The 11th International Scientific Conference

EXERCISE FOR HEALTH AND REHABILITATION

The 24th of April, 2026

Kaunas, Lithuania

BOOK OF ABSTRACTS

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CONTENTS

NOISE THAT HELPS: APPLYING STOCHASTIC RESONANCE TO MOTOR LEARNING IN PHYSIOTHERAPY

Prof. dr. Wolfgang Schöllhorn
Johannes Gutenberg-Universität Mainz, Germany

Physiotherapy based on stochastic resonance applies principles from system dynamics, cybernetics, and motor learning to enhance rehabilitation outcomes. Within the framework of differential learning, movement variability and stochastic perturbations are intentionally integrated into therapeutic exercises to exploit the adaptive capabilities of the neuromuscular system. Instead of repeating a single idealized movement pattern, patients experience a wide range of continuously varied movement conditions. This variability encourages the motor system to explore multiple solutions and to self-organize functional coordination patterns that are individually suited to the patient's current physical and neurological state.

The conceptual foundation of this approach is rooted in a cybernetic understanding of information processing in biological systems. In this context, a distinction is made between objective information and subjective information. Objective information refers to externally observable aspects of movement, such as joint angles, trajectories, or therapist-provided instructions. Subjective information, in contrast, emerges from the patient's internal interpretation of sensory input, prior experiences, and current physiological and cognitive states. Motor learning occurs primarily through the transformation of objective stimuli into subjective information within the individual organism.

Traditional physiotherapy often focuses on correcting deviations from an assumed optimal movement model through repetition and explicit instruction. However, because the internal state of the learner constantly changes, identical repetitions rarely produce identical subjective information. Consequently, strict repetition may limit the learning process by reducing opportunities for exploration and adaptation.

Differential learning addresses this limitation by systematically introducing fluctuations and variations into therapeutic exercises. These variations function as controlled "noise" within the sensorimotor system. Through the principle of stochastic resonance, such noise can enhance the detection and processing of relevant signals within nonlinear biological systems. Small perturbations therefore stimulate the nervous system, increasing sensitivity to movement-related feedback and promoting the discovery of new coordination strategies.

In practice, this approach leads to therapeutic environments in which movements are intentionally performed under constantly changing conditions. Differences in speed, rhythm, amplitude, or environmental context create a rich landscape of sensorimotor experiences. Rather than guiding the patient toward a predefined movement template, the therapist facilitates an adaptive learning process in which functional movement solutions emerge through exploration.

By emphasizing variability, self-organization, and individualized information processing, physiotherapy based on stochastic resonance and differential learning shifts the focus of rehabilitation. The goal is not the reproduction of an ideal movement form, but the development of robust and adaptable motor behavior. This cybernetically informed perspective provides a promising framework for more effective, patient-specific physiotherapeutic interventions.

FEED THE ATHLETE: UNDERSTANDING THE RISKS OF LOW ENERGY AVAILABILITY IN SPORT

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Introduction. The importance of nutrition is widely recognized as one of the most important instrument for achieving athletic performance and maintaining good health (1,2). Only adequate nutrition, appropriate to the physical workload, enables athletes to achieve good results and remain healthy. The well-known "Female Athlete Triad" syndrome describes physically active female who, due to insufficient nutrient intake and/or excessive physical exertion, experience amenorrhea, osteoporosis, and disordered eating (3,4). In recent years, it has become clear that the term needs to be expanded, as energy imbalance affects not only these three systems; inadequate nutrition has a negative impact on other bodily systems as well (4). In 2014, the International Olympic Committee defined a new syndrome—Relative Energy Deficiency in Sport (RED-S)—which is described as characteristic of female athletes (5). This syndrome is caused by an energy deficiency that arises from an imbalance between energy intake and energy expenditure—for basic physiological functions, daily activities, and training (6–7). The main causative factor is low energy availability, which occurs when dietary energy intake is too low or the energy expended through physical activity is too high, leaving insufficient energy to maintain essential physiological functions, such as bone and muscle health, cardiovascular function, menstrual cycle, metabolism, and immune system (8). Energy imbalance leads to disturbances in various body systems, including hormone regulation, immune function, cardiovascular and metabolic health, urinary-reproductive systems (e.g., musculoskeletal system (9), impairs athletic performance (10). In 2018, the International Olympic Committee released an update to the RED-S syndrome, which highlighted its relevance to male, noting that the risk of syndrome development is similar to that in female and encouraging further research in this area (11).

Aim. The aim of this research was to summarize the impact of low energy availability on athletes' health, identify the nutritional challenges encountered by athletes, and assess the energy deficiency among Lithuanian male athletes.

Results. Numerous nutritional myths and guidelines, which are often applied to individuals engaged in high-intensity physical activity, can pose significant risks to health. Athletes face challenges in maintaining an appropriate energy balance, as their energy requirements are exceptionally high due to intense physical training. Common issues include poor nutritional habits, lack of time, diminished appetite, insufficient skills, and limited knowledge. Among Lithuanian male athletes, an energy deficit of less than 1000 kcal was observed in 62.1% of participants, while a deficit exceeding 1000 kcal was identified in 37.9%.

Conclusion. Athletes face a variety of challenges in the area of nutrition. Only individualized and carefully planned dietary regimens that take into account their specific physical workload can ensure optimal health and athletic performance.

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Best Presentation Award

REPETITIVE TRANSCRANIAL MAGNETIC STIMULATION FOR MOTOR RECOVERY AFTER STROKE IS ASSOCIATED WITH SECONDARY IMPROVEMENTS IN MENTAL STATE

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Introduction. Stroke remains one of the leading causes of death and long-term disability worldwide [1], frequently leading to motor impairments and psychological disturbances [2]. Repetitive transcranial magnetic stimulation (rTMS) is increasingly applied to enhance motor recovery after stroke, primarily by correcting interhemispheric imbalance [3]. Notably, rTMS is also widely used in the treatment of depression, typically targeting prefrontal regions [4]. This raises a question of whether rTMS applied over the primary motor cortex can induce excitability changes in other brain regions and thereby influence the mental state of stroke patients. Therefore, this study aimed to assess whether rTMS for motor recovery after stroke is associated with secondary improvements for depression and anxiety.

Research methods and organization. The study was conducted at the Department of Neurorehabilitation, Hospital of Lithuanian University of Health Sciences, Kaunas Clinics. Thirty-four individuals who had experienced a first-ever ischemic stroke were enrolled and randomly assigned to three groups: LF-rTMS (1 Hz), HF-rTMS (10 Hz), or sham-rTMS. In the LF-rTMS group, a figure-of-eight coil was placed over the primary motor cortex (M1) of the contralesional hemisphere, whereas in the HF-rTMS and sham-rTMS groups, the coil was placed over the M1 of the ipsilesional hemisphere. All groups received 10 sessions of either active or sham stimulation over two weeks. Each rTMS session consisted of 1200 pulses and was administered during the rehabilitation period as part of the standard daily rehabilitation schedule. The rehabilitation program was the same for all participants and included physiotherapy, occupational therapy, massage, electrical muscle stimulation, speech therapy, as well as consultations with a psychologist and a social worker. Mental state was assessed before and after rehabilitation using the Hospital Anxiety and Depression Scale (HADS). Outcomes were compared between sham and both active stimulation groups, as well as between the LF-rTMS and HF-rTMS groups. The study was approved by Kaunas Regional Biomedical Research Ethics Committee (No: BE-2-86). All participants gave informed consent before participation. Statistical analysis was performed using IBM SPSS Statistics version 30.0. Descriptive statistics included the number of cases, mean, and standard deviation (SD), as well as median and interquartile range (Q1-Q3). Non-parametric comparisons between groups were conducted using the Mann-Whitney U test, while within-group changes were assessed using the Wilcoxon signed-rank test. The significance was set at $p < 0.05$.

Results. Thirty-four individuals were enrolled in this study, of whom 17 (50.0 %) were male. The mean age (SD) was 60.38 (11.51) years. Seventeen participants (50.0 %) received sham stimulation, while 17 (50.0 %) received active stimulation, of whom 8 (23.5 %) underwent LF-rTMS and 9 (26.5 %) – HF-rTMS. No statistically significant differences were observed between the sham and active stimulation groups in terms of gender distribution ($\chi^2 = 1.39$, $p = 0.239$). The groups were also comparable in age ($U = 337.5$, $p = 0.604$). No significant differences were found in baseline HADS scores between groups, including anxiety (HADS-A: $U = 128.0$, $p = 0.568$), depression (HADS-D: $U = 124.0$, $p = 0.475$), and total HADS scores ($U = 120.5$, $p = 0.407$). Within-group analysis demonstrated that the active stimulation group showed significant improvements in anxiety ($Z = -2.474$, $p = 0.013$), depression ($Z = -2.931$, $p = 0.003$), and total HADS scores ($Z = -3.421$, $p < 0.001$), whereas no statistically significant changes were observed in the sham group for anxiety ($Z = -0.943$, $p = 0.346$), depression ($Z = -0.316$, $p = 0.752$), or total HADS scores ($Z = -0.601$, $p = 0.548$). Active stimulation was associated with a significantly greater reduction in depression scores (HADS-D) compared to the sham group ($U = 81.5$, $p = 0.027$), with a median change of 3.0 (0.0–3.5) versus 0.0 (−1.0–2.0), respectively. No statistically significant difference between groups was observed for anxiety scores (HADS-A) ($U = 105.5$, $p = 0.172$), with median changes of 1.0 (0.0–4.5) in the active group and 0.0 (−0.5–2.0) in the sham group. A significantly greater overall reduction in total HADS scores was found in the active stimulation group compared to controls ($U = 69.0$, $p = 0.009$), with a median change of 3.0 (1.5–6.5) versus 1.0 (−1.5–2.5). No statistically significant differences were observed between LF-rTMS and HF-rTMS groups for depression ($U = 29.5$, $p = 0.521$), anxiety ($U = 25.5$, $p = 0.306$), or total HADS scores ($U = 24.5$, $p = 0.265$). Median changes were 1.5 (0.0–3.75) versus 3.0 (0.5–3.5) for HADS-D, 0.5 (−0.75–2.75) versus 1.0 (0.0–6.0) for HADS-A, and 2.5 (1.25–3.0) versus 6.0 (1.5–8.5) for total HADS in LF-rTMS and HF-rTMS groups, respectively.

