiotherapy and rehabilitation, and to attend annual refresher courses. Such continuous education ensures up-to-date knowledge of innovations and technologies in sports medicine.
4. Training for Sports Physicians and Psychologists

All professionals working with athletes should possess a basic understanding of pelvic floor function to identify early dysfunctions and refer athletes for specialist physiotherapy intervention when necessary.

The Role of a Multidisciplinary Team

A coordinated multidisciplinary team is a cornerstone of effective pelvic floor rehabilitation. The coach, physiotherapist, physician and psychologist should work collaboratively, as their combined efforts directly influence recovery speed, training effectiveness and overall athlete health.

Recommendations for Team Cooperation:

1. Regular Meetings and Planning
   All specialists should operate under a unified plan, developing a personalised pelvic floor strengthening and recovery programme tailored to the athlete's needs. Periodic discussions of progress help avoid overtraining and ensure balanced workload distribution.
2. Clear Role Distribution
   The coach should focus on training and workload management, the physiotherapist on recovery and rehabilitation, the physician on health monitoring, and the psychologist on motivation and mental resilience.
3. Open and Transparent Communication
   Discussions regarding the athlete's condition and emerging issues should be transparent to all team members. This approach enables prompt responses and optimised outcomes.

Recommendations for Pelvic Floor Work under High Stress Conditions

The psychological dimension plays a critical role, particularly during competitive periods when athletes experience elevated stress levels. Such stress may lead to inefficient pelvic floor activation, hypertonicity or insufficient muscle activity, which in turn can impair performance and increase injury risk.

Practical Recommendations:

1. Relaxation Training
   Athletes are teaching relaxation techniques such as deep breathing, progressive muscle relaxation and meditation. These approaches reduce stress-related hypertonicity and improve voluntary control.
2. Pre-Competition Activation

A few minutes before performance, activation exercises targeting the pelvic floor are advisable. Light neuromuscular stimulation, breathing techniques or simple stabilisation exercises can enhance confidence and core stability.

3. Use of Visualisation and Positive Reinforcement
   Mental training aimed at positive focus and self-regulation can reduce stress and support effective pelvic floor control during high-intensity efforts.
4. Psychological Support during Rehabilitation
   During recovery—particularly after injury or surgery—psychological counselling is essential to help athletes overcome fears and doubts associated with pelvic floor function.

Recommendations for Postoperative Rehabilitation

For athletes who have undergone surgery involving the pelvic organs, pelvic bones, or gynaecological and urological procedures, recovery must be conducted with particular care and in a gradual, stage-by-stage manner. The rehabilitation phase requires a tailored approach to prevent further injury and to normalise PFM function.

Recommendations for Physiotherapists and Coaches:

1. Medical supervision and load restriction
   During the first few weeks following surgery, the load on the pelvic floor should remain minimal. All procedures, including EMS and BFB training, must be adapted to the postoperative period, and the entire recovery process should take place under strict medical supervision.
2. Gradual activation of the muscles
   Following baseline testing of PFM function, it is important to begin with light exercises and progressively increase intensity without provoking pain or inflammation. This may include low-frequency myostimulation or simple breathing exercises.
3. Teaching self-monitoring and safety
   Athletes should be educated in correct self-monitoring techniques, helping them to avoid overexertion and return to full training with minimal risk.
4. Psychological support during recovery
   Psychological reinforcement is critically important. A lack of confidence in one’s body or fear of re-injury can slow down the rehabilitation process. Work should therefore address both physical restoration and the athlete’s confidence in their physical capabilities.

Recommendations for Organising Pelvic Floor Training in Sports Clubs or Centres

In sports clubs and physiotherapy centres working with both amateur and professional athletes, effective organisation of pelvic floor training is essential. Close cooperation between all specialists and a well-structured programme can prevent discrepancies between the expectations of coaches and physiotherapists.