Conclusions. Repetitive transcranial magnetic stimulation for motor recovery after stroke is associated with secondary improvements in mental state, including reductions in anxiety, depressive symptoms, and overall HADS scores. No significant differences were observed between low- and high-frequency rTMS, suggesting both approaches to be equally effective. These findings highlight the potential added value of rTMS in addressing psychological outcomes during stroke rehabilitation.

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Outstanding Presentation Award

THE EFFECTS OF A CORRECTIVE EXERCISE PROGRAM ON YOUNG WOMEN WITH UPPER CROSSED SYNDROME WHO PERFORM SEDENTARY WORK

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Introduction. Sedentary work is becoming increasingly prevalent worldwide due to changes in work patterns and technological development. Prolonged sitting is considered a risk factor for postural alterations and work-related musculoskeletal disorders [1,2]. Many sedentary workers exhibit upper crossed syndrome, in which some muscles become weak and inhibited while others become tight. Neck pain is associated with prolonged sitting and low physical activity and is more common in young women than in men [2]. Physical exercise can reduce work-related symptoms and improve posture and functional mobility [3]. Individuals who engage in physical activity more than three times per week achieve greater improvements in neck function and a pain reduction compared to those who exercise three times a week or less [4]. The aim of this study is to evaluate the effect of a corrective exercise programme performed five times per week on young women with crossed syndrome who work sedentary jobs.

Research methods and organization. The research received ethical approval from the Bioethics Center of the Lithuanian University of Health Sciences (No. 2024-BEC2-313) and was conducted from June to December 2025 at the Department of Sports Medicine of the Lithuanian University of Health Sciences. Inclusion criteria: women who voluntarily agreed to participate in the study and signed the informed consent form; upper crossed syndrome, defined as a Craniovertebral Angle of <53 degrees and a Sagittal Shoulder Angle of <52 degrees [5]; young age between 18-44 years; sedentary work for more than four years and sitting for 6-8 hours per day at work; pain intensity of less than 6 points. Exclusion criteria: participation in additional sports or health-promoting activities; presence of acute pain (6 points or more); history of cervical spine trauma; significant comorbidities. In total 29 women were involved in this study, with a mean age of 36.3 (±7.3) years. Women were randomly divided into the group performing corrective exercises (experimental group) and the non-exercise group (control group). The experimental group followed a program of corrective exercises (n=15), while the control group engaged in their usual daily activities (n=14). Both groups were homogeneous in terms of age (U=100, p=0.813), duration of sedentary work and work experience (p>0.05). Corrective exercise program was performed five times a week for 30 minutes for 8 weeks. Participants were evaluated before and after the study. Body posture in the sagittal plane was evaluated measuring the Craniovertebral Angle (CVA) and Sagittal Shoulder Angle (SSA) with the "APECS" mobile app. Pain intensity was assessed using the Visual Analog Scale. "Stabilizer" device was used to evaluate the strength of deep neck flexors. The corrective exercise program was developed based on the results obtained during the assessment of the participants. It included shoulder and scapular stabilization exercises, pectoral muscle stretching and exercises to improve strength and endurance of the deep cervical flexors muscles. Data analysis was performed using IBM SPSS Statistics 31.0.0.0. The nonparametric Mann-Whitney U test was used to compare two independent samples and the Wilcoxon signed-rank test was applied for two related samples. Data were presented as median (Md), minimum (min), and maximum (max) values, mean (m) – Md(min – max; m); average. Differences were considered statistically significant if p<0.05.

Results. Before the intervention, participants in "experimental group" reported pain intensity scores of 4 (1-5; 3.9) point. After the corrective exercise program, the scores decreased to 3 (0-5; 2.7) points; Z=-3.000; p=0.003). Before the study participants in "control group" reported pain intensity scores of 3 (2-5; 3.6) points, and after the study scores increased to 5 (0-6; 4.4) points; Z=-1.966; p=0.049). When comparing the two groups, no statistically significant difference in pain intensity was observed before the study (U=83; p=0.354), but after the study, participants of "experimental group" showed significantly reduced pain (U=36; p=0.002). Before the intervention in "experimental group" demonstrated deep neck flexors strength values of 24 (0-30; 21) mmHg, and after the intervention, results increased to 28 (20-30; 27.6) mmHg; Z=-3.319; p<0.001). Before the study participants in "control group" demonstrated deep neck flexor strength values of 26 (0-30; 22) mmHg, and after the study there was no significant difference, with values of 25 (0-30; 21) mmHg; Z=-1.933; p=0.053). There was no significant difference between the groups before the study (U=86; p=0.425), whereas after the study, participants of "experimental group" showed better results (U=50; p=0.014). Before the study, the "experimental group" had CVA results of 50 (40-52; 48.4) degrees, and after the intervention, they increased to 52 (43-54; 50.9) degrees; Z= -3.002; p=0.003). Before the study, the "control group" had CVA results of 50 (45-52; 49.6) degrees, and after the study there was no significant difference, with values of 50 (45-53; 49.4) degrees; Z=-0.973; p=0.331). When comparing the two groups, no statistically significant difference in CVA was observed before the study (U=87; p=0.425) but after the study, participants of the "experimental group" showed significantly increased CVA (U=59; p=0.046). Before the intervention, the SSA in the "experimental group" was 42 (34-51; 42.3) degrees, and after the intervention it increased to 42 (36-52; 43.7) degrees; Z=-3.002; p=0.003).

Before the study, the SSA in the “control group” was 45 (32-51; 44.4) degrees, and after the study there was no significant difference, with values of 45 (30-52; 44.71) degrees; Z=-0.973; p=0.331). There was no significant difference between the groups either before (U=78; p=0.234) or after (U=92; p=0.561) the study.

Conclusions. In young women with upper crossed syndrome engaged in sedentary work, a corrective exercise program performed five times a week decreased pain intensity, improved deep cervical flexor muscle strength, and reduced forward head posture and rounded shoulder angles.

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Outstanding Presentation Award

ASSESSMENT OF MUSCULOSKELETAL SYSTEM FUNCTIONAL INDICATORS AND INJURY RISK IN ADULT STREET DANCERS

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Introduction. Street dance is a form of dance that has emerged within urban culture and has been gaining increasing popularity as a physical activity. It encompasses a variety of dance styles, including hip-hop, locking, popping, breaking, house, and others. These styles are characterized by high energy, rhythm, complexity, improvisation, and substantial physical intensity [1]. High training loads, increasingly complex choreographic sequences, abrupt changes of direction, jumps, landings, and rotational movements impose substantial biomechanical stress on dancers’ bodies. Recent studies indicated that gender differences are associated with distinct injury patterns: females are more prone to lower back and knee injuries, whereas males are at greater risk of acute injuries affecting the lower back and feet [2,3]. Research aim: to assess functional indicators of the musculoskeletal system and injury risk in male and female adults performing street dance.

Research methods and organization. The study received approval from the Bioethics Center at the Lithuanian University of Health Sciences (approval No. 2025-BEC2-1143) and was conducted at the dance studio “Tavo Fortūna". The study was conducted from December 2025 to February 2026. Participants had to meet the following inclusion criteria: aged between 18 and 25 years; regularly engaged in street dance training (2-3 times weekly) for at least two years; participated in competitions and contests; had no ankle, knee, or lower back injuries in the past three months; and were not involved in other sports activities. A total of 27 participants were included, consisting of 12 males (22.5±2.4

years) and 15 females (20.3±3.04 years). All tests were conducted in a single session. Methods used included assessing dynamic balance and injury risk with the Y-Balance Test. Participants performed three trials per leg in anterior, posteromedial, and posterolateral directions, with the best score recorded. Distances were normalized to leg length, and limb asymmetries, as well as a composite score, were analyzed [4]. Trunk-pelvic stability was evaluated using a Stabilizer device; instability was defined as pressure fluctuations exceeding 5 mmHg. Two trials were performed, and the best result was recorded (measurement accuracy ±3 mmHg) [5]. Jump-landing mechanics were assessed using the Landing Error Scoring System (LESS) to evaluate anterior cruciate ligament injury risk [6]. Ankle dorsiflexion was evaluated using a goniometer during movement; the maximal angle was recorded, with decreased range of motion or inter-limb asymmetry potentially associated with a higher risk of injury [7]. Data analysis was performed using IBM SPSS Statistics 31.0.2.0. software. The Wilcoxon test was calculated to compare two dependent samples, and the Mann-Whitney U test was used to compare two independent samples. Data are presented as median (minimum value-maximum value; mean). Qualitative data are presented as percentages (%). The Chi-squared ($\chi 2$) criterion was used to determine the equality of proportions. Quantitative data are presented as median ($\tilde{x}$), range (xmin-xmax), and mean ($\bar{x}$). Differences with $p<0.05$ were considered statistically significant.