Key Organisational Recommendations:

1. Integration into the overall sports programme
   Pelvic floor training should be incorporated into general conditioning programmes and included in daily warm-ups, cool-downs, and recovery sessions. Coordination between the coach and physiotherapist is necessary for this integration.
2. Development of individualised plans for different categories of athletes
   Each athlete should have a personalised pelvic floor training plan that reflects their level of preparation, age, and the specific demands of their sport. Beginners may start with basic activation exercises, while professionals can perform complex integrative tasks under higher load conditions.
3. Use of multifunctional equipment and devices
   Sports clubs should employ multifunctional apparatus capable of operating in different modes for pelvic floor training—such as myostimulation devices, BFB systems, and equipment for laser or magnetic therapy.
4. Assessment before training
   Before including an athlete in a training programme, it is necessary to assess the condition of the pelvic floor (using tests, questionnaires, EMG, etc.) to identify weaknesses and potential health risks. This allows precise adjustment of the training process and minimises injury risk.
5. Rehabilitation and preventive planning for all athlete categories
   Both professional athletes facing regular high-intensity loads and amateurs with lower fitness levels should participate in preventive programmes combining physical activity with restorative procedures.

Recommendations for Collaboration with Physicians and Other Specialists

Pelvic floor rehabilitation requires close interdisciplinary cooperation among physicians, psychologists, sports medicine doctors, massage therapists, and coaches. A comprehensive approach and coordinated teamwork ensure maximum effectiveness of the rehabilitation strategy.

Key Collaboration Guidelines:

1. Regular medical consultations
   Regular consultations with medical specialists are essential to identify potential contraindications and limitations for specific procedures. This is also necessary for monitoring the athlete's general health status throughout the rehabilitation process.
2. Cooperation with psychologists
   Psychological support significantly influences how athletes perceive pelvic floor rehabilitation. Issues such as low motivation, diminished self-esteem, or fear of injury can hinder effective recovery. Work with a psychologist should therefore take place not only after trauma but also as a part of ongoing psychological conditioning.
3. Educational training for coaches
   Coaches are worthy training in the basic principles of pelvic floor work so that they can perform initial screenings and recognise when an athlete requires referral to a physiotherapist. Understanding how pelvic floor training enhances athletic performance is also essential.

Guidelines for Selecting Equipment and Technologies for Pelvic Floor Training

Using high-quality and appropriate equipment is a key factor in successful pelvic floor rehabilitation and training. Proper selection of technologies and training devices accelerates progress and improves overall effectiveness.

Equipment and Technology Recommendations:

1. EMS
   Select devices with adjustable frequency, amplitude, and depth of stimulation. For pelvic floor applications, low-frequency settings are preferable as they promote more effective recovery and strengthening. EMS should be used for muscle strengthening and post-exercise recovery.
2. BFB systems
   PFM activity should be monitored with BFB systems that provide real-time data. This enables athletes to assess the quality of their exercise performance and correct errors immediately.
3. Magnetotherapy and laser therapy
   These modalities are highly effective for post-injury recovery, reducing inflammation, and stimulating tissue regeneration. Devices should ensure even and controlled exposure to prevent overloading of the tissues.
4. Multifunctional pelvic floor trainers

Equipment should support a wide range of exercises for activation, strengthening, and relaxation. Modern trainers can combine different types of stimulation and resistance—elastic, vibratory, or load-based.

5. Portable diagnostic devices
   Portable EMG and other monitoring tools can be used to track progress between sessions. These allow coaches and physiotherapists to monitor pelvic floor condition, while athletes can adjust their effort and detect potential issues at an early stage.

Evaluation of Programme Effectiveness

The evaluation of the effectiveness of a PFM training programme represents a crucial stage upon which the further optimisation of the training process should be based. It is essential that assessments are conducted on a regular basis, considering any changes in the athlete's physical condition.

Recommendations for Assessing Programme Effectiveness:

1. Functional Tests
   Conduct specific tests to evaluate the flexibility, strength, and endurance of the PFM. Examples include endurance tests for maintaining pelvic floor contraction, stabilisation assessments during various exercises, or functional performance tests involving dynamic movement.
2. Use of Biometric Analysis
   Real-time monitoring systems (such as EMG and BFB) provide precise data on muscle activation during exercise execution. These technologies are vital for tracking progress and enabling timely programme adjustments based on objective performance indicators.
3. Assessment of Subjective Well-being
   Athletes should be encouraged to record their sensations following exercise sessions and the use of apparatus-based technologies. Such self-reporting facilitates understanding of the programme's effectiveness and allows early detection of potential issues or discomfort.
4. Regular Consultations with Medical Professionals
   Periodic consultations with sports medicine specialists are essential to ensure that the rehabilitation or strengthening process is safe and effective.

These evaluations allow prompt modification of the training plan according to medical findings and physiological responses.

Conclusion

Based on the analysis and the practical recommendations presented, several key conclusions can be drawn to support coaches and physiotherapists in their daily work with PFM training.

1. Integration within the Training Process
   Pelvic floor work must be fully integrated into the athlete's overall training routine rather than treated as an isolated component. Exercises targeting pelvic floor strengthening should be included in warm-up, cool-down, and recovery sessions, ensuring functional stability of these muscles under real sporting conditions.
2. Flexibility and Individualisation
   Every programme should be tailored to the athlete's condition, level of preparation, type of sport, and current performance goals. Professionals should retain the flexibility to modify methodologies and employ diverse techniques, including instrument-assisted approaches, to achieve optimal outcomes.
3. Multifunctional Technologies
   The use of modern multifunctional devices is highly recommended. These technologies not only enhance PFM strength but also enable real-time monitoring of muscle activity. For instance, EMS, BFB, and EMG serve as both rehabilitation tools and feedback mechanisms for adjusting the training process.
4. Interdisciplinary Collaboration
   Effective collaboration among coaches, physiotherapists, physicians, and psychologists forms the cornerstone of successful pelvic floor management. Coaches must appreciate the importance of pelvic floor function for overall athletic performance, while physiotherapists should cooperate closely with them to select optimal techniques and devices.
5. Rehabilitation and Prevention
   For professional athletes and individuals recovering from injuries, it is vital not only to strengthen the PFM but also to incorporate regular restorative procedures such as magnetotherapy, laser therapy, and cryotherapy. These modalities accelerate recovery and reduce the risk of recurrent injuries.
6. Psychological Dimension of Pelvic Floor Work
   Addressing the psychological well-being of athletes is essential, particularly when dealing with issues related to the intimate area. Establishing a supportive and comfortable environment for discussion, alongside continuous psychological reinforcement from specialists, enhances motivation and promotes adherence to therapeutic and training objectives.

Part 3.4
Conclusion

The entire chapter, encompassing both theoretical and practical aspects of working with apparatus-based technologies and the PFM, provides a clear understanding of the significance of these technologies in sports physiotherapy.

The key conclusions that can be drawn from this chapter are as follows:

1. Technological Progress and Innovation
   Modern hardware-based technologies (EMS, BFB, laser therapy, magnetotherapy, and others) play a crucial role in enhancing the effectiveness of rehabilitation and PFM training. These methods enable not only muscle strengthening but also real-time monitoring and restoration of their functional activity.
2. Comprehensive Approach
   Work with the pelvic floor requires a synergistic combination of various methods—from EMS and BFB training to restorative procedures and psychological support. Such an integrative approach allows for the achievement of optimal results while minimising the risk of injury.
3. Individualised Strategy for Each Athlete
   Every athlete requires a personalised approach that takes into account their physical condition, level of training, type of sport, and individual physiological characteristics. Training and rehabilitation strategies must remain flexible and be adjusted in accordance with changes in the athlete's condition.
4. Need for Continuous Monitoring and Effectiveness Evaluation
   To assess the success of pelvic floor training programmes, it is essential to employ both objective and subjective evaluation methods. This ensures timely adjustment of the programme and guarantees its safety and efficacy.
5. Role of a Multidisciplinary Team
   Continuous cooperation between the coach, physiotherapist, physician, and psychologist is indispensable for an integrated approach to pelvic floor rehabilitation and training. This requires a high level of professional communication and interdisciplinary collaboration.