Results. In the male dancer group, no statistically significant differences were found between the right and left legs across Y-Balance Test directions: anterior ($Z=-1.581$; $p=0.120$), posteromedial ($Z=-1.684$; $p=0.102$), and posterolateral ($Z=-0.356$; $p=0.742$). The median composite score was 97(83-122; 96.42) for the right leg and 99.5(85-128; 97.75) for the left leg, with no significant difference between limbs ($Z=-1.692$; $p=0.105$). In contrast, the female group demonstrated significant asymmetry between limbs in the anterior ($Z=-3.409$; $p<0.001$) and posteromedial ($Z=-3.408$; $p<0.001$) directions, whereas no significant difference was observed in the posterolateral direction ($Z=-1.542$; $p=0.130$). The median composite scores were 96(78-132; 99.07) for the right leg and 98(78-130; 99.53) for the left leg, with no significant difference between limbs ($Z=-0.494$; $p=0.648$). Based on Y-Balance Test composite scores, an increased injury risk was identified in 41.7% of males and 40% of females, with no significant association between groups ($\chi^2=0.008$; $p=0.619$). Adequate trunk-pelvic stability during deep abdominal muscle activation was observed in 50% of males and 60% of females ($\chi^2=0.707$; $p=0.448$). During right leg elevation, good stability was recorded in 33.3% of males and 40% of females ($\chi^2=1$; $p=0.519$), whereas during left leg elevation, it was observed in 16.7% and 33.3%, respectively ($\chi^2=0.408$; $p=0.298$). Based on LESS scores, 50% of male dancers were classified as having low injury risk, compared to 86.7% in the female group. The remaining participants were categorized as having moderate risk. A statistically significant difference between groups was identified ($\chi^2=4.299$; $p=0.049$). Analysis of the male group revealed a statistically significant difference in left and right ankle dorsiflexion: right-36(34-39; 36.5), left-36(33-38; 35.75); $Z=-2.264$; $p=0.031$. In the female group, no statistically significant difference was found in left and right ankle dorsiflexion: right-37(33-39; 36.73), left-38(34-39; 37.27); $Z=-1.403$; $p=0.266$. A statistically significant difference between males and females was found in left ankle dorsiflexion ($U=40$; $p=0.012$). The results of the right ankle were similar ($U=82$; $p=0.707$).

Conclusions. The dynamic stability of both lower limbs in dancers was similar; however, nearly half of the participants exhibited an increased risk of injury. Adequate lumbopelvic stability, achieved through activation of the deep abdominal muscles, was observed in half of the dancers, whereas lumbopelvic stability was limited during leg-raising tasks. Compared to women, men demonstrated reduced dorsiflexion of the left ankle and a higher risk of injury based on jump quality.

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Outstanding Presentation Award

ULTRASONIC INVESTIGATION OF THIGH TISSUES AND BLOOD VESSELS RESPONSE TO COMPRESSIONS WITH SMART PNEUMATIC ACTUATOR

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Introduction. Venous diseases such as chronic venous insufficiency and deep vein thrombosis (DVT) are increasing, which causes a global health concern [1]. It is particularly seen in immobile, post-surgical and elderly populations. These conditions are closely related with the impaired venous return from the lower limb, which reduces the blood flow and increases thrombus formation. The routine instrumentation for vein condition diagnosis is compression ultrasonography, when limb tissues are actuated by hand without any measurements of pressurising level. The manual manipulations are time consuming, the compression skills are difficult to assess, also is hard to competently instruct newcomers with portable ultrasonic (US) devices to record data about veins of lower limb. The aim of this research is to evaluate the feasibility of the dual bladder actuator to the controlled, level-dependent compression within the soft tissues.

Research methods and organization. The sensors were mounted around the volunteer's thigh to obtain US images. Two healthy male volunteers were subjected to the dataset collection. This small sample size was selected for conducting a technical proof of concept and to develop data acquisition methods before testing with larger groups in upcoming research. A wearable actuator was used having a dual-bladder configuration (Bladders I and II), with each bladder measuring 15×8 cm. These bladders were connected to a smart pump module. Pump source adjusts speed of air flow and final pressure in two independent channels. Channels were pressurized separately: speed of air flow Fm1=0.4 & Fm2=1.6 L/min, and with pressures Pm1=80 & Pm2=120 mmHg. These specific characteristics were selected to evaluate how varying flow rates and pressure levels can reduce tissue sliding, thereby improving the stability and accuracy of anatomical measurements. The US imaging setup consisted of an US transducer supported by a rigid C-mount applicator. Two actuator configurations on the thigh were tested: increasing the lateral gap between the bladder and the transducer applicator from 0 to 10 mm. This gap of circumferential application was on lateral side of thigh to evaluate tissue transversal sliding under different mechanical constraints. Sequences of US images with synchronized pressure readings and tissue strain estimates were saved for offline analysis. The in-vivo data were utilized from research carried out following bioethical approval. For each subject, six pressurizing configurations were tested on the left thigh; this site was selected as a primary testing location as it required no specific physiological restrictions. During the experiments, US images were obtained at Fm1, Fm2, Pm1 & Pm2 levels to capture both the initial and peak vascular responses. Six specific pressure intervals (ranging from 0.15 to 0.95 of Pm1 & Pm2) were examined to measure the arterial lumen center offset from the image center. Data processing was done in MATLAB for quantitative analysis, including the annotation of structures such as the vein lumen and arterial center. Analyzed mechanical responses included transversal tissue displacement, longitudinal strain (S), and strain misbalance. The US transducer recorded 256 signals per image width i=(1…256). Misbalance was evaluated using regions SL(i=1…25) and SR(i=230...256), computed as the ratio of median values to identify deformation patterns under varying flow, pressure and lateral gap.

Results. The sliding displacement and strain ratio (SR/SL) for each compression cycle were evaluated under varying air flow (Fm1 & Fm2) and maximal pressure (Pm1 & Pm2) conditions. Using a dual-bladder (B1 & B2) actuator helps better understanding of how much pressure should be applied to each bladder individually and how this pressure distribution influences tissue and artery sliding in different people. Since each bladder can be controlled separately, we can see how changes on one area affect the overall longitudinal deformation and transversal sliding. The biggest displacement of the tissues in subject1 was upto 7mm in transversal direction with the air flow of Fm1-B1 and Fm2-B2. For subject 2, sliding was upto 5mm with flow of air Fm1-B1 and Fm2-B2. Performing interchanged pressurizations with maximal pressures combinations Pm1-B1, Pm2-B2 or Pm1-B2, Pm2-B1 in both gap configurations induced transversal displacements range from 1.5mm upto 6.0mm from for both subjects. Quality compression with the smallest transversal sliding (upto 1mm) for subject1 was obtained with air flow, Fm1-B2 and Fm2-B1. The same airflow in subject2 caused 0.5mm sliding of tissues. The actuator was placed at two different lateral gaps (0cm and 10cm) to evaluate how placement affects the tissue transversal movement. When the results from both the subjects were compared, the 10mm lateral gap consistently showed better analysis with less sliding and more stable tissue response during all types of pressurizations. The lowest numerical variance and the minimal measurable sliding were recorded during the trials, thereby providing a more consistent baseline for venous analysis. The venous deformation, tissue strain signals and vessels of transversal displacement depend highly on the lateral gap of US transducer and air bladder placement around the thigh, on air flow speed and maximal pressure. Initial piloting experiments were conducted by adjusting the pump settings and flow speeds for each bladder to calibrate the system. This shows that combinations of dual bladder pressurizations with independent maximal pressures cause greater tissue displacement in all tested application configurations. The sample size of two subjects still shows the observed data gives more consistency which provides a validation for the actuator performance. The configuration of applicator with 10cm lateral gap and subject adjusted speeds of air flow into dual bladder could be beneficial improving quality of compression.

Conclusions. The pilot study validates the dual bladder actuation. A 10 cm lateral gap gives preliminary insight on how pressure affects tissue sliding & deformation in US image that is important for venous assessment. Results suggest that adjusting air flow speeds can minimize transversal sliding, recognized via strain misbalance signals While promising for improving US image stability, these initial findings from two subjects require extensive validation with larger group to establish clinical reliability.

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EFFECT OF CLASSICAL AND TECHNOLOGY-ASSISTED PHYSIOTHERAPY ON RECOVERY OF KNEE JOINT FUNCTION IN PHYSICALLY ACTIVE INDIVIDUALS AFTER ARTHROSCOPIC KNEE SURGERY

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Introduction. Musculoskeletal disorders are a major cause of disability worldwide, and knee injuries are especially relevant in physically active populations due to their association with long-term functional limitations and increased risk of osteoarthritis (1,2). Arthroscopic surgery is commonly performed for anterior cruciate ligament and meniscal injuries; however, surgery does not ensure full recovery. Postoperative outcomes depend on rehabilitation quality, restoration of muscle strength, neuromuscular control, and functional capacity, which are essential for a safe return to sport (3,4). Technology-assisted rehabilitation approaches based on mechanotherapeutic principles are increasingly used, although their effectiveness remains debated (5–7). Further evaluation of these approaches is needed. The aim of this study was to evaluate the effect of classical and technology-assisted physiotherapy on the recovery of knee joint function in physically active individuals after arthroscopic knee surgery.

Research methods and organization. The study included 70 participants aged 20–55 years who underwent Level II outpatient rehabilitation at the Rehabilitation Clinic of Hospital of Lithuanian University of Health Sciences Kauno Klinikos after arthroscopic knee surgery. The participants were divided into two groups of 35 subjects each. Both groups received an identical standard 14-day outpatient physiotherapy programme; however, one group additionally received continuous passive motion therapy using a standardized continuous passive motion device, which in this study was defined as a technology-assisted physiotherapy approach. The duration of physiotherapy procedures was the same in both groups. The groups were comparable in terms of age and sex distribution. The study population consisted of physically active individuals, ensuring comparability of groups in terms of physical activity level. Inclusion criteria were age 20–55 years, confirmed status after anterior cruciate ligament reconstruction with meniscal surgery or arthroscopic meniscal surgery, referral to outpatient rehabilitation after the early postoperative period, and written informed consent. Exclusion criteria included refusal to participate, other neurological or cardiovascular conditions that could limit physical activity or affect biomechanical measurements, and contraindications to maximal muscle strength assessment. Outcome measures were assessed before and after the rehabilitation programme. Research methods included a questionnaire survey, thigh circumference measurement using a measuring tape, goniometric assessment of knee flexion and extension, and quadriceps muscle strength measurement using a Lafayette dynamometer. Statistical analysis was performed using IBM SPSS Statistics, version 31.0.2.0 (126). Data normality was assessed using the Shapiro–Wilk test. As the data met the assumption of normality, the paired samples t-test was used to assess within-group changes before and after rehabilitation, and the independent samples t-test was used to compare differences between the groups. Differences were considered statistically significant at $p < 0.05$. Patient confidentiality was ensured, all collected data were anonymized, and bioethical approval was granted by the Kaunas Regional Biomedical Research Ethics Committee, No. P3-BE-2-60/2024.