Overall, the third chapter emphasises the importance of a multifaceted approach that combines hardware-assisted technologies with tailored training programmes to ensure effective rehabilitation and conditioning of the PFM in athletic practice.

Conclusion

The investigation of apparatus-based technologies in sports physiotherapy aimed at the recovery, development, and strengthening of the PFM allows several key conclusions to be drawn, serving both as a theoretical foundation and a practical framework for professionals.

1. Relevance of the Study

Contemporary sporting demands, particularly in high-intensity disciplines, emphasise the importance of a comprehensive approach to restoring and enhancing PFM functionality. This muscle group not only provides structural support but also directly influences overall motor coordination, stability, and injury prevention, making it a crucial element in athletes' training regimes.

2. Scientific Novelty

The main contribution of this research lies in the systematisation of existing device-based technologies employed in sports physiotherapy for training and rehabilitating the PFM. Unlike previous studies primarily focused on medical rehabilitation, the present work highlights the specific nature of applying these technologies in sport, where the loading of the PFM is significantly higher and requires an individualised approach.

3. Practical Significance

The practical importance of the study lies in the development of recommendations for the use of apparatus-based technologies by athletes, coaches, physiotherapists, and medical specialists. The evaluation and integration of such modalities as EMS, BFB, magnetotherapy, and others considerably increase the effectiveness of recovery procedures and training. This, in turn, aids in injury prevention, enhances athletic performance, and contributes to the long-term maintenance of athletes' physical fitness.

4. Model and Strategy Development

One of the most important outcomes of the study is the creation of a generalised model for the application of device-based technologies that considers not only physiological but also individual characteristics of athletes. This enables the optimisation of recovery, training, and prevention strategies, making the process more effective and adaptable to various sports disciplines and levels of athletic preparation.

5. Need for Further Research

Despite substantial progress in the use of device-based technologies in sports physiotherapy, many issues remain insufficiently explored. In particular, the integration of these technologies into routine training processes, their efficacy across different sports, and among various athlete categories require further investigation.

Continued research is needed to create universal application protocols and to develop new methods for targeting the PFM.

6. Generalisation and Practical Implementation of Research Findings

The study identified key directions that can be applied to improve PFM recovery and training processes, relevant to both sports and medical practice. Specifically, the advancement and systematisation of techniques employing EMS, laser therapy, magnetotherapy, and BFB increase diagnostic precision, allow adjustment of individual training and rehabilitation plans, and accelerate recovery. These technologies are worth incorporating into standard coaching and physiotherapy practices to enable more effective monitoring of PFM function and to enhance their performance capacity.

7. Development of Evidence-Based Guidelines for Coaches and Physiotherapists

Creating unified protocols for device-based interventions across different athlete categories, considering their individual physiological and anatomical characteristics, represents a major step forward. Coaches and physiotherapists, with access to real-time data on PFM condition through EMS and BFB devices, can tailor training and rehabilitation more precisely. Moreover, evidence-based recommendations derived from this research can significantly reduce injury risk, improve athletic outcomes, and prolong sporting careers by ensuring controlled recovery at all training stages.

8. Effectiveness of Apparatus-Based Technologies in Sports Physiotherapy

The use of device-based technologies in sports physiotherapy not only restores athletes' physical condition but also accelerates post-injury rehabilitation, enhances neuromuscular control, and markedly increases training efficiency. Methods such as myostimulation strengthen PFM with minimal physical exertion, while BFB and laser therapy facilitate tissue regeneration and pain reduction. It is essential, however, that these technologies are properly integrated into individualised training plans to ensure maximal effectiveness.

9. Trends and Future Directions

Future research in sports physiotherapy should prioritise modern technologies and monitoring methods to achieve more precise and individualised approaches to training and recovery. Technologies for initial pelvic floor diagnostics, such as ultrasound imaging and real-time muscle tone assessment, open new opportunities for personalised rehabilitation. Furthermore, developing universal and safe approaches for device use during competitions will help to minimise temporal and physiological limitations.