Results. No statistically significant differences were found between groups in terms of age ($t(68) = 1.631$, $p = 0.105$), height ($t(68) = -1.217$, $p = 0.228$), weight ($t(68) = -0.238$, $p = 0.812$), BMI ($t(68)=0.635$, $p = 0.527$). Sex distribution between the groups did not differ significantly ($\chi^2(1) = 2.072$, $p = 0.150$). Results indicate that the groups were homogeneous at baseline. The study included 70 participants with a mean age of 38.81 ± 10.25 years, of whom 38 (54.3%) were men and 32 (45.7%) were women. In the physiotherapy group, the operated thigh circumference increased significantly from 51 cm (range 41–64; mean 51.4) before rehabilitation to 51 cm (range 41–65; mean 51.8) after rehabilitation ($t(34) = -3.769$, $p < 0.001$). In the physiotherapy combined with continuous passive motion therapy group, thigh circumference also increased significantly from 50 cm (range 40–67; mean 51.3) to 51.5 cm (range 40–67; mean 51.5) ($t(34) = -2.719$, $p = 0.010$). However, the difference in thigh circumference change between the groups was not statistically significant ($t(68) = 0.259$, $p = 0.796$). In the physiotherapy group, knee flexion improved significantly, with a mean increase of 14.46° ($t(34) = -7.024$, $p < 0.001$), and knee extension deficit decreased by 3.31° ($t(34) = 4.452$, $p < 0.001$). In the physiotherapy combined with continuous passive motion therapy group, knee flexion increased by 20.06° ($t(34) = -8.194$, $p < 0.001$), while knee extension deficit decreased by 3.40° ($t(34) = 4.400$, $p < 0.001$). No statistically significant differences were found between the groups in knee flexion ($t(68) = -1.751$, $p = 0.084$) or knee extension ($t(68) = 0.080$, $p = 0.937$). Quadriceps muscle strength increased significantly in both groups. In the physiotherapy group, the mean increase was 3.27 kg ($t(34) = -7.650$, $p < 0.001$), whereas in the physiotherapy combined with continuous passive motion therapy group, the mean increase was 7.51 kg ($t(34) = -9.459$, $p < 0.001$). The between-group comparison showed a statistically significant difference in strength change ($t(68) = -4.709$, $p < 0.001$), with greater improvement observed in the physiotherapy combined with continuous passive motion therapy group (mean difference 4.25 kg).

Conclusions. Both rehabilitation approaches significantly improved knee joint function after arthroscopic knee surgery in physically active individuals. However, physiotherapy combined with continuous passive motion therapy showed greater improvement in quadriceps muscle strength compared with physiotherapy alone. No statistically significant between-group differences were found in thigh circumference or knee range of motion.

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CHANGES IN PHYSICAL AND COGNITIVE FUNCTION FOLLOWING A SIX-WEEK MULTIMODAL EXERCISE PROGRAM IN OLDER ADULTS

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Introduction. Age-related decline in physical and cognitive function increases the risk of functional limitations and reduced independence in older adults [1]. Multimodal exercise interventions integrating physical and cognitive components may help maintain functional capacity and cognitive health in ageing populations [2,3]. However, evidence from short-term community-based programs remains limited [4,5]. The aim of this study was to evaluate changes in physical performance, gait, balance, body composition, and working memory following a 6-week multimodal exercise program in older adults.

Research methods and organization. Twenty-four community-dwelling older adults (71.3 ±6.8 years; 23 women, 1 man) participated in a single-group pre–post intervention study. Inclusion criteria were age ≥60 years, ability to walk independently, and absence of acute neurological or musculoskeletal disorders. Participants attended supervised group exercise sessions twice weekly for six weeks; each session lasted 60 minutes. The intervention included strength, balance, coordination, gait training, and dual-task exercises combining motor and cognitive tasks. Sessions were delivered by physiotherapy students under academic supervision. Outcome measures included: body composition (bioelectrical impedance analysis, Accuniq); postural stability (PhysioSensing platform; center of pressure sway area, sway velocity, stability index); spatiotemporal gait parameters (KinesisGait instrumented gait analysis system; stride length, stride velocity, cadence, gait speed); functional performance (30-second sit-to-stand test, sit-and-reach test, back scratch test for upper limb flexibility, timed up-and-go test); blood markers (venous blood samples analyzed in a certified clinical laboratory for glucose and total cholesterol); working memory (RehaCom system). Data were analyzed using paired-sample t-tests or Wilcoxon signed-rank tests where appropriate. Effect sizes were calculated using Cohen's d. Statistical significance was set at $p < 0.05$. The study was approved by the Klaipeda University Bioethics Committee (approval No. 46 SV-HMR-15). All participants provided written informed consent.

Results. Working memory improved significantly (+54.1%, $p = 0.00027$, $d = 0.90$). Functional performance showed significant improvements: 30-second sit-to-stand repetitions increased (+29.8%, $p < 0.001$, $d = 1.20$), sit-and-reach flexibility improved (+44.9%, $p = 0.022$, $d = 0.51$), and upper limb flexibility assessed using the back scratch test improved ($p = 0.027$, $d = 0.49$). No significant changes were observed in timed up-and-go performance ($p > 0.05$). Gait analysis revealed significant improvements in average stride velocity (+8.1%, $p = 0.027$, $d = 0.49$) and gait speed score ($p = 0.027$). Other gait parameters, including stride length and cadence, showed non-significant changes. No significant changes were observed in postural stability parameters, including sway area, sway velocity, and stability index ($p > 0.05$). Body composition indicators, including visceral fat (−1.9%, $p = 0.63$), and blood markers assessed from venous blood samples (glucose, cholesterol) remained unchanged.

Conclusions. A six-week multimodal exercise program was associated with improvements in working memory, sit-to-stand performance, flexibility, and selected gait parameters in older adults. No significant changes were observed in balance, timed up-and-go performance, body composition, or blood markers. Short-term interventions may contribute to neuromuscular and cognitive adaptations; however, controlled studies with larger samples are required.

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APPLICATION OF DANCE MOVEMENT THERAPY TO CHILDREN WITH AUTISM SPECTRUM DISORDER: A STUDY OF PERENTS‘ EXPERIENCES

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Introduction. Dance and movement therapy is a psychotherapeutic approach that uses movement and dance to support emotional, social, cognitive, and physical integration [1]. In the context of autism spectrum disorder, it functions as a multidimensional intervention that combines bodily experience, social interaction, and cognitive processes through structured movement activities [2]. It may enhance body awareness, self-expression, and interpersonal engagement [3]. This study aims to explore parents' perceptions of the role, value, and applicability of dance and movement therapy for children with autism spectrum disorder.

Research methods and organization. This study was designed as a qualitative inquiry aimed at exploring parents' attitudes toward the application of dance movement therapy for children with autism spectrum disorder. A semi-structured interview method was used to collect qualitative data, allowing both consistency across participants and flexibility to explore emerging themes in greater depth. An interview guide consisting of three open-ended questions was developed: (1) parents' understanding of the essence of dance movement therapy, (2) their personal experiences with this therapy, and (3) their willingness to recommend it to other parents, including reasons for their opinion. Additional follow-up questions were asked when necessary to clarify and expand participants' responses. A short demographic questionnaire was also used to describe the sample, including child's gender, age (2–7 years), and diagnosis. The study was approved by the LSMU Bioethics Center (No. 2025-BEC2-0673). Data collection took place from June to September 2025. A total of 20 parents of children with autism spectrum disorder (aged 2–7 years) participated in the study. Participants were selected using purposive sampling, as the aim was not statistical generalization but an in-depth understanding of parents' experiences with dance movement therapy. Written informed consent was obtained from all participants. Confidentiality and anonymity were ensured by replacing participants' names with pseudonyms. Data were analyzed The thematic analysis identified five core themes: application of dance movement therapy, its effects on children, post-session effects, parental satisfaction, and perceived effectiveness. The findings show that most participants had limited prior exposure to dance movement therapy, as 13 parents reported not having attended such sessions in other institutions, indicating that for many families this intervention is relatively new. The majority of participants (17) emphasized positive effects of dance movement therapy for children with autism spectrum disorder, particularly increased engagement, enjoyment, and spontaneous movement responses to music. These findings suggest that the therapy may support emotional expression, motivation, and active participation. However, some parents also reported challenges related to the therapy environment. Group-based settings and sensory stimulation were sometimes perceived as overwhelming for certain children, suggesting that contextual factors such as group size and sensory load may influence the suitability and effectiveness of the intervention. The analysis further revealed mixed post-session effects. Some parents described positive outcomes, including relaxation, improved mood, and better emotional regulation. In contrast, others observed fatigue, irritability, or overstimulation after sessions. These differences indicate that children's responses to dance movement therapy may vary depending on individual sensory processing and self-regulation capacities. Finally, parental attitudes toward dance movement therapy were generally positive. Most participants reported satisfaction with the intervention and indicated that they would recommend it to other parents of children with autism spectrum disorder. Overall, the findings suggest that dance movement therapy is perceived as a beneficial supportive intervention, although individual differences and environmental conditions should be considered.

Conclusions. After analyzing the responses of the study participants, it may be beneficial to increase the availability of dance movement therapy and expand its application within early rehabilitation and other healthcare or educational institutions. According to parents, dance movement therapy supports children with autism spectrum disorder in improving concentration, emotional expression, and self-regulation. Parents evaluated dance movement therapy positively, stating that it is an excellent way for a child to relax, socialize, and develop concentration skills.

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ASSESSMENT OF RISK FACTORS FOR THE DEVELOPMENT OF UPPER CROSSED SYNDROME, QUALITY OF LIFE, AND THEIR ASSOCIATIONS IN PROGRAMMERS

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Introduction. Upper crossed syndrome is associated with muscular imbalance in the cervical and shoulder girdle region. It is commonly linked to prolonged computer work, static sitting, poor ergonomics, and insufficient physical activity [1,3]. Programmers represent a potentially vulnerable occupational group because their work typically involves sustained sitting, repetitive upper-limb activity, and long exposure to screen-based tasks, all of which may increase the risk of postural changes and musculoskeletal complaints [1,4]. These factors may contribute not only to altered posture and reduced muscle function, but also to impaired health-related quality of life [1,2]. Although individual risk factors - such as posture, ergonomics, and physical activity - have been investigated separately, their relationship with quality of life in programmers remains insufficiently explored. This study aimed to assess upper crossed syndrome risk factors in programmers, quality of life, and their associations.

Research methods and organization. A quantitative cross-sectional study was carried out at the Department of Sports Medicine, Lithuanian University of Health Sciences, from February 20, 2026 to March 10, 2026. Bioethical approval was obtained from the Lithuanian University of Health Sciences Bioethics Centre, (approval No. 2026-BEC2-0200). The study included 40 male programmers aged 21 to 40 years who met the inclusion criteria: voluntary participation, employment in programming-related work. The mean age of the participants was 27.5 years (SD = 3.30), The programmers had a mean work experience of 5.5 (SD=1.8) years, all were employed full-time, working 8 hours per day.

Health-related quality of life was assessed using the Short Form 36 (SF-36) Health Survey. Ergonomic risk related to work posture was evaluated using the Rapid Upper Limb Assessment (RULA) method. Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ). Postural characteristics were evaluated using the W. W. K. Hoeger Posture Assessment Scale. Upper body muscle strength was assessed by manual muscle testing method aplying the Medical Research Council 0–5 grading scale [5]. The strength of the neck flexors and extensors, scapular retractors and protractors, and pectoralis major muscle was evaluated. Testing was performed three trials in standardized positions selected to isolate the target muscle group and minimize compensatory movements, with participants examined in supine, prone, or sitting positions depending on the tested muscle group. Cervical range of motion was measured in degrees using the iPhone Compass application. The following movements were assessed three times: cervical flexion, extension, right and left lateral flexion, and right and left rotation [6]. Manual muscle testing were based on standardized bedside examination principles, and smartphone-based cervical range of motion assessment has been shown to be reliable in healthy adults. Statistical analysis was performed using IBM SPSS Statistics 30. Since the sample size was below 50, the Shapiro–Wilk test was used to assess normality. Associations between variables were tested using Spearman's correlation coefficient. Correlations were interpreted as weak when $|r| < 0.4$, moderate when $0.4 \leq |r| < 0.8$, and strong when $|r| \geq 0.8$. Parametric data were presented as as mean and standard deviation, and non-parametric data as median with interquartile range. Statistical significance was set at $p < 0.05$.

Results. The mean postural score according to the Hoeger scale was 36.25 points (SD = 9.96), indicating generally good posture, although with considerable inter-individual variability. Upper body muscle strength results were within physiological limits: the median strength of neck flexors was 5.0 points (4.0–5.0), neck extensors 4.0 points (4.0–5.0), scapular retractors 5.0 points (4.0–5.0), scapular protractors 5.0 points (4.0–5.0), and pectoralis major 5.0 points (4.0–5.0). Cervical range of motion was also within physiological limits. Median cervical flexion was 40.0° (40.0–43.5), extension 43.0° (41.0–45.0), right lateral flexion 42.0° (38.0–45.0), left lateral flexion 42.0° (40.0–45.0), right rotation 50.0° (49.0–55.0), and left rotation 50.0° (49.0–56.0). Health-related quality of life was generally good. Median SF-36 scores were as follows: physical functioning 89.0 score (82.25–95.75), role limitations due to physical health 87.0 score (75.50–100.00), role limitations due to emotional problems 89.0 score (78.50–100.00), vitality 90.5 score (80.50–100.00), emotional well-being 89.0 score (83.25–96.25), social functioning 95.5 score (90.00–100.00), pain 85.0 score (78.00–100.00), and general health 89.0 score (85.00–93.00). The mean RULA score was 2.5 (SD = 1.32), indicating a relatively low but still present ergonomic risk. According to the IPAQ, median weekly energy expenditure was 487 (290–500) MET-min/week for vigorous physical activity, 487 (290–500) MET-min/week for moderate physical activity, and 400 (290–498) MET-min/week for walking. Overall, the participants demonstrated a moderate level of physical activity, with a total weekly physical activity of 1374 (870–1498) MET-min/week. Sitting time 320 min/day (287–410) was assessed separately as a sedentary behavior indicator. When associations between upper crossed syndrome risk factors and quality of life were analyzed, one statistically significant weak inverse correlation was found between RULA score and role limitations due to emotional problems: $r(40) = -0.335$, $p = 0.034$. A statistically significant weak positive correlation was also found between moderate physical activity and vitality: $r(40) = 0.385$, $p = 0.014$. No other statistically significant associations were identified between RULA or IPAQ indicators and SF-36 domains ($p > 0.05$). Overall, the study did not demonstrate strong associations between upper crossed syndrome risk factors and quality of life in programmers.

Conclusions. Programmers in this sample generally demonstrated good posture, normal upper body muscle strength, normal cervical range of motion, and good health-related quality of life. No strong associations were identified between upper crossed syndrome risk factors and quality of life. Only weak associations were observed between ergonomic risk and emotional role limitations, and between moderate physical activity and vitality.

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RELATIONSHIPS BETWEEN DYNAMIC STABILITY AND FUNCTIONAL MOVEMENTS OF ACTIVE TENNIS PLAYERS AND THE RISK OF INJURIES

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Introduction. Tennis is a rapidly growing sport, where competition and the level of intensity are increasing [1]. Injury prevention, proper assessment of player capacity and understanding of movement biomechanics, identifying weak parts of the body are essential to prevent injuries and achieve high athletic performance [2]. Due to the high loads placed on the body during training and competition, tennis players are at high risk of injuries, including chronic fatigue syndromes and acute traumatic injuries [3]. Assessment of functional movement patterns and dynamic stability can help to detect asymmetries, potential injury risks and prevent injuries in order to achieve athletic performance [4].The study is relevant in order to further clarify and deepen knowledge in this topic and to determine the risk of injury in athletes. The aim of this research is to determine the correlation between dynamic stability and functional movements and the risk of injuries in individuals actively playing tennis.

Research methods and organization. The study was approved by LSMU Bioethics Center (2025-BEC2-0923). It was conducted from June 2025 to December 2025 at Fiziomedika Clinic. The study included 15 individuals (8 males, 7 females) from 18 to 35 years (average age 24,6 years) actively playing tennis for at least three years, participating in competitions and training about four times a week, also with no injuries at the time of the study. The study was cross-sectional and applied program was not used. Trunk stability was assessed using the Stabilizer device. The test was performed with the subject lying on their back with a Stabilizer placed under the lumbar spine, performing abdominal retraction and progressive hip flexion. Instability was recorded when the pointer fluctuated more than 3 mmHg for more than 5 seconds or when the subject was unable to maintain a stable lumbar spine position for 10 seconds; Functional movement assessment was performed using the Functional Movement Screening (FMS) test. These seven FMS tests were performed: deep squat, hurdle step, lunge, shoulder mobility, active straight leg raise, trunk stability push-ups, and rotational stability. Each test was performed three times, and the best result was recorded. A total assessment score (maximum score 21) was calculated. If the result of this test is 14 points or less, this is indicated as an increased risk factor for injury; Dynamic body stability was assessed using the Dynamic Stability and Balance Y Test. During the test, the subject stands on one leg on a platform, while the other leg pushes a block in three directions: forward, sideways and inward, trying to pull it as far as possible. The movement is performed three times in each direction with both legs, and the best attempt is recorded. If the combined result is less than 94%, then the subjects have a higher chance of an injury. Data analysis was performed using IBM SPSS 31.0 program. Qualitative data are presented in percentages. Quantitative data that did not satisfy the normality assumption are presented as median (xme), minimum value (xmin), maximum value (xmax) and mean (x) – xme (xmin - xmax; x). Spearman's correlation coefficient (r) was calculated to assess the dependence of two quantitative variables that did not satisfy the normality assumption. The relationship when $|r|<0.3$ was considered weak, when $0.3\leq|r|<0.7$ – moderate, when $|r|\geq0.7$ – strong. The significance level $\alpha=0.05$. A statistically significant difference is considered when $p<0.05$.

Results. It was found that 27% of the subjects had decreased trunk stability. The average stability time was 12 (4–18; 11.53) seconds. The average pressure deviation result was 3 (1–6; 2.93) mmHg. Performing the FMS test, the subjects received the highest scores during the active straight leg raise test 3 (1–3; 2.5) points, and the lowest scores during the barrier step test 2 (1–3; 1.8) points and the rotational stability test 2 (1–2; 1.8) points. It was found that 40% of the subjects had a total score <14. The average FMS total score was 14 (11–20; 14.87) points. While performing the Y balance test, the average results of different directions of the right leg were: forward 77 (54-93; 77.3) cm., sideway 115 (100 – 133; 115.1) cm., inward 108 (87-134; 108.1) cm. Left leg results: forward 77 (58-102; 76.8) cm., sideway 113 (92-131; 113.3) cm., inward 108 (88-137; 107.6) cm. Comparing the test results of the subjects with both the right and left legs, no significant differences were found; $p>=0.05$. Evaluating the combined results, it was found that the result with the right leg was 104 (88-118; 104.1), with the left – 103 (82-120; 103.3). Based on these combined results, it was found that 20% of the subjects (combined result <94%) had a higher risk of injury. A statistically significant, direct, moderate correlation was found between the total FMS score and the Y balance test performed with the right leg sideways ($r(15) = 0.698$; $p = 0.004$), also between the total FMS score and the Y test performed with the left leg sideways ($r(15) = 0.573$; $p = 0.025$), between the total FMS score and the Y test performed with the right leg inwards ($r(15) = 0.605$; $p = 0.017$), and between the total FMS score and the Y test performed with the left leg inwards ($r(15) = 0.515$; $p = 0.05$).