10. Impact on Athletic Performance and Longevity

Proper utilisation of apparatus-based technologies in pelvic floor training and recovery directly affects athletic performance and career longevity. Improvements in strength, endurance, and overall fitness result not only from intensive training but also from recovery processes, including pelvic floor work that ensures body stability. Preventing injuries and improving pelvic floor functionality can significantly extend athletic careers and reduce the likelihood of chronic disorders such as osteoarthritis, myofascial pain, and other degenerative conditions of the joints and soft tissues.

11. Research Challenges and Limitations

Despite notable progress in employing device-based technologies for pelvic floor training and rehabilitation in sports physiotherapy, several important limitations should be acknowledged:

- Lack of Standardised Protocols
  At present, there is no unified standard governing the use of different device-based technologies in sports physiotherapy. While the protocols and recommendations developed within this study may be beneficial, further standardisation is needed to ensure safer and broader application in sports practice.
- Need for Long-Term Studies
  There is a limited number of long-term clinical studies confirming the effectiveness of device-based technologies in sports physiotherapy. Additional research is required to accurately assess their long-term impact on athletic performance and recovery outcomes.
- Dependence on Availability and Cost
  It is important to note that not all athletes or sports organisations have access to costly technological equipment, which restricts its use across all sporting levels. Therefore, developing alternative and more affordable methods and technological solutions remains essential to ensure broader accessibility for athletes.

12. Prospects for Further Research

In the future, study on the use of instrumental technologies in sports physiotherapy should focus on the following key areas:

- Improvement of Diagnostic and Monitoring Methods
  Advancement of technologies for more accurate and early detection of PFM dysfunctions, including the development of new imaging methods, ultrasound diagnostics, and neurophysiological monitoring technologies.
- Development of New Technologies and Devices

Research aimed at creating more affordable and versatile devices for physiotherapists and trainers, as well as technologies that expand the range of instrumental effects on the pelvic floor and other muscle groups.

- Cross-Disciplinary Research
  An important direction involves integrating knowledge from various disciplines—sports medicine, neurophysiology, biomechanics, and psychology—to gain a deeper understanding of how different types of load and intervention influence PFM functionality. This integration will open new opportunities for a personalised approach to treatment and athlete training.
- Evaluation of Effectiveness across Different Sports
  More detailed studies are required that consider the specific demands of different sports to develop optimal methodologies for applying instrumental technologies across various disciplines, considering their unique requirements for physical preparation and recovery.

13. Conclusion and Practical Significance of the Study

In conclusion, the conducted research has demonstrated that instrumental technologies play a crucial role in sports physiotherapy, providing athletes with new opportunities for $PFMR$ and training. These technologies enable effective muscle strengthening, improvement of neuromuscular activity, and prevention of injuries—all contributing to enhanced athletic performance and longer career longevity.

The use of instrumental methods such as EMS, BFB, and laser therapy requires close cooperation among physiotherapists, coaches, and physicians to ensure maximum efficacy. The scientific novelty of this research lies in its dual focus—it not only analyses existing techniques but also provides practical recommendations for their implementation in real sports practice, which is of significant value for professionals in sports medicine and physiotherapy.

The study confirms that the use of instrumental technologies can substantially improve training and recovery processes, as well as increase athletic achievements and overall physical condition. Further development and refinement of these technologies will be vital for enhancing the effectiveness of sports medicine and rehabilitation as a whole.

14. Recommendations for Implementing Research Results in Sports Practice

Based on the research findings, several key recommendations can be outlined for introducing new technologies and pelvic floor training methods into sports practice. These recommendations will assist coaches, physiotherapists, and medical professionals in improving rehabilitation and training efficiency.

- Integration of Instrumental Technologies into the Training Process

To enhance the effectiveness of pelvic floor training, it is recommended to actively incorporate instrumental technologies such as EMS and BFB into rehabilitation and training sessions. This approach not only improves muscle condition but also significantly enhances the athlete's body awareness and ability to control muscle activation.