Conclusions. Almost a third of active tennis players had decreased trunk stability. Slightly less than half of tennis players had functional movements below the normal range, asymmetry between different sides of the body and poorer movement quality was found. Dynamic body stability of active tennis players is moderately related to functional movements. As dynamic body stability increases, the quality of functional movements improves. One fifth of active tennis players have a higher risk of injury.

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EVALUATION OF STATIC AND DYNAMIC BALANCE IN WOMEN WITH GENERALIZED JOINT HYPERMOBILITY

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Introduction. Generalized joint hypermobility (GJH) is characterised by an increased range of motion beyond physiological limits across multiple joints and is more prevalent in women. It is associated with connective tissue alterations affecting joint stability, proprioception and neuromuscular control

[1]. Impaired proprioception in individuals with GJH may negatively influence postural control and the ability to maintain balance [2]. These changes contribute to reduced static and dynamic balance, leading to increased body sway and altered movement patterns [3]. However, objective evaluation of static and dynamic balance in women with GJH remains limited. The aim of this study was to evaluate the characteristics of balance in women with GJH.

Research methods and organization. The study was conducted from February to March 2026 at the Department of Sports Medicine of the Lithuanian University of Health Sciences and approved by the Bioethics Center of the Lithuanian University of Health Sciences (No. 2026-BEC2-0204). A total of 76 young women aged 21.32(1.34) years participated in the study. Inclusion criteria were: women aged 20-25 years; low or moderate physical activity level; voluntary consent to participate in the study. Exclusion criteria were: pregnancy; diagnosed connective tissue disorders; high-performance athletes. Participants were divided into a study group (n=39) with GJH and a control group (n=37) without GJH. GJH was evaluated using the Beighton scale and confirmed with the 5-Part Questionnaire (5PQ), applying criteria of ≥5 points on the Beighton scale and ≥2 points on the 5PQ [4]. No statistically significant differences were found between two groups in age (U=791.5; p=0.450). The mean body mass index (BMI) of the study group was 22.16(2.44) and of the control group was 23.0(2.13), with no statistically significant difference (t(74)=-1.594; p=0.115). Among participants, 57.9% (n=44) had a moderate level of physical activity, while 42.1% (n=32) had a low level of physical activity, with no statistically significant differences in physical activity level ($\chi2(1)=0.000$; p=1.000). Height and body weight were measured using the "Wunder C-201" medical scale and physical activity was evaluated using the IPAQ-SF. Balance was assessed using the Biodex Balance System SD (v4.x), with the Modified Clinical Test of Sensory Integration and Balance (m-CTSIB) used to evaluate static balance under four conditions (stable/unstable surface, eyes open/closed) and the Motor Control Test (MCT) used to assess dynamic balance across eight directions of sway. Data analysis was performed using IBM SPSS Statistics 31.0 software. The Shapiro-Wilk test was used to assess normality. For comparisons between two independent samples, the Student's t-test was used when normality assumptions were met, and the Mann-Whitney-Wilcoxon test when they were not. Qualitative variables were analysed using the chi-square ($\chi2$) test with Yates' correction. Parametric data are presented as mean (m) and standard deviation (SD) – m(SD). Non-parametric data are presented as median (Md), interquartile range (IQR) and mean (m) – Md(Q1-Q3; m). Qualitative data are presented as percentages. Differences were considered statistically significant at $p<0.05$.

Results. After evaluating the overall results of all four conditions of the Modified Clinical Test of Sensory Integration and Balance (m-CTSIB), it was found that the median score in the study group was 2.34(2.2-2.72; 2.53) points, while in the control group it was 1.8(1.56-1.89; 1.74) points. Comparison of static balance between the two groups revealed a statistically significant difference (U=28.5; $p<0.001$). Static balance was more impaired in women with GJH. When analysing the overall effectiveness score of the Motor Control Test (MCT) across different directions of sway, the mean value in the study group was 31.97(6.95)%, while in the control group it was 35.86(8.39)%. Comparison of dynamic balance between the study and control groups revealed a statistically significant difference (t(74)=-2.206; p=0.030). Women with GJH demonstrated greater impairment in dynamic balance.

Conclusions. Based on the study results, it was found that both static and dynamic balance were significantly more impaired in women with generalized joint hypermobility compared to women without generalized joint hypermobility.

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DIFFERENT MUSCLE STIMULATION METHODS: COMPARISON OF NEUROMUSCULAR ELECTRICAL AND MAGNETIC STIMULATION FOR QUADRICEPS MUSCLE WEAKNESS AFTER ARTHROSCOPIC KNEE SURGERY

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Introduction. Quadriceps femoris muscle weakness is a common outcome after arthroscopic knee surgery (ex. anterior cruciate ligament (ACL), meniscus repair surgery). The recovery of quadriceps strength is one of the main goals of the rehabilitation protocols [1]. Neuromuscular electrical stimulation (NMES) and neuromuscular magnetic stimulation (NMMS) have been used and shown to be an effective treatment for muscle strength recovery [2, 3]. The objective of this study is to compare electrical and magnetic muscle stimulation methods to control groups for quadriceps femoris weakness in patients who underwent arthroscopic knee surgery during outpatient rehabilitation.

Research methods and organization. The study was conducted at the Lithuanian University of Health and Sciences, Department of Rehabilitation, Lithuania, and included patients who underwent arthroscopic knee surgery (ACL rupture and meniscus tear). Inclusion criteria were: age between 18 and 64 years, having undergone knee arthroscopic surgery within the previous 3 months, and no contraindications to physical agent modalities. Patients with contraindications to electrical or magnetic stimulation or other conditions limiting participation in rehabilitation were excluded. Participants were randomly assigned to three intervention groups according to the rehabilitation modality applied. Group 1 (NMES, n = 13; 37.1%) received transcutaneous neuromuscular electrical stimulation. Group 2 (NMMS, n = 12; 34.3%) underwent high-intensity neuromuscular magnetic stimulation. The control group (n = 10; 28.6%) followed a standard outpatient rehabilitation protocol without additional quadriceps muscle stimulation. All groups received a standardized rehabilitation program consisting of 14 working days of physical therapy, with 30-minute daily sessions. In addition, Group 1 received NMES for 20 minutes daily for 14 days, and Group 2 received NMMS for 20 minutes daily for 14 days.Quadriceps femoris muscle strength (maximum [peak] and average values) was assessed using an isometric hand-held dynamometer (Lafayette, USA) at two time points: before rehabilitation and immediately after rehabilitation. The study was approved by the Kaunas Regional Biomedical Research Ethics Committee (Approval No. P2-BE-2-60/2024), and all participants provided written informed consent. Data were analyzed using SPSS. Due to the small sample size and non-normal distribution of the data (assessed using the Shapiro–Wilk test), non-parametric statistical methods were applied. Data are presented as median and interquartile range (IQR). Between-group comparisons were performed using the Kruskal–Wallis test, followed by pairwise comparisons with the Mann–Whitney U test. Within-group (pre–post) comparisons were conducted using the Wilcoxon signed-rank test. Results are reported as test statistics (Z values) and p-values, with a two-sided significance level set at $\alpha = 0.05$.

Results. A total of 35 patients completed the study and were included in the final analysis. The study population consisted of 20 men (57.1%) and 15 women (42.9%), with a mean age of 43.89 ± 15.63 years.No statistically significant differences in baseline quadriceps femoris muscle strength were observed between the groups (Kruskal–Wallis test, $p > 0.05$), indicating that the groups were homogeneous prior to rehabilitation. Comparisons of the average quadriceps femoris strength demonstrated statistically significant improvements in both intervention groups compared with the control group. Specifically, the NMMS group showed a significant increase compared with the control group ($Z = 2.088$, $p = 0.037$), and the NMES group also improved significantly compared with the control group ($Z = 2.537$, $p = 0.011$). No significant difference was observed between the NMMS and NMES groups ($Z = 0.432$, $p = 0.666$), indicating similar effectiveness between the two interventions for average muscle strength. Analysis of maximum (peak) quadriceps strength revealed a significant improvement only in the NMES group compared with the control group ($Z = 2.422$, $p = 0.015$). Differences between the control and NMMS groups ($Z = 1.345$, $p = 0.179$) and between the NMMS and NMES groups ($Z = 1.106$, $p = 0.269$) were not statistically significant, suggesting that NMES was more effective than NMMS in increasing maximum (peak) quadriceps muscle strength.

Conclusions. In patients who developed quadriceps muscle weakness after artroscopic knee surgery both muscle stimulation interventions were effective in improving average quadriceps femoris strength. This shows that NMMS and NMES are similarly effective for enhancing average muscle strength. However, when it comes to maximum quadriceps strength, only NMES showed a improvement over the group with no additional stimulaton method. This suggests that NMES is more effective for increasing maximal muscle strenght.

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COMPARISON OF THE EFFECTS OF TELEPHYSIOTHERAPY AND PHYSIOTHERAPY IN WOMEN WITH URINARY INCONTINENCE

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Introduction. Background: Urinary incontinence is a common condition negatively affecting women's quality of life [1,3]. Weakness of abdominal, back, and respiratory muscles may worsen symptoms [2]. Physiotherapy improves muscle function, while telephysiotherapy enables remote rehabilitation, increasing accessibility and adherence [3]. Aim: To evaluate and compare the effects of telephysiotherapy and physiotherapy on respiratory muscle function, abdominal and back muscle endurance, rectus femoris tightness, and urinary incontinence impact on daily life in women with urinary incontinence. Objectives: Assess and compare respiratory muscle function before and after therapy. Assess and compare abdominal and back muscle endurance before and after therapy. Assess and compare urinary incontinence impact on daily life before and after therapy.

Research methods and organization. The study protocol received approval from the Kaunas Regional Biomedical Research Ethics Committee (Date: 2025.01.30, number: P2-BE-2-60/2024). After the selection of subjects, 14 women - participated in the study. Women experiencing urinary incontinence symptoms were recruited and randomly assigned: treatment group I (telephysiotherapy) and treatment group II (live physiotherapy). The study was conducted over two months, with participants attending sessions twice weekly, with a duration of ~30 minutes. Inclusion criteria were:

women aged 30–50 years, at least one year postpartum (vaginal or cesarean delivery), and body mass index between 18.5 and 24.9. Exclusion criteria included uterine or internal organ pathologies (bladder cancer, bladder stones, chronic cystitis), diagnosed pelvic floor neurological disorders, Parkinson's disease, multiple sclerosis, or cognitive impairments. Outcome measures included respiratory muscle function assessed via spirometry: forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC ratio, and peak expiratory flow (PEF), along with Ghenche and Shtange's tests. Trunk muscle endurance was measured using static abdominal and back endurance tests. Rectus femoris tightness was evaluated using a modified Thomas test. Urinary incontinence impact on daily life was assessed using the Incontinence Impact Questionnaire Short Form (IIQ-7).

Results. Forced Vital Capacity (FVC): In the physiotherapy group, FVC increased from 2.82 (2.31–3.44; 2.88) L to 2.85 (2.41–3.49; 2.93) L ($Z = 2.207$; $p = 0.027$). In the telephysiotherapy group, FVC increased from 2.40 (2.31–2.51; 2.40) L to 2.60 (2.32–2.51; 2.45) L ($Z = 2.304$; $p = 0.015$). The between-group difference was not significant ($U = 13.5$; $p = 0.159$). Shtange's test: Median increased from 42 (37–50; 44) s to 48 (41–53; 47.7) s in the physiotherapy group ($Z = 2.117$; $p = 0.034$), and from 40 (33–41; 37.4) s to 40 (39–45; 40.3) s in the telephysiotherapy group ($Z = 2.214$; $p = 0.027$); The between-group difference was not significant ($U = 14.0$; $p = 0.176$). Ghenche test: Median increased from 23 (21–31; 26) s to 26 (25–33; 28.9) s in the physiotherapy group ($Z = 2.388$; $p = 0.017$), and from 19 (17–26; 22) s to 23 (21–31; 25.4) s in the telephysiotherapy group ($Z = 2.023$; $p = 0.043$); The between-group difference was not significant ($U = 15.0$; $p = 0.220$). Abdominal muscle endurance: Median increased from 41 (35–51; 43.2) s to 44 (38–54; 46.7) s in the physiotherapy group ($Z = 1.997$; $p = 0.046$), and from 49 (21–58; 42.6) s to 50 (29–57; 44.7) s in the telephysiotherapy group ($Z = 1.802$; $p = 0.007$); The between-group difference was not significant ($U = 24.0$; $p = 0.949$). Back muscle endurance: Median increased from 60 (46–68; 55.9) s to 62 (52–75; 62.6) s in the physiotherapy group ($Z = 2.371$; $p = 0.018$), and from 61 (41–71; 57.3) s to 62 (45–73; 59.2) s in the telephysiotherapy group ($Z = 2.264$; $p = 0.024$); The between-group difference was not significant ($U = 28.5$; $p = 0.608$). IIQ-7 (Urinary Incontinence Impact): Median decreased from 29 (19–38; 27.9) to 14 (10–14; 13) in the physiotherapy group ($Z = -2.371$; $p = 0.018$), and from 43 (29–57; 44.4) to 29 (10–30; 25.2) in the telephysiotherapy group ($Z = -2.207$; $p = 0.027$); The between-group difference was not significant ($U = 36.5$; $p = 0.124$).

Conclusions. All participants showed significant improvements in respiratory muscle function, static abdominal and back endurance, and reduced urinary incontinence impact after both telephysiotherapy and physiotherapy. No statistically significant differences were observed between the groups, suggesting that both interventions are equally effective for women with urinary incontinence.

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CHANGES IN MUSCLE STRENGTH AND RANGE OF MOTION IN PHYSICALLY ACTIVE INDIVIDUALS FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION OF THE KNEE JOINT IN THE ACUTE POSTOPERATIVE PHASE

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Introduction. Anterior cruciate ligament reconstruction (ACLR) is often performed in physically active people, as knee injuries are becoming more common (1,2). Studies from the United States report about 200,000 ACL injuries per year, and around 150,000 patients undergo reconstruction surgery (2). In the early period after ACLR, recovery of knee range of motion and muscle strength is important for successful rehabilitation (3). The aim of this study was to assess changes in knee flexion and extension range of motion, knee muscle strength, and hip adduction and abduction muscle strength in the acute phase after ACLR.

Research methods and organization. Participants were recruited before anterior cruciate ligament reconstruction after bioethical approval (2025-BEC2-0844) had been obtained. Research was conducted at "Nordclinic" clinic in Kaunas. All patients signed informed consent before taking part in the study. The study included 15 physically active individuals (Tegner Activity scale ≥ 6): 10 men and 5 women. The mean age of men was 23 years (18-41), the mean age of women was 29 years (28-36), and the overall mean age was 27.4 years (18-41). All participants underwent surgery performed by the same surgeon. The inclusion criteria were: diagnosed anterior cruciate ligament rupture, planned surgical treatment, first assessment no earlier than one month before surgery, and Tegner Activity scale ≥ 6. Exclusion criteria were: medically unstable conditions, meniscus injury, age under 18 years, and Tegner activity scale < 6. Knee flexion and extension range of motion were measured with a goniometer. Strength of knee flexors and extensors, as well as hip adductors and abductors, was measured with a handheld Activforce dynamometer. Muscle strength was recorded in kilograms (kg). Measurements were taken at three time points: before surgery, 1 day after surgery, and 7 days after surgery. All assessments were carried out by the same specialist. During the postoperative period, all participants followed an exercise-based rehabilitation program including knee range of motion exercises, quadriceps activation exercises and progressive lower–limb strengthening exercises. Statistical analysis was performed using IBM SPSS Statistics 30.0. Descriptive statistics are presented as median (minimum-maximum; mean). Because the sample was small, nonparametric tests were used. Comparisons between related samples were performed using Wilcoxon signed-rank test. Differences were considered statistically significant when $p \leq 0.05$.

Results. In the acute phase after anterior cruciate ligament reconstruction, muscle strength and knee range of motion changed markedly. Knee extension strength decreased from 28.2 (20.8-35; 28.51) kg before surgery to 6.6 (3.6-10.5; 6.53) kg on day 1 ($Z = -3.408$; $p = 0.001$) and then improved slightly to 9 (4.6-14.2; 9) kg on day 7, but remained significantly lower than before surgery ($Z = -3.408$; $p = 0.001$); a significant difference was also observed between day 1 and day 7 ($Z = -3.411$; $p = 0.001$). Knee flexion strength showed a similar pattern, decreasing from 27.1 (14.2-38.5; 25.57) kg to 5.2 (3.7-9.4; 5.84) kg on day 1 ($Z = -3.408$; $p = 0.001$) and then increasing to 8 (4.5-13.8; 8.29) kg on day 7, but remaining significantly lower than before surgery ($Z = -3.408$; $p = 0.001$); a significant difference was also observed between day 1 and day 7 ($Z = -3.410$; $p = 0.001$). Hip adduction strength decreased from 23.3 (14.6-32.3; 23.64) kg to 9.4 (6.8-14.3; 9.56) kg on day 1 ($Z = -3.408$; $p = 0.001$) and later increased to 12.5 (8.4-18.3; 12.52) kg on day 7, but remained significantly lower than before surgery ($Z = -3.408$; $p = 0.001$); a significant difference was also observed between day 1 and day 7 ($Z = -3.352$; $p = 0.001$), while hip abduction strength decreased from 20.1 (12.7-29.6; 20.91) kg to 9.1 (6.4-13.8; 9.4) kg on day 1 ($Z = -3.408$; $p = 0.001$) and increased to 13.1 (7.8-17.6; 12.57) kg on day 7, but remained significantly lower than before surgery ($Z = -3.408$; $p = 0.001$); a significant difference was also observed between day 1 and day 7 ($Z = -3.408$; $p = 0.001$). All strength values were lower on day

1 and were still reduced on day 7 compared with preoperative values. Knee extension range of motion worsened from 0 (-5 – 4; -0.4) degrees before surgery to 7 (4-9; 6.33) degrees on day 1 ($Z = -3.412$; $p = 0.001$) and improved to 4 (2-8; 4.93) degrees on day 7, but remained significantly worse than before surgery ($Z = -3.417$; $p = 0.001$); a significant difference was also observed between day 1 and day 7 ($Z = -3.114$; $p = 0.002$). Knee flexion decreased from 140 (136-145; 139.53) degrees before surgery to 61 (40-70; 57.93) degrees on day 1 ($Z = -3.408$; $p = 0.001$) and increased to 71 (56-88; 70.93) degrees on day 7, but remained significantly lower than before surgery ($Z = -3.409$; $p = 0.001$); a significant difference was also observed between day 1 and day 7 ($Z = -3.409$; $p = 0.001$).

Conclusions. During the first week after anterior cruciate ligament reconstruction, knee range of motion and lower limb muscle strength were reduced. Although some recovery was seen by day 7, the measured values remained lower than before surgery. These findings suggest that the acute postoperative phase is associated with clear functional limitations and support the importance of early rehabilitation, while taking the small sample into account.

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HEART RATE RESPONSE ASSESSMENT IN SIMULATED FREE-LIVING WALKING ACTIVITIES

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Introduction. Standardized exercise tests like the ergometer test or 6-min walking test are often performed in clinics to assess cardiovascular function [1]. In addition to the functional capacity evaluated during exercise test, heart rate response (HRR) measures have been proposed as an indicator of cardiovascular health [2]. HRR has value in tracking cardiac rehabilitation effectiveness, assessing the risk of developing cardiovascular diseases and evaluating autonomic function [3]. Advances in wearable technologies allow continuous, unobtrusive monitoring of physiological signals during daily activities, providing new opportunities to assess HRR in free-living. However, the impact of varying intensity and duration of naturally occurring activities on HRR has not been previously explored [4]. This study aims to investigate the relationship between varying walking durations, namely 2, 4, and 6 minutes, and HRR parameters in simulated free-living.