- Development of Individualised Training Programmes for Athletes
  Personalised approaches are worth developing for various categories of athletes (professionals, amateurs, and those undergoing post-injury rehabilitation). Individual programmes must account for the sport type, fitness level, anatomical characteristics, and physiological limitations, enabling optimal adaptation of training and recovery methods.
- Training and Professional Development of Specialists
  It is essential to organise a series of training courses and workshops for coaches and physiotherapists to enable them to master the use of modern devices and methods. The integration of these technologies into sports practice should be accompanied by the training of professionals capable of competently applying and adjusting methods according to the athlete's condition.
- Assessment and Monitoring of Athletes' Condition
  Regular monitoring of PFM status using EMS, BFB, and other technologies should become an integral part of athlete diagnostics and condition control. This will allow early detection of potential problems, timely adjustment of training and recovery programmes, and ensure athlete safety during high-intensity loads.
- Practical Significance for Long-Term Athletic Longevity
  Implementing effective pelvic floor training techniques in sports practice is crucial not only for short-term performance improvement but also for ensuring long-term athletic longevity. Strengthening and functional enhancement of PFM helps prevent strain-related injuries and chronic conditions. This is especially important for professional athletes whose careers depend on maintaining high performance levels over many years.

Proper pelvic floor management enables athletes not only to achieve better performance but also to maintain health throughout their careers. The use of instrumental technologies helps preserve PFM functionality and prevent age-related changes or trauma, thereby supporting prolonged sporting activity.

15. Prospects for the Development and Implementation of Technologies in Sports Physiotherapy

Given the rapid pace of technological progress, it can be confidently stated that instrumental technologies in sports physiotherapy will continue to evolve and find new applications in the near future. Several promising directions may significantly enhance the efficiency of pelvic floor rehabilitation and training in sports practice.

- Integration of Artificial Intelligence and Machine Learning
  One of the most promising areas is the use of AI and machine learning for analysing data obtained through instrumental technologies such as EMS and BFB. These tools will enable the creation of individualised real-time training and recovery programmes based on the athlete's dynamic physiological state. AI can analyse and predict the effectiveness of interventions and assist in adjusting load parameters.
- Improvement of Mobile and Wearable Technologies
  There is a growing trend towards developing portable and wearable devices capable of real-time muscle monitoring. Such devices may prove highly useful for athletes during training and for self-monitoring between physiotherapy or coaching sessions. In the future, these technologies are likely to become an integral part of training and recovery systems.
- Development of Combined Treatment Methods
  The advancement of instrumental technologies in sports physiotherapy also includes the creation of combined methods that integrate multiple modalities to achieve a synergistic effect. For example, combining EMS with laser therapy and BFB may significantly improve not only recovery but also injury prevention.
- Integration with Genetic and Physiological Data
  Incorporating genetic testing and physiological data analysis—such as hormone levels, tissue condition, and genetic predispositions—will open new horizons for personalised sports physiotherapy. These data will enable precise calibration of training and recovery methods, minimising injury risk and maximising training efficiency.

16. Final Recommendations

In conclusion, several recommendations can be summarised for specialists, coaches, and physiotherapists to maximise the use of research findings and successfully integrate instrumental technologies into sports practice:

- Develop universal standards for applying instrumental technologies in sports physiotherapy to ensure broader implementation and accessibility for athletes at all levels.
- Provide continuous training for physiotherapists, coaches, and sports physicians in the use of new methods and technologies to promote effective interdisciplinary collaboration and a comprehensive approach to training and recovery.
- Increase the accessibility of technologies for sports organisations of all levels, enabling the application of modern equipment and methods for $PFMR$ and training.

- Implement continuous athlete progress monitoring through digital platforms and wearable devices to enhance muscle condition tracking and achieve maximum training efficiency.

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Natalia A. Romanova

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Websites: https://tuculart.eu, https://eiid.eu
Emails: pub@tuculart.eu, pub@eiid.eu, eiid.ostrava@gmail.com

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Natalia A. Romanova

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