Research methods and organization. This study investigated 18 healthy adult participants (16 males and 2 females) with an average age of 26 years (from 22 to 30). All participants signed a written informed consent. To maintain anonymity, no personal information (including training status and physical activity level) was collected, aside from age. The study was conducted with bioethical approval from the Ethics Committee of the Kaunas Region (protocol no. BE-2-99; September 23, 2020). Data were collected from June to October 2024. Each participant performed five submaximal walking tests with different durations: three consecutive 2-minute walking tests followed by 4-minute and 6-minute walking. Each walking test was separated by a 5-minute standing rest period. Based on previous studies on both healthy and frail subjects, a 5-minute rest was sufficient for recovery while keeping the overall experiment no too long [2, 5]. Participants were instructed to walk at their natural pace in order to simulate free-living walking. Heart rate was obtained directly from RR intervals recorded by the wearable ECG device (Polar H10, Polar, Finland). Heart rate response parameters that evaluate maximum heart rate (HRmax), heart rate change (ΔHR), heart rate recovery 30 (HRR_{30}), 60 (HRR_{60}) and 120 (HRR_{120}) seconds after the end of walking were extracted. Timestamps indicating the beginning and end of each test were manually recorded. Statistical analyses were performed using the repeated measures ANOVA test to assess the difference of parameters based on walking durations. A p-value of less than 0.05 was considered statistically significant.

Results. ΔHR for 2-minute and 4-minute walking tests were 30.5 ± 8.2 and 30.1 ± 5.7 bpm respectively, compared to 36.9 ± 5.5 bpm for the standard 6-minute walking test, indicating a clear increase in exertion ($p = 0.001$). Similar differences were found for HRmax ($p = 0.001$). HRR30 across 2-minute, 4-minute and 6-minute walking durations were 18.4 ± 6.5, 16.6 ± 6.0 and 19.3 ± 7.0 bpm, which did not show a significant change. Similarly, heart rate recovery after longer duration also did not show significant differences: HRR60 were 27.1 ± 6.6, 23.9 ± 7.1 and 26.0 ± 7.5 bpm and HRR120 were 30.1 ± 7.0, 26.8 ± 7.8 and 29.2 ± 6.4 bpm for 2-minute, 4-minute and 6-minute tests respectively. The slowest recovery across walking durations was after 4-minute walking for HRR30, HRR60 and HRR120. When evaluating consecutive 2-minute walking tests, significant differences across tests were found for HRR_{30} showing 23.6 ± 7.1, 20.2 ± 6.6 and 18.4 ± 6.5 bpm for 2-minute, 4-minute and 6-minute tests respectively ($p = 0.038$). This suggests a possible accumulation of fatigue or a change in walking pace that might have reduced the recovery in subsequent tests.

Conclusions. Significant differences in ΔHR across tests indicates that walking duration had an effect on cardiac function. For HRR30, HRR60 and HRR120 values did not differ significantly across walking durations. The results suggest that HRR parameters might have a non-linear relationship across walking durations in simulated free-living for healthy subjects. The main limitations of the study are short resting duration between tests and a small number of participants.

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BETWEEN-LEG FUNCTIONAL DIFFERENCES IN STRENGTH AND DROP JUMP PERFORMANCE IN FUTSAL PLAYERS

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Introduction. Futsal is a high-intensity sport characterized by frequent accelerations, decelerations, and rapid changes of direction, increasing mechanical load and injury risk. Monitoring neuromuscular performance, including strength and jump performance ability, is essential for injury prevention and performance optimization. Between-leg functional differences have been associated with injury risk and performance outcomes, but they may also reflect functional specialization between the dominant (kicking) and non-dominant (support) limb. Previous studies indicate that these differences vary depending on the task and are often greater in strength compared to jump performance variables [1–3]. The aim of this study was to evaluate between-leg functional differences in strength and drop jump performance in futsal players.

Research methods and organization. The study included 30 adult male futsal players (aged 18–37 years) from two Lithuanian elite teams. All participants had at least 5 years of competitive futsal experience and trained at least 3 times per week. Inclusion criteria included active participation in team training and competition and absence of injury at the time of testing. The study was approved by the Bioethics Center of the Lithuanian University of Health Sciences (No. 2025-BEC2-1117). Testing was conducted during the pre-season under standardized laboratory conditions at the KTU M-Lab laboratory. All participants completed a standardized warm-up prior to testing. Neuromuscular performance was assessed using a drop jump test performed from a 30 cm platform using a Kinvent force plate. Variables included jump height (cm) and landing force (kg/kg). Three trials were performed, and average values were used for analysis. Hip adductor and abductor peak force (kg) were measured bilaterally using a Kinvent hand-held dynamometer in a standardized supine position. These muscle groups were selected due to their important role in pelvic stability and injury prevention in futsal players. Statistical analysis was performed using IBM SPSS Statistics 30. Normality was assessed using the Shapiro–Wilk test. To compare two dependent samples, when the data satisfied the assumption of normality, the paired Student's t-test was applied. Quantitative variables are described as the mean (m) and standard deviation (SD) – m(SD). Statistical significance was set at $p < 0.05$.

Results. No statistically significant differences were found between the dominant and non-dominant legs in hip adductor muscle strength. The mean adductor strength was 23,3(6,05) kg in the non-dominant leg and 23,3(7,02) kg in the dominant leg ($t(29)=0$; $p=1$). The peak adductor muscle strength was 23,6(6,61) kg in the non-dominant leg and 27,2(7,63) kg in the dominant leg ($t(29)=1{,}016$; $p=0{,}318$). Also, no statistically significant differences were found between the dominant and non-dominant legs in hip abductor muscle strength. The mean abductor strength was 20,8(4,7) kg in the non-dominant leg and 21,74(5,4) kg in the dominant leg ($t(29)=-1{,}383$; $p=0{,}177$). The peak abductor muscle strength was 23,6(5) kg in the non-dominant leg and 24,4(5,7) kg in the dominant leg ($t(29)=-1{,}271$); $p=0{,}214$). No statistically significant differences were found in jump performance between legs in functional tests ($p > 0.05$).

Conclusions. Hip adductor and abductor muscle strength exhibited bilateral symmetry, with no statistically significant inter-limb differences identified.

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CORRELATIONS BETWEEN SPINAL POSTURE, LUMBAR SPINE MOBILITY AND INTENSITY OF PRIMARY DYSMENORRHEA SYMPTOMS IN HEALTHY YOUNG WOMEN

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Introduction. Primary dysmenorrhea is defined as painful menstruation without identifiable pelvic pathology and is one of the most common gynaecological conditions among women of reproductive age [1,2]. It is associated with lower abdominal pain and systemic symptoms such as nausea, fatigue, and reduced quality of life [1-3]. The prevalence of primary dysmenorrhea ranges from 17% to 90% worldwide, highlighting its significant impact on women's health [1]. Although increased prostaglandin production is considered the main underlying mechanism, recent studies suggest that musculoskeletal factors, including body posture and physical function, may influence symptoms intensity and pain perception [4,5]. However, these associations remain insufficiently explored. The aim of this study was to evaluate the correlations between spinal posture, lumbar spine mobility and intensity of primary dysmenorrhea symptoms in healthy young women.

Research methods and organization. A cross-sectional study was conducted at the Department of Sports Medicine of the Lithuanian University of Health Sciences. The study was approved by a Bioethics Center of Lithuanian University of Health Sciences. All participants provided informed consent prior to participation. The study included 30 women meeting the following inclusion criteria: age 18–44 years, absence of musculoskeletal and gynaecological disorders, no history of childbirth, and no use of hormonal contraception. The mean age of participants was 23.5 ± 2.6 years (range 18–30). Posture assessment was performed using the DIERS formetric 4D system, which allows non-invasive three-dimensional analysis of spinal alignment. The following posture parameters were evaluated: sagittal imbalance, coronal imbalance, pelvic obliquity, pelvic torsion, thoracic kyphosis angle, lumbar lordosis angle, vertebral rotation, and apical deviation. Lumbar spine mobility was assessed using the modified Schober test and goniometry, including lateral flexion (left and right), and rotation (left and right). Primary dysmenorrhea symptoms intensity was assessed using the WaLIDD score, which evaluates pain intensity, location, duration, and impact on daily activities, with higher scores indicating greater symptoms severity. Statistical analysis was performed using IBM SPSS Statistics version 31.0.0.0. Data distribution was assessed using the Shapiro–Wilk test. Due to non-normal distribution, Spearman's rank correlation coefficient was used. Statistical significance was set at $p < 0.05$.

Results. Strong positive correlations were found between thoracic kyphosis angle and WaLIDD score ($r = 0.761$, $p < 0.001$), and between lumbar lordosis angle and WaLIDD score ($r = 0.607$, $p < 0.001$). These findings indicate that increased spinal curvature in the sagittal plane is associated with higher symptoms intensity. No statistically significant correlations were observed between WaLIDD score and sagittal imbalance ($r = 0.269$, $p = 0.151$), coronal imbalance ($r = 0.056$, $p = 0.769$), pelvic obliquity ($r = 0.183$, $p = 0.332$), apical deviation ($r = 0.086$, $p = 0.652$), vertebral rotation ($r = 0.071$, $p = 0.710$), pelvic torsion ($r = 0.156$, $p = 0.411$), or maximal vertebral rotation ($r = -0.178$, $p = 0.347$). Significant negative correlations were observed between lumbar spine mobility and WaLIDD score. The strongest correlation was found for the Schober test ($r = -0.611$, $p < 0.001$). Moderate negative correlations were identified for lateral flexion (right: $r = -0.423$, $p = 0.020$; left: $r = -0.429$, $p = 0.018$) and trunk rotation (right: $r = -0.499$, $p = 0.005$; left: $r = -0.405$, $p = 0.027$). These results indicate that better lumbar mobility is associated with lower symptoms intensity.

Conclusions. Musculoskeletal system's functional status is associated with primary dysmenorrhea symptoms intensity. Better lumbar mobility is related to lower symptom severity, whereas increased spinal curvature is associated with higher symptom intensity in healthy young women. These findings highlight the importance of musculoskeletal factors in dysmenorrhea.

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